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Dipankar Muduli
PG Scholar, CPGS, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Shubhaom Panda
Assistant Professor, Faculty of Agriculture, Sri Sri University, Cuttack, Odisha, India

Sanjeeta Biswas
Assistant Professor, Faculty of Agriculture, Sri Sri University, Cuttack, Odisha, India

Corresponding Author:
Shubhaom Panda
Assistant Professor, Faculty of Agriculture, Sri Sri University, Cuttack, Odisha, India

Analysing factors influencing the pesticide business among the intermediaries in Khordha district of Odisha, India

Dipankar Muduli, Shubhaom Panda and Sanjeeta Biswas

Abstract
The intermediaries involved in pesticide business have been very vulnerable because of the dynamic market condition, competitiveness and climatic aberrations. There is a need to investigate the factors influencing the chemical and bio-pesticides business in the state of Odisha. Khordha district of Odisha was conveniently selected for the study. Snowball sampling method was followed during the research for the identification of sample business intermediaries *viz*. dealers and retailers. 27 number of intermediaries including dealers and retailers were taken as the sample for the study. For the analysis of the objective, major variables were identified with the help of literature review which were then analysed with the help of Multiple Regression Analysis. 'Average farmers served per day (numbers) (13.188)', 'dealership of chemical pesticides-based companies (numbers) (10.577)' were found to be positive predictors determining the overall annual business turnover of intermediaries in the study area with one percent and five percent of probabilities, respectively. 'Average farmers served per day (numbers) (6.927)' and 'dealerships of Indian companies (numbers) (9.937)' were found to be the major factors influencing the chemical pesticide business in the study area. 'Villages served (numbers) (0.188)', 'Dealership of bio-pesticide based companies (numbers) (1.189)' were found to be the major predictors for the bio-pesticide business in the study area.

Keywords: Pesticides, bio-pesticides, business intermediaries, factors influencing

Introduction
Insecticides, fungicides and herbicides are commonly used for pest control in agriculture. However, insecticides form the highest share in total pesticide use in India. Both total as well as per hectare consumption of pesticides in India have shown significant increase in use since 2009–10. In the year 2014–15, pesticide consumption was 0.29 kg/ha (GCA), which is roughly 50 percent higher than that of in 2009-10. The recent increase in pesticide use is because of higher use of herbicides as cost of manual weed control has risen due to increase in agricultural wages (FICCI, 2015) [2]. However, per hectare use of pesticide in India is much lower as compared to other countries like China (13.06 kg/ha), Japan (11.85 kg/ha), Brazil (4.57 kg/ha) and other Latin American countries (FAOSTAT, 2017) [1]. The Indian crop protection chemicals market is fiercely competitive, with Bayer AG, UPL Limited, BASF SE, and Rallies India Limited, all holding significant market share. Other prominent players include Dhanuka Agritech Ltd., Insecticides India Ltd., Bharat Group, UPL Ltd., Sumitomo Chemical Co. Ltd., Meghmani Industries Ltd., and PI Industries Ltd. The key strategies used by these market leaders are new product launches, mergers & acquisitions, and alliances. To grow their market share, these companies are also focusing on investing in innovations, collaborations, and expansions. Vasoya *et al.* (2023) [5], in his research to understand the various aspects related to the usage of biopesticides found price to be the primary consideration in the purchase of biopesticides, followed by quality and brand name. Lack of credit facilities along with high input cost was identified to be the major constraint in the use of biopesticides. In case of agri-input dealers, the major constituents were found to be high competition, low profit margin and rising costs. Demonstrations followed by farmer meetings positively influenced the purchasing decision of biopesticides. The farmers in the study area were mostly middle aged with primary education, with an average land holding of about 1 to 2.5 hectares and farming experience of 21 to 30 years, mostly practicing agriculture followed by animal husbandry and average annual income of INR 1-5 lakh per annum. Khimani *et al.* (2023) [4] in their study indicated that factors such as quality, effective results and crop growth were important aspects affecting the purchase of both the products i.e.

