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PUNJAB AND HARYANA

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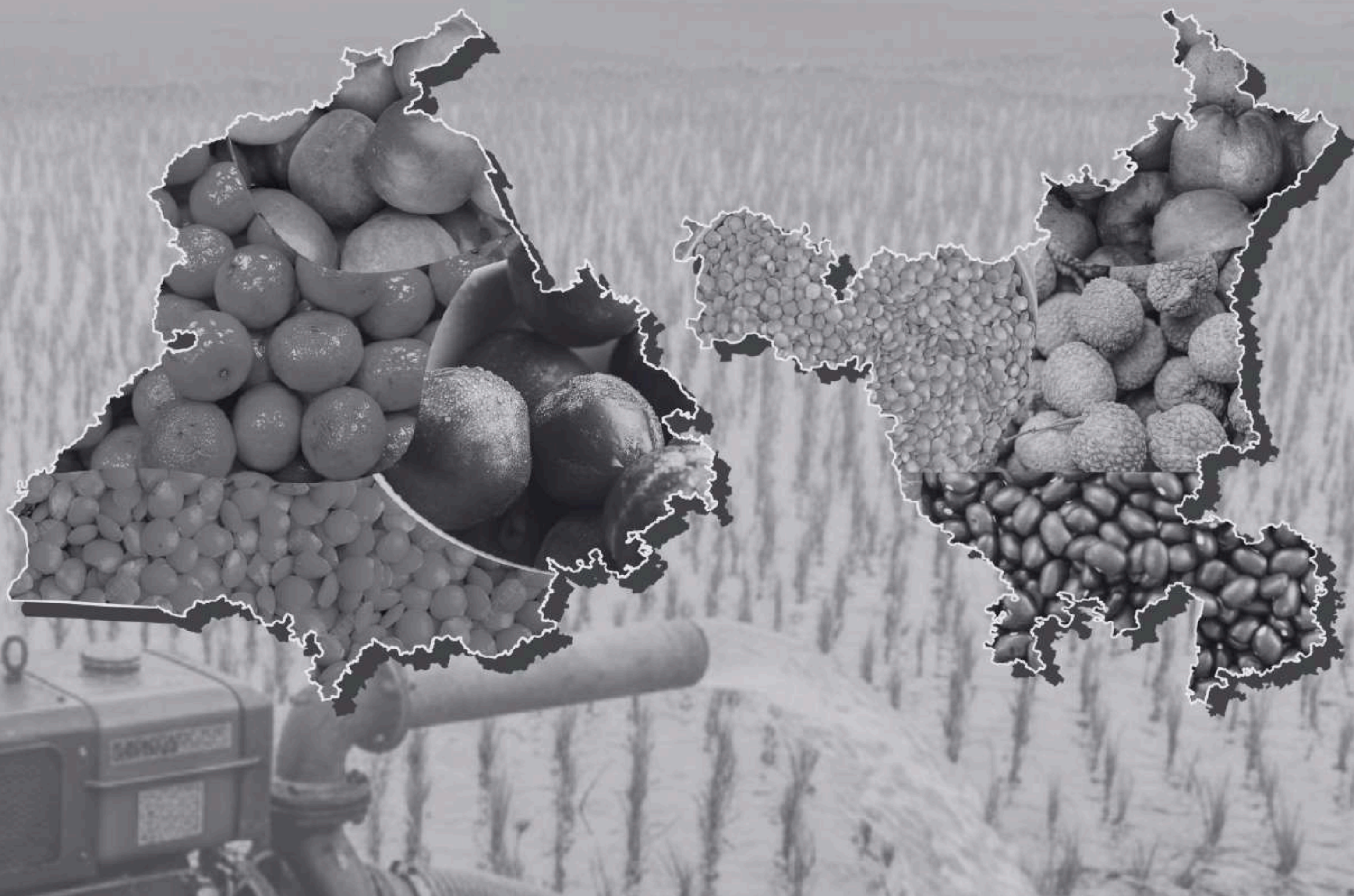

REENA SINGH | PURVI THANGARAJ | ASHOK GULATI

Diversification to Augment Farmers' Incomes and Promote Sustainable Agriculture in Punjab and Haryana

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ABSTRACT

Punjab and Haryana have long played a pioneering role in shaping India's agricultural transformation, when it was needed the most. With the adoption of input-intensive technologies during the Green Revolution, Punjab emerged as the leader in transforming Indian agriculture during the 1970s and 1980s, with Haryana following closely. This transformation led to a substantial increase in wheat and rice productivity, thereby significantly strengthening government procurement of these staple crops and ensuring food security of the country. Further, India has emerged as the largest producer of rice in the world and also the largest exporter with a share of 40 per cent in global exports of rice during Marketing Year 2025 (USDA, 2026). At the same time, the environmental costs of sustaining national food security have been substantial. Intensive paddy (rice) cultivation practices have placed severe stress on natural resources, leading to the degradation of land and depletion of groundwater in both states. Yet, farmers continue to grow this crop due to profitability and its assured procurement from the government.

Rice is a very water, greenhouse gas (GHG) and fertiliser-intensive crop in this region. The subsidies, both from the Government of India (GoI) in the form of fertiliser and state governments in the form of power, irrigation and machinery, are heavily skewed in favour of paddy cultivation. This is due to high consumption of fertilisers, irrigation water, and electricity for groundwater extraction during paddy cultivation. Our analysis indicated that during the crop year 2022–23, paddy received per-hectare input subsidies at about ₹40,577 in Punjab and ₹52,388 in Haryana. By comparison, support for oilseeds remained much lower at ₹8,685 per hectare in Punjab and ₹9,859 per hectare in Haryana, while pulses received ₹6,382 per hectare in Punjab and ₹7,430 per hectare in Haryana. This situation analysis led us to explore possibilities of providing incentives to farmers by repurposing the existing subsidies that are currently being provided for paddy cultivation by the GoI and state governments. During the course of interactions with the farmers and other stakeholders, as well as an in-depth analysis of the data for electricity consumption, fertiliser consumption, water consumption, profitability analysis and market risks, we were able to establish three things. First, an upfront incentive of about ₹35,000 per hectare (GoI and state governments in the ratio of 50:50) plus carbon credit (as per the market cost, at least 15-20 US$ per tonne of GHG emission) is likely to encourage farmers to make a switch from paddy to alternative *Kharif* crops in Punjab and Haryana. Second, in addition to the upfront incentives, assured procurement of alternate crops by governments at Minimum Support Price (MSP) at par with paddy would be required to cover market risk of the farmers. Third, availability of high-yielding varieties (HYVs) of alternate crops, viz., maize, fruit crops, oilseeds and pulses would ensure the profitability of these crops and thus the success of crop diversification in 8-15 lakh hectares of non-basmati rice areas of Punjab and Haryana. Interestingly, this expenditure on incentivising legumes or other alternative crops is not an additional expenditure, but only repurposing the existing subsidies to create crop-neutral incentives. The only thing needed is cooperation between the GoI and the state governments on a 50:50 basis to foot the bill upfront, and as farmers shift from paddy to alternative crops, the savings in fertiliser subsidy will accrue to the GoI and savings in power and irrigation subsidy will flow to the states.

FOREWORD

Punjab and Haryana have played a pioneering role in shaping Indian agriculture. With the adoption of input-intensive Green Revolution technologies, these states have been central to ensuring the country's food security and strengthening public procurement of staple crops. In 2025–26, they accounted for 28.5 per cent and 63.4 per cent of government procurement of rice and wheat, respectively (FCI, 2026). As of January 1, 2026, rice stocks with the Food Corporation of India were nearly ten times the buffer norm. India is now the world's largest producer and exporter of rice, with a 40 per cent share in global exports during Marketing Year 2025 (USDA, 2026). Notably, this progress has supported the provision of free food grains to around 800 million people across the country.

Both states, however, have borne a heavy environmental cost in sustaining the nation's food security. The paddy–wheat rotation now dominates cropping pattern in Punjab and Haryana, which together accounting for about 4.85 million hectares under rice in 2024–25, which is 9.5 per cent of the national area. This water-intensive system, requiring 20–25 irrigations for paddy compared to 4–5 for most other crops, has driven unsustainable groundwater extraction. Over-exploited blocks have reached 76 per cent in Punjab and 62 per cent in Haryana (CGWB, 2023), with water tables falling by 10.89 metres and 11.94 metres, respectively, between 2000 and 2022 (Thangaraj and Gulati, 2024). Input intensity further compounds the stress: fertiliser use averages 250 kg per hectare in Punjab and 220 kg per hectare in Haryana (2024–25), with excessive nitrogen causing environmental degradation. Rice cultivation also emits about 5 tonnes of carbon-dioxide equivalent per hectare in these states (Singh and Gulati, 2025), and stubble burning further exacerbates air pollution with serious public health consequences.

Crop diversification offers a viable pathway to address the water and sustainability challenges in Punjab and Haryana. Under India's "−5, +10" strategy, i.e. reducing 5 million hectares of rice area while increasing output by 10 million tonnes, the report proposes about 0.8–1.5 million hectares of non-basmati rice area should be to shifted from these ecologically stressed states. While both the Centre and state governments are promoting diversification during the kharif season, farmer adoption remains limited. This report identifies key barriers to diversification and outlines actionable policy measures, grounded in quantitative assessment of incentives for rice and alternative crops. One key policy innovation suggested in the report is to provide about ₹35,000 per hectare for at least five years to farmers of Punjab and Haryana for shifting from paddy to pulses and oilseeds. This can be achieved with no additional fiscal burden by repurposing existing subsidies—saving on power and irrigation at the state level, and fertiliser subsidies at the Union level—while making incentives crop-neutral. Such an approach can accelerate the transition to more sustainable and resilient cropping systems, benefiting farmers, consumers, and the environment.

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PREFACE

During 1960s, due to the achievements of the Green Revolution, Punjab emerged as the "breadbasket of the nation", closely followed by Haryana. However, today, both the states are facing severe ecological challenges, which are attributed to the wheat-rice cropping pattern. This report examines the drivers of paddy dominance by analysing incentive structures and profitability vis-à-vis other kharif crops, and explores pathways for diversification through crop-neutral incentives.

Chapter 1 sets the context and objectives, noting that agricultural development over the past five decades prioritised cereal production for food security, with Punjab and Haryana playing a central role, while largely overlooking pulses, oilseeds, and environmental sustainability. Chapter 2 details the analytical framework and methodology adopted to assess incentives, profitability, and the environmental footprint of paddy vis-à-vis alternative crops. It outlines the estimation of crop-wise input subsidies (such as power, irrigation, and fertilisers), and also explains the approach to evaluating profitability through cost of cultivation, and relative price advantages across crops. In addition, it presents the methodology for assessing environmental impacts, including indicators such as water use, groundwater extraction, fertiliser intensity, and greenhouse gas emissions. Together, these provide a comprehensive basis for comparing paddy with alternative cropping options in Punjab and Haryana.

Chapter 3 analyses the incentive structure and profitability for paddy vis-à-vis alternative crops during 2016–17 to 2022–23, revealing a clear policy bias in its favour in Punjab and Haryana. In 2022–23, subsidies for paddy were ₹40,577 per hectare in Punjab and is significantly higher than pulses (₹6,382 per hectare) and oilseeds (₹8,685 per hectare). A similar pattern is observed in Haryana, where paddy received ₹52,388 per hectare, compared to ₹7,430 per hectare for pulses and ₹9,859 per hectare for oilseeds. Chapter 4 highlighted the high environmental footprint of rice cultivation in these states, which is marked by high water requirement (5000 litres per kg of rice), groundwater depletion (average annual decline of 1.7 ft water level), high GHG emissions (5 tCO_2 eq per hectare), and heavy fertiliser use.

Chapter 5 recommends shifting 0.8–1.5 million hectares of non-basmati paddy area from Punjab and Haryana to enhance environmental sustainability. Recognising that farmers will shift only if profitability is ensured, it proposes an incentive of ₹35,000 per hectare for at least five years. This can be financed by repurposing existing subsidies—saving on power, irrigation, residue management, and fertiliser—making it fiscally neutral. The approach aims to move from paddy-skewed support to a crop-neutral incentive regime.

AUTHORS

EXECUTIVE SUMMARY

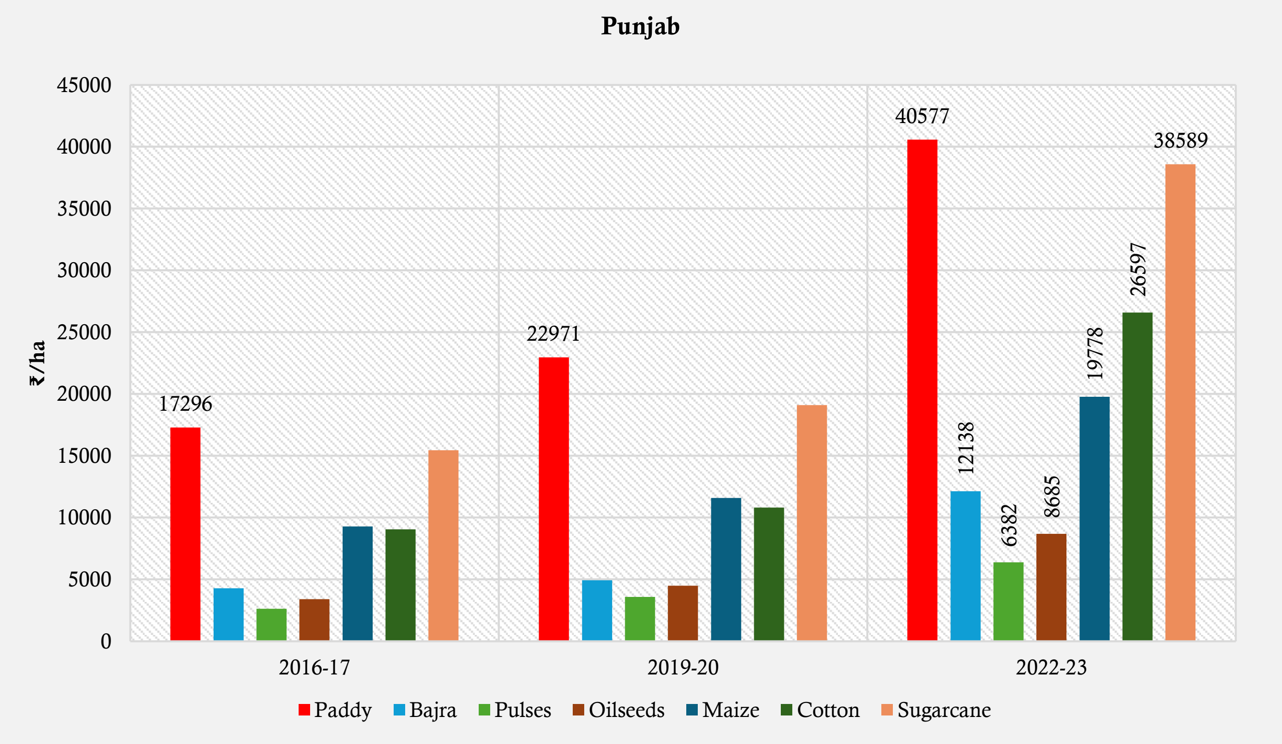
Punjab has been a star performer in agriculture during the heydays of Green Revolution. Its agriculture GDP grew at 5.7 per cent per annum during 1971- 72 to 1985-86, which was more than double the growth rate of 2.31 per cent achieved at all-India level during the same period (Gulati et al., 2021). It was this remarkable performance of Punjab, closely followed by Haryana, first observed in large wheat surpluses and then in rice, which helped India free itself from the PL 480 food aid and its associated political strings. Punjab and Haryana became the symbols of India's grain surpluses, giving India a much-needed food security. But after 1985-86, green revolution started greying and growth in Punjab agriculture slowed down to 3 per cent per annum over the period 1985- 86 to 2004-05, almost the same as achieved at all India level. But the real challenges to Punjab agriculture emerged when its growth crashed down to just 1.9 per cent per annum during 2004-05 to 2024-25, which was less than half the all-India agriculture GDP growth of 3.8 per cent over the same period. Owing to the earlier years of high agricultural growth, Punjab continues to be among the states with the lowest poverty levels in the country, with a multidimensional poverty headcount ratio of 4.35 per cent in 2022–23, which is well below the all-India average of 11.28 per cent (NITI Aayog, 2024). Providing food security to the country and reducing its own poverty to the lowest levels within all India context have been the most laudable achievements of Punjab. But lately, as a result of its decelerating agri-growth, Punjab has lost its pre-eminent position of being the state with the highest per capita income in India, a title it carried since its inception in 1966 till 2002-03. In 2014- 15, e.g., Punjab stood at the 7th position in per capita income amongst 21 major states of India and further slipped down to 12th position during 2023-24 (MoSPI, 2026).

Alongside these income concerns, both states, however, have borne considerable environmental costs in supporting the country's food security. The spread of intensive agriculture has led to serious pressures on land, water, and air resources. These challenges began to emerge in the 1980s and have become progressively more pronounced. With nearly 82 per cent of the geographical area already under cultivation and cropping intensity among the highest in the country—201 per cent in Punjab and 196 per cent in Haryana (MoAFW, 2025d)—agricultural land in both states is under significant stress, resulting in the depletion of soil nutrients. Groundwater resources used for irrigation are also being depleted at an alarming rate. Annual groundwater extraction is estimated at about 26.27 billion cubic metres (bm^3) in Punjab and 12.72 bm^3 in Haryana, while annual recharge stands at only around 18.6 bm^3 and 10.27 bm^3, respectively, indicating unsustainable levels of withdrawal. As a result, the share of over-exploited groundwater blocks has increased to approximately 72.6 per cent in Punjab and 63.6 per cent in Haryana (CGWB, 2025). As groundwater levels fall, tube wells are required to reach increasingly deeper aquifers. Between 2000 and 2022, groundwater levels declined by approximately 11.94 metres below ground level (mbgl) in Haryana—the steepest decline among Indian states—and by 10.89 mbgl in Punjab (Thangaraj and Gulati, 2024).

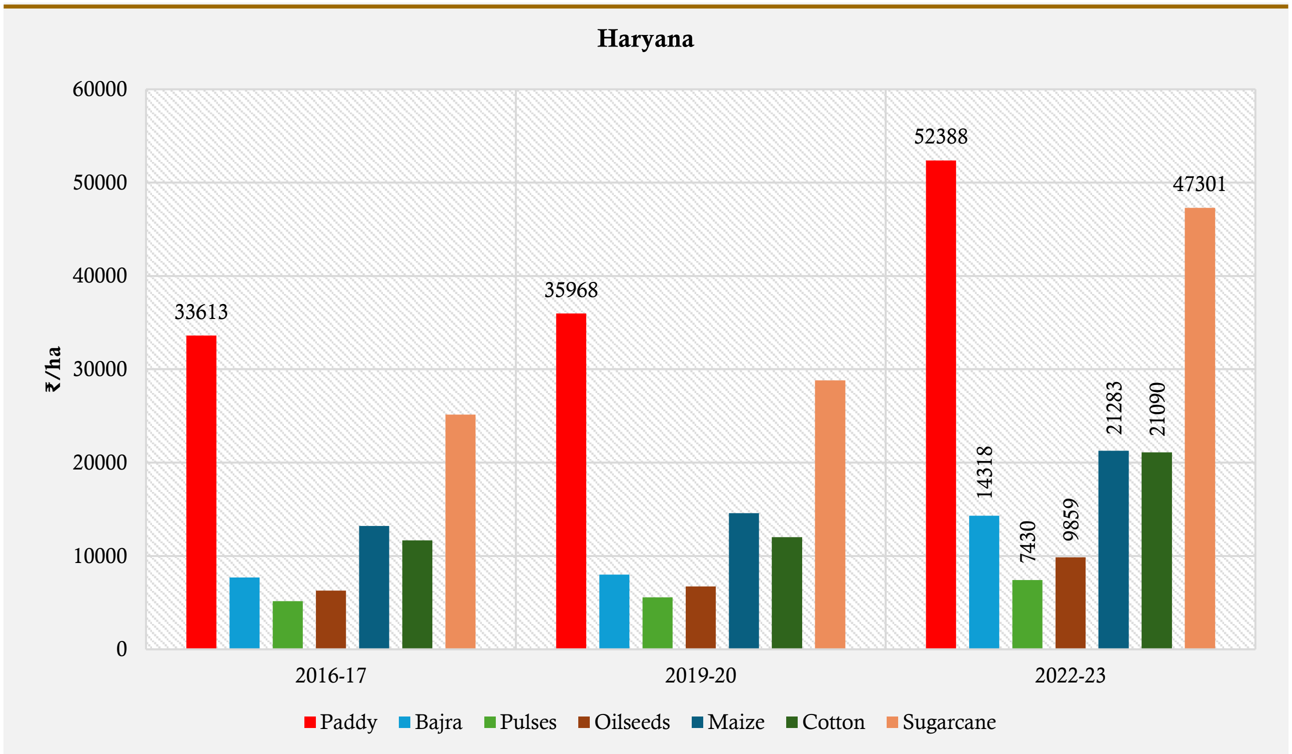
The emerging sustainability challenge in these states is driven by four interrelated structural factors: (i) the widespread cultivation of paddy during the *Kharif* (July–October) season, (ii) excessive reliance on groundwater-based irrigation, (iii) strong farmer dependence on assured procurement mechanisms, and (iv) the availability of free or highly subsidised electricity, which weakens incentives for resource-efficient cropping choices. Paddy is a highly water-intensive crop, typically requiring 20–25 irrigations, compared with about 4–5 irrigations for many alternative crops, and is widely regarded as the most inefficient user of water, with 60–83 per cent of total irrigation lost through deep percolation (ICAR-NRRI, 2021). However, the average farm applied irrigation water varies with the agro-ecology and soil conditions, and Punjab ranks first, requiring 208 cm of water (CACP, 2013-14), indicating the high irrigation demand despite being water-stressed. This heavy dependence on irrigation has placed severe pressure on groundwater resources, leading to a persistent decline in water tables over the past several decades. Paddy cultivation also contributes significantly to greenhouse gas (GHG) emissions. The anaerobic decomposition of organic matter in flooded paddy fields releases methane (CH_4), a gas with a global warming potential 27.2 times higher than carbon dioxide (CO_2) over a 100-year period and about 80.8 times higher over a 20-year timeframe. Additional emissions arise from nitrous oxide (N_2O)—which has a global warming potential 273 times that of CO_2—primarily due to the use of synthetic nitrogen fertilisers. CO_2 emissions from energy use, along with CH_4 and N_2O released during crop residue burning, further add to the emissions profile. Considering these sources together, Punjab records the highest per-hectare GHG emissions from paddy cultivation in India—about 5 tonnes of CO_2 equivalent (t CO_2 eq) per hectare compared with the national average of 3.1 t CO_2 eq per hectare—followed closely by Haryana at 4.7 t CO_2 eq per hectare (Singh and Gulati, 2025). Crop residue burning in these states also contributes substantially to local air pollution, with direct adverse effects on public health. The cultivation of HYVs of wheat and paddy has also led to heavy reliance on chemical inputs, including fertilisers and pesticides. Fertiliser application rates average about 250 kg per hectare in Punjab and 220 kg per hectare in Haryana in 2024-25 (FAI, 2026). Excessive use of fertilisers, particularly nitrogenous (N) ones in relation to phosphatic (P) and potassic (K) fertilisers, has significant environmental consequences: part of the applied nitrogen is lost as ammonia, nitrogen gas, or N_2O emissions, while another portion leaches into groundwater in the form of nitrates, leading to contamination of groundwater.

These developments illustrate the hidden environmental and social costs of agricultural growth in Punjab and Haryana and underscore the urgent need to transition toward more sustainable cropping patterns and production practices. The degradation of soil health, groundwater resources, air quality, and human well-being is not only a regional concern but also a national one, given the critical role these states play in India's food supply. These environmental stresses also increasingly affect farm productivity, costs of cultivation, and ultimately farmers' incomes. The initial recommendations for altering Punjab's cropping pattern away from the prevalent paddy-wheat cycle emerged in the late 1980s by a committee led by economist S.S. Johl. Yet, farmers continue to grow this crop due to its high profitability, lower risk of nature, and its assured procurement from the government. In the year 1971-72, rice covered only 0.39 million hectares (mha) of cropped area in Punjab, a figure that has since expanded to 3.2 mha, thereby increasing its share in gross cropped area (GCA) from 7 per cent to 38 per cent in 2023-24. The distortion in cropping pattern is due to the incentive structure that encourages mono-cropping of paddy-wheat cycle. The subsidies, both from the Government of India (GoI) in the form of fertilisers and state governments in the form of power, irrigation and machinery, are skewed in favour of paddy cultivation. This is due to high consumption of fertilisers, irrigation water, and electricity for groundwater extraction during paddy cultivation. Our analysis indicates that during 2022–23, paddy received per-hectare input subsidies at about ₹40,577 in Punjab and ₹52,388 in Haryana. By comparison, support for oilseeds remained much lower at ₹8,685 per hectare in Punjab and ₹9,859 per hectare in Haryana, while pulses received ₹6,382 per hectare in Punjab and ₹7,430 per hectare in Haryana. This situation analysis led us to explore possibilities of providing incentives to farmers by repurposing the existing subsidies that are currently being provided for paddy cultivation by the GoI and state governments.

Total Incentives towards Paddy vis-à-vis Other *Kharif* Crops



Source: Estimated by authors using MoF, GoP, GoH, FAI, MoAFW (various years)



Source: Estimated by authors using MoF, GoP, GoH, FAI, MoAFW (various years)

Recommendations and Way Forward

i. 'Paddy-skewed incentives' to 'crop neutral incentives' - Existing incentive of ₹17,500 per hectare for non-paddy farmers should be doubled by GoI

Union Agriculture Minister, Shri. Shivraj Singh Chouhan announced an ambitious "−5, +10" formula to reduce the area under rice cultivation by 5 mha while increasing rice output from the remaining rice area by 10 million tonnes (MT), to free up area for the cultivation of pulses and oilseeds (PIB, 2025). Of the target 5 mha rice area reduction, at least 8-15 lakh hectares of non-basmati rice area needs to be targeted from Punjab and Haryana. It is because these states are experiencing severe environmental degradation, specifically the unsustainable depletion of groundwater and high GHG emissions caused by water-intensive paddy farming. The shift from paddy toward diversified farming is crucial for environmental sustainability. However, at present, the agricultural subsidies as well as the assured procurement are skewed towards paddy, which is one of the major reasons that drives paddy cultivation and its profitability. Other *Kharif* crops in Punjab and Haryana have widely documented challenges, e.g. pest attack in cotton, low yield in pulses and maize, lack of cold storage facilities for perishables, uncertain market, etc., that are getting compounded with the climate change impacts. The viability of other crops remains a major concern for the farmers. The farmers' income and profitability need to be linked with crop diversification goals, which are not aligned at present, though the GoI and states have announced the crop diversification schemes.

Since *Kharif* 2020-21, under the Promotion of Crop Diversification and Water Conservation Scheme, the Government of Haryana (GoH) has introduced an incentive of ₹7,000 per acre under '*Mera Pani Meri Viraasat*' (₹17,500 per hectare) to encourage farmers to transition from paddy to other crops. However, the rice area is on a consistent upward trajectory and has steadily increased from 1.28 mha in 2021–22 to 1.7 mha in 2025–26. During *Kharif* 2020 and *Kharif* 2021, approximately 25,600 hectares and 20,752 hectares were diversified to other alternate crops, and the GoH provided incentives of ₹45 crores and ₹36 crores, respectively (Economic Survey of Haryana, 2025). This indicates that paddy cultivation decisions are being driven more by structural incentives (such as assured procurement, MSP support, and irrigation access) rather than by a one-time crop diversification incentive. In 2025–26, GoH has increased the incentive to ₹8,000 per acre (₹20,000 per hectare). Building on this, the 2026–27 Budget Speech announced an additional ₹2,000 per acre, raising the total support to ₹10,000 per acre (₹25,000 per hectare) by the GoH (GoH, 2026). But since the profitability of paddy is much higher than the other alternative crops, the incentives for alternative crops need to be doubled up, with equal share coming from the GoI, as the GoI will be saving on fertiliser subsidy as well as the costs of carrying bulging stocks of rice with the Food Corporation of India (FCI). If the GoI also contributes to the scheme, the farmer will get ₹35,000 to ₹40,000 per hectare for switching from paddy. It should be made available at least for 5 years to those farmers who switch to alternative crops, as the savings on power subsidy for the state and fertiliser subsidy for the GoI are going to be for the long haul.

GoI announced the Crop Diversification Scheme in 2023-24 with ₹289.87 crore allocation for 2024-25 BE for Punjab. This Centrally Sponsored Scheme (CSS) scheme (60:40 funding by GoI and GoP) envisaged to cover up to five hectares for the beneficiary farmer to provide an incentive of ₹17,500 per hectare. In 2024–25, GoP initially allocated ₹500 crores for the scheme (Budget Estimate, (BE)). However, this was sharply reduced to ₹40 crores (Revised Estimate, (RE)). More strikingly, the actual expenditure stood at just ₹0.85 crore—barely 0.17 per cent of the original budget and about 2.1 per cent of the revised allocation (GoP, 2026). And if we go one step further, the Comptroller and Auditor General of India (CAG) finance report indicated the Audited Expenditure to be ₹0.20 crore. This may indicate delays in scheme rollout, administrative and procedural hurdles or lack of project readiness. Another possible reason could be that this incentive falls short of covering the financial gap and market risk that farmers face when switching to alternate crops.

