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RESEARCH ARTICLE

An estimate of the potential impact of integrated weed management technologies on major field crops productivity and economic gains in India

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ABSTRACT

Weeds remain one of the most pervasive biotic constraints to crop productivity in India, causing substantial yield and economic losses across diverse cropping systems. This study aimed to estimate the potential contribution of integrated weed management (IWM) interventions to the production of major field crops in India and the possible economic gains resulting from these interventions. Weed management was estimated to be implemented in over 125.33 million hectares, representing about 67% of the total cropped area under major cereals, pulses, oilseeds and commercial crops (187.06 million hectares). Adoption of IWM interventions was estimated to result in an additional 96.62 million tonnes of crop production annually with an estimated economic returns of ₹ 1.89 trillion. The largest share of gains was estimated to be by cereals due to their extensive area coverage, with a contribution of 45.78 million tonnes of additional output which is over half of the total economic benefits. Commercial crops, particularly sugarcane and potato, generated disproportionately high production gains despite relatively less cultivated acreage, reflecting their high per-unit productivity and responsiveness to IWM. Oilseeds and pulses were estimated to have moderate absolute gains, constrained mainly due to lower adoption of IWM. Overall, the findings of this estimate demonstrate that scaling of timely IWM can substantially narrow yield gaps improve farm profitability, underscoring its central role in sustainable agricultural intensification.

Keywords: Crop productivity, Economic returns, India, Integrated weed management

INTRODUCTION

Indian agriculture remains the backbone of the national economy, contributing approximately 18.4% to Gross Value Added in 2024–25 and supporting nearly 46.1% of the population (DESE 2025). The sector has shown remarkable resilience, with total food grain production reaching a record 357.73 million tonnes in the 2024–25 crop year, an 8% increase over the previous year, driven by peak yields in staples such as rice and wheat, ensuring self-sufficiency and stabilizing domestic food availability (PIB 2025). Despite these gains, the sector faces major bottlenecks, including shrinking landholdings, stagnating factor productivity, climate variability, declining soil health, water scarcity, and significant yield losses due to biotic stresses such as weeds, insect-pests, and diseases. Among these, weed competition alone accounts for 37% yield losses in major crops, representing the single largest biotic constraint to food grain productivity (Mishra *et al.* 2024). Farmers do adopt some form of weed management (partial weed management) in their crops, depending on their socio-economic status, knowledge, and availability of resources. Gharde *et al.* (2018) estimated that weeds caused an average yield loss of 25% (13% in transplanted rice to 36% in groundnut) under farmers' level of weed management, valued at USD 11 billion annually in ten major field crops of India. There is a need to reduce these losses, and substantial improvements in the production of agricultural field crops could be achieved if yield losses are further reduced by following improved IWM practices (Rao *et al.* 2017; Rao 2022).

Weed management in agro-ecosystems in India is a critical challenge for enhancing crop productivity, as weeds have been reported to cause potential yield losses of 33% to 80% across major field crops (Rao *et al.* 2007). The shift in weed flora and rapid evolution of herbicide resistance, particularly in *Phalaris minor* within the rice-wheat cropping systems (Choudhary and Mishra 2023), *Echinochloa crus-galli* and *Cyperus difformis* in rice (Choudhary *et al.* 2021; 2023) and *Echinochloa colona* in soybean (Chander *et al.* 2023); severe labour shortages and rising wages (Rao *et al.* 2020); weed-crop dynamics altered by climate change (Chauhan 2020) have made weed management more critical in

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enhancing crop production in agro-ecosystems. To address these issues, the adoption of integrated weed management (IWM) strategies was suggested (Rao and Nagamani 2010). IWM technology was developed and has been proven to successfully bridge the crop yield gap, thus enhancing crop productivity (Singh and Singh 2020; Choudhary *et al.* 2022; Dubey *et al.* 2023; Rao and Korres 2024). However, the adoption of IWM in India remains low due to lack of technical knowledge regarding precise herbicide application and limited access to specialized mechanization (Gharde and Singh 2021).

