Economic analysis of Input and Yield gaps of IPM technology on Soybean in Vidarbha region of Maharashtra State

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ABSTRACT

Soybean occupies third position among the oilseed crop in India after groundnut and rapeseed-mustered. Soybean being a major oilseed crop of the Washim district in Vidarbha region of Maharashtra state and keeping in view the importance of IPM to manage the insects and pests on Soybean crop, the study was a Economic analysis of Input and yield gaps of IPM technology on soybean in Vidarbha region of Maharashtra State with the main objective of this topic, to assess the extent of adoption of recommended technology in soybean production by using principle component analysis approach and for develop the composite index, to study the input utilization in soybean and to estimate the input and yield gap of soybean at different level of adoption of IPM technology.

The study was carried out by Washim district in Vidarbha region. From this districts two tahasil were selected i.e. Washim and Malegaon and total 120 farmers were selected from seven villages. viz. Jawala, Ekamba, Umra, Waghlud, Degaon and Pangri Navghare. The primary data were collected by simple random sampling method and the data pertains to year 2022-23.

In all 120 farmers, 57 farmers under high level of adoption group i.e. above 65.09 per cent, 54 farmers under medium level of adoption group i.e. above 49.46 to 65.09 per cent while 09 farmers under low level of adoption group i.e. below 49.46 per cent in technology adoption range.

The result of input utilization, in all three adoption level, seed rate was nearer to recommended level. Machinery charges were the highest for high adopter group i.e 39.81 hours per hectare followed by medium adopter with 36.03 hours per hectare. Farm yard manure, highest used in high adopter group i.e. 7.54 quintal per hectare followed by medium adopter (5.83 qtl/ha) and low adopter (1.67 qtl/ha). It means no one can fully adopted the recommended level of FYM dose because the farmers can apply only owned farm FYM. In case of use of nitrogen fertilizer was fully adopted recommended level by the high level of the adopter group. And phosphorus and potassium were used in nearer to recommended dose in high adopter group. It has been reflected in the productivity of soybean.

Per hectare yield was highest in high adopter group i.e. 19.42 quintal followed by medium adopter group i.e. 16.82 quintal while it was lowest for low level of adoption i.e. 14.36 quintal. The highest total yield gap was observed 7.64 quintal per hectare in low adopter group, followed by 5.18 quintal per hectare yield gap in medium adopter and comparatively lower yield gap was observed i.e. 2.58 quintal per hectare in high adopters. Hence, it is concluded that, the adoption of recommended technologies, reduces the yield gap and ultimately the net returns increases in high adopter group.

Key words : IPM technology, Principal Component Analysis, Input gap, Yield gap, Composite Index and extent of adoption

INTRODUCTION

Integrated pest management practices form a major role in elevating the production from quantitative and qualitative point of view. It has a direct impact on economic profitability. Moreover, IPM has been proved to be a cost minimization technique. Birthal *et al* (2000). IPM builds on ecosystem services such as pest predation while protecting others, such as pollination. It also contributes to increased farm productivity and food availability by reducing pre- and post-harvest crop losses. Reduces pesticide residues. IPM contributes to food and water safety, as reducing the amount of pesticides used in turn reduces residues in food, feed and fiber, and environment.

Keeping in view of these aspects the study was planned and undertaken with specific objectives, i.e. to assess the extent of adoption of recommended technology in Soybean production, to study the input utilization in Soybean at different level of adoption of IPM technology, to estimate the input and yield gap of Soybean at different level of adoption of IPM technology.

METHODOLOGY

As study relates to Economic analysis of Input and yield gaps of IPM technology on Soybean in Vidarbha region of Maharashtra State, the recommended technologies were considered with the consultation of Entomologist and Oilseed research unit.

The study was undertaken in Washim district in Vidarbha region of Maharashtra State. From this districts two tahasil were selected i.e. Washim and Malegaon tahasils and total 120 farmers were selected from seven villages. viz. Jawala, Ekamba, Umra, Waghlud, Degaon and Pangri Navghare. The data pertains to the year 2022-23.

Recommended Technologies of Soybean:

The study has been undertaken, to identify the level of adoption of different technologies as against recommended level in the Soybean by farmers, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola has evolved different technologies, which was considered as a recommended one. The information on these points are presented in Table 1.