A more robust incentive, ranging from ₹30,000 to ₹40,000 per hectare, is proposed for farmers in Punjab and Haryana who opt for non-paddy crops (Singh et al., 2024). This would not strain the budget of any government, as this shift would ultimately reduce electricity, water, and fertiliser usage along with a corresponding decline in subsidy expenditure. Overall, if we shift 8-15 lakh hectares of non-basmati paddy area from Punjab and Haryana, it would lead to saving on power, irrigation, and other subsidies (e.g. paddy residue management) from state government budgets and saving on fertiliser subsidy from the GoI budget. This saved amount could be repurposed to farmers shifting from paddy to non-paddy crops. This ensures the shift of incentives from 'paddy-skewed incentive' to 'crop-neutral incentive'. With every hectare of paddy in Punjab, diversified to pulses and oilseeds, the move will not only make the country self-sufficient, but each hectare of diversified paddy field will save fertiliser subsidy of ₹15,263 per hectare (for pulses cultivation) and ₹13,479 per hectare (for oilseeds cultivation). GoP will save power subsidy of ₹18,932 per hectare (for pulses cultivation) and ₹18,414 per hectare (for oilseed cultivation). Similarly, every hectare of paddy in Haryana diversifying to pulses and oilseeds will save fertiliser subsidy of the GoI of ₹20,457 per hectare and ₹18,697 per hectare, respectively. While GoH will save ₹24,500 per hectare (for pulses cultivation) and ₹23,831 per hectare (for oilseeds cultivation) in power subsidy.

ii. Incentive of ₹35,000 per hectare in Punjab and Haryana for non-paddy farmers should be provided for at least five years

As per the crop diversification scheme guidelines, the farmers who diversify from paddy get an incentive of ₹17,500 per hectare only once, while paddy farmers reap benefits every year. Considering the skewed subsidy towards paddy every year, and if the farmer switches to other crops, then subsidy on power and fertilisers on account of paddy cultivation would be saved for the long haul. Thus, it is proposed that farmers should get a minimum of ₹35,000 per hectare for switching from paddy for at least five years till the vulnerabilities of new crops are reduced. During this period of five years, heavy expenditure on agriculture research and development (R&D) for raising the productivity of pulses and oilseeds be done by the GoI and the State Agriculture Universities (SAU), given that large quantities of pulses and edible oils are imported. Profitability of paddy in Punjab and Haryana is higher compared to other alternate crops due to assured procurement of paddy at MSP and skewed incentives towards paddy. For example, in 2022-23, the incentives gap of pulses in comparison with paddy was ₹34,195 per hectare in Punjab and ₹44,958 per hectare ha in Haryana. For oilseeds, the gap was ₹31,892 per hectare in Punjab and ₹42,528 per hectare in Haryana. Since these crops save fertiliser and power subsidies, the saved amount can be repurposed to farmers for shifting from paddy at least for five years.

iii. Ensuring that MSPs for pulses and oilseeds are effective

Farmers respond to the price signals provided by the MSPs and continue to grow predominantly crops which give them an assured price. Although GoI announces MSPs for 23 commodities and Farm Remunerative Price (FRP) for sugarcane, the procurement policy has been the most successful in reaching wheat and paddy farmers, and that too only in a few states. About 35 per cent of rice (51.8 MT) and 25.4 per cent of wheat production (29.9 MT) during the *Kharif* Marketing Season (KMS) 2024–25 and *Rabi* Marketing Season (RMS) 2025–26 was procured by FCI at MSP (FCI, 2026). In 2022–2023 and 2023–2024, the average number of farmers who benefited from rice procurement was 11.5 million, whereas the average number of farmers who benefited from wheat procurement was 6.9 million. However, procurement of other crops such as oilseeds and pulses has been low. During 2023-24, 2.7 MT of oilseeds (6.8 per cent of the production) and 1.4 MT of pulses (5.8 per cent of the production) were procured under Price Support Scheme (PSS)/ Price Stabilisation Fund (PSF), and an average of 1.5 million farmers benefited from the purchase of pulses, while 1.14 million benefited from the purchase of oilseeds (NAFED, 2025).

Under the 'Mission for *Aatmanirbharta* in Pulses', aimed at achieving self-sufficiency by 2030–31, the GoI has identified 489 districts as focus areas for cluster-based interventions. Of these, 7 districts are in Punjab and 3 in Haryana. The targeted expansion in area under pulses is projected to reach 0.67 lakh hectares in Punjab (from 0.37 lakh hectares in 2024–25) and 0.84 lakh hectares in Haryana (from 0.74 lakh hectares in 2024–25) by 2030–31. However, the envisaged expansion in these states needs to be more ambitious to drive meaningful crop diversification. This requires strengthening price incentives, particularly through repurposing subsidies on paddy and giving them equally for pulses and oilseeds, thereby creating crop-neutral incentives, as also more effective implementation of MSP for pulses and oilseeds. At present, the procurement ecosystem remains heavily skewed in favour of rice: during TE 2023–24, approximately 92 per cent of rice produced in Punjab and 74 per cent in Haryana is procured by the FCI (FCI, 2026). This creates a strong policy bias that discourages farmers from shifting to alternative crops. In contrast, despite persistent domestic shortages of pulses and oilseeds, market prices for these commodities often fall below MSP due to weak procurement mechanisms and weakening incentives for diversification. It is therefore recommended that pulses and oilseeds be accorded higher policy priority through assured and decentralised procurement in Punjab and Haryana, and a better price support mechanism to ensure remunerative returns for farmers and promote sustainable crop diversification.

iv. Punjab and Haryana as export hubs for high-value horticulture crops

To promote diversification, Punjab should also target doubling the area under high-value fruit orchards (like plums, peaches, litchi, guava, etc.) and vegetables (potatoes, peas, chilli, bell peppers, seedless cucumbers, gherkins, etc.) that are suitable for Punjab. They will need to be linked to processors, organised retailers and exporters, well in advance, to take care of price risks which are generally higher in perishables than in cereals. The Food Parks supported by the GoP should be part of this linkage. Air freight subsidy for exports to Gulf countries, and major investments in cold storage and reefer vans, for exports through Amritsar, will go a long way to augment farmers' incomes sustainably. However, this can only be extended by the GoI. Agricultural and Processed Food Products Export Development Authority (APEDA) should be involved in making some districts of Punjab as export hubs for high-value agriculture targeting Middle East countries. An alternative would be to work with Middle East countries and their Sovereign Wealth Funds to invest in Punjab as a source of food security for Middle East countries.

Amongst Middle East countries, the United Arab Emirates, Saudi Arabia, Turkey and Iraq are the largest importers for edible fruits and nuts in TE 2024 with shares of 27 per cent, 18 per cent, 13 per cent and 11 per cent respectively. Citrus fruits (13 per cent) are the sizeable category, followed by dates, figs, pineapples, avocados, guavas, and mangoes (12 per cent) (ITC Trade Map, 2026).

v. Carbon credits for farmers

Carbon is a tradable good in carbon credit system where one carbon credit unit is equivalent to one tonne of carbon dioxide emissions. This system provides financial incentives to farmers by allowing them to sell the carbon credits generated through the reduction of GHG emissions in their farmlands. Paddy cultivation in Punjab and Haryana emits 5 tonnes CO_2 eq per hectare (Singh and Gulati, 2025), and by switching to alternate crops, the farmers can earn up to 4 carbon credits. Some private companies are trying to develop this carbon market on voluntary basis. But there is need for the Central Government and state governments to work out pricing of carbon, and the certification process through due diligence.

In conclusion, the shift from prevalent paddy cultivation in Punjab and Haryana to oilseeds and pulses requires gearing of policy making towards sustainable and profitable agriculture. One of such policy innovations is suggested in this report, where farmers shifting from paddy to pulses and oilseeds can be given roughly ₹35,000 per hectare for at least 5 years. Interestingly, there is hardly any additional expenditure involved in this 'repurposing' of subsidies. It will lead to commensurate saving of the state government's power, canal irrigation subsidy, and the GoI will save fertiliser subsidy, as farmers switch from paddy to these environmentally benign crops. Hence, this is just repurposing the same subsidy and making incentives crop-neutral. If this is done, then the carbon footprint of paddy can be reduced in this region, and water and soil can be saved.

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The responsibility of facts, figures, analysis and views expressed in this report fully rests with the authors.

ABBREVIATIONS

APC	Agricultural Prices Commission
APEDA	Agricultural and Processed Food Products Export Development Authority
AWD	Alternate Wetting and Drying
BE	Budget Estimate
Bm^3	Billion cubic meters
CACP	Commission for Agricultural Costs and Prices
CAG	Comptroller and Auditor General
CCI	Cotton Corporation of India
CCSHAU	Chaudhary Charan Singh Haryana Agricultural University
CF	Carbon Footprint
CGWB	Central Ground Water Board
CH_4	Methane
CIP	Central Issue Prices
CO_2	Carbon dioxide
CO_2 eq	Carbon dioxide equivalent
CoC	Cost of Cultivation
CREAMS	Consortium for Research on Agroecosystem Monitoring and Modelling from Space
CSS	Centrally Sponsored Scheme
DSR	Direct Seeded Rice
FAI	Fertiliser Association of India

FCI	Food Corporation of India
FPO	Farmer Producer Organisations
FRP	Farm Remunerative Price
GCA	Gross Cropped Area
GHG	Greenhouse Gas
GoH	Government of Haryana
GoI	Government of India
GoP	Government of Punjab
GSVA	Gross State Value Added
HERC	Haryana Electricity Regulatory Commission
HYV	High Yielding Varieties
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
IEC	Information, Education and Communication
IPCC	Intergovernmental Panel on Climate Change
JCI	Jute Corporation of India
K	Potassium
KMS	*Kharif* Marketing Season
MBGL	Meter Below Ground Level
Mha	Million Hectare
MoAFW	Ministry of Agriculture and Farmers' Welfare
MSP	Minimum Support Price

MT	Million Tonne
N	Nitrogen
N_2O	Nitrous Oxide
NAFED	National Cooperative Marketing Federation of India Ltd.
NCCF	National Co-operative Consumers' Federation of India Ltd.
NF	Nitrogen Footprint
NMEO-O	National Mission on Edible Oils - Oilseeds
NMEO-OP	National Mission on Edible Oils and Oil Palm
P	Phosphorus
PAU	Punjab Agricultural University
PDC	Punjab Development Commission
PM-AASHA	Pradhan Mantri Annadata Aay SanraksHan Abhiyan
PoP	Package of Practices
PSF	Price Stabilisation Fund
PSPCL	Punjab State Power Corporation Limited
PSS	Price Support Scheme
R&D	Research and Development
RB	Residue Burning
RE	Revised Estimate
RMS	*Rabi* Marketing Season
SATHI	Seed Authentication, Tractability and Holistic Inventory
SAU	State Agriculture University

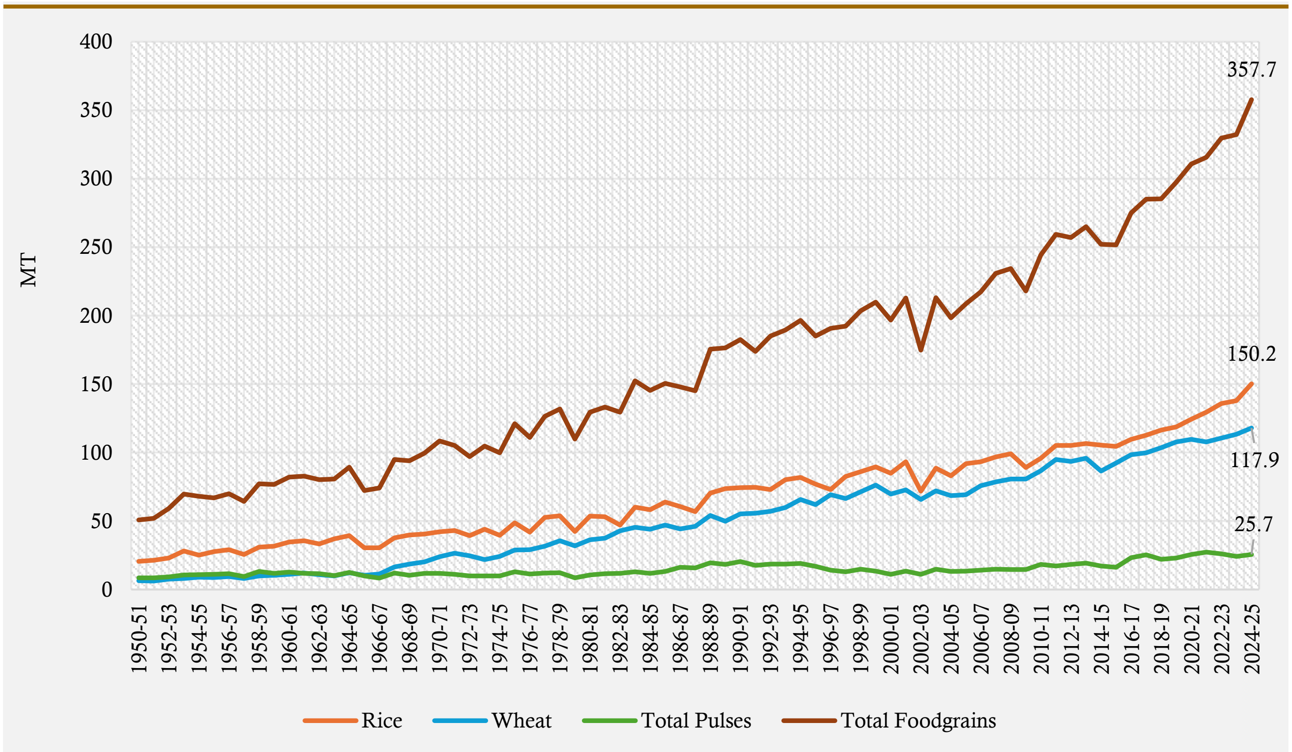
SEB	State Electricity Board
SHC	Soil Health Card
TBOs	Tree-Borne Oils
TIFAC	Technology, Information, Forecasting, and Assessment Council
TPDS	Targeted Public Distribution System
UHBVNL	Uttar Haryana Bijli Vitran Limited
WF	Water Footprint

INTRODUCTION

1

India's agricultural policy successfully targeted food grain self-sufficiency. Between 1950–51 and 2024-25, India's foodgrain production increased more than sevenfold, from about 50.82 million tonnes (MT) to over 357.73 MT (MoAFW, 2025b). This growth, however, has been driven mainly by wheat and rice production, which together accounted for nearly three-fourths of the total foodgrain output in 2024-25 (**Figure 1.1**). This enabled India to become a net exporter of wheat and rice, contributing to national food security and containing inflation in staple prices. In 2024–25, India exported close to 20 MT of rice, valued at about US$ 12.5 billion, making it the world's leading rice exporter (APEDA, 2026). However, the sustained policy focus on wheat and rice has resulted in a relative neglect of other critical elements of the food basket, particularly pulses and oilseeds. These crops are vital for nutrition and moderating price volatility, yet domestic production has remained insufficient to meet demand. As a result, India continues to rely heavily on imports to bridge gaps in pulses and edible oils.

Figure 1.1: All-India Production of Foodgrains, Rice, Wheat and Pulses



Source: MoAFW, 2025b

1.1 Import Dependency of Edible Oils and Pulses

Despite being among the world's leading producers of oilseeds, India's edible oil economy remains structurally dependent on imports. In 2024–25, domestic oilseed production reached about 43 MT, cultivated over 30.4 million hectares (mha). However, this translated into only 12.5 MT of edible oil availability, meeting less than half of national consumption requirements. As a result, India imported 16.4 MT of edible oils in the same year, highlighting a persistent and widening gap between domestic supply and demand (**Table 1.1**).

Between 2020–21 and 2024–25, oilseed production increased from 36 MT to 43 MT, yet domestic edible oil availability rose only marginally from 11.2 MT to 12.5 MT. Over the same period, edible oil imports expanded from 13.5 MT to 16.4 MT, while the import bill nearly doubled from ₹ 82,123 crore to ₹ 1,46,450 crore. The import basket remains dominated by crude palm oil, soybean oil, and sunflower oil, exposing India to international price volatility, geopolitical disruptions, and policy shifts in major exporting countries.

Table 1.1: Production and Import Trends of Edible Oils in India

	Area under oilseed production (mha)	Production of oilseeds (MT)	Domestic availability of edible oils (MT)	Import of edible oils (MT)	Import value (₹ crores)	Import as a per cent of total availability
2020-21	28.8	36.0	11.2	13.5	82,123	54.7
2021-22	29.0	38.0	11.7	14.2	141,532	54.9
2022-23	30.2	41.4	12.4	15.8	167,270	55.9
2023-24	30.2	39.7	12.2	15.5	123,079	55.9
2024-25	30.4	43.0	12.5	16.4	146,450	56.7

Source: MoAFW, 2025c

A similar structural challenge is evident in the pulses sector. India is the world's largest cultivator, producer, and consumer of pulses. Domestic production has expanded threefold, rising from 8.41 MT in 1950–51 to 25.7 MT in 2024–25 (MoAFW, 2025b). However, this growth has not been sufficient to eliminate dependence on imports. Between 2020–21 and 2024–25, pulse imports increased from 2.5 MT to 7.3 MT, while import dependence rose sharply from 8.9 per cent to 22.6 per cent (**Table 1.2**). Over the same period, the value of imports nearly quadrupled, from ₹11,938 crore to ₹46,428 crore, indicating growing exposure to international price volatility. Although exports increased from 0.3 MT in 2020–21 to 0.8 MT in

2024–25, they remain small relative to domestic requirements and do not offset the widening import gap.

The persistence of imports despite rising production also reflects the high yield variability due to rainfed conditions, and relatively weaker price support mechanisms compared to rice and wheat. Moreover, pulses are increasingly important from a nutritional security perspective, serving as the primary protein source for a large share of the population. In this context, reliance on imports exposes vulnerable households to sharp price spikes during global supply disruptions.

Table 1.2: Production and Import Trends of Pulses in India

	Area under pulses production (mha)	Production of pulses (MT)	Export of pulses (MT)	Import of pulses (MT)	Import value (₹ crores)	Import as a per cent of total availability
2020-21	28.8	25.5	0.3	2.5	11,938	8.9
2021-22	30.7	27.3	0.4	2.7	16,628	9.4
2022-23	28.9	26.1	0.8	2.5	15,781	9.0
2023-24	27.5	24.3	0.6	4.7	31,072	16.9
2024-25	27.7	25.7	0.8	7.3	46,428	22.6

Source: MoAFW, 2025c

Taken together, the experience of oilseeds and pulses highlights that India's objective of self-sufficiency (*aatmanirbharta*) in these critical commodities requires a strategic reorientation of agricultural policy, moving beyond cereal-centric interventions towards a more diversified, nutrition- and market-responsive framework that strengthens domestic value chains for oilseeds and pulses.

1.2 Policies for Achieving Self-Sufficiency in Edible Oils and Pulses

National Mission on Edible Oils

The National Mission on Edible Oils–Oil Palm (NMEO-OP) was launched in 2021 with an outlay of ₹11,040 crores, targeting edible oil production of 25.45 MT by 2030–31. This was followed by the National Mission on Edible Oils–Oilseeds (NMEO-O), a seven-year programme (2024–25 to 2030–31) with an outlay of ₹10,103 crores, aimed at raising oilseed output from 39 MT in 2022–23 to 69.7 MT by 2030–31. When implemented in conjunction with the NMEO-OP, domestic edible oil production is projected to reach 25.45 MT by 2030–31, meeting approximately 72 per cent of India's estimated edible oil requirement. The core interventions, proposed in NMEO-OP, include: (i) Adoption of high-yielding, high oil-content varieties and development of high quality seeds by using cutting-edge global technologies such as genome editing.; (ii) Area expansion of oilseed cultivation by an additional 40 lakh hectares through rice/potato fallows, intercropping, and diversification; (iii) Seed systems reform, which is a five-year rolling seed plan via Seed Authentication, Traceability and Holistic Inventory (SATHI) portal; 65 seed hubs and 50 storage units; (iv) Cluster-based value chains covering over 600 clusters across 347 districts (~10 lakh per hectare per year); (v) Post-harvest & processing support to Farmer Producer Organizations (FPOs), cooperatives, and industry players for enhancing recovery from sources such as cottonseed, rice bran, corn oil, and Tree-Borne Oils (TBOs); and (vi) Information, Education and Communication (IEC) initiatives to promote awareness of recommended dietary guidelines for edible oils.

Complementary price and market support mechanisms have also been strengthened. The Minimum Support Price (MSP) for major edible oilseeds has been raised consistently to ensure remunerative returns for farmers. The continuation of *Pradhan Mantri Annadata Aay Sanrakshan Abhiyan* (PM-AASHA) assures price support and price deficiency payment mechanisms. In addition, the imposition of a 20 per cent import duty on edible oils seeks to protect domestic producers from low-priced imports while incentivising local cultivation and investment.

Mission for Aatmanirbharta in Pulses

The Government of India (GoI) approved the Centrally Sponsored Scheme (CSS) 'Mission for *Aatmanirbharta* in Pulses' from 2025–26 to 2030–31, with a financial outlay of ₹11,440 crores. The overall aim is to scale up domestic pulses production to 35 MT, expand the cultivation area to 31 mha by 2030–31 and improve yields to 1,130 kg per hectare. The core interventions proposed under the mission include: (i) Area expansion of pulses cultivation by additional 35 lakh hectares through rice fallows, intercropping, and diversification; (ii) Seed system reform supported by Indian Council for Agricultural Research (ICAR) led breeder seed production and digital governance via SATHI; (iii) Assured MSP-based procurement of key pulses *Tur, Urad,* and *Masoor* and under PM-AASHA, the National Agricultural Cooperative Marketing Federation of India (NAFED) and the National Cooperative Consumers' Federation (NCCF) to ensure 100 per cent procurement in participating states over the next four years; (iv) Development and dissemination of high-yielding, pest-resistant, climate-resilient varieties; (v) Production and distribution of 126 lakh quintals of certified seed and 88 lakh seed kits; (vi) Establishment of 1,000 processing and packaging units supported by subsidies of up to ₹25 lakh per unit using a cluster-based approach; and (vii) Large-scale demonstrations and capacity building.

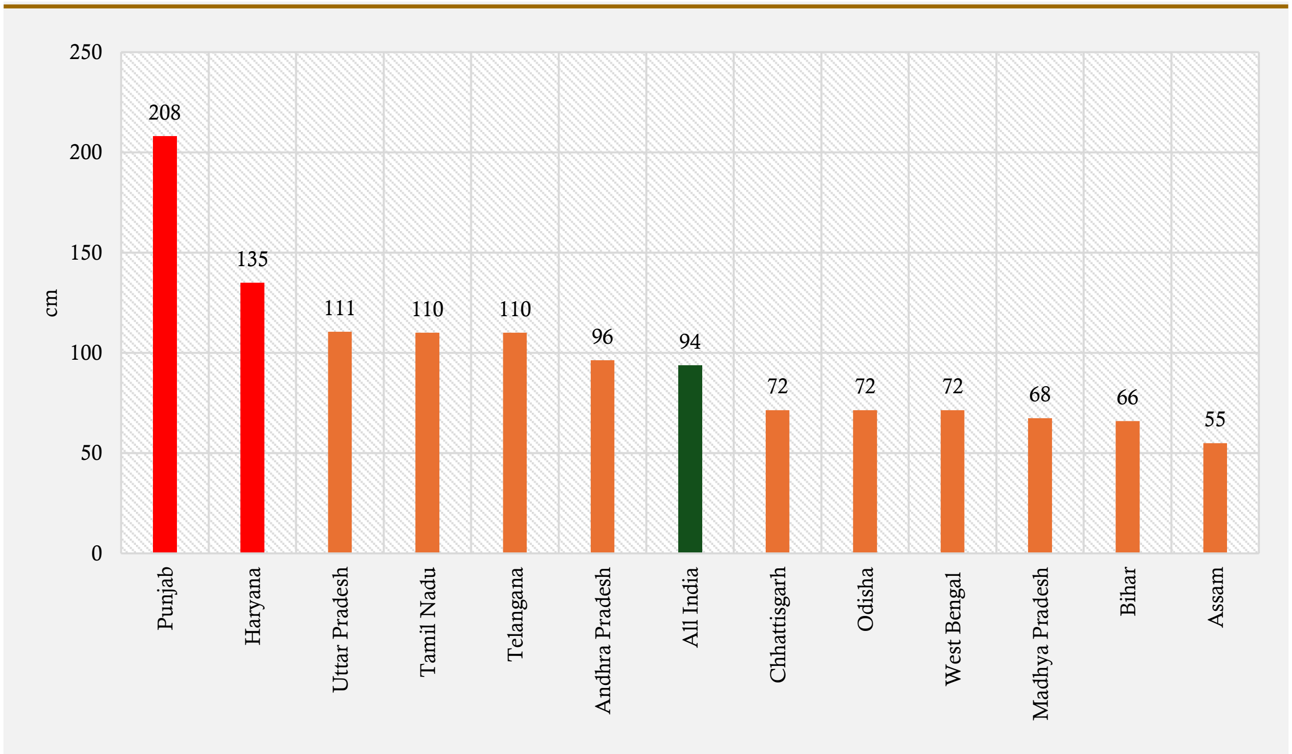
1.3 Rationale and Objectives

Punjab has been a star performer in agriculture during the heydays of Green Revolution. Its agriculture GDP grew at 5.7 per cent per annum during 1971- 72 to 1985-86, which was more than double the growth rate of 2.3 per cent, achieved at all-India level during the same period (Gulati et al. 2021). It was this remarkable performance of Punjab, closely followed by Haryana, first observed in large wheat surpluses and then in rice, which helped India free itself from the PL 480 food aid and its associated political strings. Punjab and Haryana became a symbol of India's grain surpluses, giving India a much-needed food security. But after 1985-86, green revolution started greying and growth in Punjab agriculture slowed down to 3 per cent per annum over the period 1985- 86 to 2004-05, almost same as achieved at all India level. But the real challenges to Punjab agriculture emerged when its growth crashed down to just 1.9 per cent per annum during 2004-05 to 2024-25, which was less than half the all-India agri-GDP growth of 3.8 percent over the same period. Owing to the earlier years of high agricultural growth, Punjab continues to be among the states with the lowest poverty levels in the country, with a multidimensional poverty headcount ratio of 4.35 per cent in 2022–23, which is well below the all-India average of 11.28 per cent (NITI Aayog, 2024). Providing food security to the country and reducing its own poverty to lowest levels within all India context, have been the most laudable achievements of Punjab. But lately, as a result of its decelerating agri-growth, Punjab has lost its pre-eminent position of being the state with highest per capita income in India, a title it carried since its inception in 1966 till 2002-03. In 2014- 15, e.g., Punjab stood at the 7th position in per capita income amongst 21 major states of India and further slipped down to 12th position during 2023-24 (MoSPI, 2026).

Alongside these income concerns, both states, however, have borne considerable environmental costs in supporting the country's food security. The spread of intensive agriculture has led to serious pressures on land, water, and air resources. These challenges began to emerge in the 1980s and have become progressively more pronounced. With nearly 82 per cent of the geographical area already under cultivation and cropping intensity among the highest in the country—201 per cent in Punjab and 196 per cent in Haryana (MoAFW, 2025b)—agricultural land in both states is under significant stress, resulting in the depletion of soil nutrients. Groundwater resources used for irrigation are also being depleted at an alarming rate. Annual groundwater extraction is estimated at about 26.27 billion cubic metres (bm^3) in Punjab and 12.72 bm^3 in Haryana, while annual recharge stands at only around 18.6 bm^3 and 10.27 bm^3, respectively, indicating unsustainable levels of withdrawal. As a result, the share of over-exploited groundwater blocks has increased to approximately 72.6 per cent in Punjab and 63.6 per cent in Haryana (CGWB, 2025). As groundwater levels fall, tube wells are required to reach increasingly deeper aquifers. Between 2000 and 2022, groundwater levels declined by approximately 11.94 metres below ground level (mbgl) in Haryana—the steepest decline among Indian states—and by 10.89 mbgl in Punjab (Thangaraj and Gulati, 2024).

The emerging sustainability challenge in these states is driven by four interrelated structural factors: (i) the widespread cultivation of paddy during the *Kharif* (July–October) season, (ii) excessive reliance on groundwater-based irrigation, (iii) strong farmer dependence on assured procurement mechanisms, and (iv) the availability of free or highly subsidised electricity, which weakens incentives for resource-efficient cropping choices. Paddy is a highly water-intensive crop, typically requiring 20–25 irrigations, compared with about 4–5 irrigations for many alternative crops, and is widely regarded as the most inefficient user of water, with 60–83 per cent of total irrigation lost through deep percolation (ICAR-NRRI, 2021). However, average farm applied irrigation water varies with the agro-ecology and soil conditions, and Punjab ranks first, requiring 208 cm of water, indicating the high irrigation demand despite being water-stressed (**Figure 1.2**).

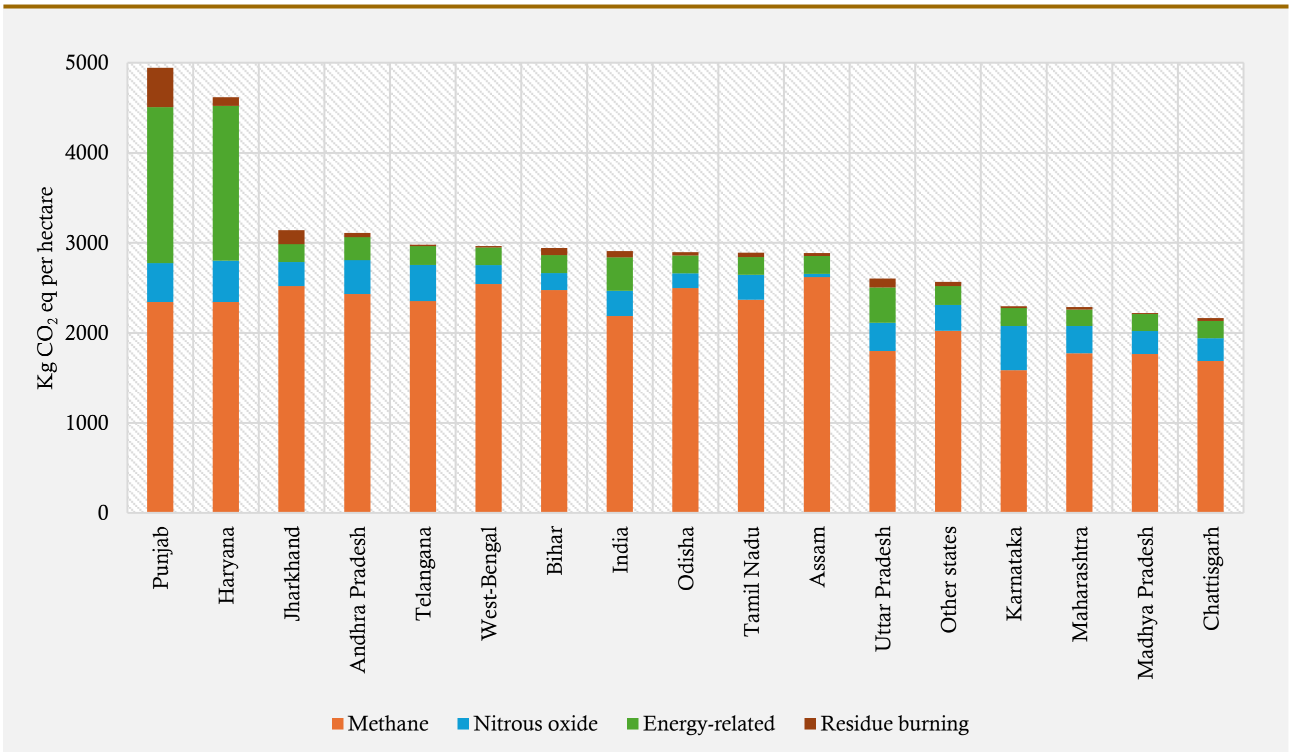
Figure 1.2: Average Farm Applied Irrigation Water for Paddy Cultivation in Top Rice-Producing States



Source: CACP, 2013-14; Gulati et. al., 2018

This heavy dependence on irrigation has placed severe pressure on groundwater resources, leading to a persistent decline in water tables over the past several decades. Paddy cultivation also contributes significantly to greenhouse gas (GHG) emissions. The anaerobic decomposition of organic matter in flooded paddy fields releases methane (CH_4), a gas with a global warming potential 27.2 times higher than carbon dioxide (CO_2) over a 100-year period and about 80.8 times higher over a 20-year timeframe. Additional emissions arise from nitrous oxide (N_2O)—which has a global warming potential 273 times that of CO_2—primarily due to the use of synthetic nitrogen fertilisers. CO_2 emissions from energy use, along with CH_4 and N_2O released during crop residue burning, further add to the emissions profile. Considering these sources together, Punjab records the highest per-hectare GHG emissions from rice cultivation in India—about 5 tonnes of CO_2 equivalent (t CO_2 eq) per hectare compared with the national average of 3.1 t CO_2 eq per hectare—followed closely by Haryana at 4.7 t CO_2 eq per hectare (**Figure 1.3**, Singh and Gulati, 2025). Crop residue burning in these states also contributes substantially to local air pollution, with direct adverse effects on public health. The cultivation of high-yielding varieties (HYVs) of wheat and rice has also led to heavy reliance on chemical inputs, including fertilisers and pesticides. Fertiliser application rates average about 250 kg per hectare in Punjab and 220 kg per hectare in Haryana in 2024-25 (FAI, 2026). Excessive use of fertilisers, particularly nitrogenous ones, has significant environmental consequences: part of the applied nitrogen is lost as ammonia, nitrogen gas, or N_2O emissions, while another portion leaches into groundwater in the form of nitrates, leading to contamination.

