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Aruna S Katole
Ph.D., Scholar, Department of Extension Education, PGI, Dr. PDKV, Maharashtra, India

NM Kale
Professor, Department of Extension Education, PGI, Dr. PDKV, Akola, Maharashtra, India

VS Tekale
Associate Dean, College of Agriculture, Mul, Chandrapur, Dr. PDKV, Akola, Maharashtra, India

Adoption status of pink bollworm management practices by the cotton growers in Vidarbha

Aruna S Katole, NM Kale and VS Tekale

Abstract
The impact of Pink Bollworm (PBW) attack has been felt the most in regions of Vidarbha, where cotton is cultivated as the main cash crop. The present study was conducted in purposively selected six districts and two taluka of each selected district of Vidarbha region in Maharashtra. From each selected taluka five villages and from each selected villages five cotton growers were selected randomly. Thus, total 300 cotton growers constituted as sample. Majority of cotton growers had fully adopted improved integrated management practices for control of pink bollworm such as deep ploughing (90.33%), Clean up/ destruction of cotton stubbles (88.33%), timely sowing (69.67%), avoiding stacking of cotton stalks for fuel purpose, use of pheromone traps (68.00%), use of neem insecticide during flush and boll formation stage (68.67%). While 87.67 per cent of them did not adopt application of *Beauveria bassiana*, 69.33 per cent of the cotton growers did not adopt hand plucking of rosettle flowers, 54.33 per cent of them did not use appropriate insecticides as per warning of ETL, 47.00 per cent were non adopters crop rotation, 41.67 per cent and 40.33 per cent did not adopt avoid excess use of chemicals and insecticides and urea and growth promoting chemicals, respectively. Overall majority 41.33 per cent of the cotton growers had medium adoption level about management practices of pink bollworm.

Keywords: Adoption, *Beauveria bassiana*, cotton growers, pink bollworm management practices, Rosettle flowers

Introduction
Cotton, the 'white gold' and 'king of fibers' is a crop of prosperity and is one of the most important crops producing natural fibers. It has been under commercial cultivation for domestic consumption and its export need is of about 111 countries in the world. In India, cotton is cultivated in an area of 126.55 lakh ha. Is the largest cotton area in the world? But while India ranks first in total area of cotton cultivation, it ranks third in total cotton production because of the low yield per acre. Maharashtra is a traditional producer of cotton. Over 80.00 per cent of the production comes from Khandesh, Vidarbha and Marathwada regions and about 3 million farmers are engaged in cotton cultivation in the state mostly in backward regions of Marathwada and Vidarbha. In Vidarbha region, cotton is the most important cash crop and cultivates more than 50.00 per cent cotton area of Maharashtra. Although India stands first in acreage of cotton however the yield is well below the other cotton growing countries. Cotton yield primarily depends on weather, pest, diseases and management practices. Among the several factors that are responsible for the low productivity of cotton in India, the damage caused by insect pests is the major limiting factor. As many as 1326 species of insect pests have been reported on this crop through the world. Also, cotton is subject to severe damage by 162 spp. of pests right from germination to the final picking (Dhaliwal and Arora, 1998) [2]. The global losses due to insect pests were 10.08 per cent towards the beginning of this century, whereas in India, the crop losses are around 17.05 per cent at present. In terms of monetary value, Indian agriculture currently suffers an annual loss of about Rs. 8, 3,884 million due to insect pests (Dhaliwal *et al*., 2010) [3] farmers. Nearly two decades after 1985, bollworms caused yield losses of 30–80% (Kranthi *et al.* 2009) [7].

In 2017 witnessed pink bollworm (PBW) attacks on cotton, in Vidarbha region pink bollworm emerged as a major pest in cotton growing area. One of the most listed reasons of PBW attack is partly to poor or inefficient pest management practices by farmers. Pest management has always been a challenging task and plays an important role in sustaining economic cotton production. Adoption of any improved technology which is recommended by the researchers and extension worker depends on the individual development and acceptance of technology / practices technologies.

Corresponding Author:
Aruna S Katole
Ph.D., Scholar, Department of Extension Education, PGI, Dr. PDKV, Maharashtra, India

As pink bollworm is a prevalent problem of the study area and cotton cultivation offering livelihood security to millions of marginal and small farmers in Vidarbha region. Keeping in view the economic importance of cotton and pest status of pink bollworm, the current study is therefore designed to collect baseline information regarding adoption about improved integrated management practices of pink bollworm by cotton growers with the objective to study the profile and to assess their adoption about improved integrated management practices of pink bollworm which helps to appropriate transfer of technology for better management practices.