The IWM technologies were proven to significantly improve the farm productivity and profitability in Indian agriculture compared with conventional weed control (farmer's practices), due to superior weed suppression and efficient input use. Thus, this study hypothesizes that regional variation in yield and economic gains is driven by differences in IWM adoption and area coverage. This study was conducted with an objective to estimate the potential contribution of IWM interventions to major Indian crops production and to economic gains. In this assessment, we have: (i) assessed the status of weed management in India with respect to area coverage and adoption levels; (ii) quantified yield gains in major field crops with the adoption of IWM; (iii) estimated the economic benefits; and concluded by identifying constraints and opportunities for scaling up IWM adoption in India.

MATERIALS AND METHODS

The data source

The study was based on the detailed data collected from national and state-level institutional/ organisational sources, including the Directorate of Economics and Statistics (DES), Ministry of Agriculture & Farmers' Welfare, ICAR research reports, AICRP on Weed Management, published literature, and government databases. The data, from the sources mentioned, on major food grain and commercial crops across key agro-ecological regions of India was used for this study.

Assessment of IWM coverage and adoption area

Data on crop-wise acreage under different weed management practices (manual, mechanical, chemical, and IWM) were collected with the help of AICRP on weed management centres, herbicide industries, personal communication with state department of agriculture, KVKs, NGOs, *etc.* across the country (detailed data with authors, unpublished) and the summary of collected data was compiled. Similarly, the herbicide consumption data were also collected from various states of India and used to estimate the area under herbicide use (detailed data with authors, unpublished). The percentage adoption of weed management was estimated by relating the area under weed management to total cropped area for each crop across the country. Area coverage under IWM (*e.g.* $\geq$2 complementary weed control practices) was estimated, and then stratified farmer surveys were conducted across major crop-growing regions to determine the proportion of land where multiple weed control practices are used. These proportions were extrapolated to total crop area using area-weighted expansion and separated with secondary sources such as extension records and input-use data. The synthesized estimates underwent internal consistency screening, outlier checks, and expert validation to enhance methodological robustness and reliability.

The estimation of crop yield gain due to IWM

The data on different crop grain yields with IWM and conventional or farmer-managed weed control practices, as reported in multi-location trials and on-farm studies, were pooled, compiled, and used to estimate the crop yield gains due to the adopted weed management practices. The crops yield gain was compared with the National average productivity of different field crops.

Economic analysis

The economic advantages due to the adoption of weed management practices was assessed using minimum support price and market rates (₹/ton) of each of the crop for the year 2024-25 (rice: 23,000, maize: 22,250, jowar: 33,710, bajra: 26,250, ragi: 42,600, other minor millets: 35,000, wheat: 24,250 and barley: 24,250, pigeonpea: 75,500, blackgram: 74,000, greengram: 86,820, lentil: 67,000, chickpea: 56,500, other pulses: 52,000, groundnut: 67,830, castor: 45,000, sesame: 92,670, niger: 87,170, soybean: 48,920, sunflower: 72,800, rapeseed and mustard: 59,500, linseed: 55,000 and safflower: 59,400, sugarcane: 3,400, cotton: 71,210 and potato: 15,000). The incremental economic gains attributable to IWM were calculated based on additional crop yield and additional cost due to the adopted weed management practice.

Data analysis

The descriptive statistics and comparative analyses were used to evaluate the adoption trends, yield advantage, and economic benefits across the crops considered for this study.

RESULTS AND DISCUSSION

Previous studies indicate that limited adoption of timely weed management remains a major constraint in several crops in India, despite their high relative yield responsiveness to improved weed management (Choudhary *et al.* 2022, Kumar *et al.* 2022). The estimated weed management coverage and improved crop productivity and economic returns as observed in this assessment study are discussed here.

