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Evaluating the Impacts of Integrated Pest Management Techniques on Cotton Crop for Cost-effectiveness as Recommended by Dr. PDKV, Akola, Maharashtra, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Since cotton is a major crop grown for commercial purposes in the Vidarbha region, Dr. PDKV Akola conducted and recommended the current study, which has several goals, including determining the extent to which recommended technology has been adopted in cotton production, examining input utilization in cotton at varying levels of adoption of IPM technology, calculating the cost-effectiveness and profitability of cotton at varying levels of adoption of IPM technology, and analyzing the barriers to technology adoption. The districts of Akola and Buldhana in Maharashtra State's Vidarbha area served as the study's locations. Three tahasils—Akola, Akot, and Sangrampur—were chosen from these districts, and 120 farmers were chosen from these villages, namely Varvat Khanderao, Khiroda, Sangrampur, Rambhapur, Mandala, Kinkhed Purna, and Khambora. The primary data, which cover the years 2022–2023, were gathered using a straightforward random sample technique. As a result of input usage, the group with a high adoption level utilized the most human labor. All three categories had seed rates, resistant variety usage at the indicated level, and sowing times that were closer to the recommended level. Farmyard manure, at 30.68 quintals per hectare, is most commonly used in the high adopter category. This is followed by medium adopters (16.80 q/ha) and low adopters (14.05 q/ha). The results of applying fertilizer (NPK) indicate that more was applied in all three categories at the recommended level. The highest per hectare yield, 16.64 quintals, was recorded by the high adopter group, followed by 14.01 quintals for the medium adopter group, and 12.71 quintals for the low adopter group. The net returns at Costs "A1," "B2," and "C2" were in the high adopter category, with amounts of Rs. 76557.94/-, Rs. 59781.64/-, and Rs. 50163.47/-. For low, medium, and high adopters, the input-output ratios at cost "A1" were 1.95, 2.05, and 2.27, respectively, but the input-output ratios at cost "C2" were 1.36, 1.43, and 1.58 for these same adopters. High adopter farmers saved Rs. 599.58 and Rs. 854.32/-per quintal at Costs "A1" and "C2" as a result of the per unit cost decrease. IPM technology was discovered to make cotton farming profitable because it reduced the cost of plant protection measures while simultaneously increasing yield. As a result, all cotton growers need to employ IPM technology more widely.

Keywords: Economic impact; pricipal component analysis; input-output ratio and composite index.

1. INTRODUCTION

The first IPM initiative in India was the Operational Research Project (ORP), which was implemented in rice and cotton between 1974 and 1975 Swaminathan, [1]. Promoting and assisting safe, efficient, and environmentally responsible pest management is the primary goal of IPMP.Integrated pest management techniques play a significant part in improving output both quantitatively and qualitatively. It directly affects the profitability of the economy. Furthermore, it has been demonstrated that IPM is a cost-minimization strategy [2].

Since cultivators see this topic as being of utmost importance, the research topic has been chosen for its economic investigation in varying degrees of IPM technology adoption. Acceptedly, IPM is the only practical way to lessen reliance on chemical input. By giving more weight to biological management, this environmentally safe, ecologically sound, and sustainable option helps to reduce the usage of pesticides. In order to reduce the use of pesticides and manage insects, it is crucial to apply integrated pest management (IPM) techniques wisely and promptly. Therefore, it's important to determine the current state of understanding and adoption of IPM techniques for cotton pest management, as well as the obstacles farmers experience in implementing IPM technology.

With a specific focus on cotton production, the study aimed to determine the extent of adoption of recommended technology, analyze the barriers to technology adoption, and determine the cost-effectiveness and profitability of cotton at varying levels of IPM technology adoption. Additionally, the study examined the input utilization in cotton at different adoption levels.

2. METHODOLOGY

Dr. PDKV, Akola's recommended technologies for the Impact Assessment of Integrated Pest Management on Cotton Production were taken into consideration with input from the Cotton Research Unit and Entomologist. The study was conducted in the districts of Akola and

Buldhanain the Vidarbha area. The study's primary data are employed. The area used for cotton farming determined the selection of the three tahasils, Akola, Akot, and Sangrampur. Out of the three tahasils, seven villages were selected: Khambora, Madala, Kinkhed Pruna, Rambhpur, Sangrampur, Khiroda, and Varvat Khanderao. One hundred and twenty cultivators were selected in order to collect the required data. The data pertains to 2022–2023.

2.1 Recommended Technologies of Cotton

The goal of the study is to determine how much farmers in Akola, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, have adopted various technologies compared to the suggested level. Akola has developed a number of technologies that were thought to be recommended. Chart 1 presents the data about these points.

