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Mali Patil Vijay Kumar
Department of Agricultural Economics & Agribusiness Management Allahabad School of Agriculture Sam Higginbottom Institute of Agriculture Technology & Sciences Allahabad, Uttar Pradesh India

Dr. Nahar Singh
Department of Agricultural Economics & Agribusiness Management Allahabad School of Agriculture Sam Higginbottom Institute of Agriculture Technology & Sciences Allahabad, Uttar Pradesh India

Correspondence
Mali Patil Vijay Kumar
Department of Agricultural Economics & Agribusiness Management Allahabad School of Agriculture Sam Higginbottom Institute of Agriculture Technology & Sciences Allahabad, Uttar Pradesh India

Study of the frequency, extent, type and intensity of pesticides use in paddy production in Raichur district, Karnataka

Mali Patil Vijay Kumar and Dr. Nahar Singh

Abstract
About 70 per cent of pesticides are being used in developing countries like India and remaining 30 per cent in developed countries. In all respondents the insecticides were the most frequently used pesticides which accounted for bulk of share (59.17%) followed by fungicide (24.89%) and weedicides (15.29%) in total pesticides used. The large respondents (36.26%) used more than 9 liter active ingredient per hectare which was the highest quantity. In the cultivation of one hectare of paddy about 29.93 per cent of the pesticides applied belonged to Organophosphates category. Organochlorines comprised 15.78 per cent of total technical grade pesticides followed by Aclyurea compounds, Pyrethroids and Neoonicotinoids (11.95, 11.18 and 6.31%, respectively). Thus the respondents were found to use almost nearly 6% (296 rs) more to the optimal requirement. The independent variables included in model explained 80 per cent (small respondents), 70 per cent (medium respondents), 87 per cent (large respondents) and 77 per cent (all respondents) of total variation in expenditure on PPCs.

Keywords: Paddy, respondents and pesticide use

Introduction
India ranks 10th in pesticide consumption in the world as its total consumption amounts to about 500 million tonnes. India is presently the largest manufacturer of basic pesticides among the South Asian and African countries, with the exception of Japan. The Indian pesticides market is the 12th largest in the world with a value of US$0.6 billion (Hundal *et al.*, 2006) [13].
The crop is damaged by more than 100 species of insect pests of which about dozen are of significance. The state loses 30 per cent yield every year on this account. However, out of all inputs, pesticides play key role in increasing agriculture production by controlling agriculture pests and diseases. It has been observed that about on third of reliable global output is estimated to be lost due to insect pests, disease and weeds. In India, the value of crop lost due to pest was estimated at Rs.6, 000 crores in 1983 (Atwal, 1986) [6], which reported to have further increased to Rs.29, 000 crores in early 1990's (Dhaliwal and Arora, 1996) [9]. The agrochemical policy group, apex body of 200 crop protection companies has said agriculture produce lost in 2007 due to pest was estimated at Rs.1.40 lakh crores (Kumarswamy, 2008).
Pesticides, together with fertilizer and high yielding varieties have helped Indian farmers to achieve significant increase in crop productivity since mid1960s. For example, the yield of two most pesticide using crops, cotton and paddy increased by a factor of 1.9 times and 1.8 times respectively. During the initial years of green revolution, effectiveness of pesticides was so unambiguous that soon these over showed the traditional methods of pest control. According to one estimate, every rupee spent in chemical pest control helps saving crop output worth Rs. 3.The average per hectare consumption of pesticides in India had increased from 3.2 gm in 1954-55 to 570 gm in 1996 (Bami, 1996) [7]. The present use of pesticides in India was 580 gm per hectare which is very low as compared to Taiwan (17 kg/ha) followed by Japan (16.5 kg/ha) and in the US it is 4.5 kg/ha (Kumarswamy, 2008). However, India compares well with advanced countries in respect certain cash crops and other intensively cultivated crops. For example, cotton consumed 55 per cent of total pesticides in India while the total area under cotton was only 5 per cent. Similarly in the case of paddy 17 per cent of the pesticide was consumed, while the total area under paddy was 24 per cent. In the case of fruits and vegetables the usage was 13 per cent of total production and the area was only 3 per cent total cultivated area (Dikshit, 2008) [10].