Table 1

Recommended technologies developed by Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in Soybean crop

S.N.	Particulars	Units	Recommendation
A	Cultural Control		
1	Ploughing		One
2	Sowing time		Before second Fort Night of July
3	Resistant variety		e.g. TAMS-9821,PhuleVikram
4	Use of Trichoderma.		@ 4 gm / kg
5	Seed rate	kg / ha	75 kg / ha
6	FYM	Qtl / ha	50
7	Fertilizer		
	N	kg / ha	30
	P	kg / ha	75
	K	kg / ha	30
8	Early stage Weeding		Before 20 days after crop emergence
B	Mechanical Control		
1	Removal of affected plant part and pest		Remove and destroy the pest affected plant / plant parts at the beg inning when the infestation is very high.
2	Use Pheromone trap	Per / ha	10
3	Use of Light Trap	Per / ha	10
C	Biological Control		
1	Use of Neem Seed Extract		@ 5 percent
2	Use of HaNPV		@250 to 500 LE
3	Use of bio Fungicide		Eg. : Use *Beauveriabassiana, Metarrhiziumanisopliae*etc
4	Crop Rotation		Soybean – Gram-Sorghum
D	Chemical Control		
1	Use of Pesticide		Eg. : Ethion, Thiamethoxam,ProfenophosEmamactinBezoate @ 5% etc

Analytical techniques :

The Impact Assessment of Integrated Pest Management on Soybean Production technology recommended by Dr. PDKV, Akola were workout extent of adoption of technologies, input utilization, input gap and yield gap at different level of adoption of IPM technologies.

1. To assess the extent of adoption of selected technologies.

For the first objective of the study, the extent of adoption of technologies of Soybean 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 Principle components of technology recommended by the University for Soybean crop expressed in terms of adoption score (X1, X2, --------- Xn) were utilized for developing technological adoption index of technology adopted. A technological adoption index is a single numerical value representing the net adoption of all components of technologies whose value lies between 0 to 1.

Development of composite Index :

The components of technology recommended by the University for Soybean crop expressed in terms of adoption score (X1, X2 …….. X18) were utilized for developing composite index of technology adopted. A composite index is a single numerical value representing the net adoption of all components of technologies whose values lies in between 0 and 1.

The Principle component analysis (PCA) approach was used for developing composite index. The principle components based on 18 x 18 co-rrelation matrix of 18 component of technology were computed. A set of 18 principle component explaining 100 per cent of total variation of all components of recommended technology were considered.

Consider 18 eigen vectors in the form of 18 x 18 matrix where rows represent variables and columns represent eigen vectors from which weight (wi) coefficient of component of technology say 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.

The components of technologies recommended by the University for Soybean 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 same is utilized for developing composite score 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.

Development of composite Index(scores) of technology:

The estimated composite adoption score (Si) is;

Si = W1X1 + W2X2 + ---------------- + W18X18

Where,

Si = Composite Index of ith farmers, X1 =Ploughing, X2 = Sowing time, X3 = Resistant variety, X4 = Use of Trichhogamma card, X5 = Seed rate, X6 = FYM, X7 = Nitrogen, X8 = Phosphorous, X9 = Potassium, X10= Early stage of Weeding, X11= Removal of affected plant part & Pest, X12 = Spacing between the plant, X13 = Intercropping, X14 = Use of Phromane trap / Light trap X15 = Installation of Bird perches, X16 = Crop rotation, X17 = Use of bio logical control, X18 = Use of pesticide, Wi = Use of weight given of ith technology

Which provides adoption index (of all

component of technologies) for each cultivators. 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. 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.

3. To analyse the input gap and yield gap of Soybean at different level of adoption of

IPM technology.
Input Gap:

Input Gap = Recommended Input - Actual Input

1. Seed(Kg)
2. Organic Manures (qt)
3. Chemical Fertilizers N & P (kg)
4.

Yield Gap:

It was estimated by tabular method.

Yield gap I = Yp - Yd

Where,
Yp = Potential Yield
Yd = Demonstration yield

Yield gap II = Yd - Ya
Yd = Demonstration yield
Ya = Actual Yield

Total Yield gap I = Yp - Ya
Yp = Potential Yield
Ya = Actual Yield

Results and Discussion:

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

Adoption range of different adopter group on the basis of Composite Index:

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.

Table 1
Adoption range of different adopter group in Soybean.