Cereals

The major cereal crops considered for this study were rice, maize, jowar, bajra, ragi, other millets, wheat and barley. The estimates made by this study indicated substantial crop-wise gains in productivity, total production, and economic gains due to the weed management interventions across major cereals and millets in India (**Table 1**). Out of the total cultivated area of 109.83 million hectares under cereal crops, nearly 81.45 million hectares were under some form of weed management. The estimated average production gain due to the practiced IWM ranged between 150 kg/ha in millets to 1000 kg/ha in maize, which was estimated to result in 4.75% to 27.68% increase in yield over the national average productivity with an additional food grain production of 45.78 million tonnes. These findings align with earlier estimates that weeds alone account for 25–40% yield losses in cereals under farmers' field conditions, underscoring the importance of weed management as a critical yield-enhancing intervention (Chauhan *et al.* 2012, Rao and Chauhan 2015).

Effective weed control in rice systems, particularly under transplanted and direct-seeded conditions, has been shown to increase yields by 15–35% by reducing early-season competition for nutrients, water, and light (Choudhary *et al.* 2025a). Similarly, in wheat, unchecked infestation of grasses and broad-leaved weeds can reduce yields by 30–50%, making weed management a key determinant of profitability (Singh *et al.* 2016). In this study, rice and wheat accounted for the largest absolute gains, largely due to their extensive area coverage and dominance in national food grain production. Rice contributed nearly 20.0 million tonnes of estimated additional production with the highest economic return (₹ 459,865 million) and wheat with 14.78 million tonnes and ₹ 358,371 million.

Maize recorded the highest estimated relative yield response, with an average gain of 1,000 kg/ha, representing a 27.86% increase over the national mean yield. This translated into an additional 10.40 million tonnes of production and ₹ 231,361 million in economic returns. The strong response of maize reflects its high sensitivity to weed competition during the early growth period. Although coarse cereals and millets showed lower estimated absolute gains due to smaller area coverage, relative yield improvements were notable, with increases of 16.13% in jowar, 13.13% in bajra, and 14.99% in millets. These observations highlight the potential of weed management to enhance productivity in rainfed and marginal environments where millets are predominantly grown (Dubey *et al.* 2023). Overall, the findings of this study confirm that improved weed management could be a high-returns potential strategy for bridging yield gaps and enhancing national food grain production without expanding cultivated area.

Pulses

Weeds were reported to cause 30–80% yield losses in pulses due to their slow initial growth and weak competitive ability (Kumar *et al.* 2022, Mishra and Choudhary 2026). Across major pulse crops, weed management interventions estimated to be

Table 1. The estimated weed management coverage and its impact on productivity and economic returns of major cereals and millets in India (2024-25)

Crop	Area (mha)	Production (mt)	Productivity (kg/ha)	Estimated area under weed management (mha)	Estimated % of area coverage under weed management	Estimated crop productivity gain (kg/ha) due to IWM	Estimated % increase in yield over national average	Estimated additional crop production due to IWM (mt)	Estimated additional gains in economic return (Rs in million)
Rice	51.27	150.18	2929	39.99	78	500	17.07	19.99	459,865
Maize	12.09	43.41	3590	10.40	86	1000	27.86	10.40	231,361
Jowar	4.00	4.96	1240	1.20	30	200	16.13	0.24	8,080
Bajra	7.36	11.21	1523	1.47	20	200	13.13	0.29	7,725
Ragi	1.25	1.98	1584	0.26	21	150	9.47	0.04	1,675
Other millets	0.46	0.46	1001	0.10	21	150	14.99	0.01	502
Wheat	32.80	117.95	3595	27.88	85	530	14.74	14.78	358,371
Barley	0.61	1.92	3159	0.15	25	150	4.75	0.02	451
Total	109.83	332.05		81.45				45.78	1,068,031

implemented in over 14.10 million hectares, about 51% of the total pulse area of 27.72 million hectares, resulted in an estimated additional 3.76 million tonnes of pulse production with an estimated economic returns of ₹ 269,783 million (**Table 2**). The pulses are highly responsive to effective weed management, with relative yield gains often exceeding those reported for cereals Mishra and Choudhary (2026) reported 20-45% gain in pulse productivity due to adoption of IWM technologies. Greengram and chickpea contributed to the estimated increased production with each adding about 1.15 million tons due to their relatively higher area coverage under weed management (3.83 and 4.56 million hectares, respectively), coupled with substantial yield improvements. Blackgram and greengram had the highest relative yield responses of 42.25% and 41.72% increases over national average yields, corresponding to per-hectare gains of about 300 kg. Such strong responses reflect the high sensitivity of short-duration pulses to early-season weed competition (Choudhary *et al.* 2025b).

