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Assessment of awareness level and constraints of cotton farmers following Integrated Pest Management (IPM) technology in Rajasthan, India

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Abstract
This research is an attempt to assess the awareness level and constraints in adoption of IPM technology among the farmers in Rajasthan, India. In Rajasthan, Zone Ib, comprising of Sri Ganganagar and Hanumangarh districts, was purposively selected for the research. Cotton growing IPM farmers were selected based on the PPS (Probability Proportional to Size) method from two villages for the crop year 2017–18. Farmers were found to be highly aware about neem-based formulations, nutrient management, intercultural operations and mechanical traps. The major constraints in adoption of IPM technology were found to be scarcity and high wage of skilled labour under cultural constraints, time consuming and laborious method of mechanical practice under mechanical constraints, unavailability of bio-fertilizers and bio-pesticides under biological constraints, high cost of plant protection chemicals under chemical constraints, and lack of separate marketing facility for remunerative pricing under other constraints.

Keywords: Cotton, IPM technology, awareness, constraints

Introduction
Rajasthan, with its diverse agro-climatic conditions, is richly endowed with the cultivation of a variety of crops and a strong animal husbandry sector. Agriculture in Rajasthan continues to be the backbone of the state's economy. Among ten agro-climatic zones of Rajasthan, due to abundance of canal water irrigation, Irrigated North Western Plain region (Zone Ib) comprising of Sri Ganganagar and Hanumangarh districts has today become the granary of Rajasthan. In Sri Ganganagar and Hanumangarh districts of Rajasthan, cotton is sown on an average of 2.39 lakh hectares with highest average production of 7.44 lakh bales (DOA, 2019 [1]). The problem of pest resistance has compelled the farmers to use more of pesticides in these major crops and has led to the over reliance of farmers on chemical pesticides. Integrated Pest Management (IPM), being an integrated approach to pest management involves a number of cultural, biological, mechanical and chemical components, is perceived to be a complex technology. It emphasizes on the need-based adoption of suitable practices recommended by the government agencies, which are region and crop specific. Bt cotton being genetically modified is resistant to bollworm infestation and therefore has been considered as an essential component of IPM technology by several scientists. Awareness regarding the effective implementation of IPM technology has always been a matter of concern. Many studies have been conducted for evaluating the awareness of farmers regarding the IPM technology. Researches have indicated a positive and significant relationship between the level of knowledge and the level of IPM adoption by farmers (Jayasooriya and Aheeyar, 2015 [2]; Sudhakar and Ponnusamy, 2019 [3]). In studies, certain factors like, lack of good quality IPM inputs, high cost of inputs, lack of training in IPM, lack of credibility of IPM measures, lack of precision of IPM techniques utilization, labour shortage, inability of state government extension agencies to conduct need and time-based training programmes, lack of belief on the credibility and effectiveness of IPM techniques in controlling the insects of the cotton crop, etc. are found to be the major constraints in IPM adoption (Bhati *et al*., 2010 [4]; Zunjar, 2011 [5]; Sable, 2012 [6]; Neerja *et al.*, 2017 [7]). This research is an attempt to assess the level of awareness of cotton farmers regarding components of IPM and constraints faced in adoption of IPM technology in the study area.

Materials and Methods
This study was conducted as doctoral research during 2016–20 at Institute of Agri Business

Management, Swami Keshwanand Rajasthan Agricultural University, Bikaner. In Rajasthan, the Irrigated North western Plain Region (Zone Ib), which comprises of Sri Ganganagar and Hanumangarh districts, was purposively selected for the research under reference due to considerable area and production in irrigated cotton. As per estimates of government (average of last five years ending 2016–17), both Sri Ganganagar and Hanumangarh districts, taken together, ranked first, and second in the area and production of cotton and Bt cotton, respectively in Rajasthan. Cotton growing IPM farmers were selected based on judgmental sampling where the list of IPM farmers were collected from the experts of Central Integrated Pest Management Centre (CIPMC), Sri Ganganagar. Based on the PPS (Probability Proportional to Size) method, 30 IPM farmers from two villages viz. 24 Z of Sahibsinghwala under Sri Ganganagar tehsil and 3 DWM of Nirwal gram panchayat under Rawatsar tehsil were selected for the study. With the help of structured schedules, primary data was collected from the sample farmers for the crop year 2017–18, whereas secondary data for the recommended practices for IPM technology were gathered from reports of CIPMC, Sri Ganganagar, Agricultural Research Station, Sri Ganganagar and Agriculture Technology Management Agency (ATMA), Hanumangarh, etc.