Chart 1. Recommended technologies developed by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in Cotton crop

S.N.	Technology	Units	Recommendation
A	**Cultural Control**		
1	Grazing animals (Sheep,Goatetc)		End Dec. to Jan.
2	Ploughing		1
3	Burning of plat debris & Cleaning Campaign		Yes/No
4	Sowing time		Second week of June to First week of Jully
5	Resistant variety		e.g. PKV 5 PKV Suvarna, AKH 8828,
6	Seed rate	kg/ha	2.00 to 2.50 kg/ha
7	FYM	Qtl/ha	50 qunitals /ha
8	Fertilizer N P K	 kg/ha kg/ha kg/ha	 60 30 30
9	Crop Rotation		Cotton – Soybean – Gram Cotton – Mung – Safflower Cotton – Udid – Safflower Cotton – Jowar – Gram
10	Inter cropping		Cotton +Mug/Udid(1:1) Cotton + Jowar + tur + Jowar(3:1:1:1) Cotton + Tur(8 to 10:1)
B	**Mechanical Control**		
1	Use of Proper Spacing between plant		90 x 45, 60 x 30 & 60 x 45
2	Removal of Rosette flower and removal of infested plant parts		Remove and destroy the pest affected plant/plant parts at the beginning when the infestation is very high.
3	Use Pheromone trap/Light trap/Yellow Sticky trap	Per/ha	P.T. : 4 per ha Y,S.T.: 25 per ha. L.T. : 1 per ha.
4	Installation of Bird perches	Per/ha	10-12 per ha
C	**Biological control**		
1	Use of Biological Sprey		Spray of NSE 5% or Azadirachtin formulation
2	Use of Trichogramma Card		40-50 DAS
D	**Chemical Control**		
1	Use of Pesticide		Eg. : Ethion, Quinalphos, Fipronil, Chorpyrifos, Acephate etc. Combination of Insecticide

2.2 Analytical Techniques

The Impact Assessment of Integrated Pest Management (IPM) technology on Cotton Production, as proposed by Dr. PDKV Akola, looked at the level of technology acceptance, input utilization, profitability, and cost-effectiveness at different IPM technology adoption levels.

2.2.1 To assess the extent of adoption of selected technologies

For the first objective of the study, the extent of adoption of technologies of Cotton crop following formulae was used,

$$TAI = \frac{1}{k}\left[\frac{AX_1}{RX_1} + \frac{AX_2}{RX_2} + \cdots + \frac{AX_K}{RX_K}\right] X\ 100$$

Where,

TAI = Technology Adoption Index

K = No. of technologies

AXi = Actual use of selected technology

RXi = Recommended use of selected technology.

The University of Cotton Crop's Principal Components of Technology, represented in terms of adoption score (X1, X2, --------- Xn), were used to produce the technological adoption index of adopted technology. An index of technological adoption is a single number that ranges from 0 to 1 that indicates the net adoption of all technology components.

2.2.2 Development of composite Index

The University's recommended technology components for cotton crops were expressed as adoption scores (X1, X2,..., X19), and used to create a composite indicator of adopted technology. One number that represents the net adoption of all technology components with values between 0 and 1 is called a composite index. The composite index was developed using the Principal Component Analysis (PCA) approach Snehal Datarkar, [3] and Omaid S/O Najamuddin, [4]. The main components were calculated using a 19 x 19 co-relation matrix containing 19 technological components. A group of 19 fundamental elements that accounted for all of the variance in all of the suggested.

Consider 19 eigen vectors in the form of 19 x 19 matrix where rows represent variables and columns represent eigen vectors from which weight (wi) coefficient of component of technology say Σ was determined as under.

$$Wi = \frac{Mi}{\Sigma Mi}$$

Where,

Wi = Weight
Mi = Maximum element in ith raw
ΣMi = Sum of maximum element in ith raw.

2.2.3 Development of composite of technology

The components of technologies recommended by the University for Cotton were identified and then the level of adoption of each component of recommended technology be the farmer is expressed in terms of adoption scores and the same is utilized for developing composite scores of technology adoption.

In this process, weights were properly scaled so that the composite scores lie in between 0 and 1. Composite scores were computed for all selected farmers using the following function.

2.2.4 Development of composite Index (scores) of technology

The estimated composite adoption score (Si) is;

$$S_i = W_1X_1 + W_2X_2 + \text{--------} + W_{19}X_{19}$$

Where,

S_i = Composite Index of i^{th} farmers, X_1 = Grazing Animals, X_2 =Burning of Plant, debris and cleaning compaign, X_3 = Ploughing, X_4 = Sowing time, X_5 = Resistant variety, X_6 = Seed rate, X_7 = FYM, X_8 = Nitrogen, X_9 = Phosphorous, X_{10} = Potassium, X_{11}= Crop Rotation, X_{12}= Intercropping, X_{13} = Spacing between the plant, X_{14} = Removal of Rosette flower and removal of infested plant parts, X_{15} = Use of Phromane trap/Light trap/ Yellow sticky trap, X_{16} = Installation of Bird perches, X_{17} = Use of Trichhogamma card, X_{18} = Use of bio logical control, X_{19} = Use of pesticide, W_i = Use of weight given of i^{th} technology

Which provides adoption index (of all component of technologies) for each cultivator. The composite index obtained in the process lie in between 0 & 1.