S.N.	Particular	Low adopter (N = 09)	Medium adopter (N = 54)	High adopter (N = 57)
1	Total No. of Farmers	120		
3	Adoption Range	Below 49.46 %	49.46 to 65.09 %	Above 65.09 %
4	No. of farmers	9	54	57
5	Percentage	7.50	45.00	47.50

It is reveled from the Table 1 that the adoption level of recommend technologies was below 49.46% percent for low adopter category, 49.46 to 65.09percent, Medium adopter and above 65.09 per cent for high adoption category. About 47.50 percent i.e.57 farmers were under high adoption level, 45per cent (57 farmers) under medium adoption level and 7.50percent lowest percentage of farmers (09 farmers) were categorized under low adoption level. It shows that the highest percentage of adoption level of technology was above 65.09 percent. Recommended technologies were not fully adopted by large number of farmers.

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.

Table 2
Extent of Adoption of Technology

S.N.	Particulars	Extent of Adoption			
		Low Adopter (N = 09)	Medium adopter (N = 57)	High adopter (N = 54)	Overall (N = 120)
A	Cultural Control				
1	Ploughing	100	100	100	100
2	Sowing time	67	88	96	84
3	Resistant variety	00	49	89	46
4	Use of Trichoderma.	33	65	80	59
5	Seed	94	96	97	96
6	FYM	03	13	13	10
7	Fertilizer				
	N	88	86	100	91
	P	85	96	98	93
	K	89	94	97	93
8	Early stage Weeding	56	75	89	73
B	Mechanical Control				
1	Removal of affected plant part & pest	22	49	83	52
2	Use Pheromone trap	30	42	54	42
3	Use of Light Trap	11	37	50	33
C	Biological Control				
4	Use of Neem Seed Extra.	11	32	65	36
2	Use of HaNPV	0.00	18	33	17
3	Use of Bio Fungicide	11	12	35	20
4	Crop Rotation	44	51	76	57
D	Chemical Control				
1	Use of Pesticide	78	89	94	87

It is observed from the table 2 that among the recommended technologies at overall level, the cultural control technology of IPM, the ploughing technology has been adopted at 100.00 per cent, followed by the seed Rate i.e. 96.00 per cent, Nitrogen 91.00 percent, phosphorus 93.00 Potassium 93.00 per cent and percent, sowing time 84 per cent, early stage weeding 96.00 percent and the lowest adoption was observed in farm yard manure application (10.00 %).The result of mechanical control of IPM technology shows that the recommended technology at overall the highest technology was adopted by removal of affected plant part and pest i.e. 52.00 percent followed by use of pheromone trap i.e. 42.00 percent and use of light trap i.e. 33.00 percent. In biological control of IPM technology adoption of crop rotation technology was highest 57 percent and lowest was adoption of use of HaNPV, 17 percent followed by use of neem seed extract (36.00%), use of bio fungicide (20.00%)

The ploughing technology has been adopted at 100 per cent in all three adoption level categories. Use of resistant variety of soybean was adopted by highest in high adopter 80.00 percent followed by medium adopter 65.00 percent, low adopter 33.00 per cent. Among the comparison of three adoption levels, adoption of use of recommended dose of nitrogen was highest in high adopter group i.e. 100.00 per cent followed by low adopter group i.e. 88.00 per cent and medium adopter group i.e. 86.00 per cent. In case of adoption of use of phosphorous was highest in high adopter group i.e. 98.00 per cent followed by medium adopter and low adopter group 96.00 and 85.00 per cent respectively. The lowest adoption of use of FYM application was observed in low adopter group(0.30%), medium adopter(13%) and high adopter (13%). At over all study concluded that, the adoption of cultural technology in IPM was highest used in high adopter category.

In case of mechanical control of IPM technology, the highest adoption of removal of plant affected part and pest was in high adopter group i.e. 83.00 percent followed by medium and low adopter i.e49.00 and 22.00 percent respectively. For use of pheromone trap it was highest in high adopter group i.e 54.00 percent followed by medium and low adopter category i.e 42.00 and 30.00 percent respectively.

In case of biological control of IPM technology the adoption of use of neem seed extract was highest in high adopter group i.e. 65.00 percent followed by medium and low adopter category i.e. 32.00 and 11.00 percent.

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. The reason of this lack of knowledge about use of pheromone trap, non-availability of improved seed, non-availability of bio-agent of seed treatment, non-availability of fertilizer in time, unavailability of FYM and lack of guidance about recommended technology.

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.

