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Economic impact of IPM technology on gram production in Amravati district of Maharashtra

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ABSTRACT

Gram (*Cicer arietinum* L.) is an important pulse crop in Maharashtra, but its productivity is affected by insect pests, particularly pod borer, and by reliance on chemical pest-management practices. Integrated Pest Management (IPM) offers an approach that combines cultural, mechanical, biological and need-based chemical measures. The present study was undertaken in Amravati district of Maharashtra during 2025–26 to assess the economic impact of IPM technology in gram production and to identify the major constraints limiting its adoption. Primary data were collected through personal interviews from 120 Gram growers selected from nine villages of three tehsils, namely Teosa, Bhatkuli and Morshi. The economic impact of IPM was estimated using the partial budget technique, considering additional costs, reduced costs (savings), reduced returns and added returns. Constraints were analyzed using Garrett's ranking technique. The partial budget showed an additional cost of Rs.4,848.75 per hectare, including Rs.4,272.03 per hectare for direct additional IPM-related expenditure and Rs.576.72 per hectare towards opportunity cost of capital, management cost and risk premium. Savings due to IPM were Rs.3,640.19 per hectare, while added returns from a yield increase of 4.66 q/ha valued at Rs.5,282.50 per quintal amounted to Rs.24,616.45 per hectare. Thus, total benefits on the credit side were Rs.28,256.64 per hectare and the net gain from IPM adoption was Rs.23,407.89 per hectare. Garrett's ranking identified lack of awareness about IPM as the most important constraint (54.58), followed by lack of skilled labour (49.87), difficulty in identification of natural enemies and pests (48.58), non-availability of bioagents such as HaNPV and *Trichogramma* (47.25), and comparatively higher price (16.91). The findings indicate that IPM has substantial economic potential in gram production, while wider adoption requires stronger awareness, practical training, skilled labour support and timely availability of biological control agents.

Keywords: Gram, *Cicer arietinum*, integrated pest management, partial budgeting, garrett's ranking, economic impact, constraints

Introduction

Agriculture continues to play a central role in India's food security, employment and rural development. Pulses are especially important because they provide dietary protein and contribute to soil fertility through biological nitrogen fixation. Among pulse crops, gram (*Cicer arietinum* L.), commonly known as chickpea or Bengal gram, occupies an important position in India and Maharashtra and is widely cultivated during the Rabi season under rainfed as well as irrigated conditions.

Gram production is constrained by several biotic and abiotic factors. Among biotic stresses, pod borer (*Helicoverpa armigera*) is a major pest and can cause substantial yield losses when not adequately managed. Farmers commonly depend on chemical pesticides because of their quick action; however, repeated and indiscriminate use may increase production costs and create risks related to pest resistance, residues and environmental health. Integrated Pest Management (IPM) provides a more sustainable approach by integrating cultural, mechanical, biological and need-based chemical measures.

IPM adoption among the selected gram growers varied considerably. The overall IPM adoption index was 0.4708, while the index was 0.340 for low adopters, 0.472 for medium adopters and 0.602 for high adopters. Seed rate, proper spacing, summer ploughing and seed treatment were relatively well adopted, whereas hand collection of larvae, destruction of infested plant parts, botanicals and HaNPV were poorly adopted. These adoption patterns provide the context for examining whether the change towards IPM generates an economically meaningful benefit and what prevents farmers from adopting more of its components.

Partial budgeting is particularly useful for assessing the economic effect of a partial change in the farm plan because it organizes the additional costs, reduced returns, reduced costs and added returns associated with the change. Earlier studies have applied partial budgeting to evaluate improved agricultural technologies, including IPM and other crop-management interventions (Durgad *et al.*, 2018; Shende *et al.*, 2022; Sowjanya and Kumari, 2017) [1, 2]. Studies on pulse crops have also documented knowledge, input and labour-related constraints that restrict adoption of improved technologies (Tiwari *et al.*, 2020; Sinha *et al.*, 2019) [3].