Materials and Methods
The present investigation was carried out in six districts of Vidarbha region in Maharashtra considering the maximum area under cotton cultivation namely Buldana, Akola, Amravati, Yavatmal Wardha and Nagpur by conducting field survey with Ex-post-facto research design of social research. On the basis of maximum area under cotton two taluka from each district were purposively selected. From each selected taluka five villages and from each selected villages five cotton growers were selected randomly. Thus, total three hundred cotton growers constituted as sample of the study. The data were collected from cotton growers during 2019-20 by using personal interview method and collected data were tabulated and analyzed by suitable statistical method. For accessing the adoption level of respondent about management practices of pink bollworm, total 21 important statements of university recommended improved integrated management practices of pink bollworm were considered. The responses of the respondents were taken on three point continuum as full adoption, partial adoption and no adoption by assigning the score 2, 1 and 0 respectively. The obtained adoption raw score by the individual respondent was converted in to adoption index with help of following formula.

$$\text{Adoption Index} = \frac{\text{Sum of adoption score obtained by a respondent}}{\text{Sum of obtainable adoption score}} \times 100$$

Results and Discussion
Age of the selected cotton growers
It is observed from Table 1 that nearly one half (51.00%) of the cotton growers were under middle age category. Whereas, 27.33 per cent of cotton growers were young age category and 21.67 per cent were under old age category. It is inferred that nearly one half of cotton growers belongs to middle age (36 to 50 years).

The education level
The data presented in the Table 1 indicated that little less than one half i.e. (45.33%) of the cotton growers were having education up to secondary school (8th to 10th std.) and 25.33 per cent were educated up to higher secondary school (11th to 12th std.). While, 16.33 per cent had graduate (Above 12th std.) and 11.67 per cent had middle school level education i.e. up to (5th to 7th std.). Only 01.34 per cent cotton growers were having primary level education (1st to 4th std.) and no one respondents found under illiterate category.

Occupation of selected cotton growers
From Table 1 revealed that majority (68.00%) of the cotton growers were having agriculture (farming) as their main occupation. While 17.67 per cent of the cotton growers were doing dairy, goat rearing, poultry and tractor driver as an allied occupation along with agriculture and 08.33 per cent of the cotton growers were engaged as farm labour for wage earning as a supportive endeavor to farming. Furthermore very little percent i.e. 04.33 per cent of the cotton growers were doing business like tailoring, kirana shop, cloth shop, hotel, krishi seva kendra with farming and meager 01.67 per cent of them had farming supported by monthly income from salary.

Land holding
It is evident from Table 1 that nearly two fifth (40.33%) of the cotton growers were found to be in semi medium category having land holding between 2.01 to 4.00 hectares, followed by 36.67 per cent cotton growers in medium category possessing land of 4.01 to10 hectares. Whereas 14.33 per cent of cotton growers were small farmers having 1.01 to 2.00 hectares of land holding. While only 07.00 per cent of cotton growers having large land holding above 10.00 hectors and meager (01.67%) of them having marginal land holding up to 1.00 hectors. Thus, it is observed from the above findings that, maximum number of the cotton growers i.e. 40.33 per cent had semi medium (between 2.01 to 4.00 ha) land holders.

Area under cotton cultivation
It is observed from Table 1 that, nearly half of the cotton growers (49.33%) were having 1.51 to 3.00 ha. area under cotton cultivation. Whereas equal numbers (18.00%) of the cotton growers were having Up to 1.50 ha. and 3.01 to 4.50 ha. land under cotton cultivation. While very few of them i.e. 09.00 per cent and 05.67 per cent were having above 6.00 ha. And 4.51 to 6.00 ha. Area under cotton cultivation, respectively. Thus, it is inferred from above finding that, nearly half of cotton growers had up to 1.51 to 3.00 ha area under cotton cultivation.

Farming experience in cotton cultivation
The result from Table 1 shows that nearly two fifth (40.33%) of the cotton growers had farming experience between 11 to 20 years, followed by 24.00 per cent of the cotton growers with farming experience between 21 to 30 years. Nearly equal percentage of the cotton growers 18.67 per cent had above 30 years farming experience and 17.00 per cent of them up to 10 years of farming experience in cotton cultivation.