Figure 1.3: GHG Emission from Paddy Cultivation (Kg CO_2 eq/ha), 2022-23



Source: Singh and Gulati, 2025

As shown in **Table 1.3**, the overall environmental footprint data highlight that Punjab and Haryana have a high environmental footprint. These states exhibit high irrigation intensity, severe groundwater depletion, high GHG emissions per hectare and heavy fertiliser use. In contrast, eastern states, including Assam, Bihar, Odisha, West Bengal, and Eastern Uttar Pradesh, demonstrate lower irrigation intensity, relatively stable groundwater, and moderate emissions per hectare. Madhya Pradesh is marked by rising fire counts. Southern states (Andhra Pradesh, Telangana and Tamil Nadu) exhibit high fertiliser consumption.

The data illustrates the hidden environmental and social costs of paddy cultivation in Punjab and Haryana and underscores the urgent need to transition toward more sustainable production practices. The degradation of soil health, groundwater resources, air quality, and human well-being is not only a regional concern but also a national one, given the critical role these states play in India's food supply.

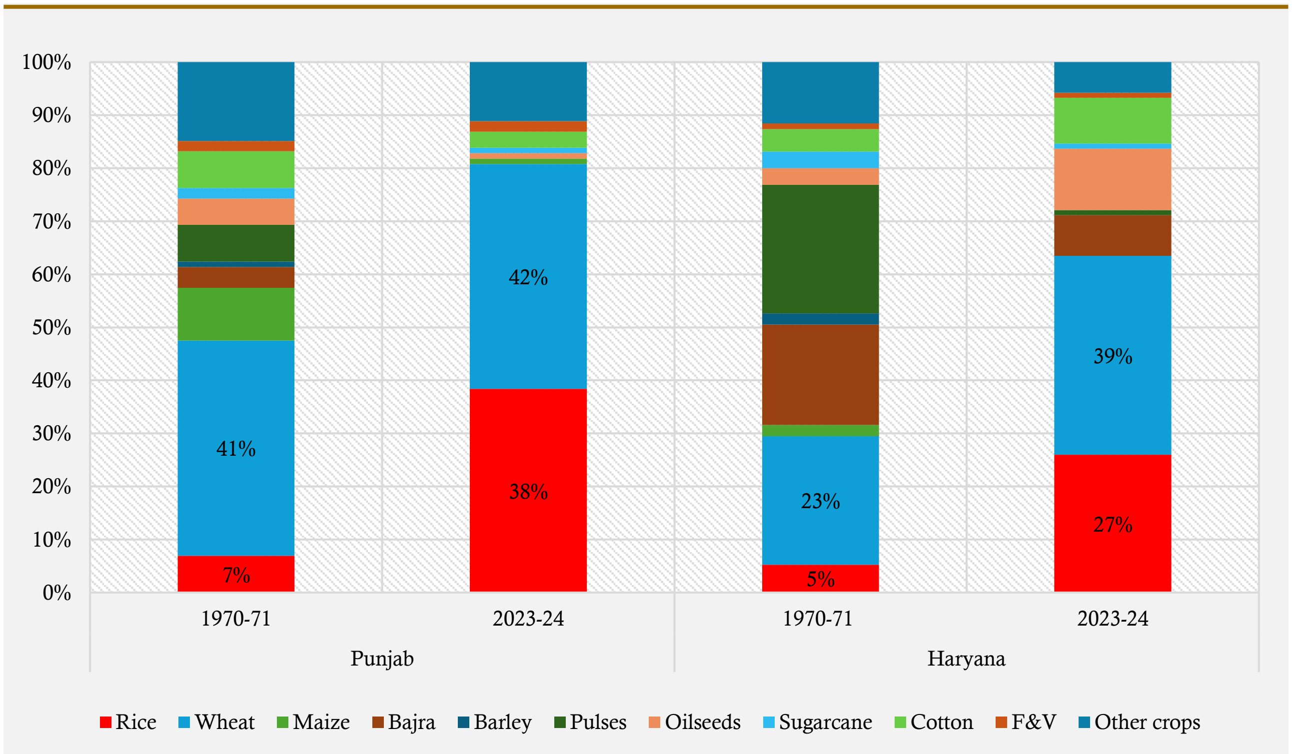
Table 1.3: Comparison of Environmental Footprint from the Top Rice-Producing States

	Irrigation required for rice cultivation (cm)	Over-Exploited, Critical & Semi-Critical Blocks (%)	Average groundwater level decline (2000-22)	Irrigation Ratio (%)	GHG Emissions (t/ha)	Cumulative fire counts (Sep 15-Nov 30)	Fertiliser consumption in Rice (kg/ha)
Andhra Pradesh	96	7	1.5	57	3.4		276
Assam	55	0.4	-0.2	15	3.1		29
Bihar	66	12	-0.2	80	3		122
Chhattisgarh	72	18	0.3	34.3	2.1		147
Haryana	135	75	-11.9	91.9	4.9	662	251
Madhya Pradesh	68	30	1.2	60.2	2.3	17067	154
Odisha	72	5	0.9	32.3	3		131
Punjab	208	86	-10.9	93.5	5	5114	192
Tamil Nadu	110	86	-8.1	62.7	3.2		214
Telangana	110	24	-2	74.1	3.1		264
Uttar Pradesh	111	32	-1.5	82.2	3.3	7290	171
West Bengal	72	31	-2	72.9	3		171
All India	94	25		59.9	3.1		

Source: CACP, 2013-14; Gulati et. al., 2018; CGWB, 2025; Thangaraj and Gulati, 2024; MoAFW, 2025a; Singh and Gulati, 2025; CREAMS, 2025; MoAFW, 2021-22

The initial recommendations for altering Punjab's cropping pattern away from the prevalent paddy-wheat cycle emerged in the late 1980s by a committee led by economist S.S. Johl. In 1986, the committee's report proposed that at least 20 per cent of the land currently used for paddy-wheat cultivation should be shifted to other crops to ensure the long-term sustainability of Punjab's resources. Since then, crop diversification has been mentioned in many other policy documents, such as the second committee led by S.S. Johl in 2002, Punjab Agriculture University's (PAU) Vision 2040 document, Reviving Green Revolution Cell by Tata Trust, World Bank, etc. Recognising the multidimensional nature of this crisis, the GoI, along with the Governments of Punjab (GoP) and Haryana (GoH), have initiated a range of crop diversification programmes aimed at reducing ecological pressures while sustaining farm incomes. Yet, farmers continue to grow this crop due to its high profitability, lower risk of nature, and its assured procurement from the government (Singh et al., 2024). In the 1971-72 period, rice covered only 0.39 mha in Punjab, a figure that has since expanded to 3.2 mha, thereby increase in gross cropped area share from 7 per cent to 38 per cent in Punjab during 2023-24 (**Figure 1.4**).

Figure 1.4: Change in Cropping Pattern of Punjab and Haryana, 1970-71 to 2023-24



Source: Statistical Abstract of Punjab and Haryana; MoAFW, 2025a

Against this backdrop, the study aims:

1. To analyse current incentive structures in Punjab and Haryana that have promoted the cultivation of paddy vis-à-vis other crops, including oilseeds and pulses.
2. To estimate the profitability of paddy vis-à-vis other crops, including oilseeds and pulses, in Punjab and Haryana.
3. To look at the environmental impact (carbon footprint, water footprint, fertiliser consumption, residue burning) of paddy vis-à-vis other crops, including oilseeds and pulses, in these states;

To suggest an alternative and crop-neutral incentive structure which is aligned with environmental sustainability and reducing India's structural dependence on edible oil imports and achieving *Atmanirbharta* in pulses, without adversely affecting farmers' returns. This could be a win-win situation for peasants and the planet.

METHODOLOGY 2

2.1 Calculation of Crop-Wise Incentives

The GoI and State Budgets make provisions for a scheme or a programme over several major heads in the revenue and capital sections. Crop-wise subsidies provided by the centre and state were calculated as follows:

2.1.1 Fertiliser Subsidy (Centre Support)

The budget of the Department of Fertilisers, Ministry of Chemicals and Fertilisers, provides fertiliser subsidy to fertiliser producers/ importers to allow farmers to buy fertilisers below the cost of production/imports. The difference between the cost of production/import of a fertiliser and the actual amount paid by farmers is the subsidy borne by the government. The subsidy includes urea and nutrient-based components and is funded by the GoI. The state-specific figures are not available in published reports.

A two-step approach was employed to estimate the state-wise fertiliser subsidy for this study. First, the per unit (tonne) subsidy was calculated at the national level by dividing the total subsidy by the total fertiliser consumption. Then, the per tonne subsidy was multiplied by each state's fertiliser consumption, giving an estimate of the subsidy for individual states. Fertiliser consumption by specific crops (in kg per hectare) was derived from the Cost of Cultivation (CoC) data provided by Ministry of Agriculture and Farmers' Welfare (MoAFW). By multiplying the crop-specific fertiliser consumption rates by the area under cultivation (in hectares) for each crop, the total fertiliser consumption (in kg) was estimated for each crop. The percentage share of fertiliser consumption attributable to each crop was calculated. This percentage share was applied to allocate the overall fertiliser subsidy among the various crops, proportional to their respective contributions to total fertiliser use. To estimate per hectare fertiliser subsidy for each crop, the crop-specific subsidy was divided by the corresponding area under cultivation.

2.1.2 Power Subsidy (State Support)

Power subsidy for agriculture in Punjab was obtained from state budget documents, and for Haryana from the Annual Reports of Haryana Electricity Regulatory Commission (HERC). To estimate crop-wise power subsidies in Punjab and Haryana, data on crop-specific water requirements were derived from a study conducted by the PAU for 2011- 12

(**Annex 1**). By multiplying these water requirements with the area under cultivation during the *Kharif* months, crop-specific water consumption or requirements and their percentage shares were determined. Subsequently, based on these water consumption figures and the associated electricity requirements, particularly for groundwater extraction, the contribution of each crop to total electricity consumption was estimated. It was assumed that though the specific water requirement of crops may differ in the study years from that of the reference year 2011-12, the percentage share of water consumption and thus electricity consumption for the studied crops is the same as that of 2011-12. The total power subsidy for the entire agricultural season was disaggregated to estimate the power subsidy for the *Kharif* months, based on monthly electricity consumption data obtained from the state electricity boards of Punjab (**Annex 2**). For Haryana, since monthly electricity consumption data was not available, using crop-wise water requirement for major crops (**Annex 1**), the share in total water consumption or requirement was estimated for Paddy and other *Kharif* crops. Based on this share, the total power subsidy was allocated across crops. To estimate per hectare power subsidy for each crop, the crop-specific subsidy was divided by the corresponding area under cultivation.

2.1.3 Irrigation Subsidy (State Support)

Paddy is irrigated mainly by tubewells, but in areas where the canal network is available (22 per cent in Punjab and 37 per cent in Haryana), farmers use canal water for irrigation, particularly during power shortage. Irrigation subsidy is the difference between the expenditure and receipts of major, medium, and minor irrigation projects, obtained from state budget documents. To calculate the irrigation water consumed across crops, the area sown during the *kharif* season and the water per hectare for each crop were considered. The irrigation subsidy for the *kharif* months was allocated among different crops based on each crop's share in the irrigation water consumption in the *Kharif* season to obtain crop-wise irrigation subsidy. To estimate per hectare irrigation subsidy for each crop, the crop-specific subsidy was divided by the corresponding area under cultivation.

2.1.4 Other Subsidies

There are other subsidies, e.g. crop diversification, crop residue management subsidies for paddy cultivation. The volume of subsidy per hectare of gross cropped area for both states was examined for this analysis.

2.2 Profitability Analysis of Various Crops in Punjab and Haryana

The analysis used data from the CoC studies conducted by the MoAFW, which details the revenue and cost structure for various crops in the major producing states. Cost A2 is the paid-out costs by the farmer and includes the value of hired labour and machinery, value of owned machine labour, value of seeds, fertilisers, manure, pesticides, irrigation charges, land revenue, interest on working capital and rent paid on leased-in land. Profitability was calculated by deducting the A2 costs per hectare from the gross output value per hectare.

2.3 Calculation of Environmental Footprint

2.3.1 Residue Burning (RB)

The information on residue burning of paddy in Punjab and Haryana was obtained from the Consortium for Research on Agroecosystem Monitoring and Modelling from Space (CREAMS) Laboratory, Division of Agricultural Physics, ICAR – Indian Agricultural Research Institute (IARI), New Delhi.

2.3.2 Water Footprint (WF)

Package of Practices (PoP) by the agriculture universities, viz. PAU, and Chaudhary Charan Singh Haryana Agricultural University (CCS HAU), as well as Kaur et al., 2015 were referred for collecting the irrigation requirement of the crops. For assessing groundwater level decline, the India-Water Resource Information System data was analysed.

2.3.3 Nitrogen Footprint (NF)

Fertiliser consumption data was collected from the Fertiliser Association of India (FAI). However, crop-specific data were collected from CoC studies. By multiplying the crop-specific fertiliser consumption rates by the area under cultivation (in hectares) for each crop, the total fertiliser consumption (in kg) for each crop was estimated. PoP of PAU and CCSHAU were also referred.

2.3.4 Carbon Footprint (CF)

Agricultural input and other management information, including the yield of *Kharif* crops grown in selected states, were collected from MoAFW. CoC surveys were also referred to. Data on fertiliser consumption were obtained from FAI. The water management system during rice cultivation was determined from the databases at the national and state levels (Gupta et al., 2009). The electricity consumption data was obtained from the Central Electricity Authority, Ministry of Power. The information on surplus residue availability was taken from the Technology Information, Forecasting and Assessment Council (TIFAC)-IARI Report (2018). Based on the activity data from the above-mentioned sources, the CF of paddy was estimated using Intergovernmental Panel on Climate Change (IPCC) Tier 2 country-specific emission factors (MoEFCC, 2021).

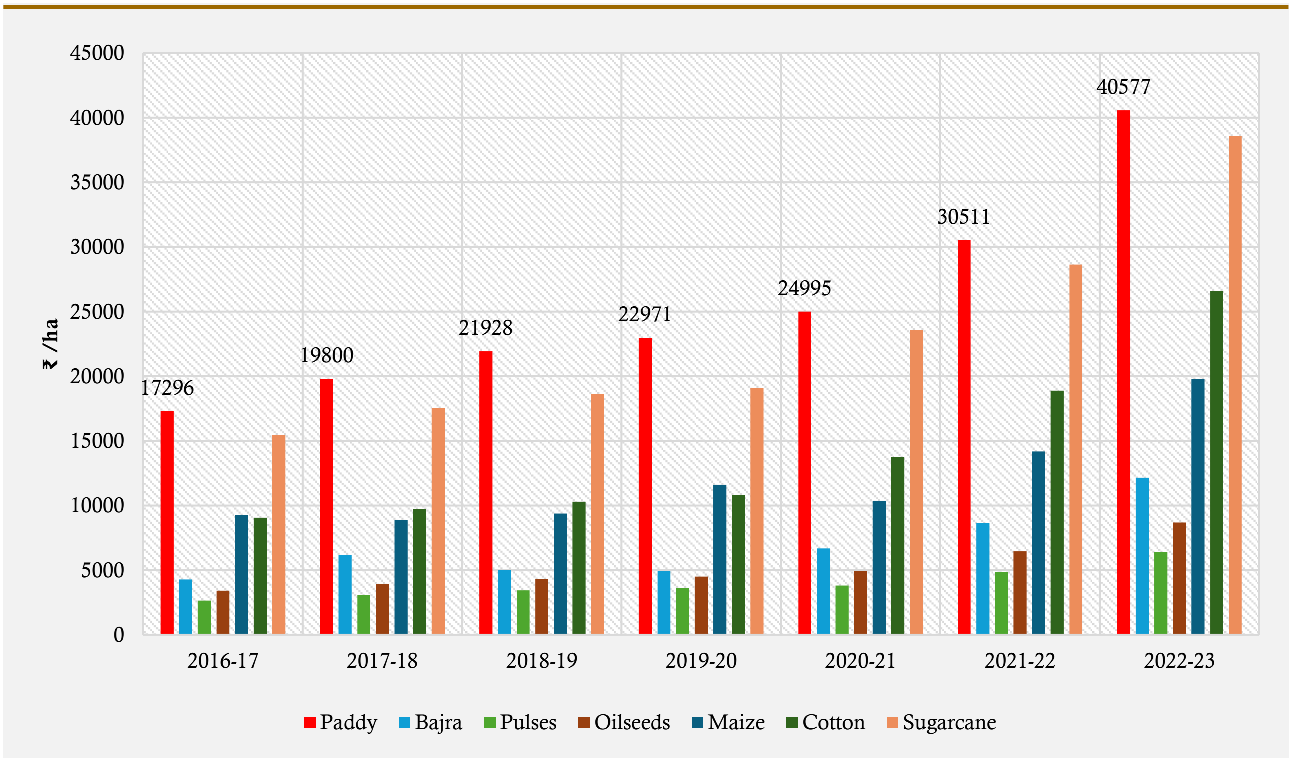
INCENTIVES AND PROFITABILITY

3

3.1 Paddy Incentives *vis-à-vis* other *Kharif* Crops in Punjab and Haryana

Consumption analysis of subsidised inputs (fertiliser, water, electricity) was done at the crop level and state level, and a huge disparity was observed across states and crops during 2016-17 to 2022-23, indicating a disproportionate allocation and use of subsidies in Punjab and Haryana. In 2022-23, the subsidies for paddy amounted to ₹40,577 per hectare in Punjab and were significantly higher than its *Kharif* counterparts, which ₹19,778 per hectare for maize, ₹8,685 per hectare for oilseeds and ₹6,382 per hectare for pulses. (**Figure 3.1**).

Figure 3.1: Paddy Incentives vis-à-vis Other *Kharif* Crops in Punjab

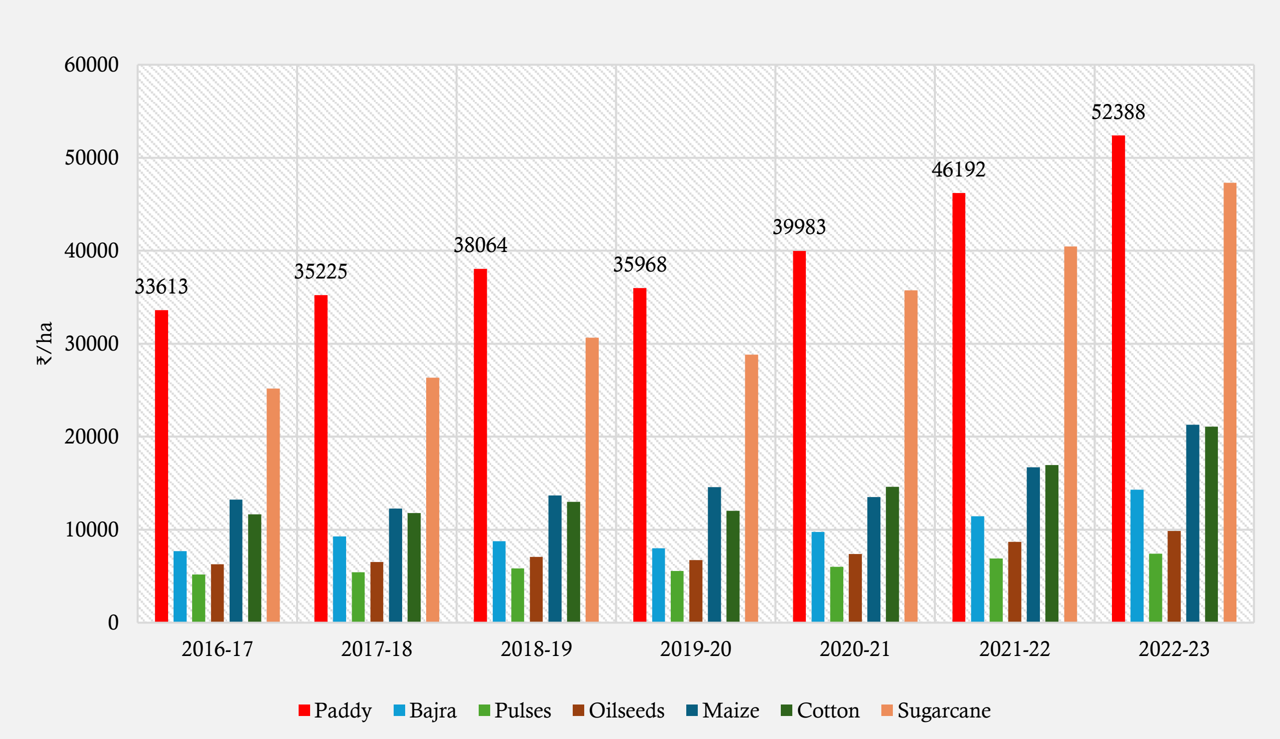


Source: Estimated by authors using MoF, GoP, GoH, FAI, MoAFW (various years)

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

Haryana also witnessed a similar trend with paddy subsidies amounting to ₹52,388 per hectare, ₹21,283 per hectare for maize, ₹9,859 per hectare for oilseeds and ₹7,430 per hectare for pulses in 2022-23. (**Figure 3.2**).

Figure 3.2: Paddy Incentives vis-à-vis Other *Kharif* Crops in Haryana



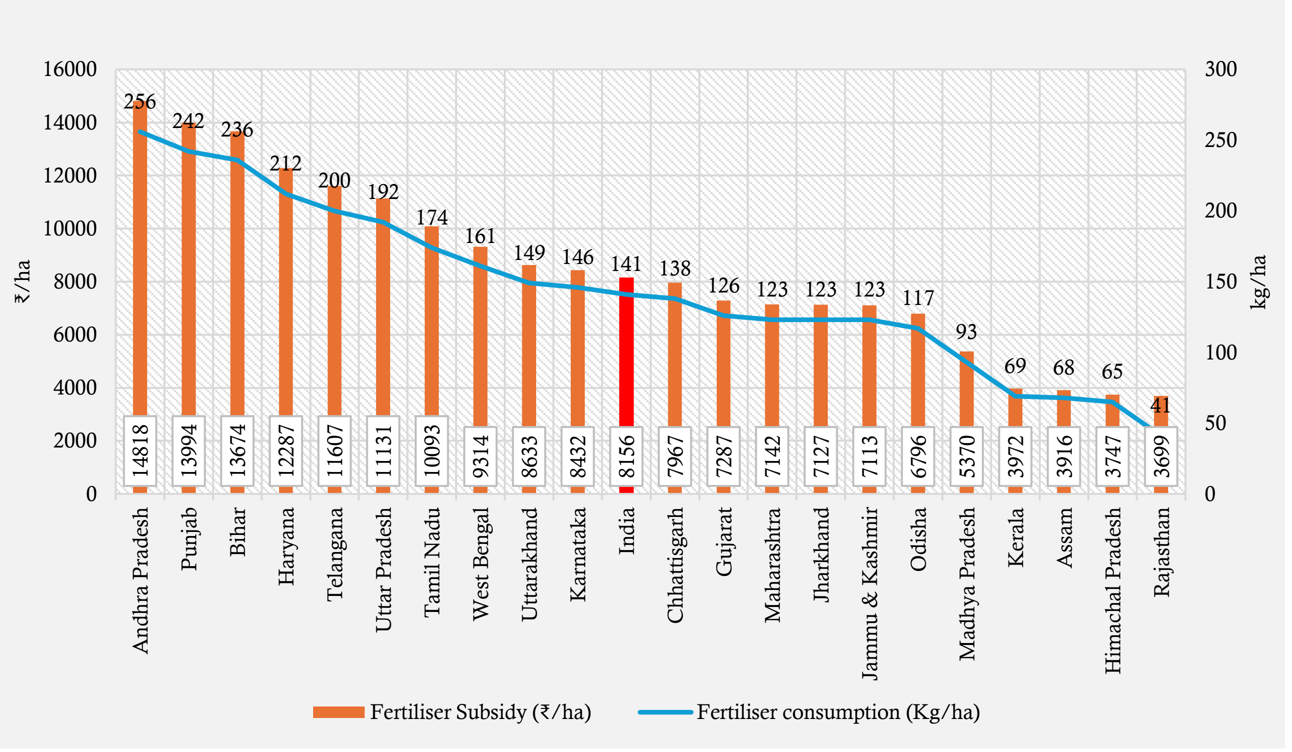
Source: Estimated by authors using MoF, GoP, GoH, FAI, MoAFW (various years)
Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

3.1.1 Fertiliser Subsidy

India is the second largest consumer of fertilisers globally after China, with about 29.8 MMT used by the agricultural sector in 2022-23 (FAI, 2026). Studies have shown a clear link between fertiliser use and crop yields. The GoI spends a large number of fiscal resources on subsidising fertilisers. Over the years, the volume of fertiliser subsidy has steadily increased, from ₹138 billion in 2000-01 to ₹1,883 billion in 2023-24, peaking at ₹2,252billion in 2022-23. The subsidy on urea constitutes around 70 per cent of the total fertiliser subsidy. In absolute terms, the consumption of total nutrients has increased from 16.7 MT in 2000-01 to 29.8 MT in 2022-23. In terms of per hectare of GCA, it has increased from 90 kg/ha in 2000-01 to 136.2 kg/ha in 2022-23. Based on per hectare of GCA, GoI spends ₹11,892 per hectare through fertiliser subsidy, which increased from ₹744 per hectare in 2000-01.

However, at the state level, a huge disparity is observed in the consumption of nutrients, even though support is provided by the GoI. During TE 2022-23, the level of fertiliser consumption per hectare of GCA is much higher than the all-India average (141 kg/ha) in Andhra Pradesh (256 kg/ha), Punjab (242 kg/ha), Bihar (236 kg/ha), Haryana (212 kg/ha), Telangana (200 kg/ha), Uttar Pradesh (192 kg/ha), and Tamil Nadu (161 kg/ha) (**Figure 3.3**).