The net adoption of recommended technologies expressed in terms of "Technological adoption Index" of the 120 farmers are classified as below.

Low adopter = Mean - SD

Medium adopter = Mean - SD to Mean + SD

High Adopter = Mean + SD

2.2.5 To study the input utilization at different level of adoption of IPM technology

The objective of the input utilization at different level of adoption of IPM technology were worked out by on the basis of level of adoption i.e. low, medium and high level of adoption of technologies.

2.2.6 To workout cost effectiveness and profitability at different level of adoption of IPM technology

After developing technologies adoption index, farmers were classified into low, medium and high adopters on the basis of technological adoption index.

The standard cost concept viz; Cost 'A_1', Cost 'A_2', Cost 'B_1' Cost 'B_2' Cost 'C_1' Cost 'C_2' and Cost 'C_3' were used to estimate per ha cost of cultivation of Cotton.

Gross Return: Return obtained from the sale of crops output i.e. Main Produce and by-produce.

Net Return: Net returns were computed at different costs i.e. Cost 'A_1' , Cost 'A_2', Cost 'B_1' Cost 'B_2' Cost 'C_1' Cost 'C_2' and Cost 'C_3' by deducting respective costs from the gross returns.

Input output Ratio: The Output – input ratio were worked out with reference to Cost 'A_1' , Cost 'A_2', Cost 'B_1' Cost 'B_2' Cost 'C_1' Cost 'C_2' and Cost 'C_3'.

2.3 To Analysethe Constraint of Non-Adoptability of Technology

The constraints faced by non adoptability of IPM technologies of the Cotton grower were identified. Garrett's ranking technique were used to rank the problems faced in the non-adoptability of IPM technologies of Cotton growers [5]. The problems in non-adoptability of IPM technologies of Cotton faced by cultivators were collected and the respondents were asked to rank their priority of problems and ranks given by respondents was converted into per cent position by using the following formula.

$$\text{Per cent position} = \frac{100(R_{ij} - 0.50)}{n_j}$$

Where,

R_{ij} = Rank given for the i^{th} factor by jth individual.

n_j = Number of factors ranked by j^{th} individual

The percent position for each rank was converted into score by using Garrett's table. The scores given by individual to total number of respondents were added. The mean scores of all problems were arranged in descending order and ranks was given accordingly.

3. RESULTS AND DISCUSSION

Keeping in view the objectives of the study, the data were analyzed using suitable techniques. The results obtained from this study have been presented and discuss critically.

3.1 Adoption Range of Different Adopter Group on the Basis of Composite Index

The adoption index calculated the levels of adoptions and the distribution of 120 farmers as per their adoption level of recommended technologies is presented in Table1.

The technology adoption index for each recommended technology were estimated with the help of mean and standard deviation. The adoption levels were calculated and accordingly, the adoption of each technology under low, medium and high adoption level.

The Table 5. show that the farmers whose adoption index was below 63.34 per cent were distributed into low adoption group, The farmers whose adoption index was between 63.35 to 78.11 per cent were distributed into medium group and similarly the farmers with composite adoption index more than 78.11 per cent were

Table 1. Adoption range of different adopter group in Cotton

S.N.	Particular	Low adopter	Medium adopter	High adopter
1	Total number of farmers	120		
3	Adoption Range (%)	Below 63.34	63.35 to 78.11	Above 78.11
4	No. of farmers	22	79	19
5	Percentage to number of farmer	18.33	65.83	15.84

Table 2. Extent of adoption of technology

S.N.	Particular	Extent of Adoption (%)		
		Low adopter (N = 22)	**Medium adopter (N = 79)**	**High adopter (N = 19)**
a	**Cultural Practices**			
	Farm preparation (Grazing, Burning of Plant debries& Field Pre.)	86.36	93.67	94.74
	Sowing time	90.91	91.14	100.00
	Short & Medium duration variety	100.00	100.00	100.00
b	**Seed Rate**	100.00	100.00	100.00
c	**FYM**	25.37	33.61	38.01
d	**Fertilizer**			
	N	111.48	109.70	104.43
	P	140.60	136.16	136.58
	K	139.55	115.85	112.51
e	**Inter cropping**	45.45	73.42	84.21
6	**Crop Rotation**	77.27	88.61	100.00
7	**Mechanical Control**			
	Proper Spacing	86.36	91.14	94.74
	Removal of Rosette flower and removal of infested plant parts	27.27	64.56	89.47
	Use Pheromone trap/Light trap/Yellow Sticky trap	9.09	21.52	52.63
	Installation of Bird perches	18.18	40.51	63.16
8	**Biological Control**			
	Biological Spray	4.55	31.65	47.37
	Use of Trichogramma Card	0.00	10.13	31.58
9	**Chemical Control**			
	Use of Pesticide	100.00	72.15	57.89

