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Impact of Vegetable Integrated Pest Management Farmer Field School Programme in Sub-Tropical Region of Jammu and Kashmir

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ABSTRACT

A field study was conducted to evaluate the impact of vegetable Integrated Pest Management- farmer Field School (IPM-FFS) Programme in the sub-tropical Jammu region of the state of Jammu and Kashmir (J&K). *Ex-post facto* with-without research design was employed to for conducting the impact evaluation. A sample of 80 IPM-trained and 60 non-IPM farmers were selected for the study. IPM practices namely raised nursery beds in cabbage (p=0.026), timely transplantation of cauliflower (p=0.034), collection of eggs and egg masses of insect pests (p=0.048) were adopted by significant proportion of IPM trained farmers. A logistic regression model was fitted which showed IPM training programme impacted adoption of IPM practices namely deep ploughing and collection of insect pest eggs and egg masses. IPM training did not influence adoption of other cultural and mechanical practices. IPM trained farmers decision of pesticide use was not influenced by IPM training.

Keywords: IPM, Farmer field school, Impact evaluation

INTRODUCTION

India is the second largest vegetables producing country in the world after China. Vegetable crops are grown on an area of 8.99 million hectare (m ha) with an annual production of 156.33 million tonnes (NHB, 2011). The insect pests inflict 40 percent crop losses in vegetable crops (Gaurav 2011). To counter the problem of insect pests, the vegetable growers depend on chemical pesticides. The average pesticide use in vegetable crops is 1.247 kg ha^{-1} (Peshin *et al.*2014) which is approximately 150 per cent more than the world average of 500 grams per hectare (Betne, 2011). The concerns about pesticide residues are especially important in fruits and vegetables as these are often consumed with little postharvest processing (Mullen *et al.,* 1997). The overemphasis on the use of chemical pesticides by the vegetable growers leads to the multitude of problems to human health and ecology.

In Jammu and Kashmir (J&K) state, the pesticide use was low till the last decade of the twentieth century compared to states of Punjab, Haryana (Agnihotri 2000, Peshin *et al.* 2014). However, the pesticide use in Jammu Kashmir has increased from 142 metric tons in 1994-1995 (start of IPM programmes in the state) to 1711 metric tonnes in 2011-2012(Puri 1995; MoA 2012).

To overcome the negative externalities of pesticide use in agriculture, Integrated Pest Management (IPM) is the accepted strategy of pest management all over the world. IPM is integration of different pest management practices in a compatible manner, so as to keep pest population below economic injury level, in such a way that it is not only economically viable but also ecologically sound. The objective of IPM is to reduce the pesticides use and to maintain ecological balance thereby generating sustainable agricultural growth. In India, IPM was adopted as the main strategy of plant protection by the Government of India in 1985 (Raghunathan, 1995) and its activities were intensified only since 1993 (Peshin and Kalra, 2000). All over the country, the Farmer Field School (FFS) training model for disseminating IPM technology was introduced in 1993 through Central Integrated Pest Management Centers (CIPMC) in rice, cotton and vegetable crops. Upto 2007-08, 951 vegetable IPM-FFS have been conducted in India by CIPMC (Peshin *et al.,* 2009a).

In J&K, IPM-FFS programme on pilot basis was started in 1993 in rice, vegetable and oilseed crops. The major vegetables covered under the programme in *kharif* season were cucurbits, brinjal, okra and tomato and in *rabi* season were peas, knol-khol, cauliflower and cabbage. A field study was conducted to evaluate the impact of vegetable Integrated Pest Management-Farmer Field School (IPM-FFS) Programme in the sub-tropical Jammu region of the state of Jammu and Kashmir (J&K). The impact evaluation indicators were adoption of IPM practices, pesticide use frequency, field use of the environmental impact quotient, pesticide use (a.i) by

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weight and pesticide expenditure. In this paper, the adoption of IPM practices by the farmers trained under IPM-FFS programme besides the impact of training on farmers' adoption of non-chemical IPM practices are discussed.