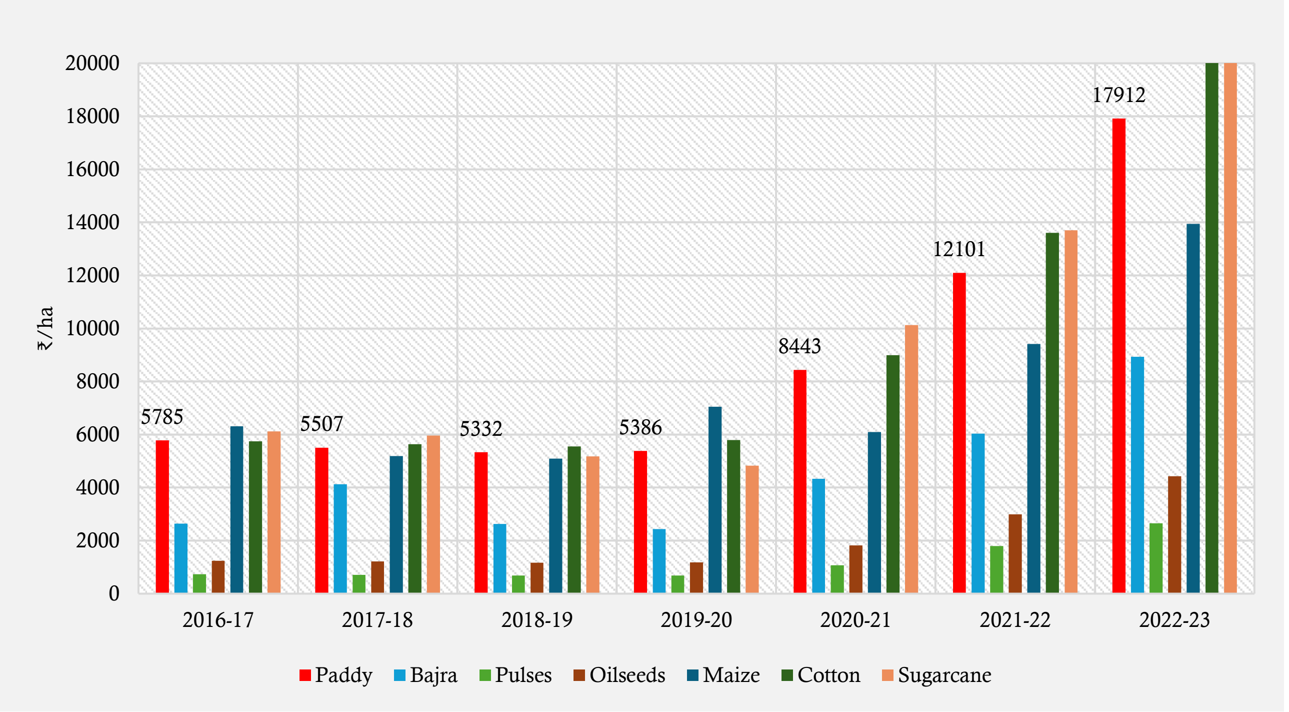
Figure 3.3: State-Wise Per Hectare Fertiliser Subsidy and Consumption, TE - 2022-23



Source: Estimated by authors using MoF, FAI, MoAFW (various years)

A crop-wise analysis reveals that the per-hectare fertiliser subsidy is significantly higher for crops such as paddy and sugarcane compared to environmentally sustainable crops like coarse cereals and pulses in Punjab (**Figure 3.4**) and Haryana (**Figure 3.5**). The subsidy burden has escalated for all crops over time, due to the excessive and unregulated use of subsidised fertilisers beyond actual agronomic requirements. During 2022-23, the fertiliser subsidy for paddy amounted to ₹17,912 per hectare in Punjab and was significantly higher than for pulses and oilseeds, which were ₹2,649 per hectare for pulses and ₹4,434 per hectare for oilseeds. This means substantial savings in fertiliser subsidy if farmers shift from paddy to pulses and oilseeds. Fertiliser subsidy was estimated to be ₹13,948 per hectare for maize, ₹20,145 per hectare for cotton and ₹20,280 per hectare for sugarcane in Punjab for the same year. As per CoC, during 2022-23, fertiliser consumption for paddy in Haryana was comparatively higher than in Punjab, and thus a higher fertiliser subsidy of ₹23,071 per hectare was estimated for paddy in Haryana. For other *Kharif* crops in Haryana, the fertiliser subsidy was estimated to be ₹2,614 per hectare for pulses, ₹4,374 per hectare for oilseeds, ₹13,754 per hectare for maize, ₹12,765 per hectare for cotton and ₹23,678 per hectare for sugarcane in the same year.

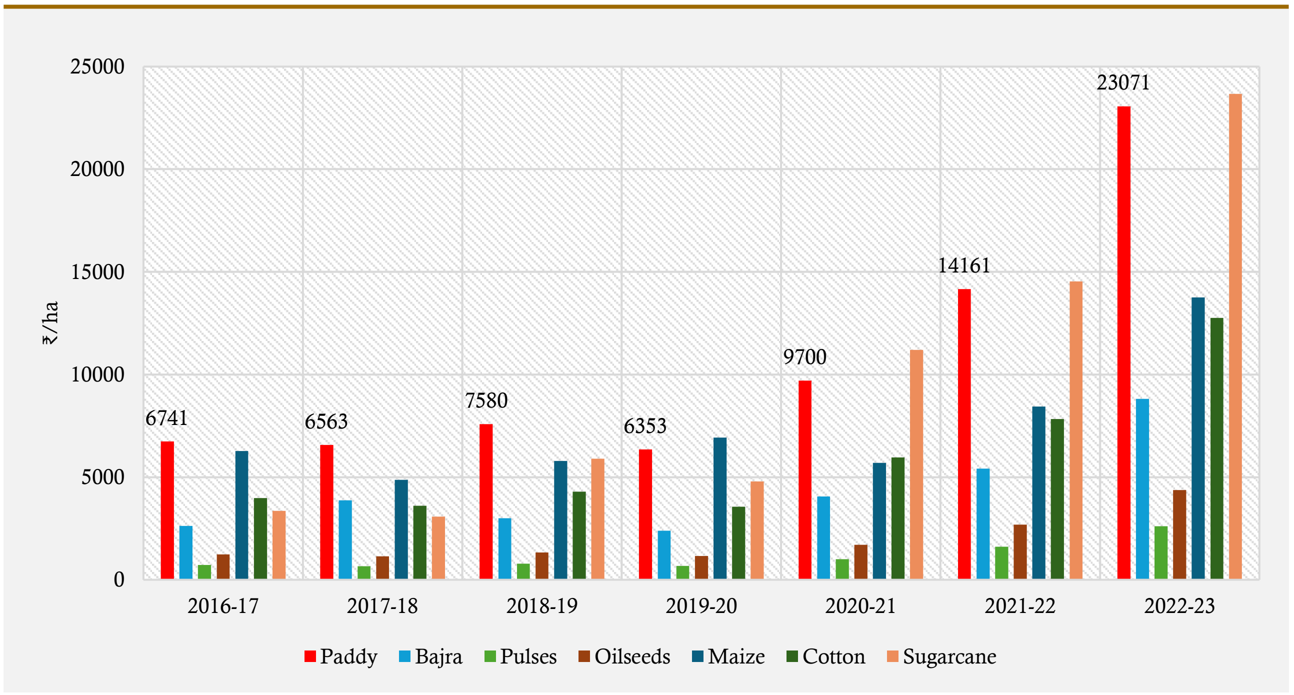
Figure 3.4: Crop-wise Fertiliser Subsidy in Punjab, 2016-17 to 2022-23



Source: Estimated by authors using MoF, GoP, FAI, MoAFW (various years)

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

Figure 3.5: Crop-wise Fertiliser Subsidy in Haryana, 2016-17 to 2022-23



Source: Estimated by authors using MoF, GoH, FAI, MoAFW (various years)

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

3.1.2 Power Subsidy

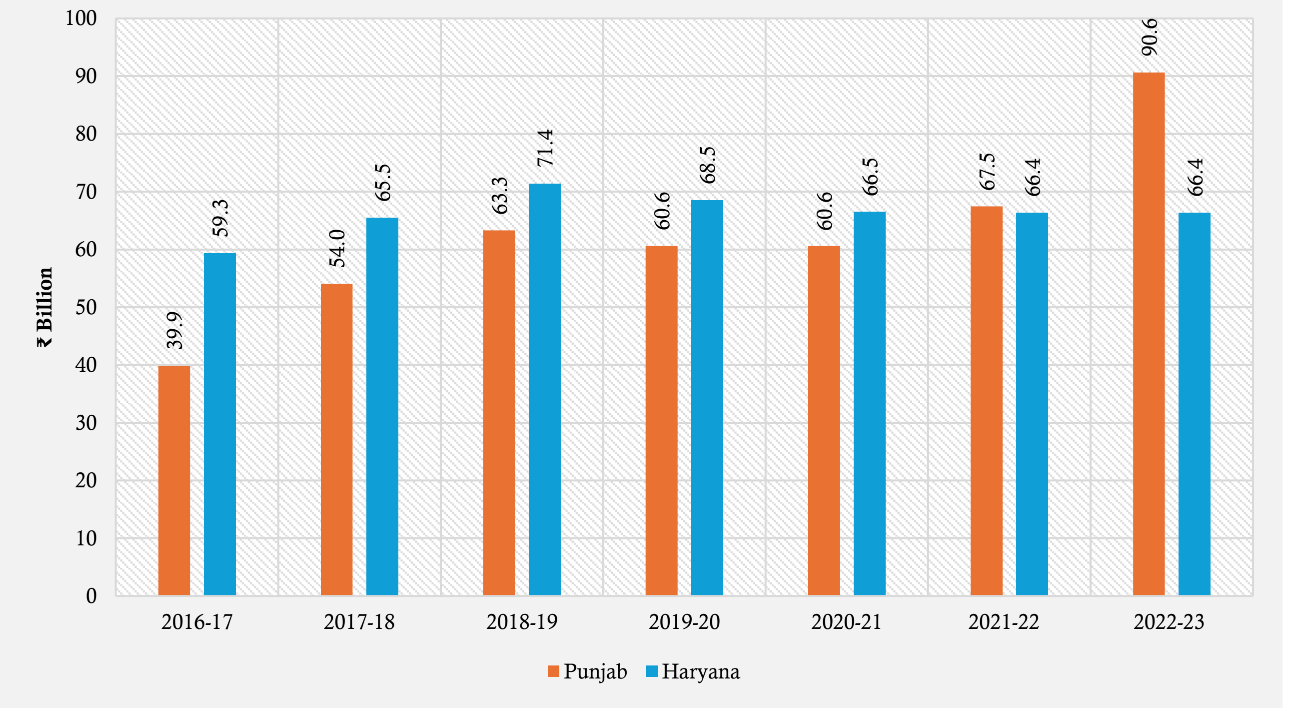
The power sector in India falls under the Concurrent List of the Constitution (as per Article 246), meaning it is jointly administered by the central and state governments. The central government is tasked with overseeing the overall development of the sector, while state governments are responsible for power generation and distribution. State Electricity Boards (SEBs) were established as autonomous entities, and the overall performance of the power sector is largely contingent upon the efficiency and functioning of the SEBs.

Until the early 1970s, the state electricity utilities in India charged electric tube well owners based on their metered consumption. However, with the rapid increase in the number of electric tube wells during the 1970s, utilities introduced flat tariffs for agricultural electricity. This shift was to reduce transaction costs and gradually align tariffs with the rising costs of electricity generation and supply. However, the influence of electoral politics made it challenging to increase tariffs, and many states transitioned to providing free and unmetered electricity to farmers. As a result, farmers have started viewing free or heavily subsidised electricity as an entitlement, and any attempt to reduce or eliminate these subsidies is seen as politically untenable at the state level. While unmetered and subsidised electricity has boosted agricultural production, it has placed a significant financial burden on the government and power corporations. Due to inadequate surface irrigation infrastructure farmers prefer groundwater over canal water as they have access to water any time of the day in unlimited quantity. Power is free in Punjab and costs Rs. 0.1/kWh in Haryana.

Figure 3.6 shows a steady rise in the power subsidy allocated to the agricultural sector in Punjab and Haryana from 2016-17 to 2022-23. In 2016-17, the subsidy stood at ₹39.9 billion in Punjab, and it has seen a consistent upward trajectory, reaching ₹90.6 billion by 2022-23. While the power subsidy in Haryana's agricultural sector has seen a moderate increase in the same period. The subsidy, which was ₹59.3 billion in 2016-17, has gradually increased to ₹66.4 billion in 2022-23.

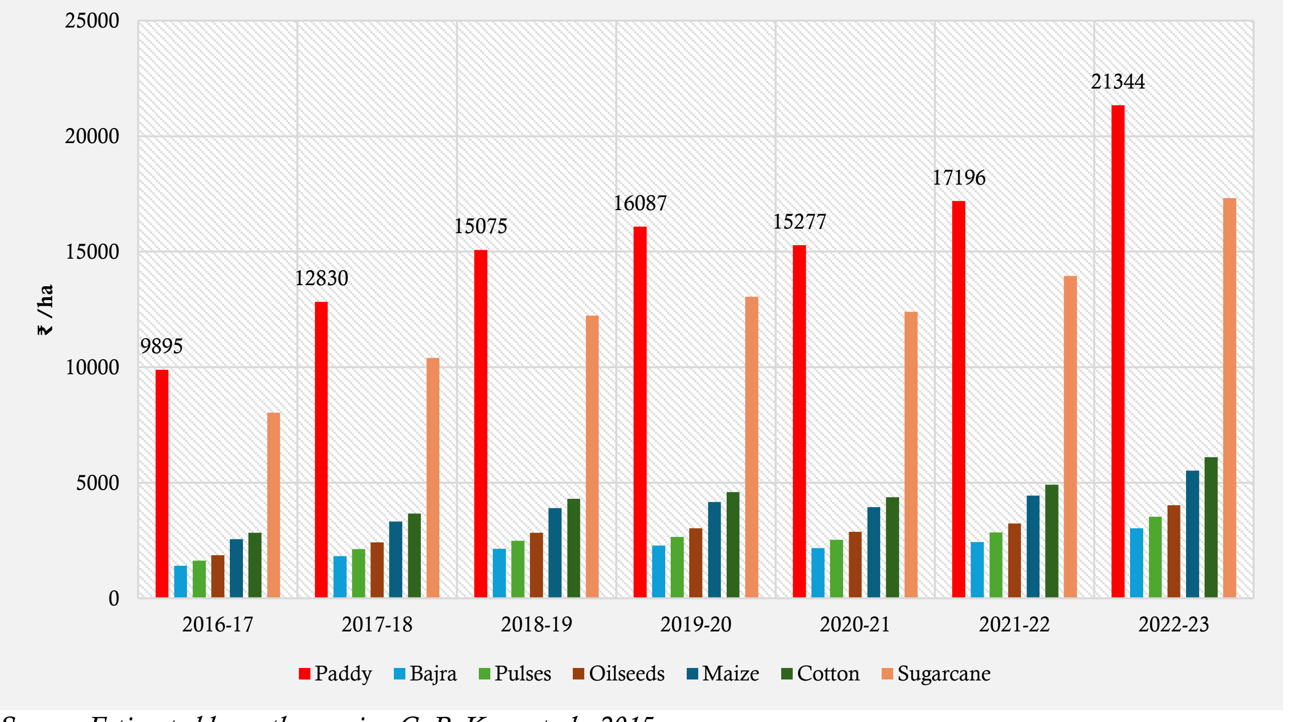
Amongst crops, paddy receives the highest subsidy. In Punjab, the power subsidy for paddy amounted to ₹21,344 per hectare, up from ₹9,895 per hectare in 2016-17 (**Figure 3.7**). In Haryana, the paddy subsidy amounted to ₹24,096 per hectare in 2022-23 **(Figure 3.8)**, up from ₹22,537 per hectare in 2016-17. The power subsidy allocated to other *Kharif* crops was estimated to be substantially lower, which was ₹3,531 per hectare for pulses, ₹4,022 per hectare for oilseeds, ₹5,520 per hectare for maize and ₹6,104 per hectare for cotton during 2022-23. Since sugarcane also has high irrigation demands, and thus power subsidy allocation was also higher and estimated to be ₹17,320 per hectare in the same year. A similar trend was observed in Haryana.

Figure 3.6: Power Subsidy in Punjab and Haryana, 2016-17 to 2022-23



Source: GoP; HERC (various years)

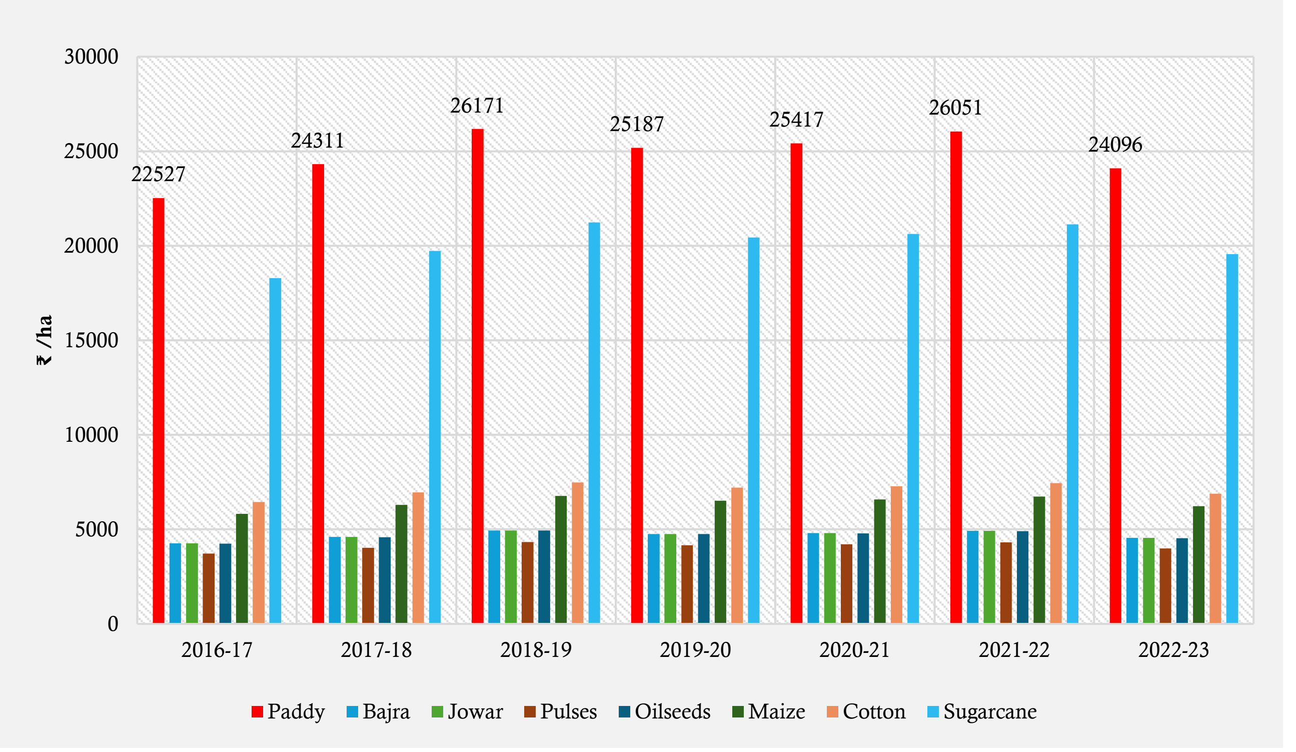
Figure 3.7: Crop-Wise Power Subsidy in Punjab, 2016-17 to 2022-23



Source: Estimated by authors using GoP, Kaur et al., 2015

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

Figure 3.8: Crop-Wise Power Subsidy in Haryana, 2016-17 to 2022-23



Source: Estimated by authors using GoP, HERC, Kaur et al., 2015

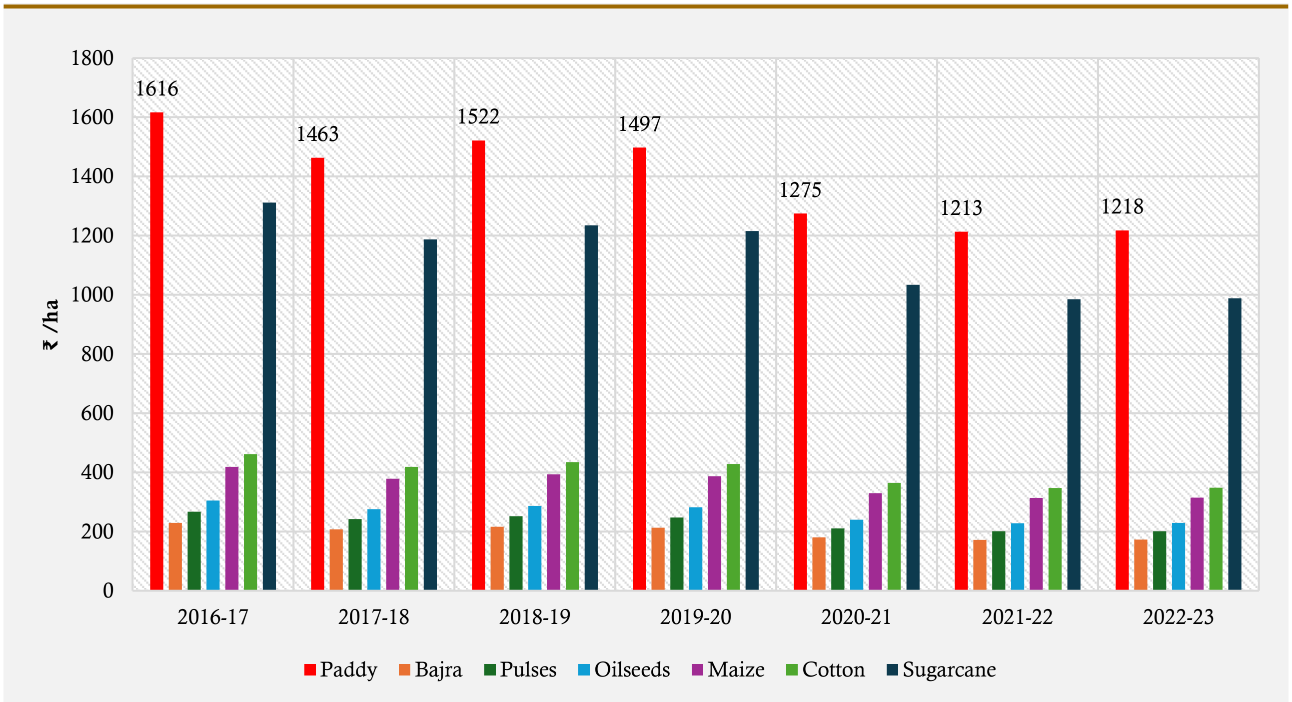
Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

3.1.3 Irrigation Subsidy

Irrigation plays a significant role in increasing yield. The use of high-yielding varieties of seeds and fertiliser can boost productivity, provided there is a steady supply of water for cultivation. As part of the Green Revolution strategy, it was necessary to ensure enough water for the fields so as to increase agricultural productivity. For using surface water, the public sector creates major, medium, and minor irrigation projects. This is subsidised by charging a minimum price for water use. These subsidies were necessary for uninterrupted supply of water that boosted productivity of food grains.

The analysis of crop-wise irrigation subsidy shows that the subsidy for paddy and sugarcane is much higher than the environmentally sustainable crops like coarse cereals and oilseeds, in Punjab (**Figure 3.9**) and Haryana (**Figure 3.10**). During 2022-23, the irrigation subsidy for paddy was estimated to be ₹1,218 per hectare in Punjab and ₹5,016 per hectare in Haryana. Overall, the irrigation subsidy has been declining over the past few years in Punjab, whereas it has been steadily increasing in Haryana. In 2022-23, the share of surface irrigation is 22.6 per cent in Punjab, while it is 37 per cent in Haryana (MoAFW, 2025).

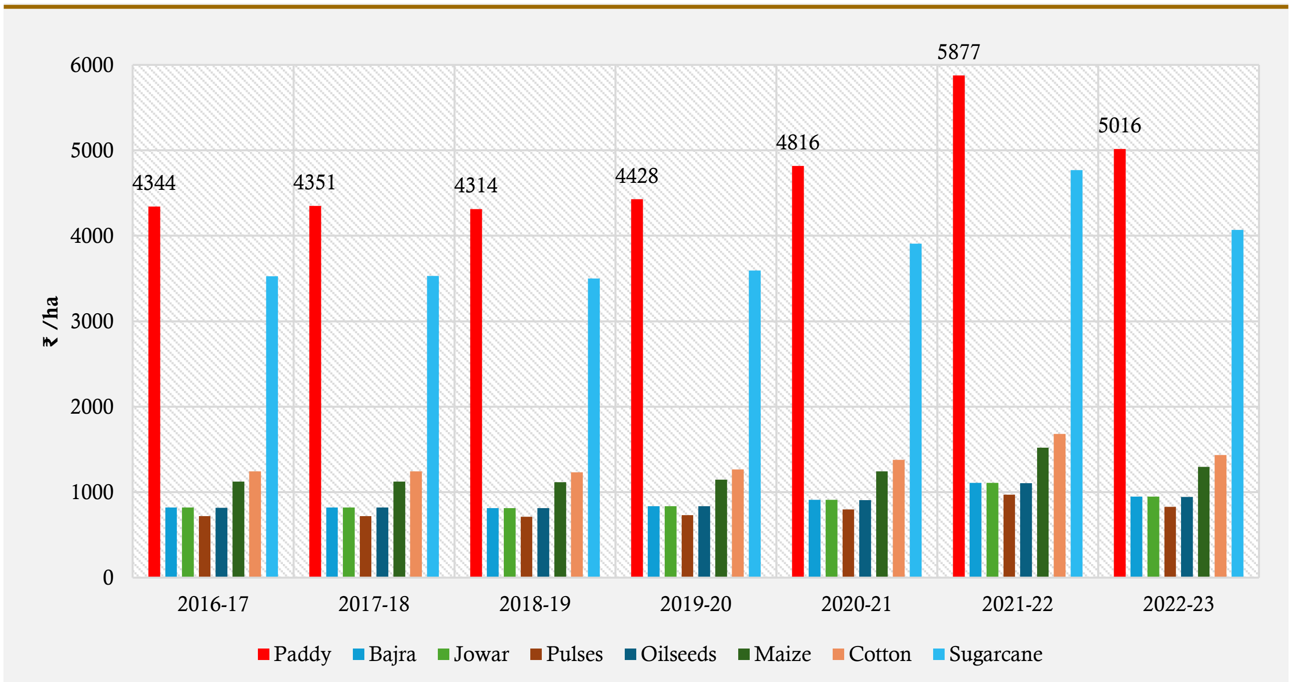
Figure 3.9: Crop-Wise Irrigation Subsidy in Punjab, 2016-17 to 2022-23



Source: Estimated by authors using GoP, Kaur et. al., 2015

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

Figure 3.10: Crop-Wise Irrigation Subsidy in Haryana, 2016-17 to 2022-23



Source: Estimated by authors using GoH, Kaur et. al., 2015

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence incentives for sugarcane and cotton cannot be straightforwardly compared with paddy.

3.2 Profitability Analysis of Various Crops in Punjab and Haryana

The increase in rice cultivation is better understood by examining the net profitability per hectare for the major crops in these states, as shown in **Table 3.1** and **Table 3.2**. These results highlight a clear trend: water-intensive crops such as paddy and sugarcane offer significantly higher returns compared to crops like pulses and coarse cereals. Farmers are naturally inclined towards cultivating these high-profit crops, despite their heavy water demands.

Sugarcane generally takes about a year to mature in the sub-tropical regions of Punjab and Haryana. During that same period, a farmer could grow two to three shorter-duration crops like paddy and wheat, which together constitute even higher profit than sugarcane. In contrast, pulses and oilseeds generate considerably lower profits than paddy, sugarcane, or even cotton, which are more commercially viable.

These crops, despite being less water, GHG and fertiliser intensive and more suited to sustainable farming, do not offer the same financial security as the water-guzzling alternatives. In the absence of robust market support or price incentives for eco-friendly crops, farmers prioritise high-profit paddy crop, even at the expense of environmental sustainability. This dynamic underscore the need for agricultural policy reforms that can bridge the gap between profitability and environmental sustainability, ensuring that farmers are adequately compensated for growing crops that are less harmful to natural resources.

Table 3.1: Crop-Wise Profitability in Punjab, 2016-17 to 2021-22

₹ per hectare	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Paddy	73291	87773	82061	80916	94491	89453
Moong	NA	NA	NA	NA	72522	77991
Maize	17963	17596	24577	14711	2273	22790
Cotton	70227	46846	79287	76525	69618	122279
Sugarcane	NA	190519	201487	183345	NA	NA
Wheat	61839	66831	67984	68577	94491	64954
Gram	NA	37146	13744	NA	NA	NA
Rapeseed & Mustard	NA	34147	39038	31341	57169	61127

Source: MoAFW, 2021-22

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence profitability for sugarcane and cotton cannot be straightforwardly compared with paddy. Paddy cultivation allows farmers to take 1-2 additional crops, hence ensuring more profits as compared to sugarcane, which is a standing crop for 12 months.

Table 3.2: Crop-Wise Profitability in Haryana, 2016-17 to 2021-22

₹ per hectare	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Paddy	68723	87362	88180	104099	71041	86156
Bajra	17805	12907	17562	27568	15622	NA
Maize	NA	NA	NA	NA	NA	19307
Cotton	50308	37854	50776	44869	31603	49761
Sugarcane	NA	237976	223376	219564	183279	NA
Wheat	67021	66453	75746	73553	71041	72883
Gram	43657	38276	63292	47744	31035	31220
Rapeseed & Mustard	50791	60385	60436	56838	79769	88738

Source: MoAFW, 2021-22

Note: Crop duration for sugarcane (12 months) and cotton (8 months) is longer than paddy (4 months), hence profitability for sugarcane and cotton cannot be straightforwardly compared with paddy. Paddy cultivation allows farmers to take 1-2 additional crops, hence ensuring more profits as compared to sugarcane, which is a standing crop for 12 months.

3.3 Market Price Support

In 1965, the GoI established the Agricultural Prices Commission (APC) to implement a comprehensive and balanced price policy for agriculture. Through the mechanism of MSP and assured procurement, the government aimed to provide farmers with a stable and predictable price environment, helping them make informed decisions on crop choices while safeguarding them from price volatility. This system not only ensured better price realisation for farmers but also shielded consumers from sharp price fluctuations. In 1985, the APC was renamed the Commission for Agricultural Costs and Prices (CACP), with a renewed focus on shaping a price structure that aligned agricultural production with the broader needs of the economy (Sen and Chatterjee, 2002).Based on the CACP's recommendations, the Department of Agriculture, Cooperation and Farmers' Welfare, GoI, announces MSPs for 23 crops before the sowing season. These crops include seven cereals, eight oilseeds, and four commercial crops. Occasionally, the central or state governments offer a bonus over the MSP to promote the cultivation of certain crops during specific periods (FCI, 2026).

The CACP considers multiple factors when determining MSPs, such as demand and supply dynamics, cost of production, price trends (domestic and international), inter-crop price parity, the terms of trade between agriculture and non-agriculture, and the potential impact of MSP on consumers. Once crops are harvested, the government, through agencies like the Food Corporation of India (FCI), NAFED, Cotton Corporation of India (CCI), and Jute Corporation of India (JCI), procures these crops at the MSP.

However, in practice, the MSP mechanism is most effective for just a few crops—primarily wheat, paddy, sugarcane (for which mills are legally mandated to purchase at government-fixed prices), and to some extent, cotton (Chatterjee & Kapur, 2016, CACP Sugar Policy, 2023-24). These MSPs significantly influence farmers' production decisions (Gulati et. al., 2017), steering the agricultural production pattern in the country.

The FCI, in coordination with various central and state agencies, supplies the food grains it procures—primarily wheat and rice—to designated agencies at Central Issue Prices (CIP). These grains are distributed to consumers through the Targeted Public Distribution System (TPDS) and other welfare schemes. In addition, the FCI maintains buffer stocks of wheat and rice to safeguard food security and stabilise market prices. However, the government's disproportionate procurement of these two crops, coupled with steadily increasing MSPs, often leads to stockpiles exceeding the prescribed buffer stocking norms, resulting in frequent oversupply. As a result, the FCI is holding much higher stocks than required. The rice stocks as of 1st January 2026 were almost 10 times higher than stocking norms, much higher than last year (DFPD, 2026). Farmers tend to respond to the price incentives offered by MSPs by prioritising crops that guarantee a secure return. As a result, water-intensive crops like rice and sugarcane are predominantly cultivated, even in the water-scarce regions of northern and north-western India.