categorized among the high level of adopters. Out of 120 selected farmers, 19 farmers had high level of adoption with composite adoption index, above 78.11 per cent, 79 farmers had medium level of adoption with composite adoption index 63.35 to 78.11 per cent while 22 farmers had low level of adoption with composite adoption index of below 63.34 per cent. It is concluded that the highest percentage of adoption level of technology was above 88.37 per cent. It means recommended technologies were not fully adopted in high adoption level categories.

3.2 Extent of Adoption Technology

Actual level of adoption of each item of technologies by farmer's was identified with the help of recommended technologies developed by Dr. P.D.K.V., Akola. The efficiency of each technology was calculated. All efficiency score was scaled down to 0 to 1. All the selected farmers having more or less similar type of soil, therefore, the recommendation of soil type was not considered.

It is observed from the Table 2, that among the recommended technologies all level, the cultural control technology of IPM, the use of resistant variety has been adopted at 100.00 per cent. Sowing time was followed by the recommended level i.e. 90.91, 91.14 and 100. Per cent in low, medium and high adopter categroeies respectively. Seed Rate used in cotton growers was 89.97, 96.97 and 99.47 per cent respective categories. Among the comparison of all three adoption levels, the Nitrogen, Phosphorus and Potassium was not used at recommended level in all three categories. It means the fertilizers were used by farmers more, at recommended level, in all three categories. The lowest adoption was observed in farm yard manure application i.e. 25.37, 33.61 and 38.01 per cent in low, medium and high adopter categories. The resones of low application of FYM, farmers used only owned farm FYM. In case of mechanical control of IPM technology, the highest adoption was proper spacing and Removal of Rosette flower and removal of infested plant parts in both high and medium adopter categaories. For use of pheromone trap it was highest in high adopter group i.e 52.63 per cent followed by medium and low adopter category i.e 21.52 and 9.09 per cent respectively. In biological control of IPM technology has been adopted 78.95 per cent in high adoption group. In case of low adopter group not used in biological control, it means farmers were not aware and lack of knowledge of biological control. In case of chemical control, was used 100 per cent in low adopter group followed by medium (72.15 %) and high adopter group (57.89%). In overall study, concluded that the adoption of all 18 technologies were highest in high adoption level group. Moreover, technology of sowing time, use of resistant variety, use of trichoderma, FYM and biological control is very negligible use in low adopter group. It was due to unawareness about the importance and proper knowledge about the technologies.

3.3 Input Utilization

The information about per hectare physical input used by selected farmer according to their adoption of recommended technology level is shown in Table 3.

From the Table 3, it was revealed that per hectare labour utilization was observed in small, medium and high levels of group i.e. 106.19, 109.70 and 113.20 days respectively. It was observed that the human labour utilization was highest in high adoption level group. Per hectare seed rate was used at recommended level in all three categories i.e. 2.00 kg to 2.50 kg per hectare. It shows that, in all three adoption level, seed rate was recommendation level.

Machinery charges were the highest for high adopter group i.e 32.09 hours per hectare followed by medium adopter with 27.54 hours per hectare.

Among the farm yard manure, highest used in high adopter group i.e. 30.68 quintal per hectare followed by medium adopter (16.80 q/ha) and low adopter (14.05 q/ha). In low adopter group shows that negligible use in FYM. The reasons of low application of FYM, farmers are apply only owned farm FYM due to shortage of cattles population.

In case of use of nitrogen fertilizer for low, medium, high adopter group was 66.89 kg per hectare, 65.82 kg per hectare, 62.66 kg per

Table 3. Input utilization at different level of adoption of IPM technology (Per ha)

S.N.	Input Utilization	Unit	Low adopter (N = 22)	Medium adopter (N = 79)	High adopter (N = 19)
1	Male Labour	Days	32.60	34.53	31.86
2	Female Labour	Days	73.59	75.17	81.34
	Total Human Labour	Days	106.19	109.70	113.20
4	Bullock Labour	Days	7.66	7.36	7.59
5	Machine Labour	hrs	24.21	27.54	32.09
6	Seed rate	Kg/ha	2.34	2.30	2.26
7	FYM	Qtl/ha	14.05	16.80	30.68
8	Fertilizer				
	N	Kg/ha	66.89	65.82	62.66
	P	Kg/ha	42.18	40.85	40.97
	K	Kg/ha	41.87	34.76	33.75

hectare respectively. And for the phosphorus, was adopted 42.18 kg per hectare, 40.85 kg per hectare, 40.97 kg per hectare for low, medium, high adopter groups respectively. Among potassium fertilizer were used 41.87 kg per hectare, 34.76 kg per hectare and 33.35 kg per hectare for low, medium, high adopter group respectively.