METHODOLOGY

1.1. Profile of the Study Area

The study was carried out in the subtropical region of the Jammu province of the J&K state. The state of Jammu and Kashmir is situated in North West Himalayan region extending over 32^0- $17^'$ and 36^0-$58^'$ North latitude and 73^0-$26^'$ and 80^0-$30^'$ East longitude. The average height of the state, above mean sea level, varies from less than 300 meters to about 9400 meters. The total geographical area of the Jammu and Kashmir State is 101387 sq. kilometers (2416000 ha). Out of which, 742000 (30.38%) is the net sown area, 658000 ha (27.24%) is under forests, 7300 ha (3.02%) is follow, 293000 ha (12.13%) under non-agricultural use, 289000 ha (11.96%) are barren plus uncultivable and 361000 ha (14.94%) under cultivable waste, permanent pastures and other grazing land etc (Statistical Digest J&K Govt. 2007-08). The sub tropical region of the Jammu province constitutes of the entire Jammu district, part of Samba, Kathua, Udhampur and Rajouri districts. The characteristic features of subtropical region are: height ranges from less than 300 meters to nearly 800 meters above mean sea level. The summers are hot and relatively dry, winters are pronounced. The favourable agro-climatic conditions, fertile soils and sub tropical climate are ideally suited for cultivation of vegetable in the subtropical Jammu province. The average holding size of the state is 0.66 hectares, and average holding size of the Jammu province is 0.94 ha. The total net sown area of the division is 392616 ha, of which 93233 ha (24.77%) is irrigated.

1.1. Research Design

Ex-post facto research design (with/without) was employed for conducting the study. Instead of actual manipulation of the treatment, *ex post facto* experimental design uses a pre-existing condition as the treatment. The pre-existing condition is the implemented IPM programme. An *ex-post facto* design uses a comparable site as the control to find the programme effects. Therefore, this design is appropriate for studying the impacts of an already conducted IPM programme (Peshin *et al.* 2009b).

Sampling Plan

The villages covered under the IPM FFS programme from 2003-04 to 2007-08 formed the population for the study. During this period, the district-wise number of villages covered in Jammu, Samba, Kathua, Udhampur and Reasi districts were 28, 10, 4, 4 and 2, respectively. Jammu, Samba and Kathua districts were selected as the maximum numbers of IPM-FFS were implemented in these three districts. From the selected districts, a total number of eight villages were selected by the proportionate random sampling method. The list of farmers trained under the IPM-FFS programme by CIPMC Jammu was used for drawing the sample of IPM farmers from the selected IPM villages. From each selected IPM village, 10 IPM trained vegetable farmers were selected randomly. For comparison, six control villages were selected, four from Jammu district and one each from Samba and Kathua districts. From non-IPM villages, a matching sample of 10 vegetable farmers from each control village was selected. In order to exclude the potential diffusion effects, the control villages were selected in the same agro-ecological zone but located 5-10 km away from the FFS villages. The total sample size was 140 farmers (80 IPM and 60 non-IPM farmers).

1.4. Data Collection

The data were collected with the help of pre-tested questionnaire. Data pertaining adoption of IPM practices was collected in two phases. In first phase, data from cabbage and cauliflower growers were collected at the end of *rabi* season from IPM and non-IPM farmers. In the second phase, data were collected from IPM and non-IPM farmers for okra and brinjal crops at the end of *kharif* season.

1.5. Data Analysis

Statistical analyses were done using computer based SPSS-16 (Statistical Package for Social Sciences) programme. 'Z' test of proportionate was used to compare the per cent difference between IPM and non-IPM farmers in adoption of IPM practices. Two sample't' test was applied to test whether the two samples differ from one another significantly in their age, education, land holding and area under vegetable crops.

1.5.1. Empirical model

Binary logistic regression model was applied to find out the impact of IPM training on the adoption/non-adoption of IPM practices namely timely plantation (Y_1), deep summer ploughing (Y_2), destruction of crop residues (Y_3), removal of crop stubbles (Y_4), use of treated seed (Y_5), collection of eggs and egg masses (Y_6), removal of damaged fruits and shoots (Y_7), timely hoeing/hand weeding (Y_8) and pesticide use (Y_9). A score of “1” for IPM trained farmers and “0” for non-IPM farmers (Table 1).

