TRADE AND SUSTAINABILITY CHALLENGES IN INDIA: POSSIBILITIES FOR PADDY CROP IN PUNJAB

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The study traces the evolution of the State policies for the agricultural sector, since the Green Revolution and the evidence suggests that while some of the policy measures like power and irrigation subsidies have contributed to ground-water depletion and soil degradation; the situation though serious and warrants attention but is not alarming or an imminent threat to the continuation of the rice-wheat cropping pattern. Therefore, this paper attempts to investigate the cost of cultivation of five crops central to Punjab and their farm gate prices along with the prices prevalent internationally. It is observed that these support prices and the subsidies have not only helped rice and wheat gain a competitive edge over the other crops but also makes the cultivation of these crops profitable in Punjab, the highest amongst other states as well as the national average. Hence, the plans to diversify away from paddy cultivation are not feasible.

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ABSTRACT

Owing to the miracles of the Green Revolution, Punjab emerged as the "breadbasket of the nation". However, today, the state is reeling under a crisis in its agricultural sector as it faces severe ecological and technological challenges. Most of these problems were attributed to the wheat-rice cropping pattern that was found to be extremely extractive and environmentally degrading. The study sets out to investigate these claims and explore the possibilities of the cultivation of paddy in Punjab. The study traces the evolution of the State policies for the agricultural sector, since the Green Revolution and the evidence suggests that while some of the policy measures like power and irrigation subsidies have contributed to ground-water depletion and soil degradation; the situation though serious and warrants attention but is not alarming or an imminent threat to the continuation of the rice-wheat cropping pattern. Therefore, this paper attempts to investigate the cost of cultivation of five crops central to Punjab and their farm gate prices along with the prices prevalent internationally.

An assessment of the cost-benefit analysis suggests that the Minimum Support Prices (MSP) and the input subsidies have played an instrumental role in ensuring the commercial viability of production by guaranteeing remunerative returns over the costs of production. It is these support prices and the subsidies that have not only helped rice and wheat gain a competitive edge over the other crops but also makes the cultivation of these crops profitable in Punjab, the highest amongst other states as well as the national average. In fact, the next best alternative to the rice-wheat crop combination in Punjab which is cotton offers much lower and volatile returns. Hence, the plans to diversify away from paddy cultivation are not feasible.

Thus, the sustainable approach to this problem would be allow for paddy cultivation in areas with rain water harvesting facilities, adoption of sustainable water management practices and the adoption of new, water-efficient varieties of rice, such as CR Dhan 801 and CR Dhan 802. Also, given the tremendous export potential of rice, it is recommended to shift to cultivation of basmati rice which is less water-intensive and has a shorter cycle than the non-basmati variety. At the same time, the shift away from paddy cultivation threatens food sovereignty due to Punjab's significant contribution to the central pool as well as its critical role in supporting the livelihoods of a vast majority of the state's population.

Hence, Punjab's agricultural strategy must integrate agricultural viability with productivity and sustainability, in the form of resource conservation and environmental preservation, while ensuring remunerative returns to cultivators through greater public investment in better technology adoption and infrastructure, and also capital formation.

Keywords- Punjab, agriculture, paddy, sustainability, environment

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Trade and Sustainability Challenges in India: Possibilities for Paddy Crop in Punjab

Introduction

Due to the benefits of the Green Revolution[1] of the mid-sixties, Punjab has emerged as the country's breadbasket. The State-led Green Revolution through its various components of State support, comprising a package of HYV seeds, input subsidies on fertiliser, credit and power, development of an enabling irrigation and rural infrastructure and a favourable agricultural price policy, not only raised agricultural productivity but was also instrumental in ensuring the food sovereignty of the nation as well as rural growth and development[2].

Rice holds special significance in India. India is the second-largest producer of rice in the world, accounting for over a quarter of the world's rice production, and also its largest exporter (CACP, 2025-26). The cultivation of rice is concentrated mainly in states such as Punjab (10%), Haryana, Uttar Pradesh (12%), Telangana (10.9%), West Bengal (10.2%), Tamil Nadu (6.5%), Chhattisgarh (6.5%), Odisha (6.4%), and Andhra Pradesh (6.2%).