Farmers' preference for paddy cultivation is due to high remunerative prices, which are fixed at 1.5 times the cost of production incurred by the farmers. For instance, the MSP of common paddy was fixed at ₹2,183 per quintal in *Kharif* 2023. Wholesale price of paddy has reached as high as ₹2,634 per quintal and ₹2239 per quintal in Punjab and Haryana, respectively, in the harvest months, as MSP works as a floor price in these states. On the other hand, in West Bengal, which is a major producer of Paddy, the wholesale price (₹2,126 per quintal) remained lower than MSP. Without a well-functioning procurement mechanism, paddy is not as lucrative a crop in states where it is environmentally sustainable for cultivation.

In Punjab, the wholesale price of maize (₹1,305 per quintal) remained very low in the *Kharif* marketing season of 2023 compared to its MSP (₹2090 per quintal). Similarly, in Haryana, the wholesale price of moong (₹8057 per quintal) hovered below the MSP (₹8558 per quintal) in the marketing season (AGMARKNET, 2024). The crop-specific and region-specific procurement operation has distorted the cropping pattern of these states. Consequently, the reliance on paddy has sharply increased in these states, which have generated severe environmental costs.

ENVIRONMENTAL IMPACT 4

4.1 Water Footprint

4.1.1 Irrigation Requirement for Paddy vis-à-vis other Kharif crops in Punjab

Punjab has the second-highest irrigation ratio (percentage of Gross Irrigated Area to Total Cropped Area) of 97.5 per cent, with 7.72 mha irrigated, with 78 per cent irrigated from groundwater resources and 22 per cent irrigated through surface water resources in 2021-22 (MoAFW, 2025a).

Table 4.1: *Kharif* Irrigation Water Requirement in Punjab

Crop	Total irrigation water requirement/ use (million m^3)	Percentage Share in Total (%)
Rice	33187	92.9
Bajra	3	0.01
Maize	308	0.9
Tur or Arhar	5	0.01
Sugarcane	792	2.2
Citrus Fruits	18	0.1
Groundnut	3	0.01
Sesamum	5	0.01
Cotton	804	2.3
Others	608	1.7
Total	35733	

Source: Estimated by authors' using Kaur et al. 2015

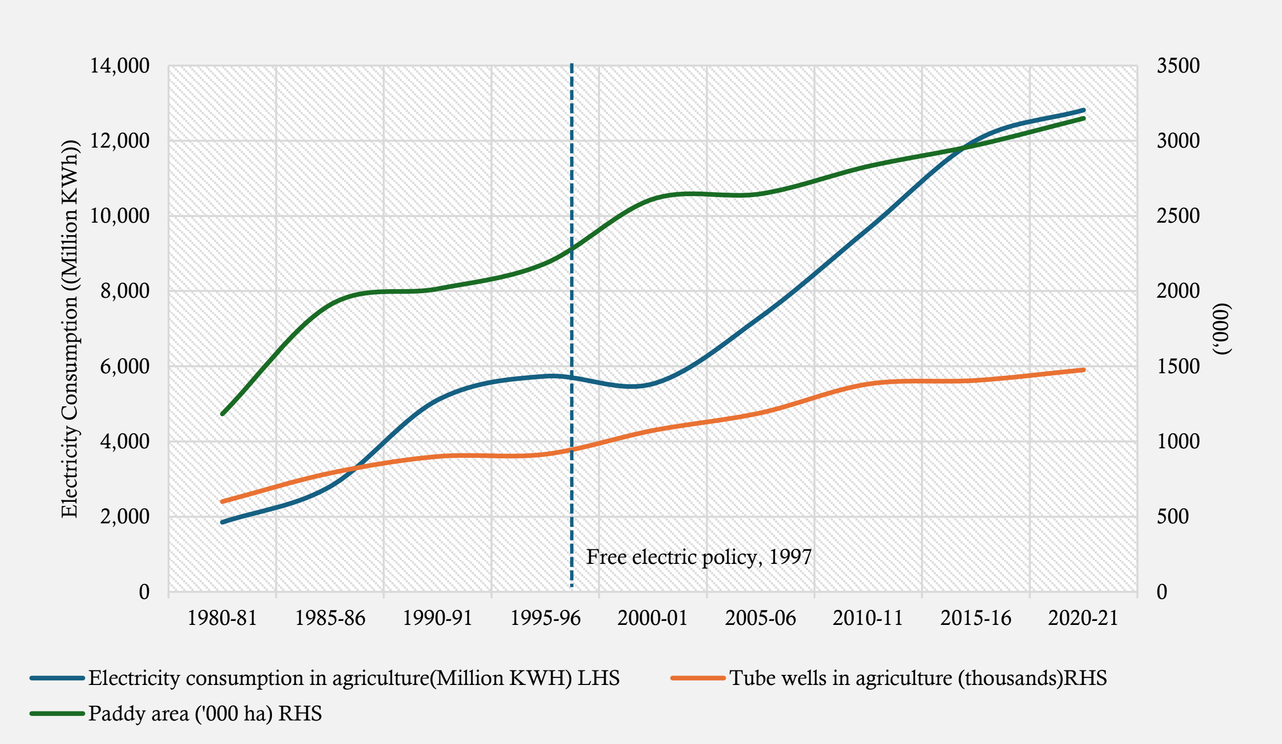
Based on the area under respective *Kharif* crops and per-hectare irrigation water requirement, the average total *Kharif* irrigation water use was estimated to be 35.73 bm^3 (Kaur et al., 2015). Paddy's average irrigation water use, accounting for 92.9 per cent of the total, was 33.19 bm^3, followed by cotton and sugarcane accounting for 2.3 per cent and 2.2 per cent with 0.8 bm^3 and 0.79 bm^3 of irrigation water use, respectively (**Table 4.1**). Since crop-wise data for groundnuts and sesamum were not available from the same source, we assumed the water requirement of rapeseed and mustard for these, as they are all oilseeds. However, for citrus fruits and all other crops, we assumed an average of 2000 m^3 per hectare to account for other horticulture crops, fodder, etc. Due to the lack of updated information available, the current usage of irrigation water might not be fully accurate.

4.1.2 Groundwater decline driven by increasing paddy cultivation area and free electricity in Punjab

In Punjab, the current surface water resources are insufficient to meet the growing demands of agriculture, resulting in an escalating reliance on groundwater resources. The excessive exploitation of groundwater has become necessary to fulfil the increasing water requirements for various purposes such as intensive irrigation, drinking water, industrial usage, and power generation. Since the implementation of the Green Revolution in the mid-1960s, the number of tube-wells has dramatically increased. Initially numbering only 50,000 in the early sixties, the count rose to over 70,000 in the early eighties, approximately 10.70 lakhs in 2001, 11.80 lakhs in 2005-06, and approximately 12.0 lakhs in 2012-13, according to the Statistical Abstract of Punjab. Currently, the number of tube-wells has reached 14.76 lakhs. The increase in the number of tube-wells also shows a proportionate increase in paddy cultivation area, and increased electricity consumption **(Figure 4.1).**

Punjab currently exhibits the second-highest irrigation ratio in the country, with 97.5 per cent of the GCA (equivalent to 7.72 million hectares) being irrigated in 2021–22. Of this irrigated area, 78 per cent is dependent on groundwater, while only 22 per cent relies on surface water sources such as canals (MoAFW, 2025a). This overwhelming reliance on groundwater highlights the central role of electricity subsidies in shaping irrigation outcomes. Punjab provides agricultural consumers with free and largely unmetered electricity, a policy that has become a major and recurring fiscal burden for the state while also contributing to severe environmental stress. In 2011–12, power subsidies to farmers amounted to 4.4 per cent of the Gross State Value Added (GSVA) of agriculture and allied sectors. By 2022–23 (BE), this share had risen to 5.6 per cent, reflecting the growing dominance of electricity subsidies in the state's agricultural support framework. The provision of free power has significantly altered farmers' irrigation behaviour by lowering the marginal cost of groundwater extraction to near zero. This has encouraged excessive and often inefficient use of groundwater, especially for paddy cultivation, which has expanded steadily under assured procurement and minimum support prices. As a result, it has also reinforced cropping patterns that are misaligned with Punjab's agro-ecological conditions.

Figure 4.1: Electricity Consumption, Paddy Area and Tube Wells, 1980-81 to 2020-21

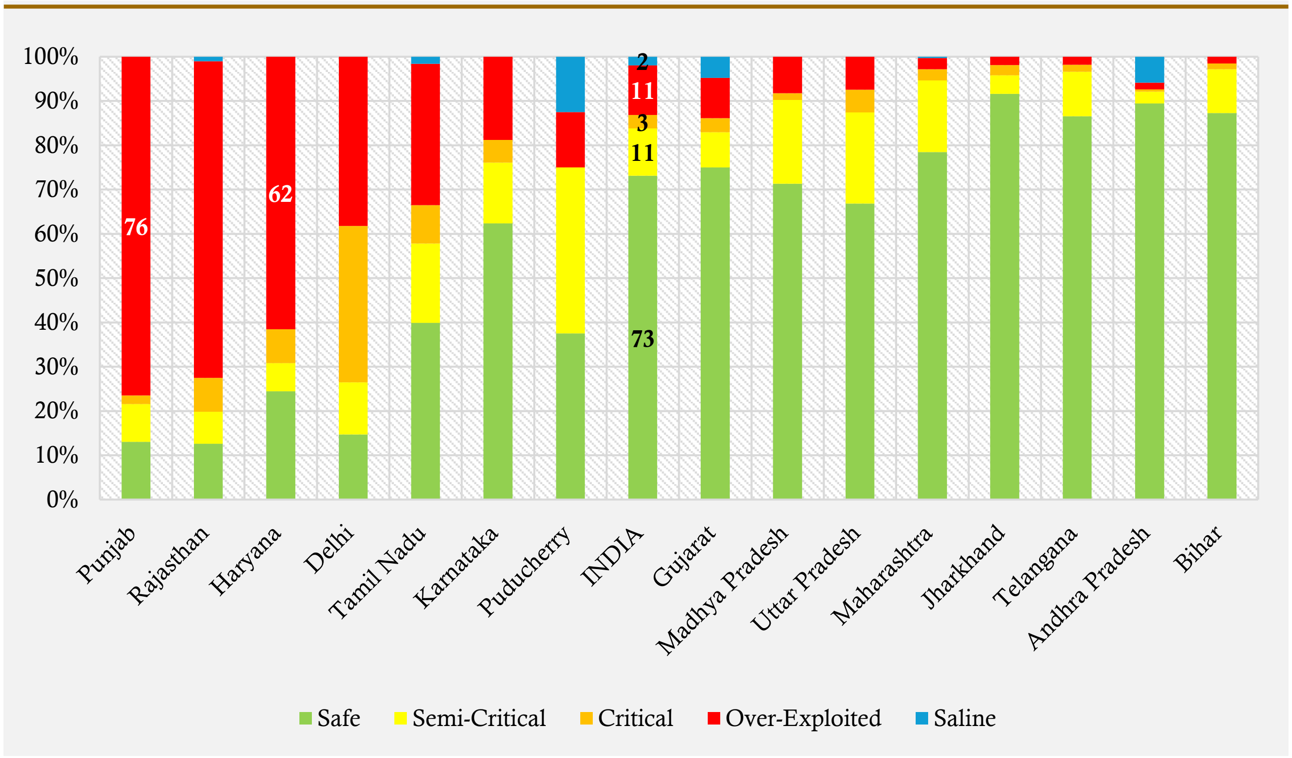


Source: Statistical Abstract of Punjab

The alignment of free electricity, high groundwater dependence, and the dominance of water-intensive crops has created a self-reinforcing cycle of resource overuse. Power subsidies lower the cost of pumping groundwater, enabling the cultivation of highly water-intensive crops, which in turn increases demand for irrigation and electricity. This cycle has contributed significantly to the overexploitation of groundwater resources. The severity of groundwater stress in the state is clearly reflected in the stage of groundwater extraction, defined as the ratio of total annual groundwater extraction to annual extractable groundwater resources. A stage of extraction exceeding 100 per cent indicates unsustainable use, where withdrawals outpace recharge. Punjab has consistently remained in this category, signalling chronic overexploitation.

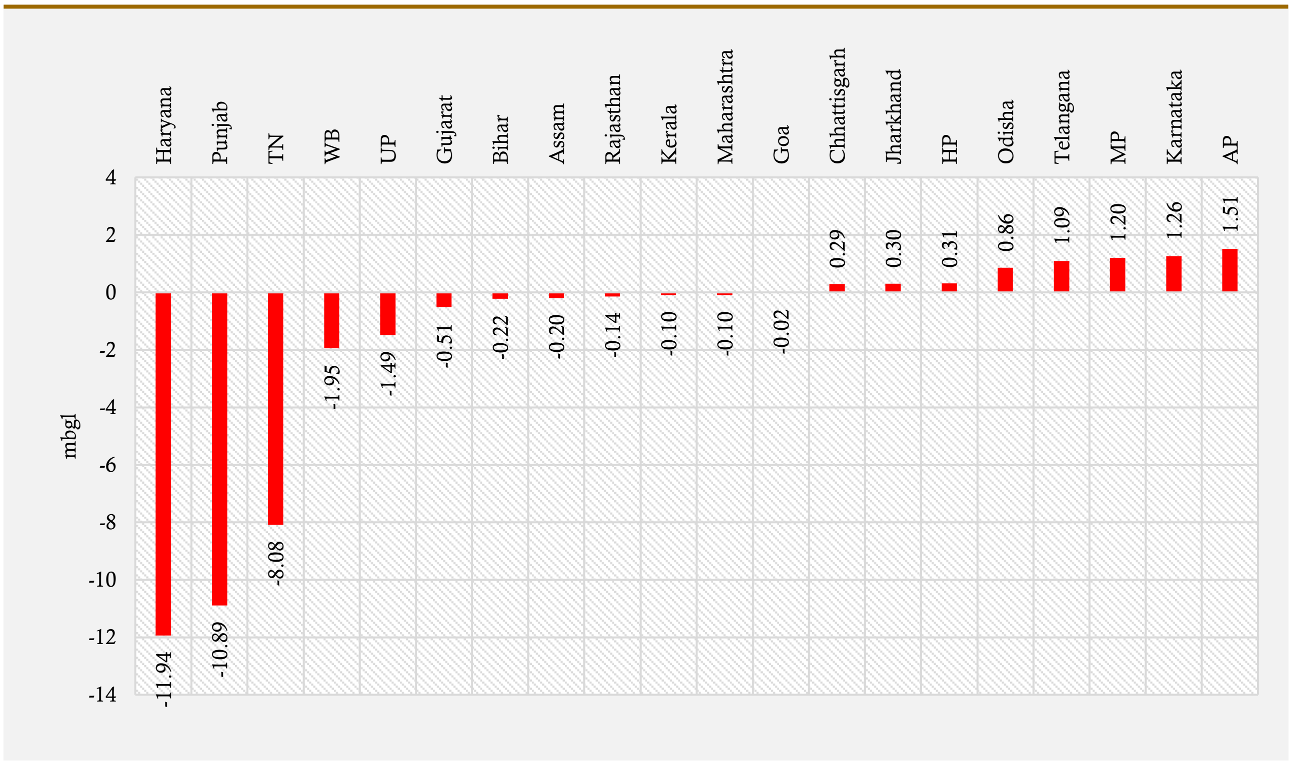
Ground Water Resources Assessment of states and union territories carried out jointly by state groundwater/ nodal departments, Central Ground Water Board (CGWB), and the Dynamic Ground Water Resources found that in 2023, the ground water resource units categorized as 'safe', are only 13 per cent, 'semi-critical' units are 9 per cent, 'critical units are 2 per cent, and 'over-exploited' units accounted for 76 per cent (**Figure 4.2**). In Punjab, the water level has declined to –10.89 meters below ground water level (mbgl) (**Figure 4.3**) between 2000 and 2022. In Sangrur, the decline was -24.8 mgbl **(**Gulati et al., 2022; **Figure 4.4)**. **Figure 4.5** depicts the progressive decline in groundwater levels from 1985 to 2023.

Figure 4.2: Categorisation of Groundwater Resource Assessment Units, 2023



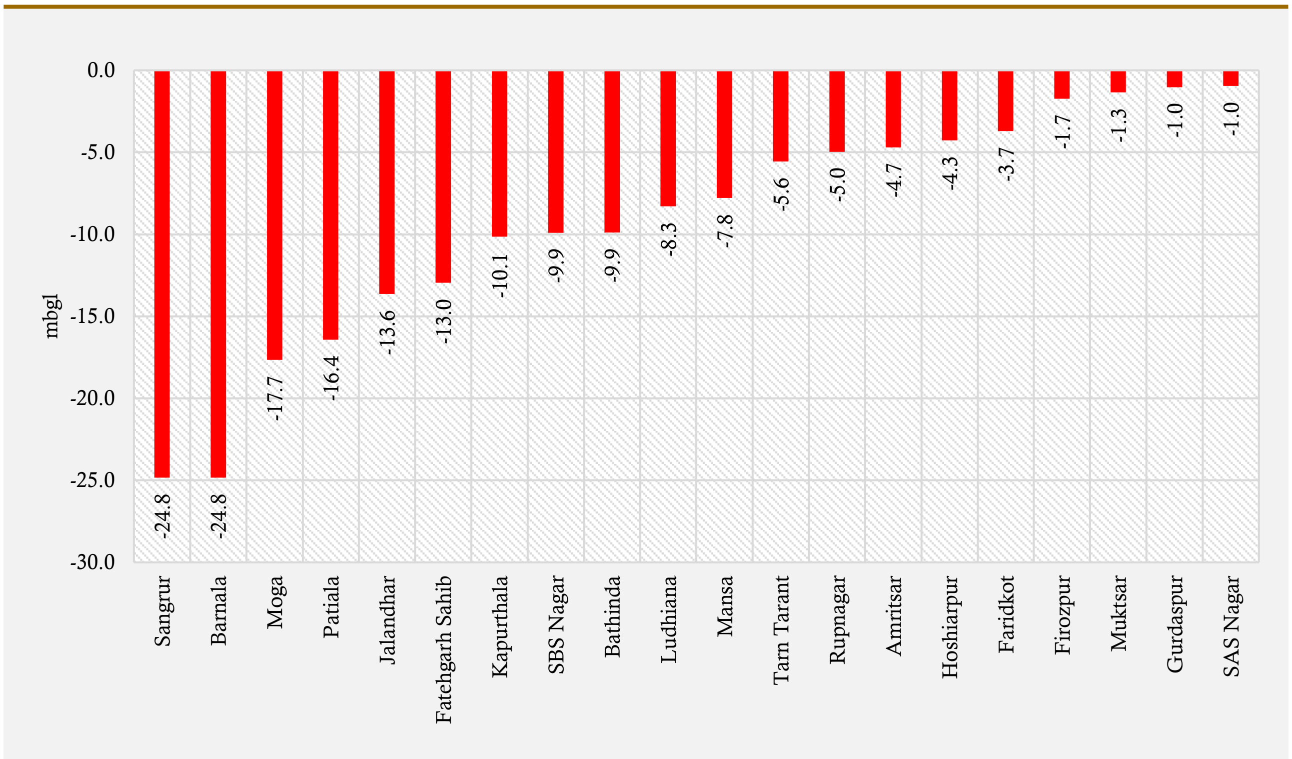
Source: CGWB, 2023

Figure 4.3: State-wise Average Decline in Groundwater Level, 2000-2022



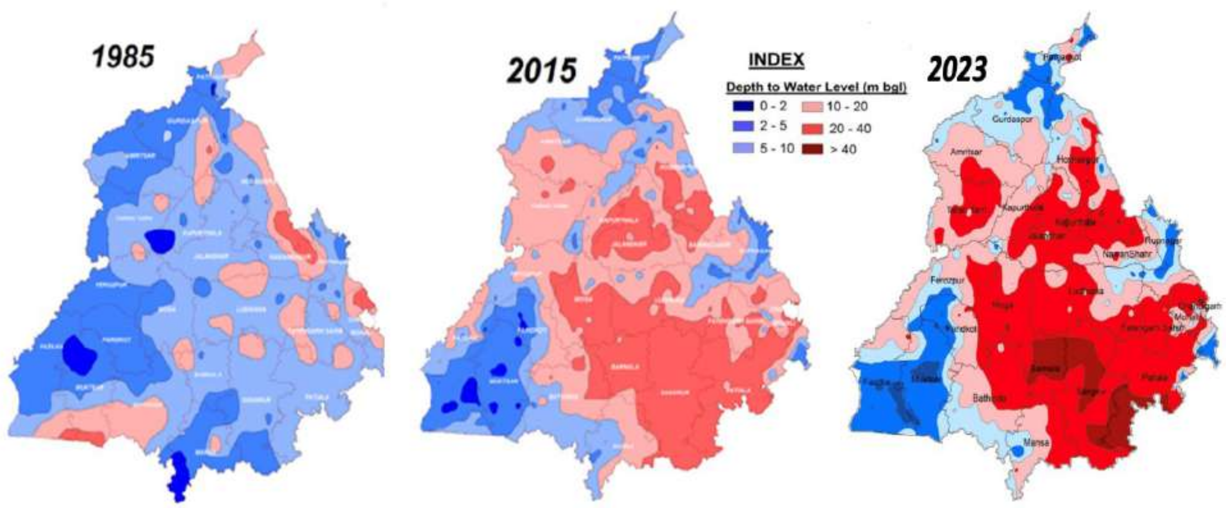
Source: Thangaraj and Gulati, 2024

Figure 4.4: District-wise Average Decline in Groundwater Level in Punjab, 2000-2019



Source: Gulati et al, 2022

Figure 4.5: Decline in Water Level in Punjab: Time Comparison



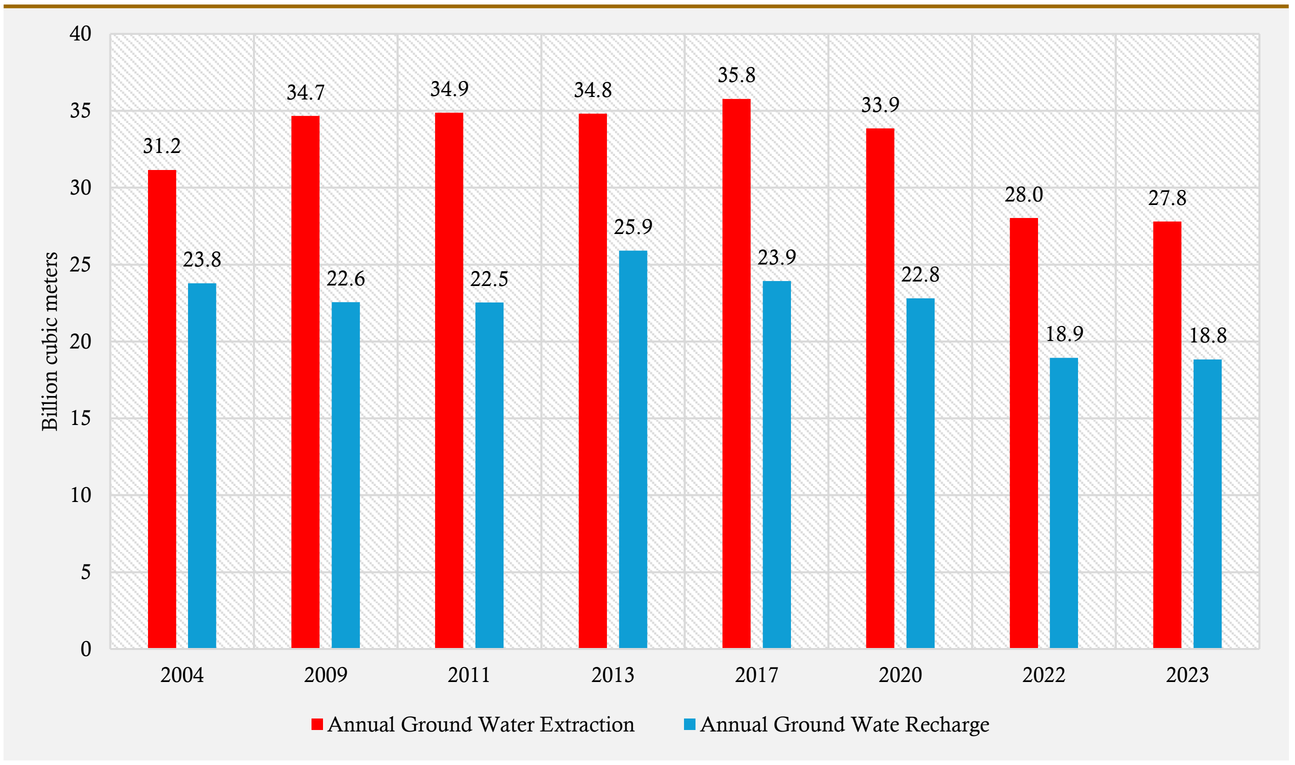
Source: CGWB (various years)

Out of the assessment years[1] of Dynamic Groundwater Resources from CGWB in Punjab, on average, groundwater extraction was 32.6 bm^3 while the annual groundwater recharge was 22.4 bm^3. The highest extraction was reported in 2017 at 35.8 bm^3 while highest

[1] Assessment years: 2004, 2009, 2011, 2013, 2017, 2020, 2022 and 2023.

recharge was seen in 2013 at 25.9 bm^3 (**Figure 4.6**). Recharge is possible from rainfall and other sources (including recharge from canals, surface water irrigation, groundwater irrigation, tanks, ponds and water conservation structures. Groundwater extraction is primarily classified into irrigation, industrial and domestic. Irrigation accounted for the highest share, on average 97 per cent in all reported years, followed by domestic and industrial extraction. The situation of worsening groundwater is clearer from the stage of groundwater extraction (estimated as a share of existing gross groundwater extraction for all uses to annual extractable groundwater resources. Punjab's stage of groundwater extraction peaked at 172 per cent in 2011 and averaged 162 per cent over 8 assessment years.

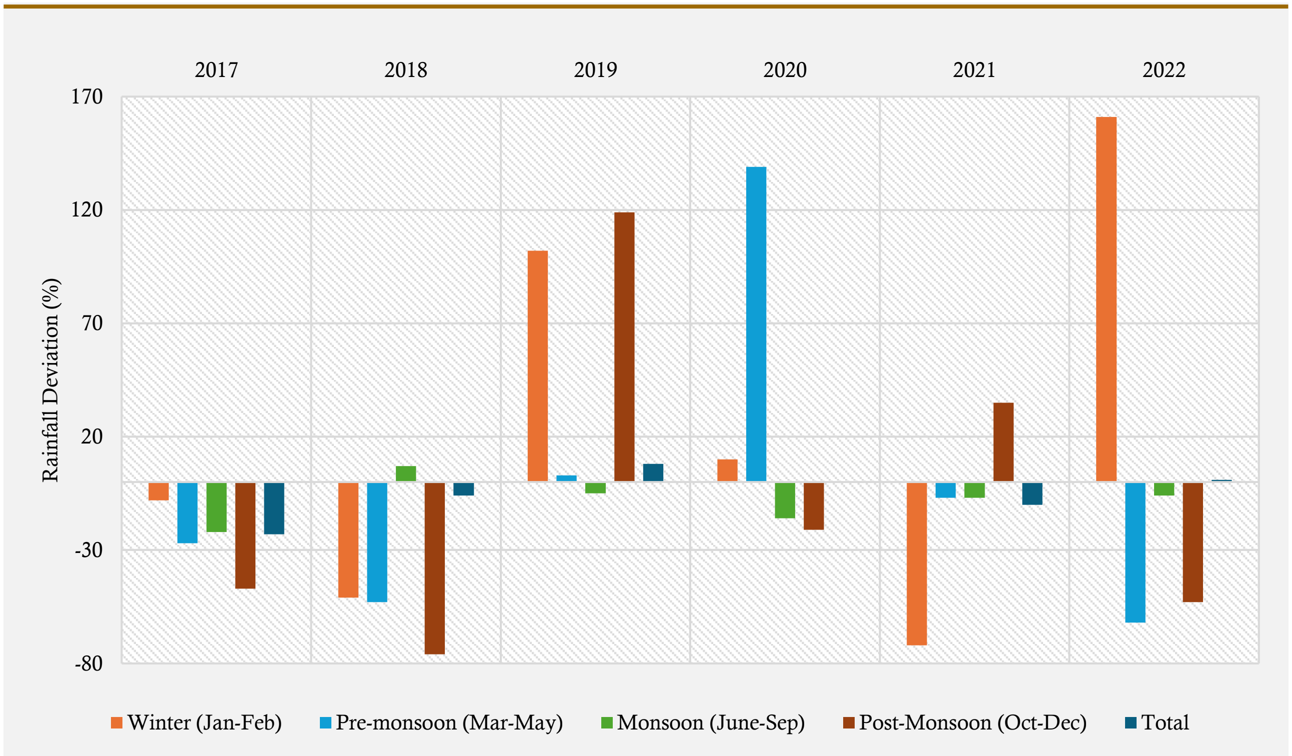
Figure 4.6: Annual Groundwater Extraction and Recharge in Punjab



Source: CGWB, various years

Since rainfall is a major source of groundwater recharge, the trends in rainfall deficit were analysed over winter, pre-monsoon, monsoon and post-monsoon seasons in Punjab (**Figure 4.7**). During 2017 and 2022, total rainfall deficit occurred in 2017 (-23 percent), 2018 (-6 percent) and 2021 (-10 percent). However, seasonal variations will have varied impacts on crop production. In 2017, there was a decline in rainfall across all seasons, with the highest during the post-monsoon (Oct-Dec) season at 47 per cent. Rainfall variability could tend to have mixed impacts during the crop cycle. Excess rainfall during the winter season (2019 and 2022) and pre-monsoon (2020) led to lodging in the wheat crops. Monsoon rainfall across all years except 2018 experienced a rainfall deficit, leading to more dependence on groundwater for irrigation.

Figure 4.7: Rainfall Deficit (%) in Punjab, 2017-2022



Source: MoAFW, 2025d

4.1.3 Irrigation Requirement for Paddy vis-à-vis other Kharif crops in Haryana

Based on irrigation water requirement (Kaur et al., 2015), the total irrigation water requirement/use amounts to 28.4 bm^3 in Haryana, from 2016-2023, where paddy accounted for the highest share of 52.7 per cent using 15 bm^3 of water (**Table 4.2**).