For assessing awareness level, 14 IPM components were identified for cotton farming viz. land preparation, cropping system, seed management, nutrient management, water management, intercultural practices, pest-defender ratio, mechanical traps, bio-control agents, bio-fertilizers and bio-pesticides, neem-based formulations, economic threshold level, recommended dosage of pesticides, and safety parameters of using pesticides. Farmers were asked about their awareness regarding the components. Three levels of awareness were set based on the experts' opinion and researcher's acumen viz. low, medium and high were formed based on 'meaning', 'meaning + purpose' and 'meaning + purpose + technicality' regarding IPM components, respectively.

For constraints in adoption of IPM technology, Kendall's W statistic (also called as the coefficient of concordance), a non-parametric statistic was used. It was used to assess agreement between different raters. The value of W ranges from zero to one; zero means no agreement at all between raters, while one means perfect agreement. This statistic is calculated either on an interval scale or on an ordinal scale. As our data were in ordinal form, and the ratings were to be done for each group of constraints relating to certain criteria viz. cultural, mechanical, biological, chemical and others, this statistical technique was found suitable. Also, W values were checked for their significance.

The formula for the W statistic is:

$$W = \frac{12S}{m^2(n^3 - n)}$$

Where:
'S' is the sum of squared deviations,
'm' is the number of judges (raters),
'n' is the total number of objects being ranked.

$$S = \sum_{i=1}^{n} (R_i - \bar{R})^2$$

Where:
R_i = Ranking of the subject i
$\bar{R}$ = Mean of the R_i

Results and Discussion

Awareness is a prerequisite to the process of adoption. In order to adopt a certain practice, one needs to be aware or should possess some degree of knowledge regarding a particular concept. Under this objective, knowledge level of farmers, following IPM practice in the study area was assessed, with respect to recommended package of practice for IPM technology. Based on the data collected from cotton farmers of the area under study, the total numbers of responses elicited were compiled together for analyzing the level of awareness, regarding the selected major recommended components of IPM technology. Using percentage method, the compiled data were tabulated and the results have been depicted in Table 1.

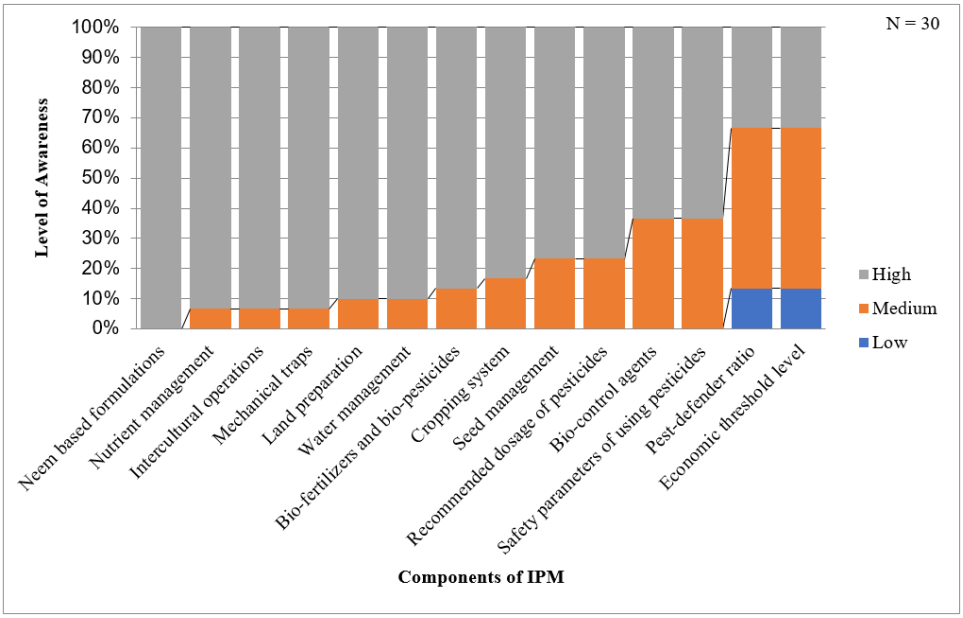
Table 1: Awareness level of farmers following IPM technology in cotton