In India the Consumption of Chemicals and Bio-Pesticides in 2011-12 were 37186.47 MT and 4523.03 MT respectively, in Karnataka 1412 MT and 307 MT Chemicals and Bio-Pesticides. In macroeconomic point of view the Bio-Pesticide consumption was 7738.59 MT in particular Karnataka 370.00 MT reported in 2012-13, as compared to previous year the consumption of Bio-Pesticide were increased. In 2011-12 the consumption of Bio-Pesticide in India and Karnataka were 5170.69 MT and 307.00 MT respectively (India stat-2011-12).

Materials and Methods

The present study attempted to analyze the frequency, extent, type and intensity of pesticides use in Paddy. Paddy is predominantly grown in Raichur district. The area under Paddy in Raichur district is 1, 78,356 hectare (2014). The Pesticide use in study area is more hence, Raichur in Karnataka state is purposively selected for the study. The soil of district is Medium Black, Deep Black, Mixed Red and Black cotton soils suitable for agriculture and horticulture crops. The total sample constitutes 125 paddy farmers from nine villages of two talukas in Raichur district. From each selected village, small, marginal and big farmers were randomly selected for the study. The Tabular analysis and Plant protection chemical expenditure function analytical tool was used in the present Study.

Tabular analysis

The tabular analysis were employed for determining general characteristics, Socio–economic conditions, cropping pattern, pesticide usage, costs, returns and profits etc, from paddy production in the study area. The percentages and averages were worked out to draw meaningful inferences.

Plant protection chemical expenditure function

The following log linear regression function was used for estimating plant protection chemical expenditure elasticity coefficient.

$$\text{Log } Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + \log u$$

Where,

Y= expenditure on plant protection chemicals (Rs\ha)

X_1 = total family income (Rs\ha)

X_2 = fertilizers and manures (Rs\ha)

X_3 = intensity of pesticide application (no of time \ha)

X_4= area under paddy (ha) & u = random error

Results & Discussion

Quantity of pesticide use on paddy

Table 1 revealed that among three categories of respondents, the quantity of pesticide use was observed to be highest for large respondents. The large respondents because of their better investment capacity and risk aversive nature to crop loss due to pests used higher quantity of PPCs. The insecticides were the most frequently used pesticides which accounted for bulk of share (59.17%) in total pesticides used. This was because of the severity of loss due to infestation of insect pests like stem borer, brown plant hopper and leaf roller in the study area. The respondents in the study area used 8.19 ltr (active ingredient) of pesticides per ha to protect the crop from pest infestation. Most of the previous research reported the use of about one kg (a.i) of pesticides per ha of paddy crop. Thus the current use was on a higher side. The optimality analysis also supported (Table 4.13) that respondents need around 7.75 liter (a.i) of pesticides per ha for profit maximization. This again supported the hypothesis of indiscriminate use of pesticides in the study area.

The study conducted by Singh *et.al* (2007) [4] in paddy, vegetables and cotton found that the pesticide consumption was 2.47 kgs and 1.85 kgs active ingredient per hectare on NIPM and IPM respondents respectively. The fungicides used were in meager quantity and weedicides application observed to be almost same on both categories of respondents. In the case of tomato, cabbage and cotton, the consumption of pesticide was 3.17 kgs, 2.63 kgs and 2.71 kgs for non IPM respondents respectively. Sanatha and Dandapani (2000) reported that on an average one hectare of cotton area received 3.2 kg technical grade pesticides. Nyugen and Tran Thi (2003) [15] found that on an average one hectare of paddy area received 1.02 kgs active ingredient and also observed that among pesticides, insecticides used were most.