The result of this type of regression can be expressed as follows:

$$\mathrm{Ln}\,[p/(1-p)] = b_0 + b_1 x_1 \qquad (1$$

-where, p represents the probability of an outcome

-b_1 is the coefficients associated with the independent variable

-b_0 is the y-intercept

-x_1 represent the independent variable IPM-FFS training included in the model

Table 1: Variables used, their coding and units

Dependent variables for binary logistic regression	Code/units
Adoption of IPM Practices ($Y_1, Y_2 ... Y_9$)	1 -adoption, 0-non-adoption
Independent Variables	Code/units
Training (X)	1 for IPM trained farmers, 0 for non-IPM farmers

RESULTS AND DISCUSSION

1.1. Descriptive Statistics

The mean age of the IPM farmers was 48.4 years and non-IPM farmers were 47.3 years. The difference in mean age of the IPM and non-IPM farmers was not statistically significant (t=0.513, d.f=138, p=0.530) (Table 2). Mean education of the IPM and non-IPM farmers was same (7.3). The difference in mean education of the IPM and non-IPM farmers was not statistically significant (t=0.034, d.f=138, p=0.372). Majority of the sampled farmers in both the IPM and non-IPM villages were literate (77.6 and 80, respectively). In the IPM and non-IPM villages, 23 and 20 per cent of farmers had received no formal education while equal percentage (10%) of the IPM and non-IPM farmers had elementary primary education. Middle level education was received by 26 per cent of the IPM farmers and 33 per cent of the non-IPM farmers. The percentage of farmers in the IPM villages who were matriculates and 10+2 were 36 and 33 per cent, respectively.

Table 2: Descriptive statistics of the sampled farmers

Particular	IPM villages (n=80)	Non-IPM village (n=60)	t value	p value
Average Age (in years)	48.4	47.3	0.513	0.530
Average Education (in years)	7.3	7.3	0.034	0.372
i. Education (% farmers)				
ii. Illiterate	23.0	20.0		
iii. Up to Primary	10.0	10.0		
iv. Middle	26.0	33.0		
v. Matric	30.0	25.0		
vi. 10+2	6.0	8.0		
vii. Graduation and above	5.0	4.0		
Average operational land holding(in ha)	1.85	1.74	0.557	0.568
Operational land holding(% farmers)				
i. < 1ha (Marginal)	25.0	32.0		
ii. 1-2ha (Small)	30.0	28.0		
iii. 2-4ha (Semi-medium)	39.0	32.0		
iv. 4-10ha (Medium)	6.0	8.0		
Total Cultivable Area (in ha)	147.7	104.2		
Area under vegetable crops (ha)	21.2	16.6	0.249	0.829
Mean area under vegetable crops	0.27	0.28		

In the non-IPM villages, 25 per cent of the farmers were matriculate and eight per cent were 10+2. Only five per cent of the IPM and four per cent of the non-IPM farmers had graduation or above degrees. The data in the Table 2 reveals that a majority, 55 per cent of the IPM farmers and 60 per cent of the non-IPM farmers had less than 2 hectares of landholding. Semi-medium land holdings were possessed by 39 per cent of the IPM farmers and 32 per cent of the non-IPM farmers. Only six per cent of the IPM farmer and eight per cent of the non-IPM farmers possesses medium land holdings. The mean farm size of the selected IPM and non-IPM farmers was 1.85 ha and 1.74 ha, respectively. There were no significant difference in the mean farm size of the IPM and non-IPM farmers (t=0.557, d.f=138, p=0.568).

1.1. Adoption of Non-chemical Pest Management Practices

One of the impact indicators of the IPM programme evaluation is the adoption of IPM practices by the trained farmers after acquiring knowledge and skills (Peshin *et al.* 2009b). The cultural practices which play an important role in reducing the pest build-up involve crop husbandry practices that have dual purpose of crop production and insect pest suppression (Litsinger, 1994). In cauliflower crop, there was significant difference between the IPM and non-IPM farmers in adoption of timely plantation and use of treated seed. More than half (57%) of the IPM farmers and about one third (33%) of the non-IPM farmers had adopted timely plantation practice. The difference of 24 per cent between the IPM and non-IPM farmers was statistically significant (z=1.832, p=0.034). Treated seeds were used by 60 and 30 per cent of the IPM and non-IPM farmers, respectively and the difference of 30 per cent was statistically significant (z=2.246, p=0.025). There was no significant difference between the IPM and non-IPM farmers in adoption of any of the other cultural practices (Table 3). In cabbage crop, the practice of raising nursery beds for draining excess water was adopted by 67 per cent of the IPM farmers and 20 per cent of the non-IPM farmers (Table 3) and difference of 47 per cent was statistically significant (z=2.229, p=0.026). The percentage of the IPM and non-IPM farmers removing plant stubbles from cabbage field were 13 and 7 per cent, respectively. However, the difference of 6 per cent was not statistically significant (z=0.061, p = 0.951). In case of brinjal and okra crops there was no significant difference between the IPM trained and non-IPM farmers in the adoption of different cultural practices namely timely plantation, deep ploughing, destruction of crop residues, removal of plant stubbles and use of treated seed. The results showed that there was no significant impact of IPM training on farmers' adoption of cultural practices namely raised nursery beds, deep ploughing, destruction of crop residues and removal of plant stubbles of previous crops to avoid pest build-up or/and pest suppression. There was significant impact in case of timely plantation and use of treated seeds in cauliflower, and using raised nursery beds to avoid damping of the seedling disease in nursery in cabbage crops.