Irrigation facilities
From Table 1 it is noticed that nearly half i.e. 46.00 per cent of the cotton growers were not having any access as source of irrigation. They solely depended on monsoon rains. Followed by nearly half 44.67 per cent of cotton growers who were having open well / tube well as source of irrigation. While reaming 04.33 per cent cotton growers have canal and 02.67 per cent of them have canal plus well as source of irrigation. Only a very few of them i.e. 01.67 per cent were having river as source of irrigation.

Cropping pattern
As regards to cropping pattern the distribution according to cotton growers cropping pattern is mentioned in Table 1 indicated that more than half i.e. (54.33%) cotton growers were following kharif + rabi season cropping pattern,

followed by 31.33 per cent of cotton growers who were following only kharif season cropping pattern and 14.33 per cent of them were following kharif +rabi + summer season cropping pattern.

Annual income
From the Table1 revealed that little more than two fifth of the cotton growers i.e. 40.67 per cent were having their annual income between Rs. 1,50,000 to 300000/-, followed by 38.33 per cent of cotton growers were having their annual income up to 1,50,000/-. Whereas, 14.33 per cent and 04.67 per cent of the cotton growers were having annual income up to Rs. 3,00,001 to 4,50,000/- and Rs. 4,50,001 to 6,00,000/- annual income, respectively. However, meager i.e. 02.00 per cent of them were having annual income above Rs.6, 00,000/-

Input infrastructure facilities
Nearly half i.e. 48.33 per cent cotton growers were having medium level availability of input infrastructure facilities followed by 43.33 per cent cotton growers were having high level availability of input infrastructure facilities and 08.33 per cent of them had low level availability of input infrastructure facilities for management of PBW.

Source of information
It is observed from Table 21 that 67.00 per cent of cotton growers had used medium level of sources of information. Whereas, almost equal percent i.e. (16.67 and 16.33%) of them had used high and low level of sources of information, respectively.

Extension contact
The data in the Table 1 shows that, majority i.e. 67.00 per cent of the cotton growers had medium level of extension contact, followed by about nearly equal percentage of the Bt cotton growers 16.33 per cent and 16.67 per cent had low and high level of extension contact, respectively.

Economic motivation
It is observed from Table 1 that, majority of the cotton growers i.e. 67.67 per cent had medium economic motivation, followed by 40.00 per cent of the cotton growers who had low economic motivation. While 14.66 per cent of them had high economic motivation.

Risk preference
It is apparent from Table 1 that nearly three fifth i.e. (58.00%) of the cotton growers who adopted improved integrated management practices of pink bollworm exhibited medium risk preference level, followed by 22.00 per cent of the cotton growers had low risk preference level and reaming 20.00 per cent of them high risk preference.

Adoption of cotton growers towards improved integrated practices of pink bollworm
Adoption is the decision to make full use of innovation as the best course of action available. Here it refers full use of improved integrated management practices of pink bollworm. The data in this regard are presented in Table 2 revealed that majority of cotton growers had fully adopted practices such as deep ploughing in the month of March and April (90.33%), clean up/ destruction of cotton stubbles immediate to harvest (88.33%), timely sowing (69.67%), avoiding stacking of

cotton stalks for fuel purpose over long periods summer and use of Pheromone traps (4-5 Pheromone traps/ha) (68.00%), use of neem insecticide during flush and boll formation stage (68.67%).More than half of the cotton growers had fully adopted planting of non -Bt cotton as refugia, timely termination of crop latest by December and avoid ratoon or extended crop, avoid mixed spraying of insecticides/growth chemicals/ chemical fertilizers (57.00%, 56.67% and 52.33%, respectively), followed by use of insecticides according to toxicity triangle (i.e. green, blue, yellow and red) being slightly, moderate, highly and extremely toxic grading, respectively (50.33%), selection of recommended varieties with early maturity (140 to 160 days duration) and resistant to sucking pests (49.33%), sow intercrops like Udid/Mung/Tur/Jowar in cotton (42.00%).The above result shows that wider acceptance of practices by majority of cotton growers the probable reason behind it might be due to it is a general and regular practice in cotton cultivation and favourable acceptance to use of pheromone traps for control of PBW the probable reason behind this it might be due to traps were provided to the cotton growers at subsidized rate from state agriculture department and APMC.