The results of application of fertilizer shows that NPK was used more at recommended level in all three categories.

3.3.1 Cost effectiveness and profitability at different level of adoption of IPM technology

The information regarding per hectare cost of cultivation of soybean on the farms of low, medium and high adopter groups is presented in Table 4. The cost has determined on the basis on the standard cost concept viz; Cost 'A_1', Cost 'A_2', Cost 'B_1', Cost 'B_2', Cost 'C_1', Cost 'C_2'and Cost 'C_3' the different cost concept have different utilities in research. Here on attempts has been made to estimate the figure of cost of cultivation of cotton cultivation in study area.

The Table 4 revealed that, per hectare cost of cultivation at Cost A_1 was highest for high adopter group i.e. Rs 60454.71/- followed by medium and low level of adoption groups i.e. Rs 56109.31/- and Rs. 53797.33/- respectively. The resons of increased in Cost A_1, the cost of hired human labour and cost of FYM is very high in high adoption group as compared to medium and low adoption group. The expenditure of Integrated pest Management components was highest in low adopter categories (Rs 4969.57/-) as compared to medium(Rs. 4508.22/-) and high adopter(Rs.4184.31/-) categories. The reasons of low adopter, high expenditure of Integrated pest management components was the 100 per cent farmers can use chemically control that means 3 to 4 spraying was use in cotton in low adopter group.

In case of Cost 'B_2' contribution to total cost was 78.39 per cent i.e. Rs.66564.97/-, 79.35 per cent i.e. Rs. 70196.00/- and 80.84 per cent i.e. 77231.02/- for low, medium and high adopter group respectively. The rental value of land is a major item in Cost B_2 that covered 7.39 per cent, 7.82 per cent and 8.61 per cent in low, medium and high adopter group respectively.

The Cost C_2'was also observed that to be highest for high adopter i.e. Rs. 86849.19/- followed by medium adopter i.e. Rs. 80424.97/- and low level of adoption group i.e. Rs. 77194.35/-. The low adopter group count more family labour charges i.e. 12.52 per cent as compared to medium (11.56%) and high adopter group(10.07%).

In overall study concluded that, the Cost 'A_1', Cost 'A_2', Cost 'B_1', Cost 'B_2', Cost 'C_1', Cost 'C_2 'and Cost ''C_3'were the highest for high adopter groups, while it was lowest for low adopter group. Further it depicted that highest technology was adopted in high adopter group because of it the requirement of cost was high for high adopter group as compared to medium and low adopter group.

3.2 Economics of Production of Cotton

The economics of production of Cotton as per the technology adoption level i.e. low, medium and high adoption is presented in the Table 5.

From the Table 5, it is observed that the per hectare yield of low, medium and high adopters was 12.71 quintals, 14.01 quintals and 16.64 quintals, respectively. The gross return of low adopter, medium adopter and high adopters was Rs. 104683.43/-, Rs. 115295.80/-. and Rs. 137012.65/-, respectively.

The per hectare Cost 'A_1' of low, medium and high adopters was Rs. 53797.33/- Rs. 56109.31/- and Rs. 60454.71/- respectively.

The. per hectare Cost 'B_2' was Rs. 66564.97/-, Rs.70196.00/- and Rs. 77231.02/- of low, medium and high adopters, respectively. At overall level, it was Rs. 71330.66/- per hectare. The per hectare Cost 'C_2' of low, medium and high adopters was Rs. 77194.35/- Rs. 80424.97/- and Rs. 86849.19/-, respectively.

The net returns at Cost 'A_1' Cost 'B_2'and Cost 'C_2' was in high adopters i.e. Rs. 76557.94/-, Rs.59781.64/- and Rs. 50163.47/- respectively followed by medium adopter i.e. Rs. 59186.49, Rs 45099.79/- and Rs. 34870.82/- and lowest in low adopters i.e. Rs. 50886.10/-., Rs.38118.46/- and Rs. 27489.08/- respectively.

The result of Input output Ratio at Cost 'A_1' was 1.95, 2.05 and 2.27 in low, medium and high adopters, respectively, while Input output ratio at Cost 'B_2' was 1.57, 1.64 and 1.77 for low, medium and high adopters, respectively, In case of Input output ratio at Cost 'C_2' for low, medium, high adopter 1.36, 1.43 and 1.58 respectively.

Table 4. Cost of cultivation of different level of adoption of IPM technology

(Rs./ha.)