Table 3

Input utilization at different level of adoption of IPM technology

(Per ha)

S.N.	Input Utilization	Unit	Low adopter (N = 09)	Medium adopter (N = 54)	High adopter (N = 57)	Overall (N = 120)
1	Male Labour	Days	19.21	22.42	24.97	22.20
2	Female Labour	Days	30.50	32.98	35.32	32.93
3	Total Human Labour	Days	49.71	55.40	60.29	55.13
4	Bullock Labour	Days	0.97	0.92	0.88	0.92
5	Machine Labour	hrs	30.09	36.03	39.81	35.31
6	Seed rate	Kg / ha	76.65	77.79	78.76	77.73
7	FYM	Qtl / ha	1.67	5.83	7.54	5.01
8	Fertilizer					
	N	Kg / ha	27.02	28.07	30.00	28.36
	P	Kg / ha	70.82	71.90	73.51	72.07
	K	Kg / ha	26.89	27.32	28.37	27.52
10	Main Produce	Qtl / ha	14.36	16.82	19.42	16.87
11	By produce	Qtl / ha	10.85	10.00	10.81	10.55

From the Table 3, it was revealed that per hectare labour utilization was observed in low, medium and high adopter group i.e. 49.71, 55.40 and 60.29 days respectively. And at overall level it was 55.13 labour days. It was observed that the human labour utilization was highest in high adoption level group. Per hectare seed rate was the highest in high level of adoption (78.76 kg / ha) followed by medium level of adoption (77.79%) and low level of adoption (76.65%). It shows that, in all three adoption level, seed rate was nearer to recommendation level.

Machinery charges were the highest for

high adopter group i.e 39.81 hours per hectare followed by medium adopter with 36.03 hours per hectare.

Among the farm yard manure, highest used in high adopter group i.e. 7.54 quintal per hectare followed by medium adopter (5.83 qtl/ha) and low adopter(1.67 qtl/ha). In low adopter group shows that negligible use in FYM.

In case of use of nitrogen fertilizer for low, medium, high adopter group was 27.02 kg per hectare, 28.07kg per hectare, 30.00 kg per hectare respectively. Recommended dose of nitrogen was fully adopted by the large level of the adopter group. And for the phosphorus, was adopted 70.82 kg per hectare, 71.90kgper hectare, 73.51 kg per hectare for low, medium, high adopter groups respectively. Among potassium fertilizer were used 26.89 kg per hectare, 27.32 kg per hectare and 28.37 kg per hectare for low, medium, high adopter group respectively. It shows that, phosphorus and potassium were used in nearer to recommended dose in large adopter group and low and medium adopter groups, phosphorus and potassium fertilizer were not use in recommended level because lack of knowledge about recommended doses of fertilizer in low and medium adopter groups. It has been reflected in the productivity of soybean.

The result of yield, per hectare was highest in high adopter group i.e. 19.42 quintal followed by medium adopter group i.e. 16.82 quintal while it was lowest for low level of adoption i.e. 14.36 quintal.

Input gap at different level of adoption of IPM technology:

Input gap was estimated by deducting actual input used from recommended level of input and is presented in table 4. The input gap was calculated at the different level of the adoption of IPM technology with the help of comparing with actual recommended technologies by the Dr. P.D.K.V, Akola. Input gap was calculated on the basis of the recommended use of input and actual use of the input by the different level of the adopter. From which the result obtain which show that the different input gap for different level of the adoption of the IPM technology these are in respect of the following inputs.

Table 4
Input gap of Soybean crop

(Per ha)

S.N.	Particulars	Units	Recommended	Low adopter (N = 09)	Medium adopter (N = 54)	High adopter (N = 57)	Overall (N = 120)
1	Seed rate	Kg/ha	75	-1.65 (76.65)	-2.79 (77.79)	-3.76 78.76)	-2.73 (77.73)
2	FYM	Qtl/ha	50	48.33 (1.67)	44.17 (5.83)	42.46 (7.54)	44.99 (5.01)
3	Fertilizer						
	N	Kg/ha	30	2.98 (27.02)	1.93 (28.07)	0.00 (30.00)	1.63 (28.36)
	P	Kg/ha	75	4.18 (70.82)	3.10 (71.90)	1.49 (73.51)	2.92 (72.07)
	K	Kg/ha	30	3.11 (26.89)	2.68 (27.32)	1.63 (28.37)	2.47 (27.52)

Note: Figures parenthesis indicates the actual use of input.

From Table 4, it was revealed that the recommended dose of the seed rate was 75 kg per hectare. The result of input gap, for the use of seed rate with respect to recommended use for low, medium and high adopter group gap was observed that 1.65 kg/ha, 2.79 kg/ha, 3.76 kg per hectare respectively. It means the seed rate was not used in recommended level.