Pigeonpea has a longer growth duration; its wide row spacing and slow early growth make it vulnerable to weed pressure, particularly during the rainy season, thereby explaining the sizeable benefits from weed management (Kaur *et al.* 2015). Pigeonpea also exhibited a pronounced yield response (29.90%), contributing 0.65 million tons of additional production. In contrast, lentil showed limited absolute gains despite relatively higher baseline productivity, primarily due to very low weed management coverage (≈ 10% of area). This indicates a significant unrealized potential, as previous studies have reported yield losses of 25–50% in lentil under weedy conditions (Yadav *et al.* 2013). Overall, the findings underscore weed management as a high-impact intervention for enhancing pulse productivity, profitability, and national pulse availability. Expanding weed management coverage, particularly in area-dominant and short-duration pulses, could substantially bridge existing yield gaps and support nutritional security and sustainable intensification in rainfed and semi-arid regions (Choudhary *et al.* 2025c).

Oilseeds

Weed management interventions across major oilseed crops covered 18.47 million hectares, accounting for about 61% of the total oilseed area of 30.44 million hectares, and resulted in an additional 5.36 million tonnes of oilseed production with an estimated economic return of ₹ 295,112 million (**Table 3**). These gains are substantial in view of the high yield losses (20–50%) commonly attributed to weed competition in oilseed crops, particularly during early growth stages (Choudhary *et al.* 2022). The results confirm that oilseeds are highly responsive to effective weed management, especially in crops with large spatial coverage. Soybean and groundnut emerged as the principal contributors to production and economic gains due to their extensive cultivated area and relatively high adoption of weed management practices. Soybean alone contributed 3.42 million tonnes of additional production, reflecting high coverage under weed management (88%) and a yield increase of 25.45% over the national average, which translated into the highest economic returns (₹ 167,274 million). Soybean is known to be particularly vulnerable to early-season weed competition because of its slow initial growth and wide row spacing, and yield losses of 30–40% under weedy conditions have been widely reported (Jadhav *et al.* 2025). Similarly, groundnut recorded an additional 1.30 million tonnes of production with 75% area coverage and a yield increase of 14.47%, consistent with earlier findings that timely weed control can enhance pod yield by 15–35% (Mehriya *et al.* 2021).

Among minor oilseeds, niger, linseed, and safflower exhibited the highest relative yield responses (20–38%). Although their absolute production gains were small due to limited area, the

Table 2. Weed management coverage and its impact on productivity and economic returns across major pulse crops in India (2024-25)

Crop	Area (mha)	Production (mt)	Productivity (kg/ha)	Estimated area under weed management (mha)	Estimated % of area coverage under weed management	Estimated crop productivity gain (kg/ha) due to IWM	Estimated % increase in yield over national average	Estimated d additional crop production due to IWM (mt)	Estimated additional gains in economic return (Rs in million)
Pigeonpea	4.34	3.62	836	2.60	60	250	29.90	0.65	49,105
Blackgram	3.16	2.24	710	2.05	65	300	42.25	0.62	45,556
Greengram	5.90	4.24	719	3.83	65	300	41.72	1.15	99,869
Lentil	1.70	1.65	973	0.17	10	150	15.42	0.03	1,707
Chickpea	9.12	11.11	1218	4.56	50	250	20.53	1.14	64,424
Other pulses	3.51	2.80	799	0.88	25	200	25.03	0.18	9,121
Total	27.72	25.68		14.10				3.76	269,783

Table 3. Weed management coverage and its impact on productivity and economic returns across major oilseed crops in India (2024-25)