Galileo sensa and *Delegate*. Both the products were perceived to provide value for money and safe to use for chilli farmers as well as the soil ecology. Also, farmers' meetings proved to be effective product promotional tool, whereas, factors like unavailability of preferred brands, high pricing and lack of credit facilities were identified to be major problems encountered by farmers in the purchasing process. Kachroo *et al.* (2023) [3] in their research aimed at studying the factors influencing farmers buying behaviour towards pesticides in the Jammu region of Jammu and Kashmir from a sample of 80 farmers and 20 dealers, found that all the respondents used pesticides in the routine farming with insecticides constituting the highest percentage (47.50 percent) among all the pesticides. It was also found that local markets were preferred by most of the farmers (56.30 percent) with about majority of farmers (67.50) preferring to purchase from dealers and retailers. Most of the farmers (57.50 percent) were found to make their own purchasing decision, spending about INR 1000-2000 in a single farming season. Bayer crop Science Ltd was preferred by most respondents (21.30 percent). Pesticides were said to be available at the right time by 50 percent of respondents. The results indicated pesticide usage for good yield with effective control and efficacy being the preference for buying pesticides, keeping the price factor in mind. Bio pesticides are becoming more popular in India as they are less toxic (as compared to regular synthetic pesticides). In contrast to broad-spectrum conventional pesticides, which can harm other organisms, bio pesticides typically affect just the target pest and closely related organisms. Increased public awareness about the potential negative environmental impacts of synthetic plant protection goods and chemicals has prompted a search for pest control technologies and solutions based on biological processes.

Table 1: Area under cultivation and under use of chemical & bio- pesticides

Year	Area (million hectares)					
	Under cultivation	Pesticides				Not under use of pesticides
		Chemical	Bio	Both Chemical & Bio	Total	
2020–21	188.6	111.3	14.0	22.0	147.3	59.9
2021–22	195.9	96.0	16.9	14.1	127.0	68.9
2022–23*	207.6	108.2	15.6	21.3	145.1	62.4
Triennial average (2020–23)	197.3	105.2	15.5	19.1	139.8	63.8

* as on 13.07.2023

Source: https://ppqs.gov.in/statistical-database retrieved as on 01.11.2023

It can be observed from the Table 1 that out of total 197.3 mha of area (53 percent) under cultivation, 105.2 mha was treated only with chemical pesticides during the triennium ending 2023. So among all types of pesticides, chemical pesticides application represented around 75 percent of the total pesticide application. Only 19.1 mha (roughly 10 percent to total cultivated area) and 15.5 mha (8 percent to total cultivated area) of the total 197.3 mha cultivated area were treated with 'both chemical and bio-pesticides' and 'bio-pesticides', representing 14 percent and 11 percent of total pesticides application, respectively. Agriculture and allied sector is the backbone of the Indian economy so is that of the state of Odisha. Near about 60% people of the State earn their livelihood through agriculture and allied activities. Sustainable growth of this sector is crucial for ensuring food security as well as the overall socio-economic growth of the farming community along with that of the State. Odisha has a geographical area of 1,55,707 sq. kms and is divided into ten agro-climatic zones depending upon various parameters like soil types, topography, rainfall and cropping pattern. The total cultivated land of the State is 61.80 lakh ha out of which 29.14 lakh ha (47%) is high land, 17.55 lakh ha (28%) is medium land and rest 15.11 lakh ha (25%) is low land. About 65% of cultivated land in *Kharif* season is irrigated. Rice is the major crop in *Kharif* season, so are pulses and oilseeds in *Rabi* season in Odisha. The net area sown and gross cropped area in Odisha during the year 2018-19 were 53.62 lakh ha and 83.38 lakh ha respectively. The cropping intensity for the said period in Odisha was 156%. The production of paddy, total cereals, pulses, oilseeds, fibre and sugarcane was 77.33 lakhs MT, 86.18 lakh MT, 10.54 lakh MT, 5.23 lakh MT, 5.64 lakh MT, and 18.13 lakh MT respectively. During 2018-19, the total fertilizers consumption in the state was 5.77 lakh metric tons with a breakage of 3.5 lakh MT of nitrogenous, 1.52 lakh MT of phosphatic and 0.75 lakh MT of pottasic and the consumption of fertilizer per hectare was 73.81 Kg.