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Hence, an assessment combining economic impact with constraint ranking is relevant for designing practical extension interventions in gram.

Objectives

1. To assess the impact of IPM technology in gram production.
2. To analyze the constraints during adoption of IPM technology.

Materials and Methods

Study area and data collection

The study was conducted in Amravati district of Maharashtra during the agricultural year 2025–26. The district was selected purposively for studying IPM technology in gram production. Three tehsils, namely Teosa, Bhatkuli and Morshi, were selected. Three villages from each tehsil were covered, a total of nine villages. From the selected villages, 120 gram-growing farmers who adopted IPM technology were selected for collection of primary information. Data were collected through using a structured personal interview method. The selected farmers comprised 45 small farmers (37.50 per cent), 52 medium farmers (43.33 per cent) and 23 large farmers (19.17 per cent). For the impact assessment, the analysis was made at the overall level using the partial budget information reported in the thesis.

Estimation of economic impact using partial budgeting

The partial budget technique was used to estimate the change in profit associated with the adoption of improved IPM practices. Four components were considered: (i) additional cost due to IPM, (ii) reduced returns due to IPM, (iii) reduced cost or savings due to IPM, and (iv) added returns due to IPM. The debit side was obtained as additional cost-plus reduced returns, while the credit side was obtained as reduced cost-plus added returns. The net gain was calculated as:

Net gain = Total credit side – Total debit side

The direct additional IPM-related expenditures reported were seed treatment, labour, pheromone traps, HaNPV, NSKE, destruction of larvae, need-based chemical application and destruction of infested plant parts. Opportunity cost of capital at 6 per cent per annum, management cost at 5 per cent and risk premium at 2.5 per cent were also included in the total additional cost.

Analysis of constraints

Constraints in adoption of IPM technology were analysed using Garrett's ranking technique. The rank assigned by each respondent was converted into a per cent position using the standard Garrett transformation. The corresponding Garrett score was obtained from the Garrett table. Mean scores were calculated for each constraint and arranged in descending order. The constraint with the highest mean score was assigned Rank I, followed successively by lower mean scores.

$$\frac{(R_{ij} - 0.5)}{N_j}$$

Percent position = $\times 100$

Where,

R_{ij} = rank given to the j^{th} constraint by the j^{th} respondent

N_j = number of constraints ranked by the j^{th} respondent.

Results and Discussion

Economic impact of IPM technology

The partial budget results demonstrate a positive economic effect of adopting IPM practices in gram production. The direct additional expenditure on IPM practices amounted to Rs.4,272.03 per hectare. In addition, opportunity cost of capital (Rs.256.32/ha), management cost (Rs.213.60/ha) and risk premium (Rs.106.80/ha) were included, bringing the total additional cost on the debit side to Rs.4,848.75 per hectare. No reduced return due to adoption of IPM was reported.

Table 1. Impact of IPM technology in gram production

Sr. No.	Debit side: Additional cost	Rs. / ha.	Credit side: Reduced cost / Added returns	Rs. / ha.
1	Seed treatment	300.66	Seed treatment	77.76
2	Labour	1,151.37	Labour	1,152.00
3	Pheromone trap	450.00	Other savings	2,410.43
4	HaNPV	350.00		
5	NSKE	500.00	Total savings due to IPM	3,640.19
6	Destruction of larvae	300.00		
7	Need-based chemical application	930.01	Added returns: yield increase = 4.66 q/ha $\times$ Rs.5,282.50/q	24,616.45
8	Destruction of infested plant parts	290.00		
9	Opportunity cost of capital @ 6% p.a.	256.32		
10	Management cost @ 5%	213.60		
11	Risk premium @ 2.5%	106.80		
		4,848.75	Total credit side	28,256.64

Total debit side = Rs.4,848.75/ha; Total credit side = Rs.28,256.64/ha;
Net gain = Rs.23,407.89/ha.