Little more than half of the cotton growers (54.33%) did not use appropriate insecticides as per warning of ETL. While 27.00 per cent of cotton growers were adopted this recommended practice partially and only 18.67 per cent of them were fully adopted application of appropriate insecticides if 5 to 10% loss of boll (warning of ETL) for control of PBW. Whereas more than two third (46.00%) of the cotton growers were fully adopted recommended spraying practice of Choloropyriphos/ Quinalphos/ Thyodicorb at initial stage of ETL for control of PBW followed by 30.67 per cent of them did not adopt this recommended practice and 18.33 per cent of cotton growers were partially adopt this recommended practice. The result indicates that more than one third cotton growers did not adopt recommended insecticides at initial stage of ETL and avoid mixed spraying of insecticides practice. The probable reasons might be that their lack of knowledge of recommended spraying practice and technical guidance on ETL, lack of extension support to educate and providing knowledge to the cotton growers regarding recommended spraying practice and also non availability recommended insecticides at local market. In addition to this a vast network of insecticides companies with local insecticides dealer also lured back recommended insecticides users. This finding supports the finding reported by Shital Mane (2019) [9].

With regards to partial adoption of management practices of PBW by cotton growers more than two fifth i.e. 46.00 per cent of them had partially adopted to allowing cattle grazing of the left over green bolls on the plant at the end of crop season for control of PBW and (37.00%) had partially adopted the use of trichocard (3 card/acre i.e., 20 strips of each card for 7 to 8 times after the formation of flush at the interval of 8 to 10 days) for control of PBW. The probable reason for less adoption of use of trichocard for control of PBW practices might be due to fact that also this practices required more labour and when wages are more it is not economical to the cotton growers and another is in rainy season trichocards become ineffective for use.

Majority (87.67%) of cotton growers did not adopt application of *Beauveria bassiana* @1.15% 50gm/10 lit. for control of larva of pink bollworm, followed by (69.33%) did

not adopt hand plucking of rosette flowers and their distraction along with larvae for control of PBW at initial stage. The result indicates wider non acceptance to application of Beauveria bassiana and mechanical plucking of rosette flowers and destruction of larva. This might be due to lack of proper knowledge about utility of *Beauveria bassiana* as effective bio fungicides and non - availability of it at local market whenever is required. Hence, it is for the extension agencies to educate the cotton growers in this area and their efforts are directed to popularize the use of *Beauveria bassiana* for control of PBW. Nearly similar results were quoted by Dadheech (2010) [1] and Kale *et al.* (2018) [5]. During the interaction with cotton growers most of them opined that mechanical plucking of rosette flowers is not possible because cultivated area of cotton is more and also there is a chance that labour may pluck healthy flower and secondly this practice need more labour which increases cost of cultivation. Due to all above reasons it is seen that they have not fully adopted these practices. Thus this study suggests that the extension agencies educate the cotton growers in this area by organizing the demonstration on farmer's field, organic field school, field visit and convince them about importance of mechanical plucking of rosette flowers and destruction of larva at initial stage and their cost effectiveness.

However, nearly two fifth of cotton growers i.e. (41.67% and 40.33%) were did not adopt excess use of chemicals and insecticides and avoid urea and growth promoting chemicals in the first month after sowing, respectively Similar type of observations mentioned by Khodake (2019) [6]. That means that they are using excess use of chemical insecticides for control of pink bollworm. This might be due to lack of knowledge of recommended insecticides and their thinking that the higher doze of insecticide will result in better control of pest and also misguidance of input dealers for their sale.

These are the probable reasons restricting them from fully adopting this practice. This area needs the attention of extension functionaries. Hence, it is necessary to educate the cotton growers and provide them knowledge regarding recommended insecticides and severe consequences of indiscriminate use of chemical insecticides.

Adoption level of cotton growers about improved integrated management practices of pink bollworm
The data with regards to the adoption level about improved integrated management practices of pink bollworm are presented in Table 3 indicated that slightly more than two fifth (41.33%) of the cotton growers had medium adoption level about improved integrated management practices of pink bollworm. While, 38.33 per cent and 20.34 per cent of them had high and low adoption level about improved integrated management practices of pink bollworm, respectively.