Crop	Area (mha)	Production (mt)	Productivity (kg/ha)	Estimated area under weed management (mha)	Estimated % of area coverage under weed management	Estimated crop productivity gain (kg/ha) due to IWM	Estimated % increase in yield over national average	Estimated d additional crop production due to IWM (mt)	Estimated additional gains in economic return (Rs in million)
Groundnut	5.76	11.94	2073	4.32	75	300	14.47	1.30	87,938
Castor	0.97	1.79	1852	0.14	15	200	10.80	0.03	1,303
Sesame	1.58	0.89	567	0.32	20	150	26.46	0.05	4,381
Niger	0.10	0.04	394	0.01	10	150	38.07	0.00	132
Soybean	12.95	15.27	1179	11.40	88	300	25.45	3.42	167,274
Sunflower	0.19	0.24	1214	0.07	35	250	20.59	0.02	1,236
Rapeseed & mustard	8.66	12.67	1463	2.16	25	250	17.09	0.54	32,193
Lineseed	0.17	0.11	666	0.03	20	250	37.54	0.01	465
Safflower	0.06	0.04	672	0.01	20	250	37.20	0.00	190
Total	30.44	42.99		18.47				5.36	295,112

Table 4. Weed management coverage and its impact on productivity and economic returns across major commercial crops in India (2024-25)

Crop	Area (mha)	Production (mt)	Productivity (kg/ha)	Estimated area under weed management (mha)	Estimated % of area coverage under weed management	Estimated crop productivity gain (kg/ha) due to IWM	Estimated % increase in yield over national average	Estimated d additional crop production due to IWM (mt)	Estimated additional gains in economic return (Rs in million)
Sugarcane	5.45	454.61	83416	3.00	55	12000	14.39	35.97	122,298
Cotton	11.48	29.72	440	7.46	65	125	28.41	0.93	66,444
Potato	2.14	60.14	28103	0.86	40	5620	20.00	4.81	72,161
Total	19.07	544.48		11.32				41.71	260,903

strong percentage response indicates severe yield suppression under unmanaged weed conditions and highlights significant untapped potential if weed management is scaled up. In contrast, relatively lower gains in castor and rapeseed–mustard were mainly associated with limited area coverage under weed management, despite moderate yield improvements, suggesting that expansion of coverage rather than yield response *per se* is the primary constraint. Overall, the findings emphasize that scaling integrated, crop-specific weed management strategies in oilseeds can substantially narrow yield gaps, enhance domestic oilseed availability, and reduce import dependence, while improving farm profitability across both major and minor oilseed systems.

Commercial crops

Earlier studies have reported yield reductions of 20–60% in commercial crops under unmanaged weed conditions, particularly during early crop establishment (Chauhan and Mahajan 2014). Weed management interventions in sugarcane, cotton, and potato estimated covered 11.32 million hectares, representing nearly 59% of the total cropped area of 19.07 million hectares under these crops, and resulted in an estimated additional 41.71 million tonnes of production with an estimated economic return of ₹ 260,903 million (**Table 4**). The magnitude of these gains highlights the critical role of weed management in high-value commercial crops, where yield losses due to weeds are often severe and economic stakes are high. Sugarcane is highly susceptible to weed competition during the first 90–120 days after planting, when weeds compete aggressively for nutrients, moisture, and light, leading to long-term yield penalties if not controlled (Suganthi *et al.* 2019). Sugarcane accounted for the largest share of gains, primarily due to its very high biomass productivity and substantial per-hectare yield response (12,000 kg/ha). Effective weed control resulted in an additional 35.97 million tonnes of cane production and ₹ 122,298 million in economic returns. The results reaffirm that timely weed management during the formative growth phase is essential for realizing the yield potential of sugarcane.