Table 1: Quantity of pesticide use on paddy (ai\ha) (active ingredient\ha)

Sl. No	Respondents				
	Pesticides	**Small (n=52)**	**Medium (n=42)**	**Large (n=31)**	**All (n=125)**
1	Insecticides(lit)	4.57 (58.02)	4.17 (52.00)	5.85 67.51)	4.84 (59.17)
2	Weedicides (lit)	1.41 (17.90)	1.45 (18.10)	1.02 (11.81)	1.29 (15.94)
3	Fungicides (lit)	1.90 (24.07)	2.41 (29.89)	1.8 (20.68)	2.06 (24.89)
Total		7.88 (100.00)	8.03 (100.00)	8.67 (100.00)	8.13 (100.00)

Note: Figures in parenthesis are percentages

Frequency distribution of pesticide use intensity

Table 2 revealed that most of the small respondents (51.92%) used 8.00 to 8.49 liter active ingredient per hectare while most of the medium respondents (42.86%) used in the range between 7.50 and 7.99 liter active ingredient per hectare and the most of the large respondents (36.26%) used more than 9 liter active ingredient per hectare which was the highest quantity. This was due to better investment capacity of large respondents and risk aversion nature of these respondents. On an average, most of the respondents (31.20%) used in the range between 8 and 8.49 liter active ingredient per ha. The study conducted by Santa and Dhandapani (2000) in cotton growing region of Nanded district reported that most of the respondents used pesticides in the range between 3 kgs and 3.5 kgs active ingredient per ha.

Table 2: Frequency distribution of sample respondents according to pesticide use intensity

Pesticide use intensity (l\ha)	Respondents			
	Small (n=52)	Medium (n=42)	Large (n=31)	All (n=125)
<7.49	15 (28.85)	2 (4.76)	0 (0.00)	17 (13.60)
7.50-7.99	7 (13.46)	19 (45.24)	1 (3.23)	27 (21.60)
8.00-8.49	27 (51.92)	3 (7.14)	9 (29.03)	39 (31.20)
8.50-8.99	3 (5.77)	18 (42.86)	10 (32.26)	31 (24.80)
>9.0	0 (0.00)	0 (0.00)	11 (35.48)	11 (8.80)

Note: Figures in parenthesis are percentages

Type of pesticide used by paddy growers

Pesticide use in paddy cultivation as become a regular and inevitable feature, even though most of the respondents discount the complexity involved in and consequence of indiscriminate use of pesticides. Organochlorines, Organophosphates, Pyrethroids, Neoonicotinoids and Aclyurea compounds were the major group of insecticides used by the respondents in the study area (Table 3). In the cultivation of one hectare of paddy about 29.93 per cent of the pesticides applied belonged to Organophosphates category. Organochlorines comprised 15.78 per cent of total technical grade pesticides followed by Aclyurea compounds, Pyrethroids and Neoonicotinoids (11.95, 11.18 and 6.31%, respectively).

Among the three categories of respondents, Organochlorines were used mostly by medium respondents (1.45 lit/ha), organophosphates were used most by large respondents (3.60 lit/ha), Pyrethroids were used most by small respondents (1.01 lit/ha), Neoonicotinoids were used most by large respondents (0.65 lit/ha) and Aclyurea compounds were used most by small respondents (1.12 lit/ha).

It was also observed that the cost incurred was highest on Aclyurea compounds Rs. 2116.33.75 per hectare, this accounted for about 30.52 per cent of the total cost incurred on all type of pesticides used, followed by Organophosphates Rs. 1411.84 per hectare which accounts 19.87 per cent of the total cost incurred on all type of pesticides used and Organochlorines Rs. 529.00 per hectare accounted for about 7.62 per cent of the total cost.

Organophosphates are highly toxic to human and livestock compared to other groups of insecticides (Langham and Edward, 1969) [14]. However they are less persistent in the environment, thus the effect of organophosphates is short duration in nature. They may often cause short run health problems to applicators of these chemicals.