S.N.	Particular	Low Adoption (N = 22)	Per cent	Medium Adoption (N = 79)	Per cent	High Adoption (N = 19)	Per cent
1	Hired Human Labour	17104.88	20.14	18725.26	21.17	21209.45	22.20
2	Bullock labour	5368.58	6.32	4753.71	5.37	4546.66	4.76
3	Machine Charges	6351.05	7.48	6866.68	7.76	6779.06	7.10
4	Seed Rate	3717.02	4.38	3648.44	4.12	3602.43	3.77
5	FYM	2107.64	2.48	2520.65	2.85	4602.32	4.82
6	Fertilizer	4928.03	5.80	4529.52	5.12	4411.16	4.62
7	Micro Nutrients	333.62	0.39	381.51	0.43	433.52	0.45
8	Integrated Pest Management Components	4969.57	5.85	4508.22	5.10	4184.31	4.38
9	Incidental Charges	2439.75	2.87	2453.15	2.77	2537.62	2.66
10	Repairing Charges	1282.93	1.51	1824.38	2.06	2040.07	2.14
11	Growth Regulator	191.10	0.23	274.97	0.31	328.12	0.34
12	Weedicide	258.05	0.30	277.60	0.31	147.40	0.15
13	**Working Capital (1 to 12)**	**49052.22**	57.77	**50764.09**	57.38	**54822.13**	57.38
14	Interest on Working Capital	2943.13	3.47	3045.85	3.44	3289.33	3.44
15	Depreciation	1779.39	2.10	2269.97	2.57	2314.69	2.42
16	Land revenue	22.59	0.03	29.40	0.03	28.57	0.03
17	**Cost 'A_1' (items 13 to 16)**	**53797.33**	63.36	**56109.31**	63.42	**60454.71**	63.28
18	Rental Value of Leased Land	0.00	0.00	0.00	0.00	0.00	0.00
19	**Cost 'A_2'(items 17 to 18)**	**53797.33**	63.36	**56109.31**	63.42	**60454.71**	63.28
20	Interest on fixed Capital	6488.46	7.64	7167.97	8.10	8553.83	8.95
21	**Cost 'B_1' (items 19 +20)**	**60285.79**	71.00	**63277.28**	71.53	**69008.54**	72.23
22	Rental value of land	6279.17	7.39	6918.72	7.82	8222.48	8.61
23	**Cost 'B_2' (Items 21 to 22)**	**66564.97**	78.39	**70196.00**	79.35	**77231.02**	80.84
24	Family Labour	10629.38	12.52	10228.97	11.56	9618.17	10.07
25	**COST 'C_1' (Item 21+24)**	**70915.18**	83.51	**73506.25**	83.09	**78626.71**	82.30
26	**COST 'C_2' (Items 25+24)**	**77194.35**	90.91	**80424.97**	90.91	**86849.19**	90.91
27	10 Per cent 'C_2'	7719.43	9.09	8042.50	9.09	8684.92	9.09
28	**Cost 'C_3 '**	**84913.78**	100.00	**88467.47**	100.00	**95534.11**	100.00

Note: Figures in parentheses indicate the percentages to total cost

Table 5. Economics of Production of different level of adoption of IPM technology

(Per hectare)

S.N.	Particulars	Units	Low adopter (N = 09)	Medium adopter (N = 57)	High adopter (N = 54)
1	Yield	qtl/ha	12.71	14.01	16.64
2	Rate	Rs./qtl	8239.55	8227.97	8232.63
	Gross Produce	Rs.	**104683.43**	**115295.80**	**137012.65**
3	**Cost**	Rs.			
	Cost 'A_1'		53797.33	56109.31	60454.71
	Cost 'A_2'		53797.33	56109.31	63782.85
	Cost 'B_1'		60285.79	63277.28	69008.54
	Cost 'B_2'		66564.97	70196.00	77231.02
	Cost 'C_1'		70915.18	73506.25	78626.71
	Cost 'C_2'		77194.35	80424.97	86849.19
4	**Net Return at**	Rs.			
	Cost 'A_1'		50886.10	59186.49	76557.94
	Cost 'A_2'		50886.10	59186.49	73229.81
	Cost 'B_1'		44397.63	52018.52	68004.11
	Cost 'B_2'		38118.46	45099.79	59781.64
	Cost 'C_1'		33768.25	41789.54	58385.94
	Cost 'C_2'		27489.08	34870.82	50163.47
5	**Input output Ratio at**				
	Cost 'A_1'		1.95	2.05	2.27
	Cost 'A_2'		1.95	2.05	2.15
	Cost 'B_1'		1.74	1.82	1.99
	Cost 'B_2'		1.57	1.64	1.77
	Cost 'C_1'		1.48	1.57	1.74
	Cost 'C_2'		1.36	1.43	1.58

The results concluded that the low adopters group are not making more profit. It indicates that, as adoption of technology increases the yield level of crop and so that the net returns also increases.

3.3 Reduction in Unit Cost of Cotton

Unit cost of production (per quintal production cost) was estimated to compare within the technology adopters and is given in the Table 6.