Thus, it could be concluded that majority (79.66%) of the cotton growers had medium to high adoption level about improved integrated management practices of pink bollworm. The probable reason behind this is that majority of the cotton growers had high knowledge and majority of them had medium economic motives. Secondly it was also observed that 20.34 per cent of the cotton growers were having low adoption level of pink bollworm managements practices. This might be serious issue for control of pandemic of pink bollworm. Because one boll of cotton is sufficient for one or many bollworm larvae to complete their life cycle and a single caterpillar can damage more than 50-60 bolls. Hence extension functionaries may take care of this group of cotton growers for avoiding spread of pink bollworm.

The above findings are in line with the findings of Ram *et al.* (2012) [8], Ghuge (2019) [4], Khodake (2019) [6], Shital Mane (2019) [9] and Todkar *et al.* (2020) [10].

Table 1: Distribution of the cotton growers according to their profile characteristics

Sl. No	Particulars	Respondents (n=300)	
		Frequency	Percentage
1	**Age of the cotton growers**		
	Young (Up to 35)	82	27.33
	Middle (36 to 50)	153	51.00
	Old (Above 50)	65	21.67
	Total	300	100.00
2.	**Education (Std.)**		
	Illiterate (No Schooling)	00	00.00
	Primary school (1st to 4th std)	04	01.34
	Middle school (5th to 7th std)	35	11.67
	Secondary school (8th to 10thstd)	136	45.33
	Higher secondary school (11th to 12thstd)	76	25.33
	Graduate (Above 12th std)	49	16.33
	Total	300	100.00
3.	**Occupation**		
	Agriculture (Farming)	204	68.00
	Agriculture+ labour	25	08.33
	Agriculture + allied occupation	53	17.67
	Agriculture +business	13	04.33
	Agriculture +service	05	01.67
	Total	300	100.00
4.	**Land holding (ha.)**		
	Marginal (Up to 1.00 ha)	05	01.67
	Small (1.01 to 2.00 ha)	43	14.33
	Semi-medium (2.01 to 4.00)	121	40.33
	Medium (4.01 to 10.00 ha)	110	36.67

	Large (Above 10.00)	21	07.00
	Total	300	100.00
5.	**Area under cotton cultivation (ha.)**		
	Up to 1.50 ha.	54	18.00
	1.51 to 3.00 ha.	148	49.33
	3.01 to 4.50 ha.	54	18.00
	4.51 to 6.00 ha.	17	05.67
	Above 6.00 ha.	**27**	09.00
	Total	300	100.00
6.	**Farming experience in years**		
	Up to 10 years	51	17.00
	11 to 20 years	121	40.33
	21 to 30 years	72	24.00
	Above 30 years	56	18.67
	Total	300	100.00
7.	**Source of irrigation**		
	No source / rainfed	142	47.33
	River	05	01.67
	Well/ Tube well	132	44.00
	Canal	13	04.33
	Canal + Well	08	02.67
	Total	300	100.00
8.	**Cropping pattern**		
	Kharif	94	31.33
	Kharif + Rabi	163	54.33
	Kharif + Rabi + Summer	43	14.34
	Total	300	100.00
9.	**Annual income (Rs.)**		
	Up to Rs.1,50,000 /-	115	38.33
	Rs.1,50,001 to 3,00,000/-	122	40. 67
	Rs. 3,00,001 to 4,50,000 /-	43	14.33
	Rs. 4,50,001 to 6,00,000/-	14	04.67
	Above Rs. 6,00,000/-	06	02.00
	Total	300	100.00
10.	**Input infrastructure facilities**		
	Low	25	08.34
	Medium	145	48.33
	High	130	43.33
	Total	300	100.00
11	**Source of information**		
	Low	49	16.33
	Medium	201	67.00
	High	50	16.67
	Total	300	100.00
12	**Extension contact**		
	Low	49	16.33
	Medium	201	67.00
	High	50	16.67
	Total	300	100.00
13	**Economic motivation**		
	Low	53	17.67
	Medium	203	67.67
	High	44	14.66
	Total	300	100.00
14.	**Risk preference**		
	Low	66	22.00
	Medium	174	58.00
	High	60	20.00
	Total	300	100.00

Table 2: Distribution of the cotton growers according to their adoption about improved integrated management practices of pink bollworm