Potato is a short-duration, nutrient- and water-intensive crop, and early weed interference has been shown to reduce tuber initiation and bulking, resulting in yield losses of 30–40% (Jabran *et al.* 2023). Potato also showed a strong response to weed management, recording a 20% yield increase and an additional 4.81 million tonnes of production despite moderate area coverage (40%). The observed gains are consistent with earlier findings emphasizing the importance of maintaining weed-free conditions during the first 30–

45 days after planting. Cotton's long vegetative phase and slow early growth make it particularly vulnerable to weed competition, and IWM has been shown to significantly improve yield and resource-use efficiency (Manalil *et al.* 2017). Cotton contributed relatively lower absolute production gains (0.93 million tonnes) but exhibited a high relative yield increase (28.41%) due to effective weed control across 65% of its cultivated area, generating substantial economic benefits (₹ 66,444 million). Overall, the results demonstrate that expanding timely and IWM in commercial crops can deliver disproportionate productivity and profitability gains, reinforcing its role as a core component of sustainable intensification strategies.

Overall weed management coverage and its impact

At the national level, weed management interventions covered an estimated 125.33 million hectares, representing about 67.0% of the total cropped area across major crop groups (187.06 million hectares), and resulted in an estimated additional 96.62 million tonnes of agricultural production with an estimated economic return of ₹ 1,893,828 million (**Table 5**). These aggregated gains highlight the pervasive impact of weeds as a biotic constraint and the substantial production penalties associated with inadequate control, which are often estimated at 25–40% across crops in tropical agriculture (Chauhan *et al.* 2012).

Constraints and opportunities for scaling up IWM adoption

Based on the interactions with different stakeholders during collection of the data used for the estimated in the study, a few constraints and opportunities for scaling up of IWM adoption were identified. They include:

Constraints for scaling up IWM adoption

a. Knowledge and skill gaps: Limited knowledge on weed ecology, critical period of crop–weed competition, and lack of awareness on possible integration of cultural, mechanical, and chemical methods amongst farmers is restricting the effective IWM adoption by farmers.

b. Labour and mechanization constraints: High labour requirements for manual/mechanical weeding and limited access to suitable improved agricultural implements (*e.g.*, mechanical weeders, inter-row cultivators), especially during labour scarcity.

c. Short-term cost and risk perception: IWM often involves higher initial costs and delayed benefits compared to sole herbicide use and thus discouraging IWM adoption by smallholders with limited risk-bearing capacity.

d. Herbicide-centric practices: Over-reliance on herbicides usage to manage weeds, driven by ease of use and aggressive marketing by industry, has reduced farmer's interest in diversified weed management strategies.

e. Policy and institutional limitations: Inadequate extension support, weak custom-hiring infrastructure, and limited incentives for non-chemical approaches constrain large-scale dissemination of improved IWM technology and its adoption.

Opportunities for scaling up IWM adoption

a. Rising herbicide resistance and weed shifts: Increasing cases of herbicide resistance and hard-to-control weeds create a strong rationale for promoting IWM as a sustainable alternative.

b. Advances in mechanization and precision agriculture: Availability of weeders, residue managers, drone-based herbicide applicators, and site-specific weed management tools enhances operational efficiency of IWM.

c. Conservation agriculture and climate-smart systems: Expansion of zero-till, residue retention, and diversified cropping systems aligns well with ecological IWM principles.

Table 5. Weed management coverage and its impact on productivity and economic returns across major crop group in India (2024-25)

Crop	Area (mha)	Production (mt)	Estimated area under weed management (mha)	Estimated % of area coverage under weed management	Estimated additional crop production due to IWM (mt)	Estimated additional gains in economic return (Rs in million)
Cereals	109.83	332.05	81.45	74.16	45.78	1,068,031
Pulses	27.72	25.68	14.10	50.85	3.76	269,783
Oilseeds	30.44	42.99	18.47	60.67	5.36	295,112
Commercial crops	19.07	544.48	11.32	59.34	41.71	260,903
Total	187.06	945.19	125.33	67.00	96.62	1,893,828

d. Economic and environmental co-benefits: IWM reduces long-term weed pressure, input costs, and environmental risks while improving yield stability and profitability.

e. Policy support for sustainable intensification: National initiatives on resource-use efficiency, natural farming, and sustainable agriculture provide a conducive policy environment for IWM mainstreaming.