Table 4.2: Irrigation Water Requirement in Haryana

Crop	Total irrigation water requirement/use (million m^3)	Percentage Share
Paddy	15002	52.7%
Wheat	6553	23.1%
Cotton	2014	7.1%
Others	1307	4.6%
Rapeseed and Mustard	1276	4.5%
Bajra	988	3.5%

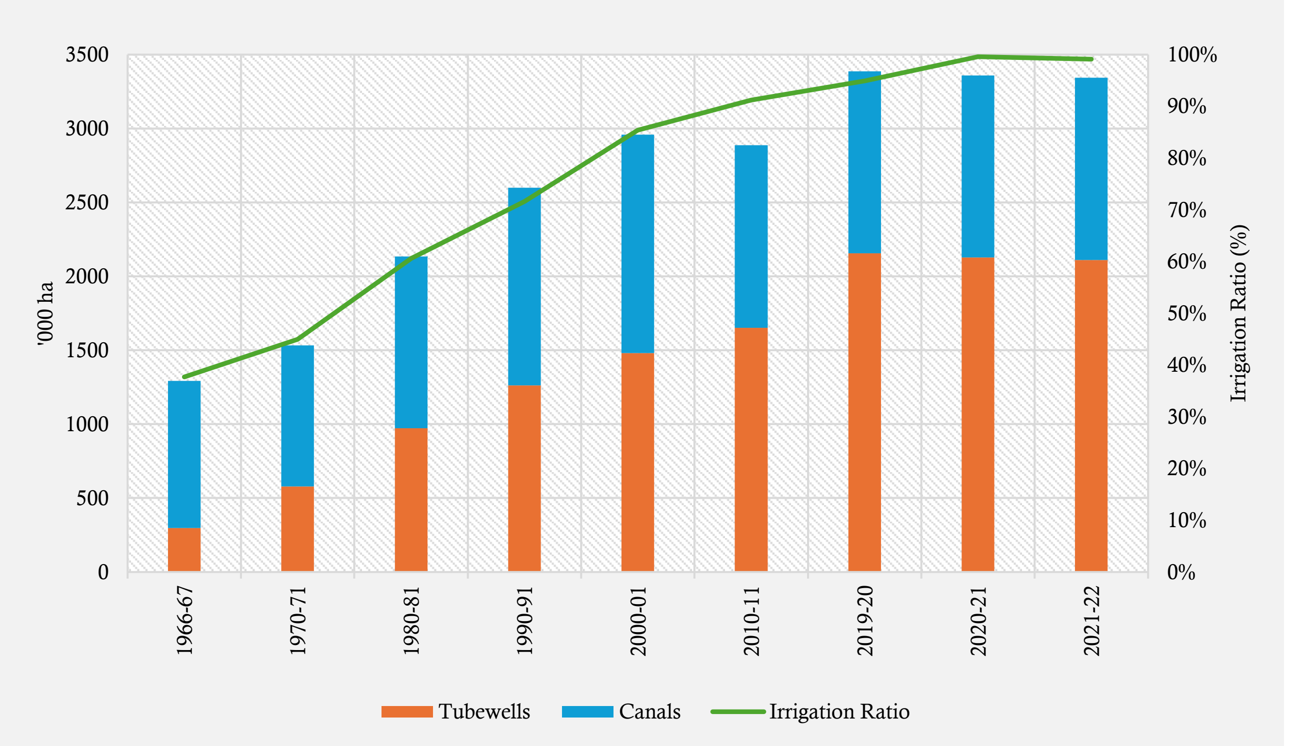
Crop	Total irrigation water requirement/use (million m^3)	Percentage Share
Sugarcane	911	3.2%
Potato	121	0.4%
Jowar	75	0.3%
Moong	64	0.2%
Gram	56	0.2%
Maize	16	0.1%
Barley	14	0.05%
Groundnut	13	0.04%
Tur	7	0.02%
Other Pulses	7	0.02%
Castorseed	4	0.01%
Sesamum	4	0.01%
Lentil	2	0.01%
Urad	1	0.00%

Source: Estimated by authors using Kaur et al. 2015

4.1.4 Groundwater decline driven by increasing paddy cultivation area in Haryana

There has been a notable shift in Haryana towards a heavier reliance on groundwater for irrigation. Back in 1966-67, canal irrigation dominated, accounting for 77 per cent of the irrigation area, encompassing 0.9 mha, while tube-wells made up 23 per cent, covering 0.3 mha (**Figure 4.8**). However, at present, this landscape has transformed, with 63 per cent, totalling 2.1 mha, dependent on tube wells, and 37 per cent, encompassing 1.2 mha, relying on canal irrigation. Haryana has the highest irrigation ratio of 99.1 per cent. The escalating dependence on groundwater has triggered significant environmental repercussions.

Figure 4.8: Sources of Irrigation in Haryana, 1966-2022

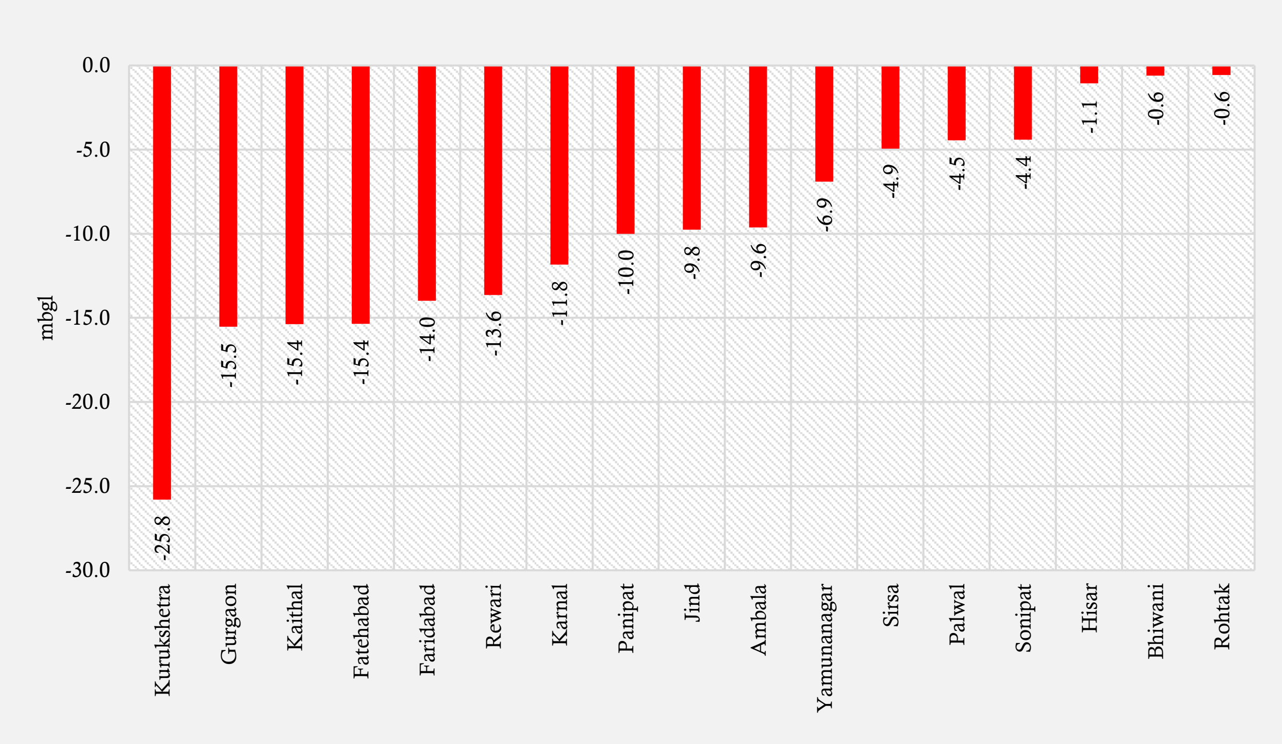


Source: Statistical Abstract of Haryana

The excessive reliance and the risks associated with the often nearly free and unmetered power supply to agriculture have intensified the pressure on the power subsidy provided by the state to its farmers, exacerbating its impact on groundwater. The persistent decrease in the groundwater table has resulted in water-stressed conditions in Haryana. Over-exploitation of groundwater, surpassing the recharge rate, leads to unsustainable water use. According to the Dynamic Groundwater Resources Report, conducted by CGWB, the status of groundwater resource units in 2023 reveals that only 24 per cent are categorised as 'safe', 6 per cent as 'semi-critical', 8 per cent as 'critical', and a significant 62 per cent as 'over-exploited'. In Haryana, the pre-monsoon water level has declined to -11.94 mbgl, with a substantial decline of -25.8 mbgl in Kurukshetra (**Figure 4.9**). Of all the districts, 6 fell in the range where the water level was between 0-5 mbgl and 10-15 mbgl; there were 4 districts between the 5-10 mbgl and 1 district over 20 mbgl. There were 4 districts where there was an increase in the water table.

Apart from the decline in groundwater, it is important to understand the classification of the annual groundwater extraction and the extent of recharge to ascertain the unsustainable use of groundwater. Average annual groundwater extraction over the assessment years was 12.04 bm^3, while the annual groundwater recharge was 10.08 bm^3 (**Figure 4.10**). Irrigation accounted for the maximum share in groundwater extraction, averaging 93 per cent, followed by domestic (5 per cent) and industry (4 per cent). Recharge from rainfall was the highest, averaging 3.43 bm^3 during the monsoon season, while recharge from other sources (3.07 bm^3) was the highest during the non-monsoon season.

Figure 4.9: District-wise Average Decline in Groundwater Level in Haryana, 2000-2019

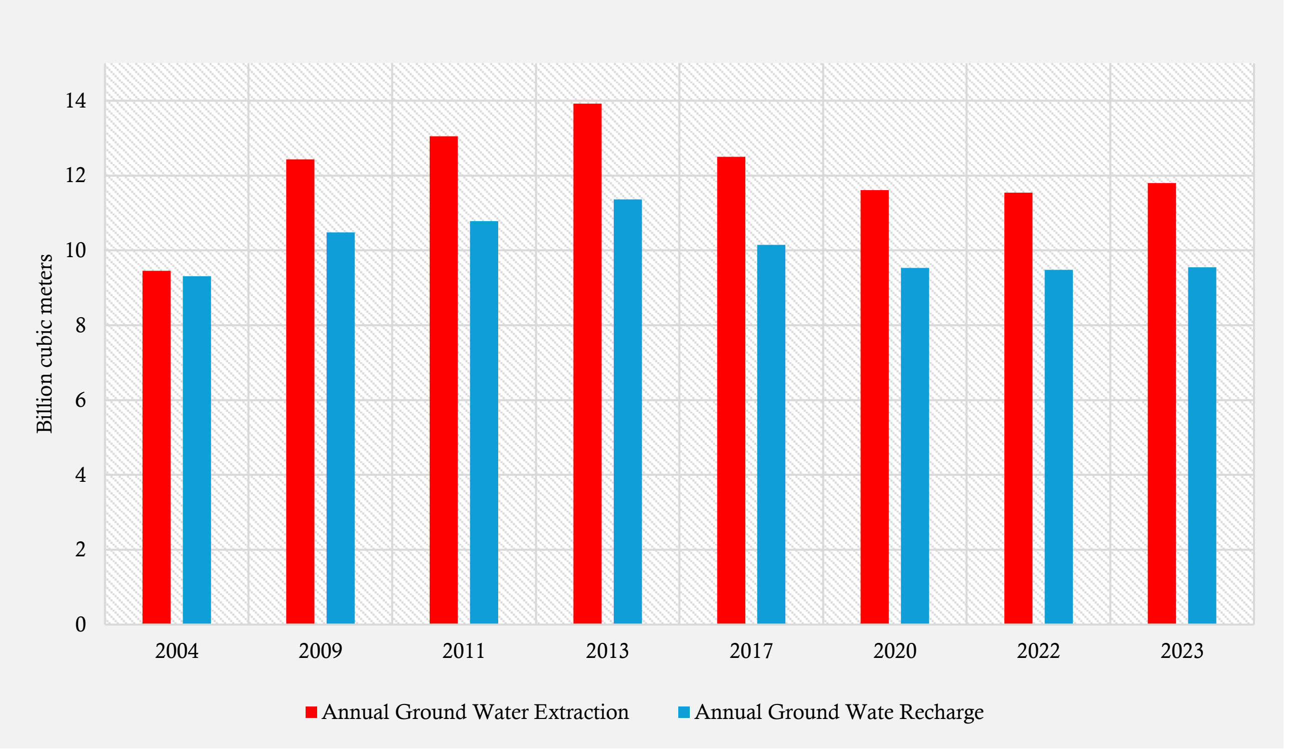


Source: Gulati et al, 2022

While recharge is an important factor, timely rainfall for cultivation and recharge is also vital for ensuring efficient and sustainable use of groundwater. Total rainfall[2] was deficient in 2017 (-28 percent), 2018 (-17 percent) and 2019 (-34 percent) while there was excessive rainfall in 2021 (28 percent) and 2022 (20 percent) (**Figure 4.11**). Monsoon rainfall was found to be deficient across all years except 2021 and 2022. The highest monsoon rainfall deficiency occurred in 2019 at -42 percent, followed by 2017 (-26 percent), 2020 (-14 percent) and 2018 (-9 percent). This deficiency in rainfall have impacts on degree of groundwater extraction for irrigation. Excessive rainfall in pre-monsoon (2020), winter and post-monsoon (2022) may impact harvesting, lodging and crop growth stage.

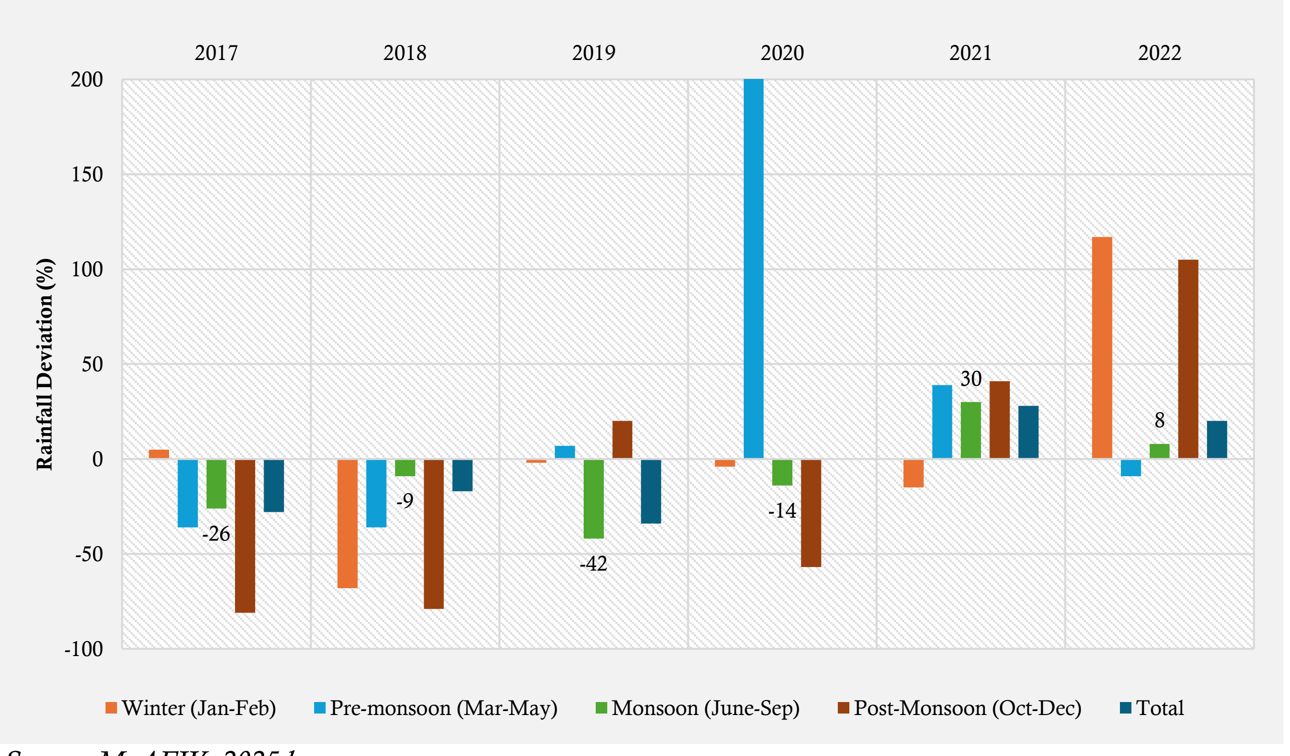
[2] Actual Rainfall, Normal rainfall and rainfall deficit (%) were reported for sub-divisions and Haryana, Chandigarh and Delhi were part of the same sub-division, hence these figures were used.

Figure 4.10: Annual Groundwater Extraction and Recharge in Haryana



Source: CGWB, various years

Figure 4.11: Rainfall Deficit (%) in Haryana, Chandigarh and Delhi, 2017-2022



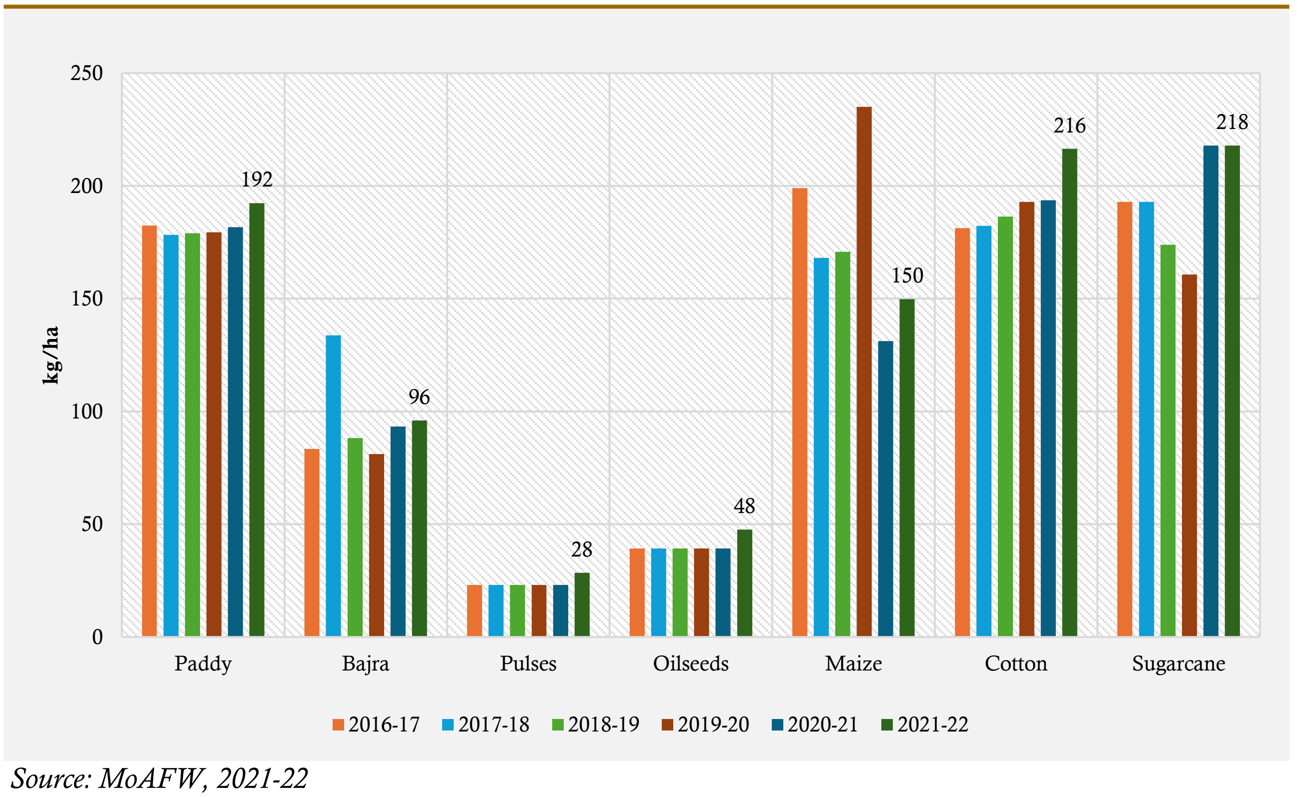
Source: MoAFW, 2025d

4.2 Fertiliser Consumption Impacts

Punjab and Haryana continue to exhibit significantly higher fertiliser consumption per hectare relative to the national average, reflecting the states' intensive cropping systems and input-driven production model. At the all-India level, per-hectare consumption of nutrients (N + P + K) increased from 96 kg per hectare in 2004–05 to 150 kg per hectare in 2024–25 (FAI, 2026), indicating a steady intensification of input use across Indian agriculture. In contrast, Punjab's fertiliser application rates were more than double the national average in 2004–05 (199 kg per hectare) and rose further to 250 kg per hectare in 2024–25, highlighting the exceptional intensity of nutrient use in the state. While Haryana's fertiliser consumption increased from 175 kg per hectare to 220 kg per hectare between 2004-05 and 2024-25 (FAI, 2026).

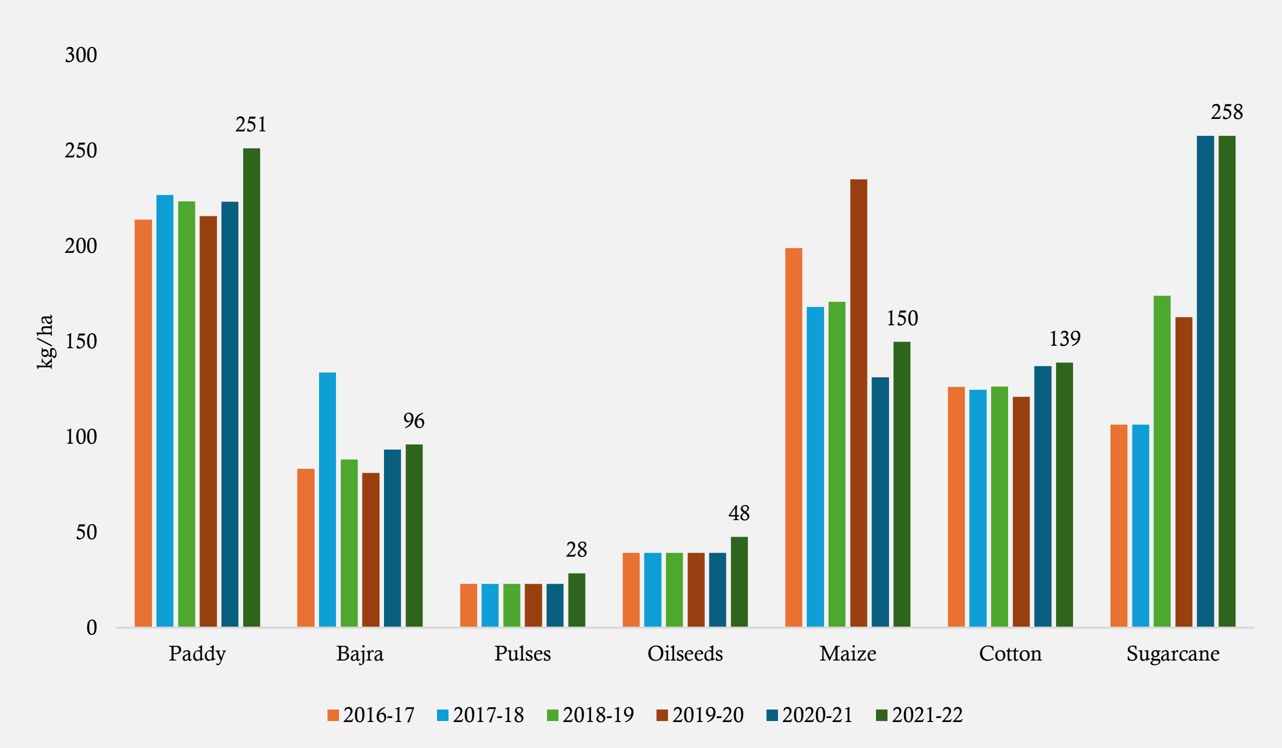
Amongst *Kharif* crops in Punjab and Haryana, paddy consumed higher fertiliser in Punjab and Haryana than their other Kharif crop counterparts. In 2021-22, fertiliser consumption in paddy was 192 kg per hectare, while pulses and oilseeds had much lower consumption of 28 kg per hectare and 48 kg per hectare, respectively (**Figure 4.14**). Similarly, in Haryana, fertiliser consumption in paddy was substantially higher at 251 kg per hectare in comparison to pulses and oilseeds (**Figure 4.13**). This suggests that a substantial portion of the states' fertiliser subsidy is diverted into paddy cultivation.

Figure 4.12: Crop-wise Fertiliser Consumption in Punjab, 2016-17 to 2021-22



Source: MoAFW, 2021-22

Figure 4.13: Crop-wise Fertiliser Consumption in Haryana, 2016-17 to 2021-22



Source: MoAFW, 2021-22

State agricultural universities routinely provide crop-specific fertiliser recommendations based on soil fertility, agro-climatic conditions, and cropping patterns. In these states, imbalance in fertiliser use, characterised by excessive application of N and inadequate use of P and K has been observed (**Table 4.3**). As a rule of thumb, the ideal NPK ratio for India is considered to be 4:2:1. Primarily due to the pricing policy, the ratio has never been close to the ideal. Punjab and Haryana have highly skewed NPK ratios of 26.5:5.9:1 and 23.2:6.1:1, respectively.

Table 4.3: NPK Ratios in Punjab, Haryana and All-India

Year	All-India	Haryana	Punjab
2000-01	7.0:2.7:1	73.9:21.3:1	42.5:11.9:1
2010-11	4.7:2.3:1	20.5:7.1:1	19.1:5.9:1
2015-16	7.2:2.9:1	52.6:14.8:1	18.6:5.4:1
2020-21	6.5:2.8:1	28.2:8.1:1	27.0:6.9:1
2021-22	7.7:3.1:1	23.2:6.1:1	26.2:5.9:1
2022-23	11.8:4.6:1	43.5:12:1	50.8:12.6:1

Source: Estimated by authors using MoAFW, FAI

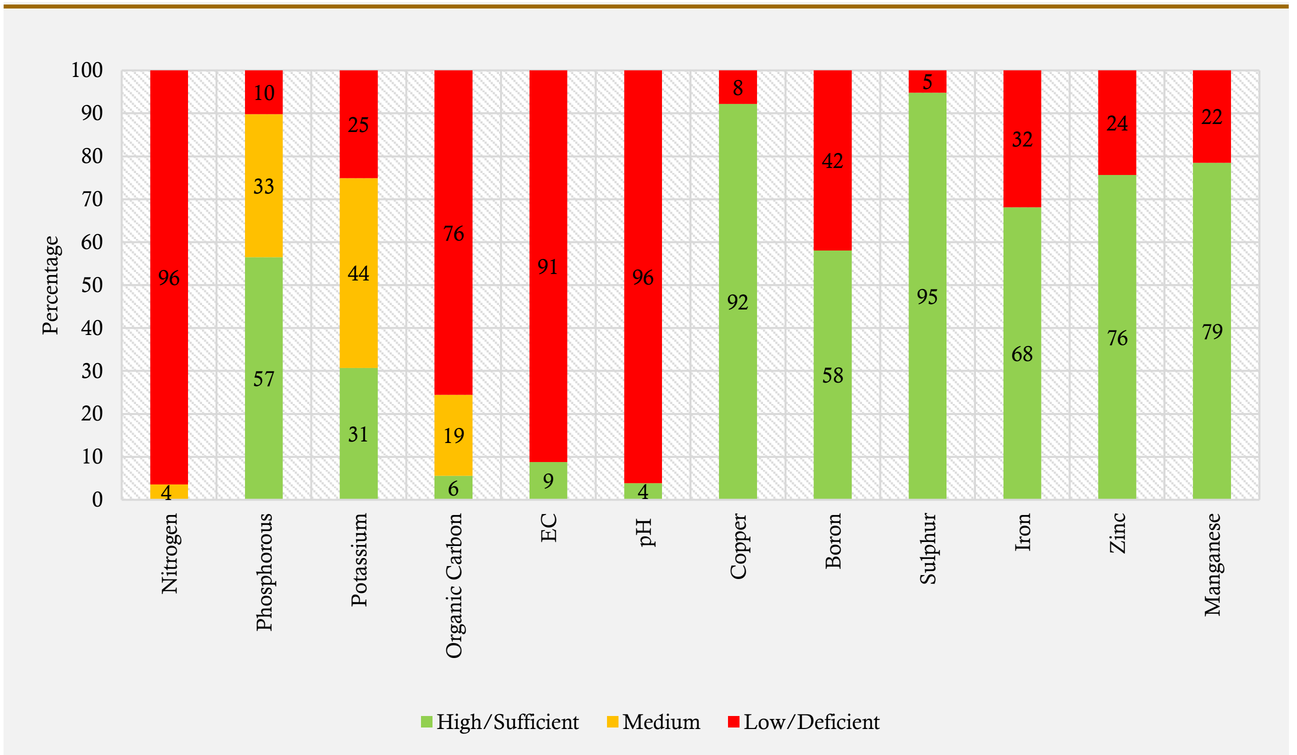
The ideal ratio and rates of fertiliser to be applied vary from state to state, soil to soil, and, plot to plot. Chand and Pavithra S (2015) have estimated the all-India ideal ratio as 2.6:1.4:1 and stated the state-wise ideal ratios in the study. According to the paper, ideal ratios of NPK for Punjab and Haryana are 4.1:1.6:1, and 4.0:1.7:1. We gather from **Table 4.3**, that neither all-India ratios nor ratios in states with troubling fertiliser use conform to the norm. Imbalance or deficiency of nutrients in soil is not limited to primary macronutrients in India. Due to the concentrated emphasis on NPK in policies, the deficiency of secondary macronutrients and micronutrients in the soil has not received enough attention. These imbalances effects on soil health, as evident from the macronutrient levels in the soil.

As per the Soil Health Card (SHC) 2024-25 data, nitrogen deficiency affects about 90 per cent of soils, alongside organic carbon deficiency in around 43 per cent (**Figure 4.14**). Potassium deficiency is widespread at about 54 per cent, and phosphorus deficiency affects nearly 37 per cent of soils. Boron deficiency is particularly acute at around 72 per cent, while most other micronutrients remain largely sufficient. While in Haryana, about 96 per cent of soils are deficient in nitrogen and around 76 per cent in organic carbon (**Figure 4.15**). Phosphorus availability is relatively adequate, with only about 10 per cent deficiency, although potassium deficiency affects roughly 25 per cent of soils. Among micronutrients, deficiencies in boron at about 42 per cent and zinc at around 24 per cent remain notable, even as most other micronutrients are largely sufficient.