Organochlorines are another group of insecticides which are also toxic in nature but highly persistent in the environment. The effects of these insecticides are observed to manifest in the long-run, through storage in human/animal bodies as bio-concentrations (Arun Kumar, 1995) [5]. It was observed in the study area that respondents were using larger quantities of Organochlorines and organophosphate compounds as insecticides to control the insect pest. Stem borer is one of the most important insects causing yield loss in paddy in the study area. Hence, to control this pest respondents in the study area are using Organochlorines in the form of endosulfon. Brown plant hopper is another serious pest in the study area which occurs in later stage of growth, causing heavy yield loss in paddy by making paddy seeds chaffy. Hence, respondents used the organophosphates and aclyurea group chemicals in the form of dichlorovas, quinolphos and monocrotophos and bufrofezin respectively. Endosulfon and dichlorovas were used in larger quantity because they are cheap and easily available insecticides, whereas bufrofezin was used in larger quantity even though price was higher because it was more effective against pests. The rice blast was serious disease in the study area and to control this, respondents used corbandizium. The Above results were in conformity with results obtained by Yogeshwari (2002) [17] in paddy respondents in Shimoga district of Karnataka.

Table 3: Type of pesticide use by paddy growers

Pesticides	Farms Groups							
	Small		Medium		Large		All	
	Quantity of ai\ha (lit)	Cost\ha (Rs)	Quantity of ai\ha (lit)	Cost\ha (Rs)	Quantity of ai\ha (lit)	Cost\ha (Rs)	Quantity of ai\ha (lit)	Cost\ha (Rs)
Organochlorines	1.41 (17.89)	566.08 (8.43)	1.45 (18.03)	585.46 (4.52)	1.02 (11.76)	435.46 (5.89)	1.29 (15.78)	529.00 (7.62)
Organophosphates	2.14 (27.16)	1157.00 (17.23)	1.62 (20.15)	707.49 (10.32)	3.60 (41.52)	2371.03 (32.07)	2.45 (29.93)	1411.84 (19.89)
Pyrethroids	1.01 (12.82)	1343.68 (20.01)	0.87 (10.82)	1323.81 (19.31)	0.87 (10.03)	1414.33 (19.13)	0.92 (11.18)	1360.61 (19.48)
Neonicotinoids	0.30 (3.81)	303.52 (4.52)	0.60 (7.46)	579.29 (8.45)	0.65 (7.50)	663.92 (8.98)	0.52 (6.30)	515.58 (7.32)
Acylurea compounds	1.12 (14.21)	2383.17 (35.49)	1.09 (13.56)	2280.16 (33.26)	0.73 (8.42)	1685.67 (22.80)	0.98 (11.96)	2116.33 (30.52)
Others	1.90 (24.11)	961.60 (14.32)	2.41 (30.00)	1379.34 (20.12)	1.80 (20.78)	822.87 (11.13)	2.04 (24.86)	1054.61 (16.19)
Total	7.88 (100.00)	6715.06 (100.00)	8.04 (100.00)	6855.55 (100.00)	8.67 (100.00	7393.28 (100.00)	8.13 (100.00)	6930.47 (100.00)

Note: Figures in parenthesis are percentages

Optimum quantity of pesticide requirement

The optimum quantity of pesticide requirement for paddy production was presented in Table 4. The optimum quantity of pesticide required for paddy was estimated to be 7.75 lit/ha in sample respondents. The requirement of pesticide as estimated through production function varied from 7.25 lit/ha in the case of small respondents to 8.00 lit/ha for large respondents. The actual quantity of pesticide use was high in case of large respondents (8.67 lit/ha) as compared to small and medium respondents (7.88 lit/ha and 8.67 lit/ha). The optimum quantity of pesticide required was 7.75 lit/ha as compared to actual quantity of 8.13 lit/ha pesticide used. Thus the respondents were found to use almost nearly 6% more to the optimal requirement.

In other words the respondents spent Rs.295.90/hectare extra because of an uneconomical use of pesticides in the paddy farming. This was because of the risk aversive nature respondents to avoid crop loss due to pest infestation. Therefore, any increase in pesticides higher than the optimal level is really not a rational expenditure. Moreover, in the process of overusing pesticides, environmental problems are inevitably generated. The above results were in concurrence

with results obtained by Nguyen and Tran Thi (2003) [15] in the paddy respondents in Mekong and Delta, Vietnam.