This reflects that IPM programmes implemented in vegetable crops have not achieved the objectives of popularizing and extensive adoption of cultural practices. The results are in agreement with studies conducted by Maraddi *et al.* (2007) and Peshin *et al.* (2009c) who reported that IPM programmes have not achieved scaling up of non-chemical practices among IPM trained farmers. Sharma *et al.* 2012 reported that CIPMC trainers were not able to convince the vegetable growers to adopted non-chemical pest management practices.

Table 3: Extent of adoption of cultural practices by vegetable growers (percent farmers)

Cultural Practices	Percentage of IPM farmers	Percentage of non-IPM farmers	Difference with/without	Z-value
Cauliflower	n=40	n=30		
Raised nursery beds	35	33	02	0.184
Timely plantation	58	33	25	1.832* (0.034)
Deep ploughing	50	33	17	1.178
Destruction of crop residues	30	10	20	1.108
Removal of plant stubbles	30	20	10	0.671
Use of treated seed	60	30	30	2.246* (0.025)
Cabbage	n=15	n=15		
Raised nursery beds	67	20	47	2.229* (0.026)
Timely plantation	67	53	14	0.410
Deep ploughing	73	40	33	1.455
Destruction of crop residues	20	13	07	0.478
Removal of plant stubbles	13	07	06	0.061
Use of treated seed	73	67	06	0.382
Okra	n=25	n=14		
Timely plantation	40	21	19	0.853
Deep ploughing	60	50	10	0.268
Destruction of crop residues	12	14	-02	0.320
Removal of plant stubbles	12	21	09	0.285
Use of treated seed	68	67	01	0.291
Brinjal	n=13	n=11		
Raised nursery beds	08	18	-10	0.119
Timely plantation	39	27	12	1.187
Deep ploughing	77	46	31	1.140
Destruction of crop residues	23	18	05	0.204
Removal of plant stubbles	23	18	05	0.204
Use of treated seed	69	64	05	0.176

Figures in the parentheses are p values. Decimals have been rounded off to the nearest whole numbers in case of percent farmers

The reduction or suppression of insect pest populations by means of manual devices is covered under mechanical control methods. The findings regarding the extent of adoption of manual mechanical practices reflects that a significant percentage of farmers in the IPM villages collected eggs and egg masses of the insect pests. In cauliflower crop, 30 per cent of the IPM farmers and 7 per cent of the non-IPM farmers collected eggs of insect pests, and the difference of 23 per cent was statistically significant (z=2.700, p=0.048). None of the non-IPM farmer collected eggs and egg masses in cabbage and brinjal crops (Table 4). There was no significant difference between the IPM and non-IPM farmers in the adoption of manual mechanical practice namely removal of damaged fruits and shoots and burying them in soil. The farmers reported that it was a cumbersome process and time and labour requirement was more which will increase cost of production. Moreover, collection and destruction of insect pests is effective for small plots, where farmers can easily and frequently inspect insect pests and apply this method. The non-IPM farmers also agreed that the practice namely collection of eggs and egg masses of insect pests and removal of damaged fruits and shoots from the field increased cost of cultivation of vegetable crops. Thus time and labour were the limiting factors for widespread non-adoption of manual mechanical practices in vegetable crops. The results are in agreement with findings reported by Moser *et al.* 2008; Timprasert *et al.* 2014. Adoption of timely hoeing or intercultural operations was high as majority of the farmers had gone for this practice even before the implementation of the IPM-FFS programme. None of the IPM and non-IPM farmers had installed pheromone traps.