Table 2; Pesticide Consumption in Odisha (Five years average)

Years	Pesticides (MT)	India (MT)	% to total	Bio-pesticides (MT)	India (MT)	% to total
2018-19	1609	59670	2.7	310	7203	4.3
2019-20	1115	61702	1.8	333	8847	3.8
2020-21	1158	62193	1.9	165	8647	1.9
2021-22	1240	63284	2.0	122	9321	1.3
2022-23	1348	52466	2.6	81	7248	1.1
5 years avg	1294	59863	2.2	202	8254	2.4

Source: https://ppqs.gov.in/statistical-database retrieved as on 01.11.2023

Table 2 indicates the five-year average use of chemical pesticides and bio-pesticides in India as well as Odisha and the percentage of pesticides consumption in Odisha to that of India. Out of the average five-year total consumption of 59,863 MT of chemical pesticides and 8,254 MT of bio-pesticide in India, Odisha accounted for about 1,294 MT of chemical pesticides and 202 MT of bio-pesticides amounting to 2.2 percent and 2.4 percent, respectively of the total consumption in India. The pesticide usage was high in India during 2021–22 with about 63,284 MT followed by 62,193 MT in 2020–21 and 61,702 MT in 2019–20 where as in Odisha, the chemical pesticide and bio-pesticide consumption is observed to be highest during 2018–19 (1,609 MT) and 2019–20 (333 MT), respectively.

The intermediaries involved in pesticide business have been very vulnerable because of the dynamic market condition, competitiveness and climatic aberrations. There is a need to investigate the factors influencing the chemical and bio-pesticides business in the state of Odisha. This research is an attempt to uncover the factors influencing the chemical and

bio-pesticides business in Khordha district of Odisha. This research may be highly beneficial to all the stakeholders involved in the supply-chain.

Methodology

The research was based on both descriptive and exploratory research designs. The research was conducted in Khordha district of Odisha state, India. The district is located in the south-eastern part of Odisha, adjoining the coastal area. From the district, the primary data were collected from the sample intermediaries with the help of structured schedules consisting open-ended as well as close-ended questions. For the study, 27 number of business intermediaries including delaers and retailers were selected for the collection of primary data. For collection of data based on the review of literature, schedules containing both open and closed ended questions were formed for the intermediaries *viz*. dealers and retailers. The data collected were presented in tabular form to facilitate easy compilations. The data were summarised with the aid of suitable statistical tools to obtain meaningful results. Multiple linear regression was used for the analysis of the objective. The multiple linear equation is given as follows:

$Y_i = \beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta_p X_{ip}+\epsilon$

where, for $i = n$ observations

Y_i = dependent variable

X_i = explanatory variables

β_0 = intercept (constant term)

β_p = slope coefficients for each explanatory variable

ϵ = the model's error term (also known as the residuals)

Results and Discussion

For the analysis, the continuous variables *viz*. 'villages served (numbers)', 'average farmers served per day (numbers), 'business age (years)', 'dealership of chemical pesticides-based companies (numbers)' and dealership of bio-pesticides based companies (numbers)' were taken into consideration. The continuous dependent variable was set to be 'total annual turnover (lakhs)'. The multiple linear regression was found to be suitable for the analysis of the predictors determining the annual turnover.

Table 3: Factors determining pesticide business

Variables	Coefficient (β)	Standard Error (β)	t value	Significance (p)
Average farmers served per day (numbers)	13.188*	4.946	2.666	0.014
Dealership of chemical pesticides-based companies (numbers)	10.577*	4.976	2.126	0.046
Dealership of bio-pesticides based companies (numbers)	-29.130^{NS}	25.921	-1.124	0.274
Villages served (numbers)	-0.679 ^{NS}	2.578	-0.264	0.795
Business age (years)	-0.357 ^{NS}	3.360	-0.106	0.916
Intercept	-146.281**	66.422	-2.202	0.039
Model value				
R square= 0.60				

Note: Dependent Variable: Total Annual turnover (lakhs)
* Significant at five percent level of probability
** Significant at one percent level of probability
Source: Researcher's computation from field data through SPSS

As shown in Table 3, out of all variables, 'average farmers served per day (numbers) (13.188)' and 'dealership of chemical pesticides-based companies (numbers) (10.577)' were found to be positive predictors with five percent of probabilities. The model was significant with R square value of 0.60.