On the credit side, savings due to IPM amounted to Rs.3,640.19 per hectare, comprising savings of Rs.77.76 from seed treatment, Rs.1,152.00 from labour and other savings of Rs.2,410.43. In addition, the yield increase was 4.66 quintals per hectare. At a price of Rs.5,282.50 per quintal, this generated added returns of Rs.24,616.45 per hectare. Therefore, the total credit side was Rs.28,256.64 per hectare.

The net gain was obtained by subtracting the debit side from the credit side: Rs. 28,256.64 – Rs. 4,848.75 = Rs. 23,407.89 per

hectare. Thus, the partial budget indicates that the economic benefits associated with IPM substantially exceeded the additional expenditure required for its implementation. The result is consistent with earlier evidence that improved pest-management technologies can generate economic benefits through yield improvement and/or cost savings (Durgad *et al.*, 2018; Sowjanya *et al.*, 2017) [1, 2].

Constraints in adoption of IPM technology

Although the partial budget indicates a strong economic advantage, the adoption of several IPM components remained low. Garrett's ranking was therefore used to identify the constraints that should receive priority in extension and policy interventions.

Table 2. Constraints in adoption of IPM technology for gram growers

Sr. No.	Constraint	Average Garrett score	Rank
1	Lack of awareness about IPM	54.58	I
2	Lack of skilled labour	49.87	II
3	Identification of natural enemies and pests	48.58	III
4	Non-availability of bioagents (HaNPV and <i>Trichogramma</i>)	47.25	IV
5	Comparatively higher price	16.91	V

Lack of awareness about IPM was the most important constraint, recording an average Garrett score of 54.58 and Rank I. This suggests that insufficient knowledge about IPM practices, their benefits, timing and proper application is a fundamental barrier. The second-ranked constraint was lack of skilled labour (49.87), indicating that several IPM operations require timely and technically appropriate field work. Identification of natural enemies and pests ranked third with a mean score of 48.58. Correct identification is central to IPM because the approach depends on distinguishing pest populations from beneficial organisms and selecting appropriate interventions. Non-availability of bioagents such as HaNPV and *Trichogramma* ranked fourth (47.25), indicating an input-supply limitation for biological control. Comparatively higher price was ranked fifth with a score of 16.91 and was therefore the least important among the listed constraints.

The ranking broadly agrees with earlier studies in pulse crops, where lack of knowledge, shortage of improved inputs, labour problems and limited access to technical guidance were reported as important barriers to improved technology adoption (Sinha *et al.*, 2019; Tiwari *et al.*, 2020) [3]. The present results indicate that extension interventions should prioritize practical awareness programmes, field demonstrations, pest and natural-enemy identification training, development of skilled labour, and reliable local supply of biological control agents.

Conclusion

The study assessed the economic impact of IPM technology in gram production and the constraints faced by farmers in adopting it in selected villages of Amravati district during 2025–26. The partial budget analysis showed a total additional cost of Rs.4,848.75 per hectare, while the total credit side was Rs.28,256.64 per hectare. The resulting net gain of Rs.23,407.89 per hectare demonstrates a substantial positive economic impact of IPM technology. The gain arose from both cost savings of Rs.3,640.19 per hectare and added returns of Rs.24,616.45 per hectare associated with a yield increase of 4.66 quintals per hectare.

Despite the favourable economics, lack of awareness was the leading constraint, followed by lack of skilled labour, difficulty in identifying natural enemies and pests, non-availability of bioagents, and comparatively higher price. Therefore, wider adoption of IPM in gram should focus not only on demonstrating its profitability but also on improving farmers' practical knowledge and access to the inputs and skills required for implementation. Regular village-level demonstrations, farmer training on pest and natural-enemy identification, skill development for IPM operations, and timely availability of HaNPV and *Trichogramma* can help address the major constraints identified in the study.

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