In respect of the FYM input gap is very high for the three level of adopter of the IPM technology. No one can fully adopt the recommended level of FYM dose because the farmers can apply only owned farm FYM. In case of fertilizer, application of recommended nitrogen dose was fully adopted only by high adopter group and in case of phosphorus and potassium was used in nearer recommended level.

In low adopter group, highest gap was observed for nitrogen (2.98 kg/ha), phosphorus (4.18 kg/ha) and potassium(3.11 kg/ha) as compared to high adopter and medium adopter group. It has been reflected in the productivity levels of the crop.

Yield Gap of selected farmer at different level of adoption

The input gaps are directly associated to the productivity level of selected sample. The results are shown in Table 5.

Table 5
Yield Gap of selected farmer in Soybean Crop production

(qtl/ha)

S.N.	Particulars	Units	Low Aodopter (N =09)	Medium Adopter (N =54)	High Adopter (N = 57)	Overall (N = 120)
1	Actual Yield	Qtl/ha	14.36	16.82	19.42	16.87
2	Potential Yield	Qtl/ha	22			
3	Demonstration yield	Qtl/ha	25			
3	Yield Gap	Qtl/ha				
a.	Yield Gap I (Yp – Yd)	Qtl/ha	-3	-3	-3	-3
b.	Yield Gap II (Yd – Ya)	Qtl/ha	10.64	8.18	5.58	8.13
c.	Total Yield Gap I (Yp – Ya)	Qtl/ha	7.64	5.18	2.58	5.13

Note: Figures parenthesis indicates the actual use of Input.

From the Table 5, it is revealed that the per hectare actual yield of low, medium and high adopters categories was 14.36 quintal, 16.82 quintal and 19.42 quintal respectively. At overall level, it was 16.87 quintal per hectare. The potential yields of soybean (Variety JS-335) was 22.00 quintal per hectare. The demonstration yield of same variety was 25.00 quintal per hectare on University farms. There was yield gap I, difference of potential yield and demonstration yield was 3 quintal per hectare. The result shows that the demonstration yield was more than the potential yield and hence it shows in negative value.

Yield gap II was calculated by subtracting the actual yield received by farmers from demonstration yield. It is observed that there was a yield gap II10.64quintal per hectare, 8.18 quintal per hectare and 5.58quintal per hectare in low, medium and high adopter group respectively.

The highest total yield gap of 7.64 quintal per hectare was observed in low adopter group, followed by 5.18 quintal per hectare yield gap in medium adopter and comparatively lower yield gap was observed i.e. 2.58 quintal per hectare in high adopters. Hence, it is concluded that, the adoption of recommended technologies, reduces the yield gap and ultimately the net returns increases in high adopter group. It means reflected in the productivity levels of the crop.

CONCLUSIONS

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

1. All 120 farmers, 57 farmers under high level of adoption group i.e. above 65.09 per cent, 54 farmers under medium level of adoption group i.e.49.46 to 65.09 per cent while 9 farmers under low level of adoption group i.e. below 49.46 per cent in technology adoption range.
2. Farm yard manure, highest used in high adopter group i.e. 7.54 quintal per hectare followed by medium adopter(5.83 qtl/ha) and low adopter(1.67 qtl/ha). In low adopter group shows that negligible use in FYM.
3. The result of input utilization of use of nitrogen fertilizer was fully adopted recommended level by the high level of the adopter group. And phosphorus and potassium were used in nearer

to recommended dose in high adopter group. It has been reflected in the productivity of soybean.

4. Per hectare yield was highest in high adopter group i.e. 19.42 quintal followed by medium adopter group i.e. 16.82 quintal while it was lowest for low level of adoption i.e. 14.36 quintal.

5. Input gap, for the use of seed rate with respect to recommended use for low, medium and high adopter group. Gap was observed that 1.65 kg per hectare, 2.79 kg per hectare, 3.76 kg per hectare respectively.

6. In case of the FYM, input gap is very high for all three level of adopter of the IPM technology. No one can fully adopt the recommended level of FYM dose due to the non-availability of the farm yard manure.

7. In case of fertilizer, application of recommended nitrogen dose was fully adopted only by high adopter group and in case of phosphorus and potassium was used in nearer recommended level.

8. The highest total yield gap of 7.64 quintal per hectare was observed in low adopter group, followed by 5.18 quintal per hectare yield gap in medium adopter and comparatively lower yield gap was observed i.e. 2.58 quintal per hectare in high adopters.

Hence, it is concluded that, the adoption of recommended technologies, reduces the yield gap and ultimately the net returns increases in high adopter group.

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