Table 4: Predictors determining sale of chemical pesticides

Variables	Coefficient (β)	Standard Error (β)	t value	Significance (p)
Average farmers served per day (numbers)	6.927**	1.724	4.017	0.002
Dealerships of Indian companies (numbers)	9.937*	3.687	2.695	0.019
Average farmers served in *Kharif* season (numbers)	-4.709*	1.824	-2.582	0.024
Dealership of bio-pesticide based companies (numbers)	-19.919*	9.833	-2.026	0.046
Credit period for farmers (days)	-0.629*	0.337	-1.864	0.047
Dealerships of MNCs (numbers)	35.535^{NS}	20.417	1.740	0.107
Average farmers served in summer season (numbers)	3.371 ^{NS}	2.343	1.439	0.176
Competitors within 10 km radius (numbers)	4.727 ^{NS}	3.465	1.364	0.198
Business age (years)	1.513 ^{NS}	1.180	1.281	0.224
Villages served (numbers)	-1.459 ^{NS}	1.229	-1.188	0.258
Manpower at shop (numbers)	-10.149 ^{NS}	9.021	-1.125	0.283
Godown capacity (tons)	-0.421 ^{NS}	0.795	-0.530	0.606
Dealership of chemical pesticide-based companies (numbers)	-2.481 ^{NS}	5.861	-0.423	0.680
Average farmers served in *Rabi* season (numbers)	0.086 ^{NS}	1.903	0.045	0.965
(Constant)	-27.233 ^{NS}	40.851	-0.667	0.518
Model value				
R square= 0.86				

Note: Dependent Variable: Annual turnover of chemical pesticides (lakhs)
* Significant at five percent level of probability
** Significant at one percent 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, five predictors were found significant with an association of dependent variable i.e. annual turnover of chemical pesticides (lakhs), out of which two variables *viz*. 'average farmers served per day (numbers) (6.927)' and 'dealerships of Indian companies (numbers) (9.937)' were found to be positive; and other three variables *viz*. 'average farmers served in kharif season (numbers) (-4.709)', 'dealership bio-pesticide based companies (numbers) (-19.919)', and 'credit period for farmers (days) (-0.629)' were found to be negative. The model was significant with R square value of 0.86.

Table 5: Predictors determining sale of bio-pesticides

Variables	Coefficient (β)	Standard Error (β)	t value	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)	-0.268^{NS}	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 value				
R square= 0.94				

Note: Dependent Variable: Annual turnover of bio-pesticides (lakhs)
* Significant at five percent level of probability
** Significant at one percent level of probability
Source: Researcher's computation from field data through SPSS

From the Table 5, 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 R square value of 0.94.

Conclusion

'Average farmers served per day (numbers) (13.188)', 'dealership of chemical pesticides-based companies (numbers) (10.577)' were found to be positive predictors for the overall annual business turnover of intermediaries in the study area with one percent and five percent of probabilities, respectively. The model was significant with R square value of 0.60. Five predictors out of 26 selected variables, were found significant with an association of dependent variable i.e. annual turnover of chemical pesticides (lakhs), out of which two variables *viz*. 'average farmers served per day (numbers) (6.927)' and 'dealerships of Indian companies (numbers) (9.937)' were found to be positive; and other three variables *viz*. 'average farmers served in kharif season (numbers) (-4.709)', 'dealership bio-pesticide based companies (numbers) (-19.919)', and 'credit period for farmers (days) (-0.629)' were found to be negative. The model was significant with R square value of 0.86. Three out of 26 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 R square value of 0.94.

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