Table 4: Extent of adoption of manual mechanical practices by vegetable growers

Cultural Practices	Percentage of IPM farmers	Percentage of non-IPM farmers	Difference with/without	Z-value
Cauliflower	n=40	n=30		
Collection of eggs and egg masses	30	07	23	2.700* (0.048)
Removal of damaged fruits and shoots	30	23	07	0.380
Timely hoeing/ hand weeding	65	63	02	0.079
Cabbage	n=15	n=15		
Collection of eggs and egg masses	20	13	07	0.478
Removal of damaged fruits and shoots	13	13	00	0.537
Timely hoeing/ hand weeding	80	80	00	0.456
Okra	n=25	n=14		
Collection of eggs and egg masses	16	00	16.0	1.03
Removal of damaged fruits and shoots	08	14	-06	0.42
Timely hoeing/ hand weeding	76	86	-01	0.329
Brinjal	n=13	n=11		
Collection of eggs and egg masses	23.0	00	23	1.078
Removal of damaged fruits and shoots	15	18	-03	0.353
Timely hoeing/ hand weeding	77	73	05	0.248

Figures in the parentheses are p values. Decimals have been rounded off to the nearest whole numbers in case of percent farmers

Impact of IPM FFS Training Programme on the Adoption of IPM Practices

To find out whether IPM-FFS programme had any impact on farmers adoption of IPM practices and pesticide use binary logistic regression was run. The "Forward Stepwise" method was followed to select the best predicting variables as the main aim was to select the best group of predictors. Forward selection starts with no variables in the model. At each step the predictor which contributes most to prediction is added. For the entry of the predictors in the model, a default value of 5% significance level was adopted. For the validation of each model, model Chi-square, Hosmer and Lameshow goodness of fit and cases correctly classified were taken into account. The Nagelkerke's R^2 was used as a measure of determination of variation caused by predictors. The significance of model Chi-square indicates that all independent variables in model jointly cause significant variation in dependent variable. Non-significance of Hosmer and Lameshow goodness fit confirms that there is no significant difference between observed and predicted frequencies of respective categories.

The model applied has log likelihood value of 205.355 and chi-squared value of 5.245 which is significant at 0.022. The prediction rate for the model is 63.2 per cent and the Nagelkerke R^2 value is 0.136 which indicates that 13.6 per cent variation in the adoption is the impact of training. The Hosmer and Lameshow test was non-significant (p=0.945) confirming that there is no significant difference between observed and predicted frequencies of respective categories. The IPM programme significantly impacted the adoption IPM practices namely deep summer ploughing and collection and destruction of eggs and egg masses (Table 5). Singh *et al.* (2008) also reported similar type of findings that IPM programme has significant impact on the adoption of IPM technology. There was no significant impact of the IPM-FFS on farmers' decision to apply pesticides for control of insect pests and diseases. Sharma *et al.* (2015) reported that farmers' decision of pesticide use was influenced by factors/variables other than IPM training.

Table 5: Impact of IPM training on adoption of IPM practices

Variable	Coefficient (B)	S.E	Wald	p-value
Constant	-0.312	0.241	1.674	0.196
Deep summer ploughing	0.756	0.333	5.154	0.023
Collection of eggs and egg masses	1.869	0.646	8.374	0.004

Nagelkerke R^2=0.136 Observations=163, X^2=5.245 p=0.022 -2log likelihood= 205.355

CONCLUSION

The objectives of IPM-FFS programmes are to enhance the analytical skills of the farmers so that they observe and discover the activities of pests, natural enemies, effect of pesticides on natural enemies, effect of other agronomic practices to reduce the pest build-up and so on to make them analyze and comprehend the principle behind such practices and use pesticide as a last resort. In vegetable crops pesticide use is high and the farmers do not observe pre-harvest waiting period thus putting consumers at risk. The results reflected that practices namely raised nursery beds, deep ploughing, destruction of crop residues and removal of plant stubbles, collecting eggs and egg masses of insect pests, removal of damaged fruits and shoots and installing of pheromone traps were not widely adopted by the IPM farmers which can be attributed to the FFS programmes conducted not implemented as envisaged. Therefore, much needs to be done with improving the quality of IPM trainings conducted by different extension agencies to achieve the goals of IPM programme in educating farmers and reducing pesticide use and adverse environmental impact. There should be institutionalisation of evaluation research to quantify the outcomes /impacts of agricultural research and development programmes for generating empirical feedback.

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