Way forward

It was estimated that 61.73 million hectares which are still left unmanaged in the country under different field crops and scaling up weed management across this area could generate an additional 55.34 million tonnes of agricultural output and a substantial economic gain of Rs 932,201 million (**Table 6**). Presently, farmers are unable to utilize available weed management technologies due to various constraints, listed above. Hence, in years to come, it is essential to take the technology to the farmers and encourage them to adopt by creating awareness amongst farmers of improved weed management technologies by capacity building and training, *etc*. The adoption of improved weed management practices by the majority of the farmers would enhance crop productivity and farm income, without expanding cultivated area and strengthen the national food security.

Two future targets to achieve the Viksit Bharat Goal @ 2047, with respect to weed management, include:

1. To create awareness on the importance of IWM adoption amongst farmers and bring entire cropped area under IWM adoption

Table 6. Potential crop productivity and economic gains of major field crops in India due to projected feasible acreage expansion with improved weed management technologies adoption

Crops	Projected extended area to be covered with improved weed management (mha)	% of total cultivable area	Estimated productivity gain (kg/ha)	Estimated additional crop production (mt) due to IWM adoption	Estimated additional economic gain (Rs in millions) due to adoption of improved weed management technologies
Cereals					
Rice	11.28	22	500	5.64	129,706
Maize	1.69	14	1000	1.69	37,663
Jowar	2.80	70	200	0.56	18,854
Bajra	5.89	80	200	1.18	30,899
Ragi	0.99	79	150	0.15	6,300
Other minor millets	0.36	79	150	0.05	1,887
Wheat	4.92	15	530	2.61	63,242
Barley	0.46	75	150	0.07	1,659
Total	28.38			11.95	290,210
Pulses					
Pigeonpea	1.73	40	250	0.43	32,737
Blackgram	1.10	35	300	0.33	24,530
Greengram	2.06	35	300	0.62	53,776
Lentil	1.53	90	150	0.23	15,367
Chickpea	4.56	50	250	1.14	64,424
Other pulses	2.63	75	200	0.53	27,362
Total	13.63			3.28	218,197
Oilseeds					
Groundnut	1.44	25	300	0.43	29,313
Castor	0.82	85	200	0.16	7,382
Sesame	1.26	80	150	0.19	17,526
Niger	0.09	90	150	0.01	1,189
Soybean	1.55	12	300	0.47	22,810
Sunflower	0.13	65	250	0.03	2,295
Rapeseed & mustard	6.49	75	250	1.62	96,580
Lineseed	0.14	80	250	0.03	1,859
Safflower	0.05	80	250	0.01	760
Total	11.97			2.97	179,713
Commercial crops					
Sugarcane	2.45	45	12000	29.43	100,062
Cotton	4.02	35	125	0.50	35,778
Potato	1.28	60	5620	7.22	108,241
Total	7.76			37.15	244,081
Grand total	61.73	33		55.34	932,201

2. To introduce a certain degree of weed management adoption in the presently unweeded cropped area of different crops by demonstrating the potential productivity and economic gains with the adoption of improved weed management

The future target achievement would lead to an estimated potential additional 55.34 million tonnes production of cereals; 11.95 million tonnes of millets; 3.28 million tonnes of pulses; 2.96 million tonnes of oilseeds and 37.15 million tonnes of commercial crops with total additional economic gain of Rs 932,201 million (**Table 6**).

Conclusions

At the national scale, the scaling up of integrated weed management across varying crops has the potential to generate additional economic gains of nearly ₹ 0.93 trillion and thus indicating that weed management is a core pillar of sustainable agricultural intensification in India. Overall, the findings of this study conclusively establish weed management as a high-impact, high-return intervention for bridging crop yield gaps and enhancing national agricultural output. Across food grains, pulses, oilseeds, and commercial crops, the timely and integrated weed management consistently improves crop productivity and farm profitability. Expanding weed management coverage particularly through crop- and system-specific integrated approaches in different agro-ecological zones can substantially improve food and nutritional security, reduce import dependence in oilseeds, and strengthen farm incomes.

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