Figure 4.14: Status of Macro- and Micronutrients in Punjab Soils

Source: SHC, 2026

Figure 4.15: Status of Macro- and Micronutrients in Haryana Soils

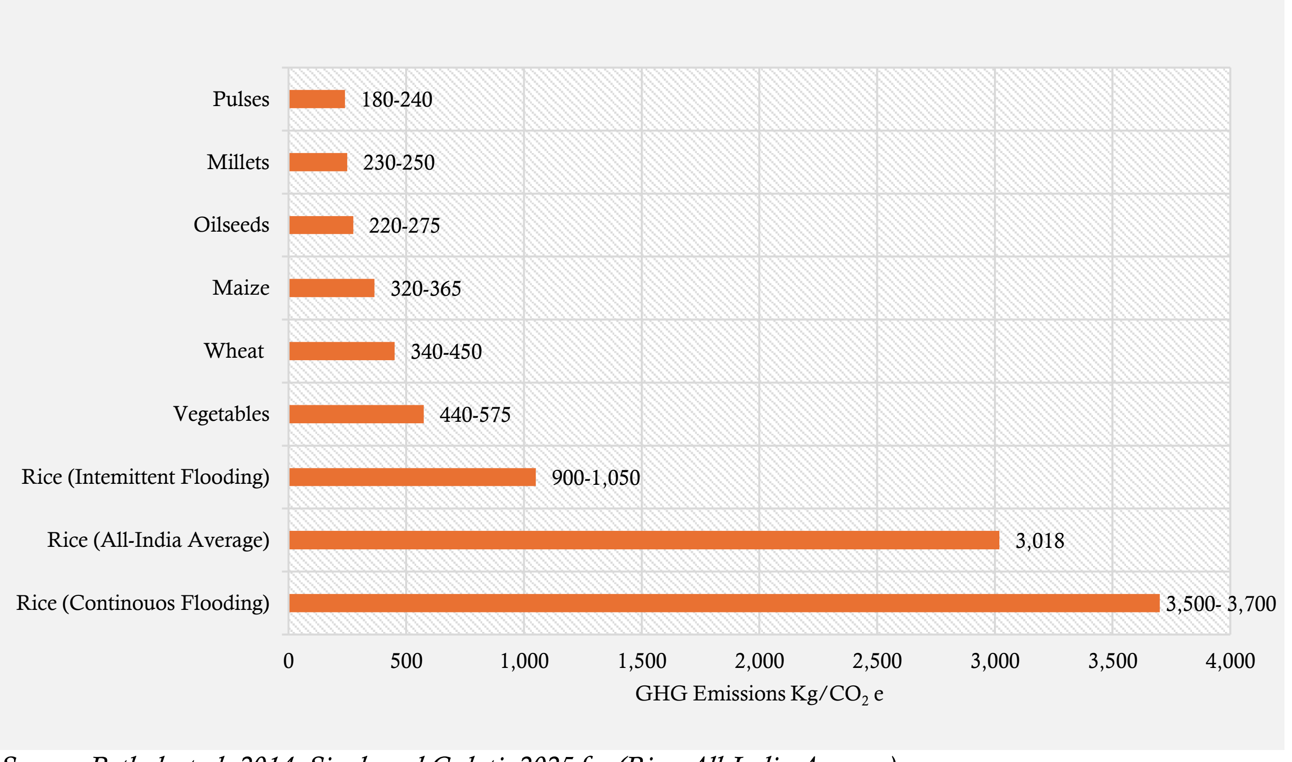


Source: SHC, 2026

4.3 Carbon Footprint

GHG emissions from crop cultivation vary significantly across crops, reflecting differences in agronomic practices, water management, and input use. Among all major crops, rice stands out as the most GHG-intensive, primarily due to the practice of continuous flooding, which creates anaerobic soil conditions conducive to methane generation. As highlighted by Pathak et al. (2014), the emissions from irrigated rice systems range between 3,500–3,700 kg CO_2 eq per hectare, making rice substantially more emission-intensive than other staple and non-staple crops (**Figure 4.16**). In comparison, crops such as wheat and maize have much lower emissions, typically in the range of 320–450 kg CO_2 eq per hectare. Similarly, pulses and oilseeds exhibit even lower emissions, generally between 180–275 kg CO_2 eq per hectare. Millets, which are increasingly being promoted as climate-resilient crops, also fall in the lower emission category, with emissions around 230–250 kg CO_2 eq per hectare. Vegetables, despite being relatively input-intensive in some cases, still emit significantly less than rice, with emissions in the range of 440–475 kg CO_2 eq per hectare. This stark contrast implies that rice cultivation can be 3–4 times more emission-intensive than intermittently flooded rice systems, 8–10 times more than wheat and maize, 12–15 times more than millets and oilseeds, and up to 15–20 times more than pulses.

Figure 4.16: GHG Emissions from Different Crops



Source: Pathak et al. 2014; Singh and Gulati, 2025 for (Rice: All-India Average)

At the national level, this translates into a disproportionately large contribution of rice cultivation to agricultural emissions. According to India's national GHG inventory (MoEFCC, 2024), rice cultivation accounted for 67,725 GgCO_2eq GHG emissions, which is about 16.7 per cent of total GHG emissions from the agriculture sector. This is particularly significant given that agriculture's contribution to India's overall emissions profile is 13.7 per cent, underscoring the crucial role of rice in shaping the sector's carbon footprint. The national GHG inventory for rice cultivation is based on methane emissions. GHG released by rice cultivation have four major sources: first, CH_4 emissions from irrigated rice production; second, N_2O emissions from nitrogenous fertilisers use; third, CH_4 and N_2O from the burning of residue and the release of CO_2 from energy sources to pump groundwater for irrigation and for other mechanical operations. The fourth component is excluded while calculating rice GHG emissions, since it is counted as part of energy-related emissions in the national inventory. If we include all four sources of emissions from rice cultivation, the emissions from rice cultivation were estimated to be 144,031 Gg CO_2 eq during 2022-23 (Singh and Gulati 2025). While states such as Uttar Pradesh and West Bengal contribute the largest share in absolute terms due to their extensive cultivation area, the climate challenge is most acute in Punjab and Haryana when assessed in terms of emissions intensity. With emissions of about 5,040 kg CO_2 eq per hectare in Punjab and 4,715 kg CO_2 eq per hectare in Haryana, these states represent the most carbon-intensive rice production systems in the country.

This high emissions intensity is rooted in a combination of input-intensive agricultural practices and policy incentives. The widespread use of nitrogenous fertilisers contributes to elevated N_2O emissions, while heavily subsidised or free electricity has encouraged excessive groundwater extraction, leading to high indirect carbon emissions from energy use. Standing water in the paddy fields creates anaerobic conditions that drive CH_4 emissions, and the prevalent practice of residue burning further adds to the emissions beyond the already high baseline associated with rice. As a result, these states not only contribute significantly to national food security but also represent critical leverage points for reducing agricultural emissions.

Addressing emissions from rice cultivation, therefore, requires a reorientation of both production practices and policy incentives, particularly in Punjab and Haryana, where mitigation gains would be the highest. A gradual reduction of rice area—estimated at around 15 lakh hectares across the two states—offers a significant opportunity, with the potential to reduce emissions by approximately 3.75 MT of CO_2 equivalent. Such a transition is feasible given that India maintains foodgrain stocks above buffer norms, but it would need to be carefully managed through improved productivity in water-abundant regions and strengthened value chains for alternative crops such as maize, pulses, and oilseeds.

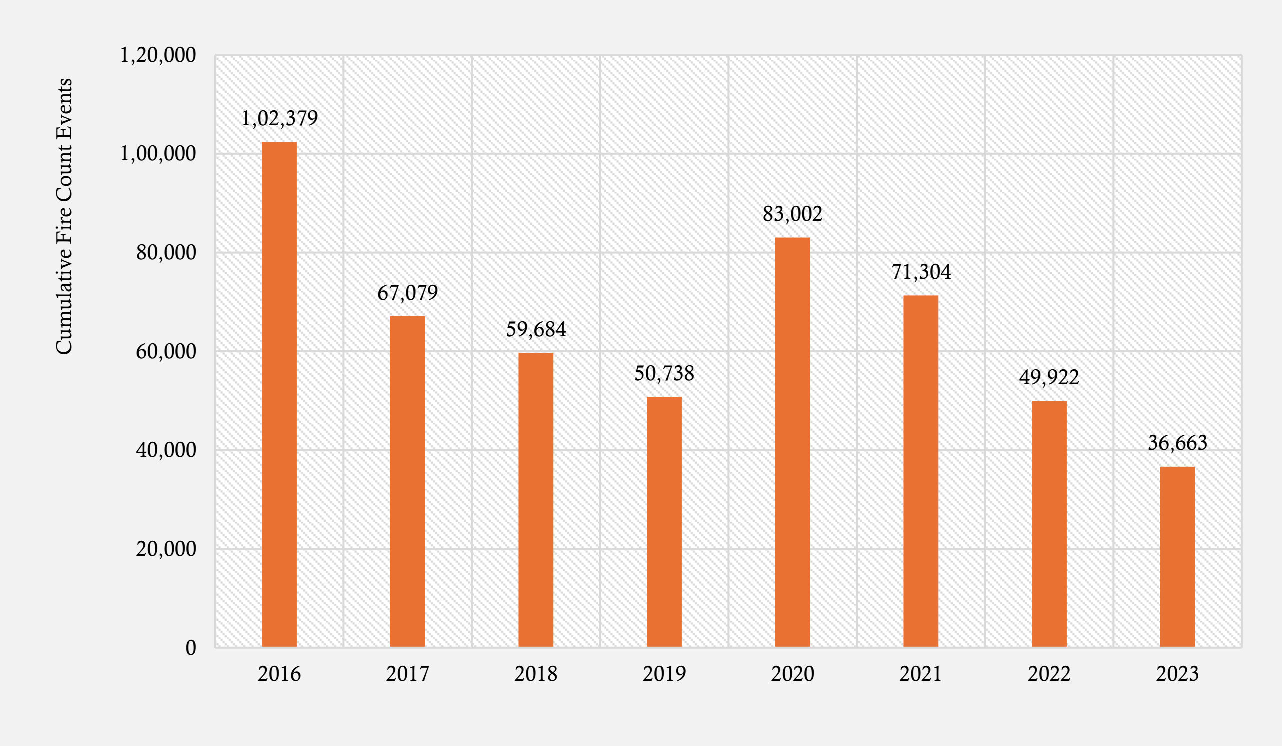
Technological interventions in rice cultivation also offer substantial mitigation potential. Practices such as Direct Seeded Rice (DSR) and Alternate Wetting and Drying (AWD) can significantly reduce CH_4 while lowering water use and energy demand. Reforming input subsidies will be central to any long-term solution. Rationalising power and fertiliser subsidies and reorienting them toward resource-use efficiency can help correct existing distortions. Similarly, scaling up residue management technologies can address emissions from stubble burning while delivering co-benefits in terms of air quality and soil health. In parallel, enabling farmers to access emerging carbon markets could provide an additional revenue stream linked to the adoption of low-emission practices.

4.4 Crop Residue Burning Trends

4.4.1 Crop Residue Burning Trends in Punjab

Despite a ban on crop residue burning, a high number of fire count events are recorded in Punjab during paddy harvesting (**Figure 4.17**). During 2016, there were 102,379 fire events from September to November. However, since 2020, there has been a declining trend, and 36,663 fire events have been recorded in Punjab during September-November 2023.

Figure 4.17: Cumulative Fire Counts in Punjab During September-November, 2016-2023



Source: CREAMS, 2025

Daily fire count events in Punjab during October-November for the duration 2016-2023 reveal that maximum fire events occur during 25th October to 30th November, the duration when Delhi's air quality index reaches its peak (**Annex 3**). Sangrur district in Punjab has reported the highest fire incidence in the reported years (**Annex 4**).

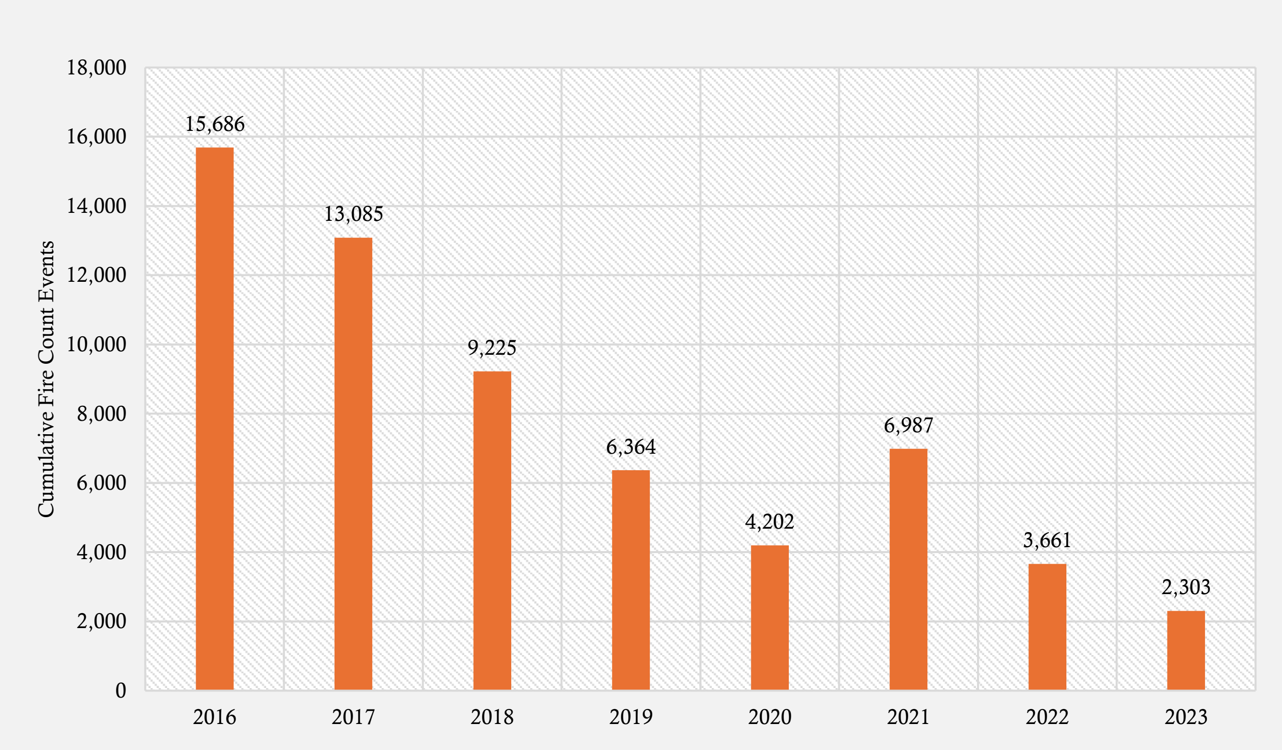
According to CREAMS, in Punjab during 2020, out of 2.97 mha rice area, 1.65 mha (56 per cent of the total rice cultivation area) was burnt in 2020 (**Annex 5**). 25.44 MT of rice straw was produced, of which 12.84 MT was burnt.

4.4.2 Crop Residue Burning Trends in Haryana

In Haryana, the fire events were comparatively lower than in Punjab, and the incidences are declining. In 2016, 15,686 fire events were reported, which declined to 2,303 in 2023 (**Figure 4.18**). Fatehabad district reported the highest fire count incidences (**Annex 6**).

During 2020, 16 per cent (comprising 0.21 mha) of the total rice cultivation area (comprising 1.4 mha) was burnt in Haryana (**Annex 7**), which produced 9.7 MT of rice straw, out of which 1.4 MT was burnt.

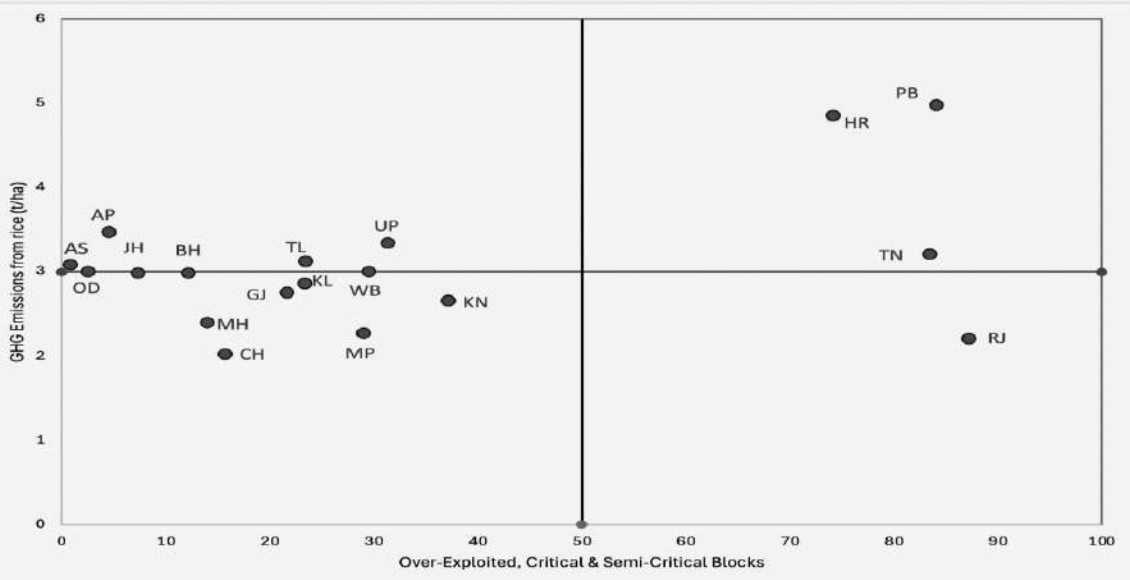
Figure 4.18: Cumulative Fire Counts in Haryana During September-November, 2016-2023



Source: CREAMS, 2025

Box 4.1: Reduce 8-15 Lakh Hectares of Non-Basmati Paddy Area from Punjab and Haryana

Union Agriculture Minister, Shri. Shivraj Singh Chouhan announced an ambitious "−5, +10" formula to reduce the area under rice cultivation by 5 mha while increasing rice output from the remaining rice area by 10 MT, to free up area for the cultivation of pulses and oilseeds (PIB, 2025). Of the target 5 mha rice area reduction, 8-15 lakh hectares of non-basmati rice area should be targeted from Punjab and Haryana, the states where severe environmental degradation is in place, specifically the unsustainable depletion of groundwater, high fertiliser consumption and high GHG emissions caused by water-intensive paddy farming. The major rice-producing states were categorised into four categories based on the percentage of overexploited, critical and semi-critical blocks and the GHG emission per hectare from rice cultivation.



Source: Authors creation using Singh and Gulati, 2025; CGWB 2025

- **High emission, high water stress regions** - Punjab (PB), Haryana (HR) and Tamil Nadu (TN)
- **High emission, low water stress regions** - Uttar Pradesh (UP), Andhra Pradesh (AP), Telangana (TL), Assam (AS), Bihar (BH), and West Bengal (WB)
- **Low emission, high water stress regions** – Rajasthan (RJ)
- **Low emission, low water stress** - Madhya Pradesh (MP), Maharashtra (MH), Karnataka (KN), Gujarat (GJ), Kerala (KL), Eastern UP, Chhattisgarh (CH) and Odisha (OD)

POLICY RECOMMENDATIONS 5

5.1 'Paddy-skewed incentives' to 'crop neutral incentives' - Existing incentive of ₹17,500 per hectare in Punjab and Haryana for non-paddy farmers should be doubled by GoI

The shift from paddy toward diversified farming is crucial for environmental sustainability. However, at present, the agricultural subsidies as well as the assured procurement are skewed towards paddy, which is one of the major reasons that drives paddy cultivation and its profitability. Other *Kharif* crops in Punjab and Haryana have widely documented challenges, e.g. pest attack in cotton, low yield in pulses and maize, lack of cold storage facilities for perishables, uncertain market, etc., that are getting compounded with the climate change impacts. The viability of other crops remains a major concern for the farmers. The farmers' income and profitability need to be linked with crop diversification goals, which are not aligned at present. though GoI and state governments have announced the crop diversification schemes.

Crop Diversification Scheme for Punjab

In 2023-24, the Crop Diversification scheme under Centrally Sponsored Scheme was announced by the Union Government with ₹289.87 crore from the GoI for 2024-25 BE that covers up to five hectares for the beneficiary farmer to provide an incentive of ₹17,500 per hectare for one year. However, the data indicate a substantial gap between planned allocations and actual spending, pointing to serious implementation bottlenecks (**Table 5.1**). In 2024–25, GoP initially allocated ₹500 crores for the scheme (Budget Estimate, (BE)). However, this was sharply reduced to ₹40 crores (Revised Estimate, (RE)). More strikingly, the actual expenditure stood at just ₹0.85 crore—barely 0.17 per cent of the original budget and about 2.1 per cent of the revised allocation (GoP, 2026). And if we go one step further, the Comptroller and Auditor General of India (CAG) finance report indicated the Audited Expenditure to be ₹0.20 crore.

This pattern reflects significant underutilization of funds. Such a steep decline from BE to RE, followed by negligible actual spending, may indicate delays in scheme rollout, administrative or procedural hurdles, lack of project readiness, or weak coordination among implementing agencies.

Table 5.1: Crop Diversification Scheme in Punjab

Year	Budget Estimate (₹ crores)	Revised Estimate (₹ crores)	Actual Expenditure (₹ crores)	Rice Area ('000 ha)	Gross Cropped Area ('000 ha)
2024-25	500	40	0.85	3243	7786
2025-26	110	91.6		3268	
2026-27	100				

Source: GoP, Statistical Abstract of Punjab, MoAFW 2025b

One possible reason could be that this incentive falls short of covering the financial gap and market risk that farmers face when switching to crops like maize, oilseeds, millets and horticulture crops. A more robust incentive, ranging from ₹30,000 to ₹40,000 per hectare, is proposed for farmers in Punjab and Haryana who opt for non-paddy crops (Singh et al., 2024).

Crop Diversification Scheme for Haryana

Under the Promotion of Crop Diversification and Water Conservation scheme, since *Kharif* 2020-21, the Haryana state government has introduced an incentive of ₹7,000 per acre under '*Mera Pani Meri Viraasat*' (₹17,500 per hectare) to encourage farmers to transition from paddy to other crops. The data indicate that despite the crop diversification initiatives, the rice area is on a consistent upward trajectory and has steadily increased from 1.28 mha in 2021–22 to 1.7 mha in 2025–26 (**Table 5.2**). This indicates that rice cultivation decisions are being driven more by structural incentives (such as assured procurement, MSP support, and irrigation access) rather than by a one-time crop diversification incentive.

Table 5.2: Promotion of Crop Diversification and Water Conservation Scheme[3]

Year	Budget Estimate (₹ crores)	Revised Estimate (₹ crores)	Actual Expenditure (₹ crores)	Rice Area ('000 ha)	Gross Cropped Area ('000 ha)
2021-22	45	499	485	1281	6566
2022-23	160	479	474	1520	6649
2023-24	350	125	215	1563	6901
2024-25	200	40	NA	1609	NA
2025-26	201	NA	NA	1726	NA

Source: GoH, MoAFW 2025a, MoAFW 2025b

[3] Under this, five schemes are covered (i) *Meri Pani Meri Viraasat*, (ii) Distributions of dhaincha seeds for green manuring, (iii) Direct Seeded Rice, (iv) Promotions of Pulses and Oilseeds and (v) *Bhavantar Bharpai Yojna – Bajra* (GoH, 2026)

During *Kharif* 2020 and *Kharif* 2021, approximately 25,600 hectares and 20,752 hectares were diversified to other alternate crops, and the GoH provided incentives of ₹45 crores and ₹36 crores, respectively (Economic Survey of Haryana, 2025). While this represents an initial step towards reducing area under paddy, scaling up diversification will require substantial enhancement in incentives, ideally with equal cost sharing by the GoI. In 2025–26, GoH has increased the incentive to ₹8,000 per acre (₹20,000 per hectare). Building on this, the 2026–27 Budget Speech announced an additional ₹2,000 per acre, raising the total support to ₹10,000 per acre (₹25,000 per hectare) by the GoH (GoH, 2026).

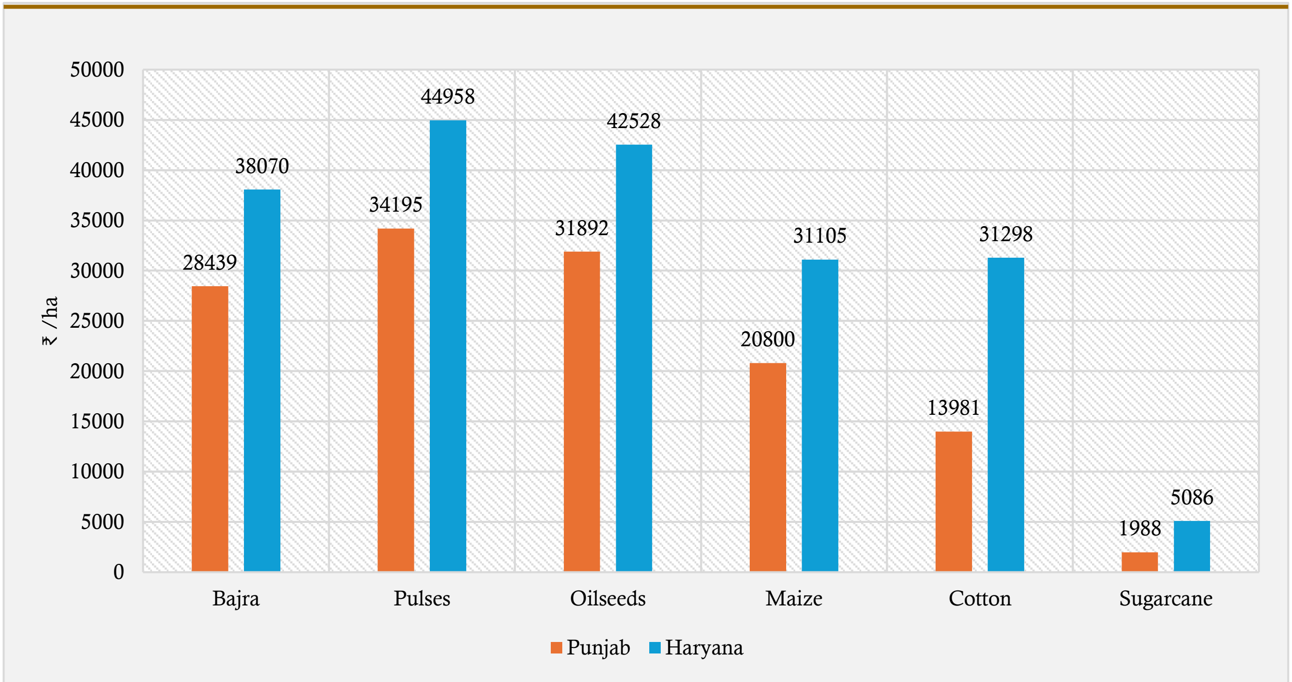
With complementary support from the GoI, the total incentive would reach around ₹35,000 to ₹40,000 per hectare for farmers shifting away from paddy. Such a policy would not impose a significant fiscal burden, as it is likely to generate savings through reduced use of electricity, water, and fertiliser usage, along with a corresponding decline in subsidy expenditures.

Overall, if we shift 8-15 lakh hectares of non-basmati paddy area from Punjab and Haryana, it would lead to saving on power, irrigation, and other subsidies (e.g. paddy residue management) from state government budgets and saving on fertiliser subsidy from the GoI budget. This saved amount could be repurposed to farmers shifting from paddy to non-paddy crops. This ensures the shift of incentives from 'paddy-skewed incentive' to 'crop-neutral incentive'. With every hectare of paddy in Punjab, diversified to pulses and oilseeds, the move will not only make the country self-sufficient, but each hectare of diversified paddy field will save fertiliser subsidy of ₹15,263 per hectare (for pulses cultivation) and ₹13,479 per hectare (for oilseeds cultivation). GoP will save power subsidy of ₹18,932 per hectare (for pulses cultivation) and ₹18,414 per hectare (for oilseed cultivation). Similarly, every hectare of paddy in Haryana diversifying to pulses and oilseeds will save fertiliser subsidy of the GoI of ₹20,457 per hectare and ₹18,697 per hectare, respectively. While GoH will save ₹24,500 per hectare (for pulses cultivation) and ₹23,831 per hectare (for oilseeds cultivation) in power subsidy.

5.2 Incentive of ₹35,000 per hectare in Punjab and Haryana for non-paddy farmers should be provided for at least five years

As per the crop diversification scheme guidelines, the farmers who diversify from paddy get an incentive of ₹17,500/ha only once, while paddy farmers reap benefits every year. Considering the skewed subsidy towards paddy every year, and if the farmer switches to other crops, then subsidy on power and fertilisers on account of paddy cultivation would be saved for the long haul. Thus, it is proposed that farmers should get a minimum of ₹35,000 per hectare for switching from paddy for at least five years till the vulnerabilities of new crops are reduced. During this period of five years, heavy expenditure on agriculture research and development (R&D) for raising the productivity of pulses and oilseeds be done by the GoI and the State Agriculture Universities (SAU), given that large quantities of pulses and edible oils are imported. Profitability of paddy in Punjab and Haryana is higher compared to other alternate crops due to assured procurement of paddy at MSP and skewed incentives towards paddy. There is a huge incentive gap between paddy and other *Kharif* crops. In 2022-23, the incentives gap of pulses in comparison with paddy was ₹34,195 per hectare in Punjab and ₹44,958 per hectare in Haryana (**Figure 5.1**). For oilseeds, the gap was ₹31,892 per hectare in Punjab and ₹42,528 per hectare in Haryana. Since these crops save fertiliser and power subsidies, the saved amount can be repurposed to farmers for shifting from paddy at least for five years.