Major components of IPM	Responses of cotton farmers (N=30)					
	Low level of awareness		Medium level of awareness		High level of awareness	
	F	%	F	%	F	%
Neem based formulations	-	-	-	-	30	100.00
Nutrient management	-	-	2	6.67	28	93.33
Intercultural operations	-	-	2	6.67	28	93.33
Mechanical traps	-	-	2	6.67	28	93.33
Land preparation	-	-	3	10.00	27	90.00
Water management	-	-	3	10.00	27	90.00
Bio-fertilizers and bio-pesticides	-	-	4	13.33	26	86.67
Cropping system	-	-	5	16.67	25	83.33
Seed management	-	-	7	23.33	23	76.67
Recommended dosage of pesticides	-	-	7	23.33	23	76.67
Bio-control agents	-	-	11	36.67	19	63.33
Safety parameters of using pesticides	-	-	11	36.67	19	63.33
Pest-defender ratio	4	13.33	16	53.33	10	33.33
Economic threshold level	4	13.33	16	53.33	10	33.33

F: Frequency, %: percentage
Source: Researcher's computation from field data

Table 1 shows the summary of the total responses of farmers following IPM technology being categorized into three level of awareness viz. 'low', 'medium' and 'high'. It can be observed from the above Table 1 that, cotton farmers

following IPM technology are fully aware about 'neem application' (100 percent) followed by 'nutrient management' (93.33 percent), 'intercultural operations' (93.33 percent), 'use of mechanical traps' (93.33 percent), 'preparation of land' (90.00 percent), 'water management' (90.00 percent), 'use of bio-fertilizers and bio-pesticides' (86.67 percent), 'cropping system' (83.33 percent), 'seed management' (76.67 percent), 'recommended dosage of pesticides' (76.67 percent), 'bio-control agents' (63.33 percent), 'safety parameters of while using pesticides' (63.33 percent), 'pest-defender ratio' (33.33 percent) and 'economic threshold level' (33.33 percent). Therefore, it is clear that, the farmers are least aware about 'pest-defender ratio' and 'economic threshold level'. The graphical representation of Table 1 with the percentage values of three levels of awareness is portrayed as in Figure 1.



Source: Researcher's computation from field data

Fig 1: Awareness among cotton farmers following IPM technology

Figure 1 shows the component wise gap in awareness level among the cotton farmers following IPM technology in the study area. From Figure 1, it can be well observed that, cotton farmers following IPM technology in the study area are highly aware about all the components except a few. There is a gap in awareness regarding ETL, PD ratio, followed by safety parameters and bio-control agents are the major components, which needs to be addressed for increasing the dissemination of the technology in a better way.

For determining the major constraints of cotton farmers in adoption of IPM technology, under each class, Kendall's W statistic was used, which gave the following results.

Table 2: Constraints in adoption of IPM technology in cotton

Class	Constraints	Mean rank	Test statistics (N=30)
Cultural	Scarcity and high wage of skilled labour	1.30	W: 0.82** χ^2: 73.80
	Lack of assured irrigation	1.70	
	Unavailability of required farm inputs	3.40	
	Lack of knowledge on balanced use of fertilizers	3.60	
Mechanical	Time consuming and laborious method of mechanical practice	1.40	W: 0.69** χ^2: 62.32
	High cost of mechanical practices	1.80	
	Non-availability of traps in market	3.13	
	Insignificance of mechanical practice	3.67	
Biological	Unavailability of bio-fertilizers and bio-pesticides	1.53	W: 0.69** χ^2: 62.52
	Lack of knowledge about friendly insects	1.83	
	High cost of biological practices	2.70	
	Ineffectiveness of neem-based formulations	3.93	
Chemical	High cost of plant protection chemicals	1.90	W: 0.36** χ^2: 32.76
	Poor quality of pesticides available in the local market	2.00	
	Lack of knowledge about ETL for using chemical pesticides	2.50	
	Impracticality of following safety measures	3.60	
Others	Lack of separate marketing facility for remunerative pricing	1.77	W: 0.31** χ^2: 28.12
	Complexity of IPM	2.10	
	Lack of community approach	2.73	
	Lack of institutional guidance	3.40	