Table 4: Optimum quantity of pesticide requirement in paddy

Respondents	Optimal use		Actual used		Savings	
	a.i (l/ha	Cost (Rs/ha)	a.i (l/ha)	Cost (Rs/ha)	a.i (l/ha)	Cost (Rs/ha)
Small (n=52)	7.25	6189.68	7.88	6715.06	0.63	525.38
Medium (n=42)	7.5	6412.13	8.04	6855.55	0.54	443.43
Large (n=31)	8	6857.02	8.67	7393.28	0.67	536.37
All (n=125)	7.75	6634.57	8.13	6930.47	0.38	295.90

Expenditure elasticity co-efficient of pesticides use in paddy

A log linear regression model was estimated considering the cost of pesticides as dependent variable. Total family income (Rs), expenditure on fertilizers and manures (Rs), number of pesticide applications and area under paddy (ha) were taken as independent variables. The independent variables included in model explained 80 per cent (small respondents), 70 per cent (medium respondents), 87 per cent (large respondents) and 77 per cent (all respondents) of total variation in expenditure on PPCs Table 5.

The regression coefficient of area under paddy was 0.09. This indicated that one per cent increase in area under paddy crop would bring about 0.0916 per cent increase in expenditure on plant protection chemicals. Thus as the area under paddy increases the chance of applying more pesticides would also increase in order to secure higher returns by controlling the insect pests.

The respondents in the study area were spending more than Rs.3600 on pesticides, similarly the intensity of pesticide application was found to contribute positively to the expenditure on PPC which clearly indicated that the respondents in the study area were spending more on pesticides. The mono-cropping without crop rotation has been followed since many years in study area. Because of this, brown plant hopper and stem borer have emerged as serious pests. It was noticed that as the family income increased, the respondents tend to spend more on pesticides to control the pests which is not only uneconomical but also would lead to emergence of pest as resistance. Similarly, manures and fertilizers were positively contributed to the expenditure on plant protection chemicals, while in the present study the co-efficient of manures and fertilizers was positive and significant.

These results were in accordance with the results obtained by Arun Kumar (1995) [5] for cabbage cultivation in Mallur Taluka of Karnataka were it was observed that total family income and pest intensity contributed positively to expenditure on plant protection chemicals. Cook and beaker (1983) stated that organic amendments could favour biological protection of the plant. The biological control achieved with organic amendments results in parts, from enhanced competition from the micro-organism for nitrogen and carbon or both and might be expressed as fewer propogules germinated or less pre-penetration growth of pathogens in the infestation count.

Table 5: Expenditure elasticity of pesticide use in paddy

Sl. No	Variables	Small	Medium	Large	All
	Intercept	-188.1434** (19.7133)	-110.8981** (22.8825)	-78.7873** (21.2600)	-114.0123** (11.5851)
1	Total family income (Rs)	14.8318** (1.3993)	9.3670** (1.3218)	6.8691** (1.7530)	9.8715** (0.8722)
2	Fertilizer and manure (Rs)	2.9843** (1.0437)	1.3765 (1.6663)	0.7965 (0.5244)	1.0104* (0.4321)
3	Number of pesticide application (no)	0.1897 (0.1797)	0.0980 (0.3731)	0.9318* (0.1493)	0.5181** (0.1147)
4	Area under paddy (ha)	0.1106 (0.1218)	-0.0701 (0.1161)	0.1418 (0.0784)	0.0916** (0.0303)
	R^2	0.80	0.70	0.87	0.77
	Adjusted R^2	0.78	0.66	0.86	0.76
	'F' value	34.72	20.07	60.93	94.77

Note: *** - Significant at 1% probability level

* - Significant at 5% probability level

Conclusion

Pesticide use in paddy cultivation as become a regular and inevitable feature, even though most of the respondents discount the complexity involved in and consequence of indiscriminate use of pesticides. Organochlorines, Organophosphates, Pyrethroids, Neoonicotinoids and Aclyurea compounds were the major group of insecticides used by the respondents, they may often cause short run health problems to applicators of these chemicals. The framers may be encouraged to use not only less toxic chemicals to human and livestock but less persistent in the environment in place of more toxic and more persistent chemicals. Use of alternative pesticides for controlling pest and diseases instead of use/spraying same chemical repeatedly so that one can avoid development of resistance to particular chemical for the particular pest and diseases. To advise the farmers by extension functionary better to adopt the Bio based pesticide instead of PPC.

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