Sl. No.	Improved integrated management practices of pink bollworm	Adoption (n=300)		
		FA (2) Freq. (%)	PA (1) Freq. (%)	NA (0) Freq. (%)
1.	Timely termination of crop latest by December and avoid ratoon and /or extended crop	170 (56.67)	87 (29.00)	43 (14.33)
2.	Allowing cattle grazing of the left over green bolls on the plant at the end of crop season	133 (44.33)	138 (46.00)	29 (09.67)
3.	Clean up/ destruction of cotton stubbles immediate to harvest	265 (88.33)	15 (05.00)	20 (06.67)
4.	Avoiding stacking of cotton stalks for fuel purpose over long periods summer	204 (68.00)	57 (19.00)	39 (13.00)
5.	Deep ploughing	271 (90.33)	08 (02.67)	21 (07.00)
6.	Selection of recommended varieties with early maturity(140 to 160 days) duration and resistant to sucking pests	148 (49.33)	89 (29.67)	63 (21.00)
7.	Timely sowing (avoid pre monsoon sowing)	209 (69.67)	80 (26.67)	11 (03.66)
8.	Planting of non -Bt cotton as refugia	171 (57.00)	63 (21.00)	66 (22.00)
9.	Sow intercrops like Udid/Mung/Tur/Jowar in cotton	126 (42.00)	79 (26.33)	95 (31.67)
10.	Follow crop rotation	48 (16.00)	111 (37.00)	141 (47.00)
11.	Avoid excess use of urea and growth promoting chemicals in first month after sowing	91 (30.33)	88 (29.34)	121 (40.33)
12.	Avoid excess use of chemical insecticides	113 (37.67)	62 (20.66)	125 (41.67)
13.	Use of trichocard (3 card/acre i.e. 20 strips of each card for 7 to 8 times after the formation of flush at the interval of 8 to 10 days)	93 (31.00)	111 (37.00)	96 (32.00)
14.	Use of Pheromone traps (4-5 Pheromone traps/ha)	204 (68.00)	80 (26.67)	16 (05.33)
15.	Mechanical plucking of rosette flowers from initiation at weekly interval and their distraction along with larvae	00 (00.00)	92 (30.67)	208 (69.33)
16.	Use of neem insecticide during flush and boll formation stage	206 (68.67)	58 (19.33)	36 (12.00)
17.	Application of *Beauveria bassiana* @1.15% 50gm/10 lit. for control of larvae of pink bollworm	19 (06.33)	18 (06.00)	263 (87.67)
18.	Application of appropriate insecticides if 5 to 10% loss of boll (warning of ETL)	56 (18.67)	81 (27.00)	163 (54.33)
19.	Application of Choloropyriphos/Quinalphos/Thyodicorb at initial stage of ETL	138 (46.00)	55 (18.33)	107 (35.67)
20.	Avoid mixed spraying of insecticides/growth chemicals/chemical fertilizers	157 (52.33)	51 (17.00)	92 (30.67)
21.	Use of insecticides according to toxicity triangle (i.e. green, blue, yellow and red) being slightly, moderate, highly and extremely toxic grading, respectively	151 (50.33)	47 (15.67)	102 (34.00)

Figures in parentheses indicate percentage

Table 3: Distribution of the cotton growers according to their adoption level about improved integrated management practices of pink bollworm

Sl. No.	Adoption level	Respondents (n=300)	
		Frequency	Percentage
1.	Low (Up to 33.33)	61	20.34
2.	Medium (33.34 to 66.67)	124	41.33
3.	High (Above 66.67)	115	38.33
	Total	300	100.00

Conclusion
The present study pointed out that recommended improved integrated management of pink bollworm namely mechanical plucking of rosette flowers and their distraction along with larvae, application of *Beauveria bassiana*, application of appropriate insecticides as per ETL, avoid excess use of chemical insecticides, urea and growth promoting chemicals and their mix spraying, planting of non -Bt cotton as refugia, fallow crop rotation and use of trichocard these are complex and difficult to remember are moderately known to cotton growers and same for their adoption. On the other hand, the practices which are simple and generally practiced like timely termination of crop latest by December and avoid ratoon, allowing cattle grazing of the left over green bolls on the plant at the end of crop season cleanup/ destruction of cotton stubbles immediate to harvest, avoiding stacking of cotton stalks for fuel purpose over long periods summer, deep ploughing and timely sowing were known to majority growers and were also adopted by majority of the cotton growers. Hence this implies that the extension agencies working on management practices of pink bollworm need to work with the cotton growers closely and for long enough (at least 2 years) and more emphasis should be given on these practices which are complex and difficult to understand for fullest

extent of adoption of recommended improved integrated management practices of pink bollworm.

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