Ranks from 1-4 for each category have been evaluated for the analysis; 1 being major constraint and 4 being the least constraint
W: Kendall's Coefficient of Concordance
χ^2: Chi-Square
**: Significant at one percent level of probability
Source: Researcher's computation from field data through SPSS

It can be seen from Table 2 that, for cotton, the constraints were classified into five categories viz. cultural, mechanical, biological, chemical and other constraints. The constraints under each category were ranked by cotton farmers following IPM practice. It was found that for cotton, in case of cultural practices, 'scarcity and high wage of skilled labour' (mean rank: 1.30) was the major constraint, followed by 'lack of assured irrigation' (mean rank: 1.70), 'unavailability of required farm inputs' (mean rank: 3.40) and 'lack of knowledge on balanced use of fertilizers' (mean rank: 3.60). Also, the value of W and χ^2 were significant at one percent level of probability [W= 0.82, $\chi^2(3)$= 73.80, p<0.01]. In mechanical constraint category for cotton, 'time consuming and laborious method of mechanical practice' (mean rank: 1.40) was found to be the major constraint, followed by 'high cost of mechanical practices' (mean rank: 1.80), 'non-availability of traps in market' (mean rank: 3.13) and 'insignificance of mechanical practice' (mean rank: 3.67). For mechanical constraints, the value of W and χ^2 were significant at one percent level of probability [W= 0.69, $\chi^2(3)$= 62.32, p<0.01]. Similarly, under biological constraint category, 'unavailability of bio fertilizers and bio pesticides' (mean rank: 1.53) was found to be the major constraint, followed by 'lack of knowledge about friendly insects' (mean rank: 1.83), 'high cost of biological practices' (mean rank: 2.70) and 'ineffectiveness of neem-based formulations' (mean rank: 3.93). For biological constraints, the value of W and χ^2 were significant at one percent level of probability [W= 0.69, $\chi^2(3)$= 62.52, p<0.01]. Under chemical constraint category, 'high cost of plant protection chemicals' (mean rank: 1.90) was found to be the major constraint followed by 'poor quality of pesticides available in the local market' (mean rank: 2.00), 'lack of knowledge about ETL for using chemical pesticides' (mean rank: 2.50), and 'impracticality of following safety measures' (mean rank: 3.60). For chemical constraints, the value of W and χ^2 were significant at one percent level of probability [W= 0.36, $\chi^2(3)$= 32.76, p<0.01]. In case of other constraint category, 'lack of separate marketing facility for remunerative pricing' (mean rank: 1.77), followed by 'complexity of IPM' (mean rank: 2.10), 'lack of community approach' (mean rank: 2.73), and 'lack of institutional guidance' (mean rank: 3.40) were found to be the major constraints. For other constraints, the value of W and χ^2 were significant at one percent level of probability [W= 0.31, $\chi^2(3)$= 28.12, p<0.01]. The W statistic for each category of constraints was found to the highly significant.

Conclusion

Cotton farmers were found to be highly aware about neem-based formulations, nutrient management, intercultural operations and mechanical traps in the study area. Farmers were least aware about economic threshold level (ETL) and pest-defender ratio (PD Ratio). Scarcity and high wage of skilled labour, unavailability of bio fertilizers and bio pesticides, time consuming and labourious method of mechanical practices, high cost of plant protection chemicals and lack of separate remunerative pricing facility for cotton were found to be the major constraints under cultural, biological, mechanical, chemical and other practices, respectively. CIPMCs, NCIPM and other agencies related to IPM may have a coordinated approach in working together and suggesting policies towards the promotion and wide spread adoption of IPM among the farming communities. All organizations may have the uniform literature for gainful adoption of IPM technology. IPM is a labour-intensive technology and also requires skill in certain activities. But in case of absence of sufficient labour force, wage becomes high and this poses problems for farmers. Efforts need to be directed to ensure the easy availability of bio-pesticides, bio-fertilizers and mechanical traps by providing support facilities and increasing awareness among dealers and distributors, regarding sustainability in agriculture, which will benefit both the farmers and dealers in the long run.

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