Figure 5.1: Incentives Gap for Paddy *vis-à-vis* Other *Kharif* Crops in Punjab and Haryana, 2022-23



Source: Estimated by authors using MoF, GoP, GoH, FAI, MoAFW (various years)

5.3 Ensuring that MSPs for pulses and oilseeds are effective

Farmers respond to the price signals provided by the MSPs and continue to grow predominantly crops which give them an assured price. Although GoI announces MSPs for 23 commodities and Farm Remunerative Price (FRP) for sugarcane, the procurement policy has been the most successful in reaching wheat and paddy farmers, and that too only in a few states. About 35 per cent of rice (51.8 MT) and 25.4 per cent of wheat production (29.9 MT) during the *Kharif* Marketing Season (KMS) 2024–25 and *Rabi* Marketing Season (RMS) 2025–26 were procured by FCI at the MSP. In 2022–2023 and 2023–2024, the average number of farmers who benefited from rice procurement was 11.5 million, whereas the average number of farmers who benefited from wheat procurement was 6.9 million. However, procurement of other crops such as oilseeds and pulses has been low. During 2023-24, 2.7 MT of oilseeds (6.8 per cent of the production) and 1.4 MT of pulses (5.8 per cent of the production) were procured under Price Support Scheme (PSS)/ Price Stabilisation Fund (PSF), and an average of 1.5 million farmers benefited from the purchase of pulses, while 1.14 million benefited from the purchase of oilseeds (NAFED, 2025).

Paddy procurement is heavily concentrated in a few states. As shown in **Table 5.3**, the data highlight a pronounced structural imbalance in India's rice economy. Punjab and Haryana exhibit strong profitability driven by procurement support. During TE 2023–24, government agencies procured about 92 per cent of rice produced in Punjab and 74 per cent in Haryana. In contrast, eastern states including Assam, Bihar, Odisha, West Bengal, and Eastern Uttar Pradesh face weaker procurement support and profitability despite favourable agro-climatic conditions for rice, though Chhattisgarh performs comparatively better. Meanwhile, central states such as Madhya Pradesh and Telangana are emerging procurement hubs. The rice cultivation areas as a per cent of GCA is also increasing in Chhattisgarh and Odisha which have announced the bonus in addition to MSP.

Table 5.3: Rice Production, Procurement and Profitability in Top Rice-Producing States

	Production		**Area**				
TE 2023-24	MT	Share in Total Rice Production	mha	Share in Total Rice area	**Share of rice area in GCA**	**Procurement shares in Production (%)**	**Rice Profitability over A2 cost (₹/ha)**
Andhra Pradesh	7.7	6%	1.9	4%	33%	40%	56,846
Assam	5.2	4%	2.3	5%	56%	7%	30,908
Bihar	7.5	6%	3.1	7%	40%	35%	27,810
Chhattisgarh	9.2	7%	3.8	8%	69%	74%	52,444
Haryana	5.2	4%	1.6	3%	23%	74%	96,334
Madhya Pradesh	6.4	5%	3.5	7%	11%	47%	55,758
Odisha	8.7	6%	4.1	9%	79%	58%	29,522
Punjab	13.4	10%	3.2	7%	38%	92%	97,865
Tamil Nadu	7.4	6%	2.1	4%	34%	29%	38,013
Telangana	15.1	11%	4.7	10%	55%	50%	53,816
Uttar Pradesh	15.8	12%	5.8	12%	19%	26%	24,927
West Bengal	16.0	12%	5.1	11%	51%	13%	37,492
All India	134.4	100%	47.8		22%	41%	43,496

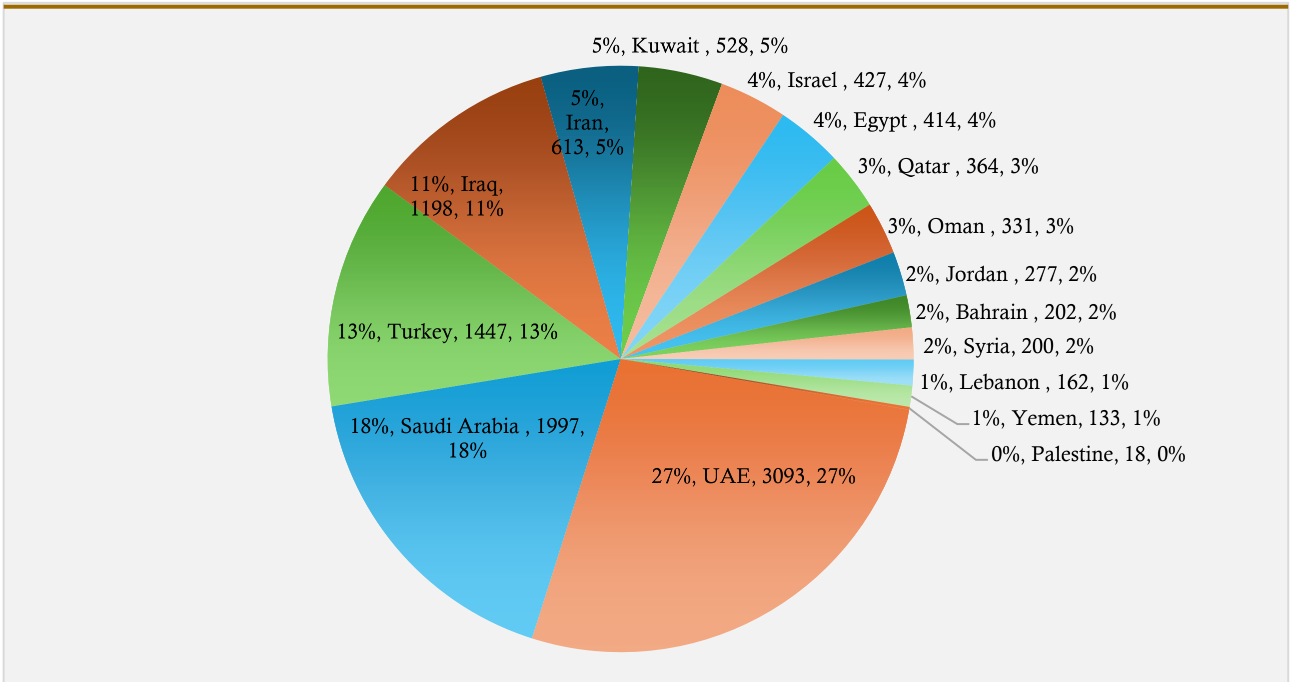
Source: MoAFW, 2025b; FCI; CACP 2025-26

Under the Mission for *Aatmanirbharta* in Pulses aimed at achieving self-sufficiency by 2030–31, the GoI has identified 489 districts as focus areas for cluster-based interventions. Of these, 7 districts are in Punjab and 3 in Haryana. The targeted expansion in area under pulses is projected to reach 0.67 lakh hectares in Punjab (from 0.37 lakh hectares in 2024–25) and 0.84 lakh hectares in Haryana (from 0.74 lakh hectares in 2024–25) by 2030–31. However, the envisaged expansion in these states needs to be more ambitious to drive meaningful crop diversification. This requires strengthening price incentives, particularly through more effective implementation of MSP for pulses and oilseeds. However, as seen in Table 5.3, at present, the procurement ecosystem remains heavily skewed in favour of paddy. This creates a strong policy bias that discourages farmers from shifting to alternative crops. In contrast, despite persistent domestic shortages of pulses and oilseeds, market prices for these commodities often fall below MSP due to weak procurement mechanisms and weakening incentives for diversification. It is therefore recommended that pulses and oilseeds be accorded higher policy priority through assured and decentralized procurement, and a better price support mechanism to ensure remunerative returns for farmers and promote sustainable crop diversification.

5.4 Punjab and Haryana as Export hubs for high-value horticulture crops

To promote diversification Punjab should also target doubling of area under high value fruit orchards (like plums, peaches, litchi, guava, etc.) and vegetables (potatoes, peas, chilli, bell peppers, seedless cucumbers, gherkins etc.) that are suitable for Punjab. They will need to be linked to processors, organized retailers and exporters, well in advance to take care of price risks which are generally higher in perishables than in cereals. The Food Parks supported by the GoP should be part of this linkage. Air freight subsidy for exports to Gulf countries, and major investments in cold storages and reefer vans, for exports through Amritsar will go a long way to augment farmers' incomes in a sustainable manner. However, this can only be extended by the GoI. Agricultural and Processed Food Products Export Development Authority (APEDA) should be involved in making some districts of Punjab as export hubs for high-value agriculture targeting Middle East countries. An alternative would be to work with Middle East countries and their Sovereign Wealth Funds to invest in Punjab as a source of food security for Middle East countries. Amongst Middle East countries, the United Arab Emirates, Saudi Arabia, Turkey and Iraq are the largest importers for edible fruits and nuts in 2024 (**Figure 5.2,** ITC TradeMap 2026).

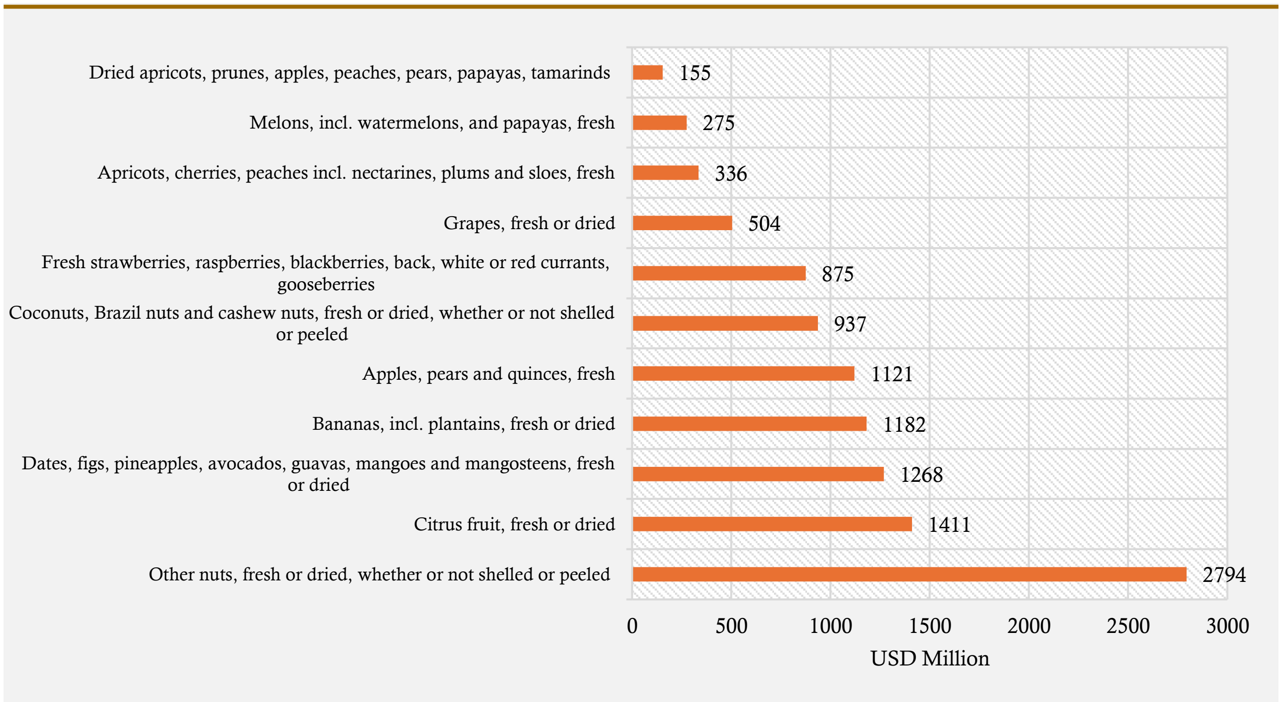
Figure 5.2: Imports of Edible Fruit and Nuts in the Middle East Countries, 2024



Source: ITC Trade Map, 2026; Note: Values are in USD Million

Citrus fruits are the sizeable category, followed by dates, figs, pineapples, avocados, guavas, and mangoes (**Figure 5.3**, ITC Trade Map 2026).

Figure 5.3: Product-Wise Imports of Edible Fruit and Nuts in the Middle East Countries, TE 2024



Source: ITC Trade Map, 2026

5.5 Carbon credit for farmers

Carbon is a tradable good in carbon credit system where one carbon credit unit is equivalent to one tonne of carbon dioxide emissions. This system provides financial incentives to farmers by allowing them to sell the carbon credits generated through the reduction of GHG emissions in their farmlands. Paddy cultivation in Punjab and Haryana emits 5 tonnes CO_2 eq per hectare (Singh and Gulati, 2025), and by switching to alternate crops, the farmers can earn up to 4 carbon credits. Some private companies are trying to develop this carbon market on voluntary basis. But there is need for the Central Government and state governments to work out pricing of carbon, and the certification process through due diligence.

In conclusion, the shift from prevalent paddy cultivation in Punjab and Haryana to oilseeds and pulses requires gearing of policy making towards sustainable and profitable agriculture. One of such policy innovations is suggested in this report, where farmers shifting from paddy to pulses and oilseeds can be given roughly ₹35,000 per hectare for at least 5 years. Interestingly, there is hardly any additional expenditure involved in this 'repurposing' of subsidies. It will lead to commensurate saving of the state government's power, canal irrigation subsidy, and the GoI will save fertiliser subsidy, as farmers switch from paddy to these environmentally benign crops. Hence, this is just repurposing the same subsidy and making incentives crop-neutral. If this is done, then the carbon footprint of paddy can be reduced in this region, and water and soil can be saved.

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ANNEXURES

Annex 1: Per-Hectare Irrigation Water Requirement for Different Crops in Punjab, 2011-12

Crop	Irrigation water requirement (cu.m./ha)
Paddy	10683
Basmati	9018
Bt cotton	3055
Maize	2763
Moong	1516
Arhar	2019
***Kharif* fodder**	2090
Sugarcane	8669
Okra	2160
Brinjal	3456
Paddy (DSR)	5549
Basmati (DSR)	4639
Wheat	2655
Rapeseed and Mustard	2013
Potato	3844
Barley	1062
***Rabi* Fodder**	7600
Pea	1569
Cauliflower	1023

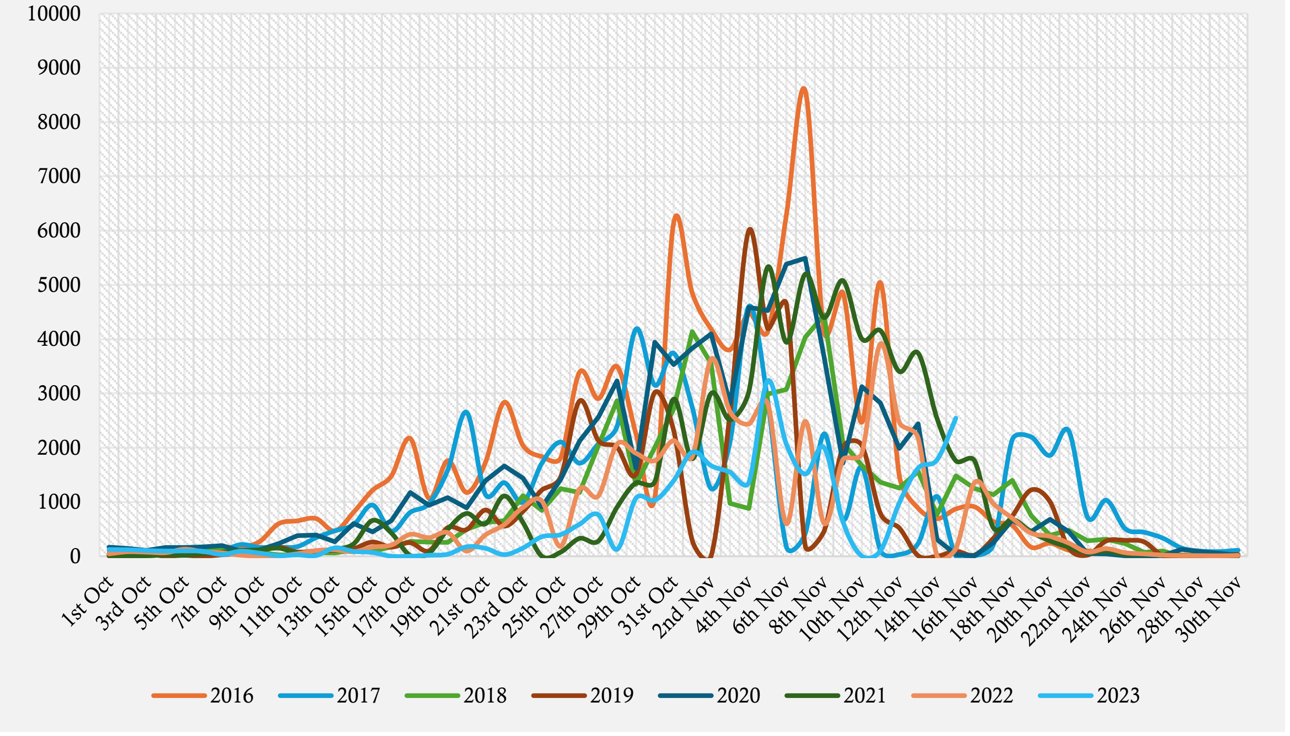
Source: Kaur et al. 2015

Annex 2: Monthly Electricity Consumption in the Agricultural Sector in Punjab (million units)

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
April	399	358	320	274	236	271	364
May	840	960	842	662	653	716	879
June	1700	1391	1353	1976	2098	2094	1853
July	2078	2502	2212	2308	2260	2691	2282
August	1988	2163	2304	2118	2263	2434	2711
September	2032	1729	1431	1995	2245	1632	2194
October	869	941	854	734	1010	772	1087
November	300	223	316	192	231	255	359
December	509	410	569	302	507	574	516
January	258	379	283	172	323	84	365
February	478	467	146	597	568	293	657
March	560	732	599	208	657	715	496
Total	12009	12254	11227	11538	13051	12533	13763

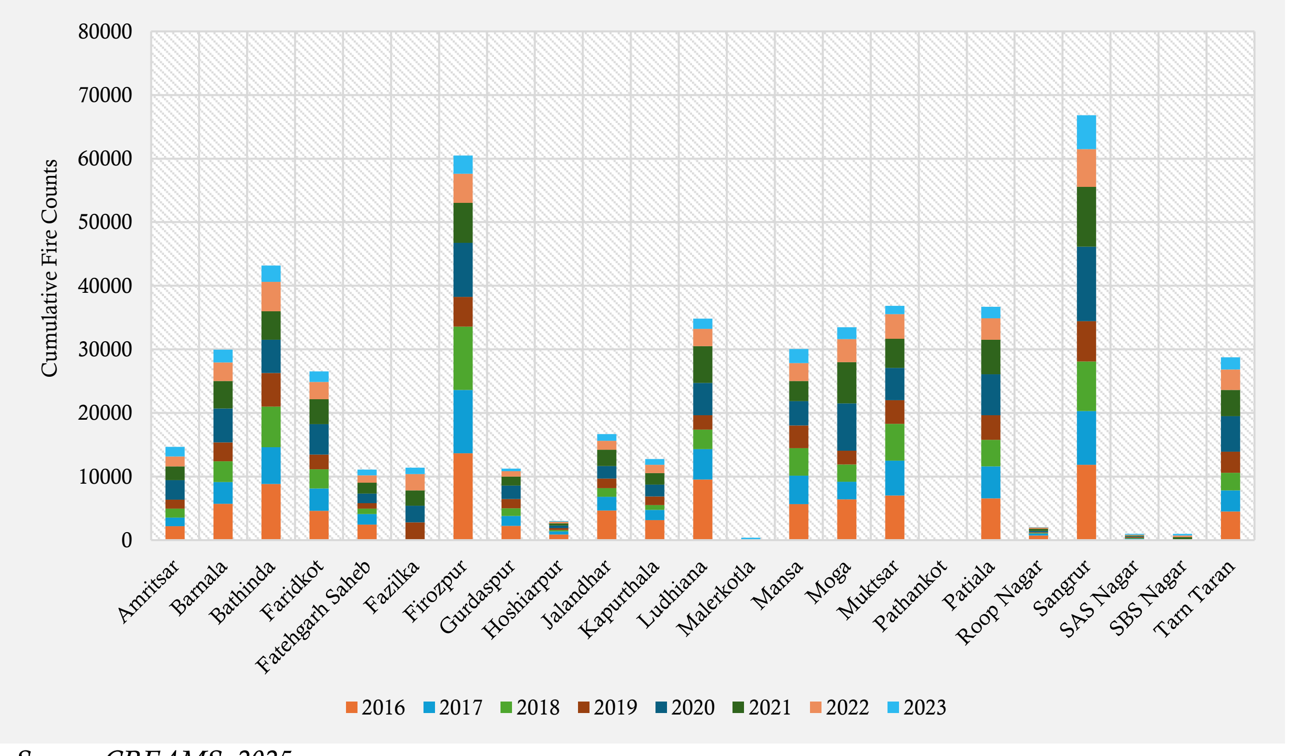
Source: PSPCL

Annex 3: Daily Fire Counts in Punjab, 2016-2023



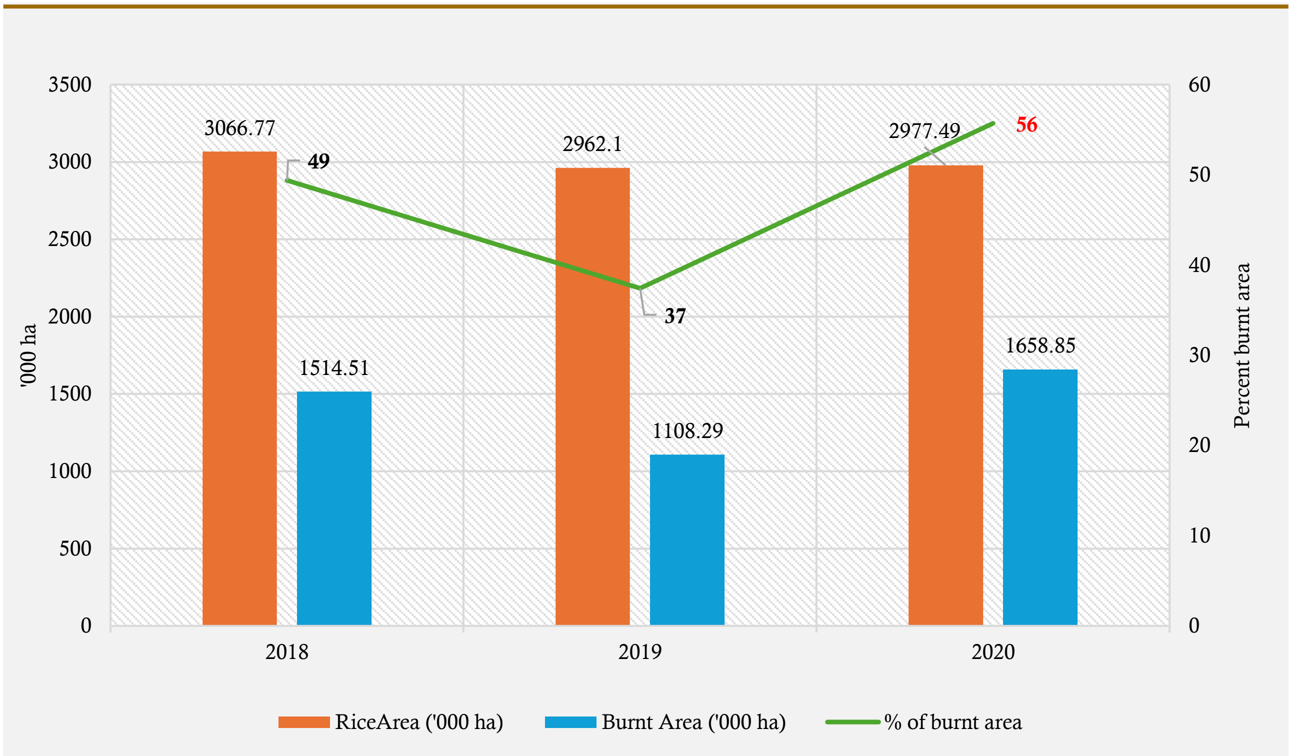
Source: CREAMS, 2025

Annex 4: District-Wise Cumulative Fire Events in Punjab, 2016-2023



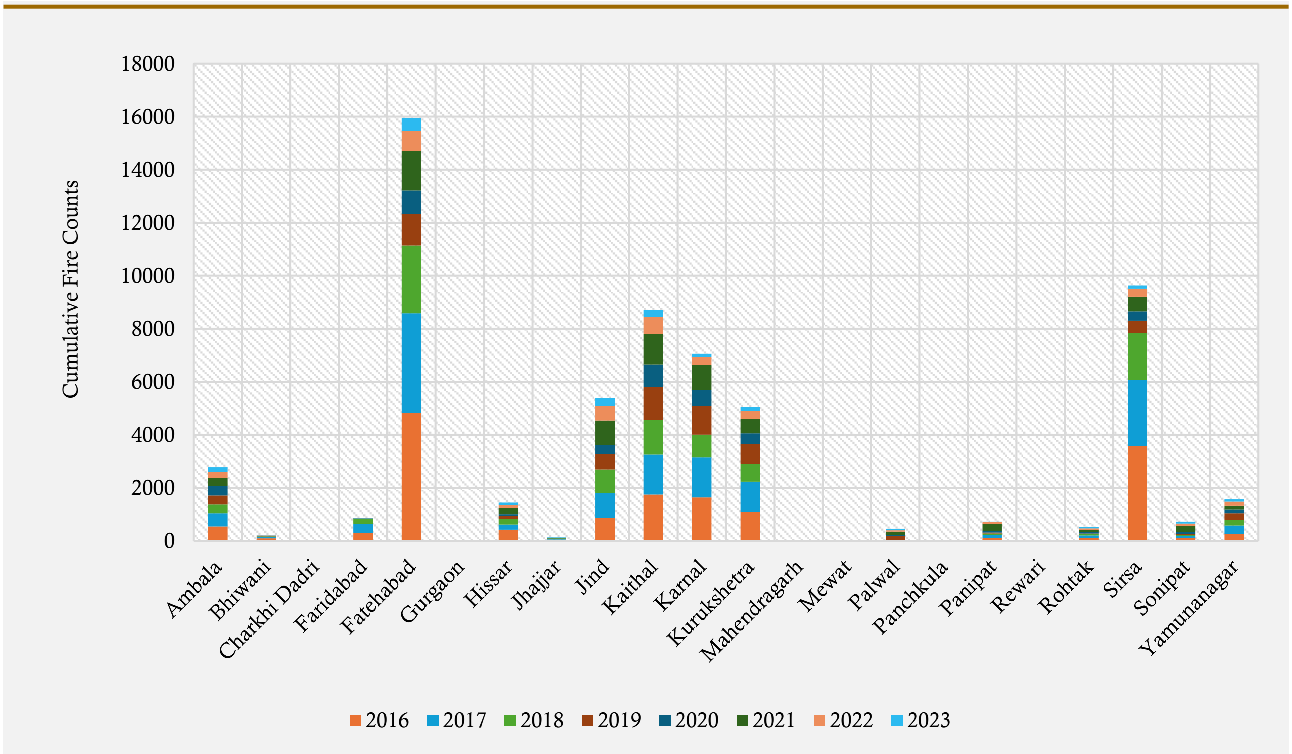
Source: CREAMS, 2025

Annex 5: Burnt Area of Punjab for Residue Burning



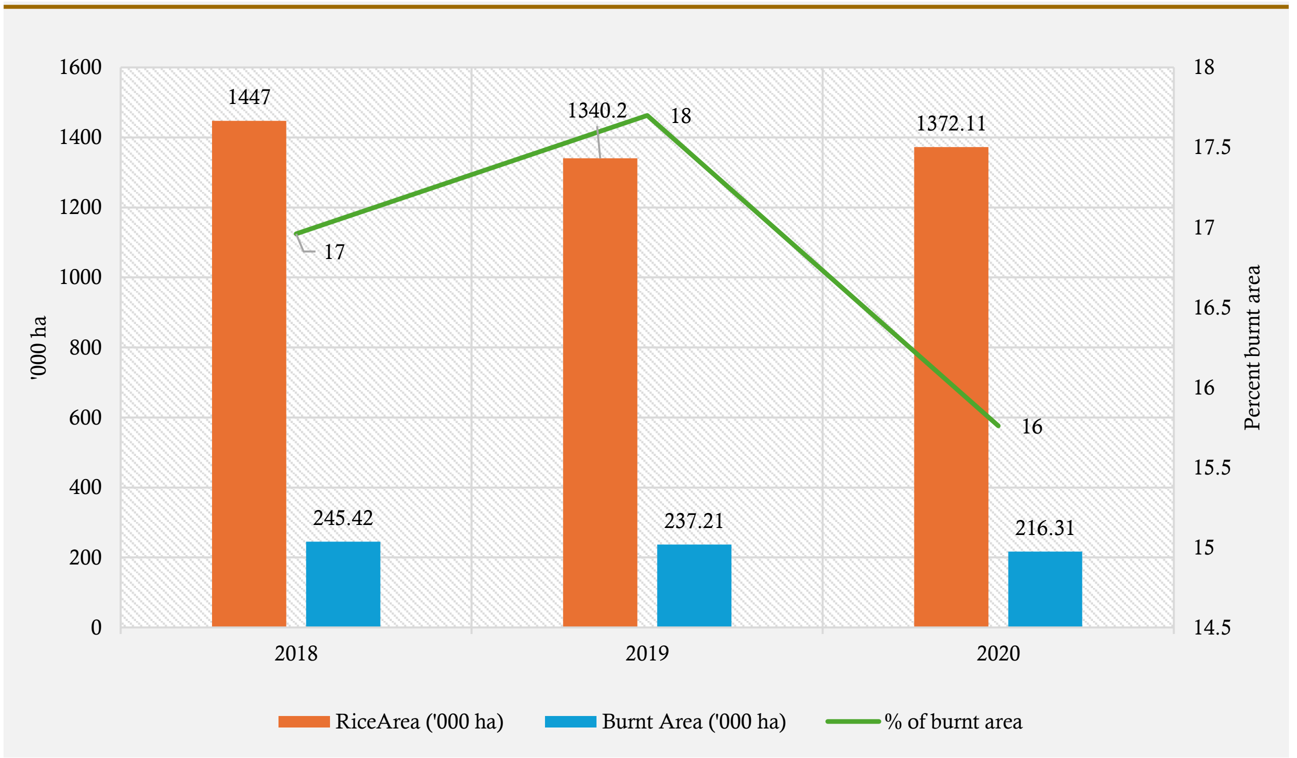
Source: CREAMS, 2025

Annex 6: District-Wise Cumulative Fire Events in Haryana, 2016-2023



Source: CREAMS, 2025

Annex 7: Burnt Area of Haryana for Residue Burning



Source: CREAMS, 2025

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