In 2022-23, Punjab accounted for approximately 3.1 million hectares of land under rice cultivation, which constitutes 6.48% of the country's total cultivated rice area. This crop not only accounts for the highest acreage and production in the state, but it is also highly employment-intensive and internationally competitive (CACP, 2024). The low production cost and risk involved, along with an assured marketing mechanism, make paddy a lucrative crop in Punjab.

Despite the various problems that plague Punjab's agriculture, it is still hailed as the most agriculturally productive state and continues to outperform the others in the country. Punjab is credited with having over 80% of its total geographical area under cultivation, with one of the highest cropping intensities[3] of about 190% and

[1] The backbone of the Green Revolution were High-yielding varieties of wheat comprising of the High-yielding Mexican semi-dwarf varieties (like 'Lerma Rojo' and 'Sonora 64') introduced by Norman Borlaug that led to a quantum leap in output, especially in Punjab and Haryana. The same for rice was introduced slightly later like IR8 varieties that spread to the southern and eastern parts of India. There were some secondary varieties of crops that benefitted indirectly in small pockets or under certain specialised conditions like maize, bajra, jowar and barley but did not receive the same level of success. There were certain crops like pulses, oilseeds, coarse cereals and cash crops like cotton, sugarcane and spices that the Green Revolution bypassed completely.

[2] The adoption of the Green Revolution techniques resulted in higher agricultural output and productivity and also led to a growth in rural incomes and employment, greater investments in rural infrastructure resulting in a subsequent decline in rural poverty.

[3] The other states reporting high cropping intensity are Sikkim (210.4), Tripura (190.2), West Bengal (189.8) and Haryana (183.4).

the most significant proportion of its cultivated area under irrigation (98%) (compared to the national average of 55.2%). Despite accounting for only 5% of the total area under food grains, it accounts for a tenth of the country's total food grain production, ranking third, only after West Bengal and Uttar Pradesh (GOI, 2024). In 2023, it also accounted for the highest yields in the country for crops such as rice (4322 kg/ha), wheat (4,868 kg/ha), and barley (3,777 kg/ha), and ranked second in cotton (691 kg/ha). The yields on rice and wheat are nearly twice the national average. The per capita availability of food grains in Punjab is also amongst the highest in the country.

However, the role that rice assumed in the Punjab economy, ushering in economic prosperity, has undergone a metamorphosis over time, from helping the nation overcome a deadly famine to becoming an environmental disaster. Punjab, the state that heralded the Green Revolution, today is reeling under a crisis in its agricultural sector. As soon as the wheels of the Green Revolution started to come off, the yields stated plateauing, intensive cultivation and monoculture pattern of cropping, inefficient and non-judicious use of farm inputs like water and chemical fertilizers, rising production costs and declining returns have challenged the viability of agricultural production and now pose a threat to environmental sustainability.

It is against this background that the study examines the sustainability of paddy cultivation in Punjab and explores the various policy measures that have contributed to the current precarious situation. The paper further examines the feasibility of alternative crop diversification by assessing the costs and returns of prominent crops in Punjab and compares them with the national average. The study also examines the export potential of paddy by making a comparative assessment of the minimum support prices, cost of cultivation and international prices of rice compared to other key crops grown in Punjab. The final section makes concluding remarks and recommendations.