From the Table 6, it is observed that the cost of cultivation increases as the technology adoption increase. The change in yield was calculated over the low adopters. The change in yield was more (3.94 q/ha) in high adopters over low adopters, followed by medium adopter (1.31 q/ha). At Cost 'A$_1$' the per quintal cost of production in high adoption group was Rs 3633.10/-. which was less than medium adopter (Rs. 4004.95/-) while the per quintal cost of production in low adopters was highest i.e. Rs. 4232.68/- This means the adoption of recommended technology has given the higher yield and so the per quintal cost of production has been reduced. The same results was observed at the Cost 'C$_3$' i.e the per quintal cost of production in high adoption group was Rs 5741.23/- which was less than medium adopter (Rs. 6314.59/-) while the per quintal cost of production in low adopters was highest i.e. Rs 6680.86/-.

It is observed that by adopting the high level of technology the unit cost is reduced by Rs. 599.58/- and Rs 854.21/- per quintal over low adopter at Cost 'A$_1$' and Cost C$_2$'. The overall study, concluded that, the per unit cost reduction of high adopter was more as compare to low adopter because high adopter group were used in to the higher adoption of recommended IPM technology.

3.4 Constraint of NonAdoptionof Different IPM Technology

The data for constraints non adoption of different IPM technology is depicted in Table 7, Constraints in adoption of IPM technology never end. However, they can be minimized. The respondents were requested to express the constraints faced by them in adoption of IPM technologies.

Table 6. Reduction in unit cost of cotton

S.N.	Particulars	Units	Low adopter (N = 22)	Medium adopter (N = 79)	High adopter (N = 19)
1	**Cost**	Rs/ha			
a	Cost 'A$_1$'		53797.33	56109.31	60454.71
b	Cost 'A$_2$'		53797.33	56109.31	63782.85
c	Cost 'B$_1$'		60285.79	63277.28	69008.54
d	Cost 'B$_2$'		66564.97	70196.00	77231.02
e	Cost 'C$_1$'		70915.18	73506.25	78626.71
f	Cost 'C$_2$'		77194.35	80424.97	86849.19
2	**Cotton Yield**	qtl/ha	12.71	14.01	16.64
3	**Change in Output**	qtl/ha		1.31	3.94
	% Increase the yield over Low adopter	%			**130.92**
4	**Unit cost assessments**	Rs/qtl			
a	Unit Cost 'A$_1$'		4232.68	4004.95	3633.10
b	Unit Cost 'A$_2$'		4232.68	4004.95	3833.10
c	Unit Cost 'B$_1$'		4743.18	4516.58	4147.15
d	Unit Cost 'B$_2$'		5237.21	5010.42	4641.29
e	Unit Cost 'C$_1$'		5579.48	5246.70	4725.16
f	Unit Cost 'C$_2$'		6073.51	5740.54	5219.30
5	**Reduction in per quintal production cost**				
a	Reduction in per quintal production cost at Cost A$_1$ over low adopter	Rs/q			**599.58**
b	**Reduction in per quintal production cost at Cost C$_2$ over low adopter**	Rs/q			**854.21**
c	**Reduction in the Cost rupees per hectare over the Low level of adoption**	Rs/h			**14214.05**

Table 7. Distribution of respondents according to the Constraint faced by them in non-adoption of different IPM practices (n = 120)

S.N.	Constraint	Average Score	Rank
1	Scarcity of availability of Biological Agent	84.34	I
2	Farmers Reluctant to adoption of Technology	75.38	II
3	Non-availability of Pheromone trap in sufficient quantity	70.51	III
4	Unaware knowledge about the use of pheromone trap	57.88	IV
5	Insufficient knowledge of the spraying technique	55.57	V
6	Timely not availability of fund	55.41	VI
7	Improper knowledge of beneficial Insect	54.48	VII
8	Lack of knowledge about Yellow sticky trap for control of white fly	52.26	VIII
9	Unaware regarding detail technical knowledge about the use of bio-agent and bio pesticide	52.06	IX
10	Unaware about proper identification of insect pests.	45.28	X

It is revealed that in Table 7, majority constraint of no adoption of different IPM technology perceived by farmer were Scarcity of availability of biological agent i.e 84.34 per cent and rank at first position. In case of, Farmers reluctant to adoption of Technology, farmers was given the rank second because farmers have not taken risk for adoption of technologies. The result of non availability of Pheromone trap in sufficient quantity and Unaware knowledge about use of pheromone trap observed that, 70.51 and 57.88 per cent i.e. rank third and rank fourth respectively. Insufficient knowledge of spraying technique 55.57 per cent i.e. rank fifth, improper knowledge of beneficial insect and pest 54.48 per cent i.e. in rank seventh, Insufficient fund to purchase inputs 55.41 per cent i.e. in rank sixth and Insufficient knowledge about beneficial insect rank was observed seventh i.e average score 54.48 per cent. Improper knowledge about yellow sticky trap for control of white fly reported by 52.26 per cent farmer which is rank eighth. Improper knowledge about bio-agent and bio pesticide reported by the farmers is 52.06 per cent, farmer which is rank ninth. Insufficient knowledge of proper identification of insect pests 45.28 per cent. The more or less similar result were obtained by the research conducted by Patel, Neerja, et al [6], Chander and Singh [5], Katole et al [7], Krishnamurthy and Veerabhadraiah (1999); Neema and Verma (2000); Sharma etal(1997) and Shinde et al. (1997).

It can be concluded that, majority of constraint perceived by the farmer were, Lack of detail technical knowledge about the use of bio-agent and bio pesticide, non-availability of bio-pesticide and Yellow stick/light trap/pheromone trap, Non availability of Pheromone trap in sufficient quantity etc. Besides, lack of knowledge about pest's life cycle and their infestation stages was severe constraints perceived by the Cotton grower which is mainly due to the lack of guidance of the recommended technology [8,9].

4. CONCLUSION

The results emerged from this study are summarized in the following conclusion.

All 120 farmers, 19 farmers under high level of adoption group i.e. above 78.11 per cent, 79 farmers under medium level of adoption group i.e. above63.35 to 78.11 per cent while 22 farmers under low level of adoption group i.e. below 63.34 per centin technology adoption range.

Extent of adoption of in all technologies were highest in high adoption level group. Moreover, use of Pheroman trap, light trap and Yellow sticky trap, use of trichograma and FYM is negligibal used in low adopter groups.The result of input utilization, the human labour utilization was highest in high adoption level group. In all three adoption level, seed rate were used at recommendation level and farmers select Short & medium duration variety.Farm yard manure, highest used in high adopter group i.e. 30.68 quintal per hectare followed by medium adopter(16.80 q/ha) and low adopter(14.05 q/ha). In low adopter group shows that negligible use in Farm yard manure. The results of application of fertilizer(NPK) shows that, more used at recommended level in all three categories. Per hectare yield was highest in high adopter group i.e. 16.64 quintalfollowed by medium adopter group i.e. 14.01 quintal while it was lowest for low adopter group i.e. 12.71 quintal. Input output

Ratio at Cost ‘A_1’ was 1.95, 2.05 and 2.27 in low, medium and high adopters, respectively, while input output ratio at Cost ‘C_2’ for low, medium, high adopter 1.36,1.43,1.58 respectively. The results concluded that the low adopters group are not making more profit. It indicates that, as adoption of technology increases the yield level of crop and so that the net returns also increases. The result of per unit cost reduction in high adopter farmers saved the Rs. 599.58/- and Rs 854.21/- per quintal over low adopter at Cost ‘A_1’ and Cost C_2’ respectively. The result of majority constraint of non adoption of different IPM technology perceived by farmer were scarcity of availability of biological agent i.e first position rank. In case of, Farmers reluctant to adoption of technology, farmers was given the rank second because farmers have not taken risk for adoption of IPM technologies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT

As per international standards or university standards, respondents’ written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Swaminathan MS. ICAR, Operational research projects, purpose and approach. Indian Farming; 1975.
2. Birthal PS, Sharma OP, Sant Kumar. Economics of integrated pest management: Evidences and issues. Indian Journal of Agriculture Economics. 2000;55(4):644-648,
3. Snehal Datarkar BV,Pagire CA. Nimbalkar HR, Shinde. A Study of technology adoption gap in Soybean production of Maharashtra State:Principal Component Approach. Interanal Journal of Tropical Agriculture. 2016;344:1149-1154.
4. Omaid S/O Najamuddin, Impact of technology on cotton production in Vidarbha region of Maharashtra state. M.Sc.Thesis (.) Dr. PDKV, Akola; 2011.
5. Chander Subhash, Singh SP. Constraint in adoption of Integrated pest management practices in Cotton, Indian Journal of Extenstion Education. 2003;39(182):41-49.
6. Neeraj Patel, Manish Kumar, Nishita Gupta & Ankita Pandey, Constraints in adoption of Integrated pest management practices by cotton growers in Nimar region of Madhya Pradesh, Agriculture Update.2017;12(3):487-490.
7. Katole RT, Nikhad DM, Ingle PO, Wankhade PP. Extent of adoption of plant protection measures in hybrid cotton AHH 468. Journal Soils and Crops. 1997;7(2):160-162.
8. Suryawanshi RB, PV. Deshpande BS. Deshpande. Constraints in the adoption of agricultural technology in production of sorghum and cotton crops. Journal of Soils and Crops. 1992;2(2):33- 35.
9. Koranne UM, Ingle PO, Deshmukh AW,Chaudhari MB. Evaluation of adoption and Impact of technologies evolved and recommended by Dr.PDKV, Akola, for cotton crop. AGRESCO Report; 1996.

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