Evolution of Agricultural Policy of Punjab

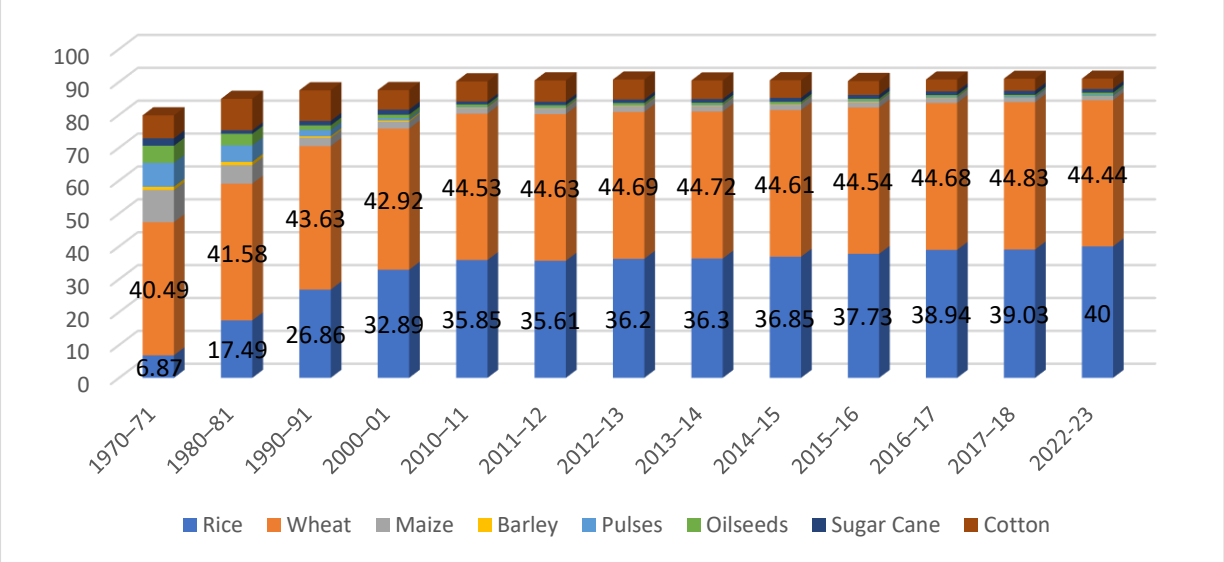
1.1 Cropping Pattern

Before the Green Revolution took hold, the cropping pattern in Punjab was quite diverse, and included crops such as wheat, maize, mustard, rapeseed, groundnut, cotton, gram, and barley (Singh & Sidhu, 2004). However, the cropping pattern of Punjab has undergone significant changes since the initiation of Green Revolution techniques in the 1960s, which were centred around the expansion and adoption of high-yielding varieties of wheat and rice.

This was mainly due to the pressing need to overcome dependence on foreign aid for food and the twin droughts that necessitated the shift to cultivating high-yielding varieties of food crops. Traditionally, Punjab was not a central rice-growing region in the pre-Green Revolution period (Sarkar & Das, 2014). During the early seventies, rice constituted only 6.87% of the gross cropped area in Punjab. The dominant share of acreage was devoted to wheat cultivation, which accounted for approximately 40% of the gross cropped area (Figure 1). The other important crops were maize (9.8%), pulses (7.3%), cotton (7.0%), oilseeds (5.2%), sugarcane (2.25%), and barley (1.0%). However, just over a decade, the share of rice acreage had almost doubled to 17.5% at the expense of other crops, whose share declined. For instance, the share of maize declined from 9.77% in the seventies to 5.65% in the eighties and further to 1.2% in 2022-23. Pulses' share declined from 7.3% in the seventies to 5% in the eighties and to just 1.2% in 2022-23. Other prominent crops, such as oilseeds, saw their acreage shrink from 5.2% in the 1970s to 0.6% by 2022-23, and sugarcane from 2.25% to 1.14% during the same period. The only other crop that saw an expansion in acreage was cotton, which accounted for 9.6% of the total gross cropped area between the seventies and the nineties. However, even its share has declined to about a third in 2022-23.

Over the years, the area under rice cultivation increased from 0.24 million hectares in 1960-61 to 2 million hectares in 1990-91 to 3.17 million hectares in 2022-23 (Govt. Of Punjab, 2023). Similarly, the share of rice in total acreage has increased progressively to approximately 40% by 2022-23. As a result, Punjab, which accounted for less than one per cent of rice production in the country in the 1950s, now accounts for a tenth of the country's rice production (Raghvan, 1999).

Figure 1: Cropping Pattern in Punjab (1970 to 2022)



Source: Government of Punjab, Statistical Abstract of Punjab (Various Issues)

In a similar vein, the area under wheat expanded from 1.14 million hectares in 1960-61 to 3.27 million hectares in 1990-91 and 3.52 million hectares in 2022-23. Interestingly, wheat, which was the dominant crop of Punjab, saw its share in the total cropping area stabilise to around 45% in recent years. This was accompanied by a decline in the share of other crops, including maize (1.2%), barley (0.07%), pulses (0.47%), oilseeds (0.64%), sugarcane (1.14%), and cotton (3.1%), in 2022-23. Consequently, the share of foodgrains in acreage has increased from 69.2% in 1970-71 to 86.1% in 2022-23 (Figure 1).

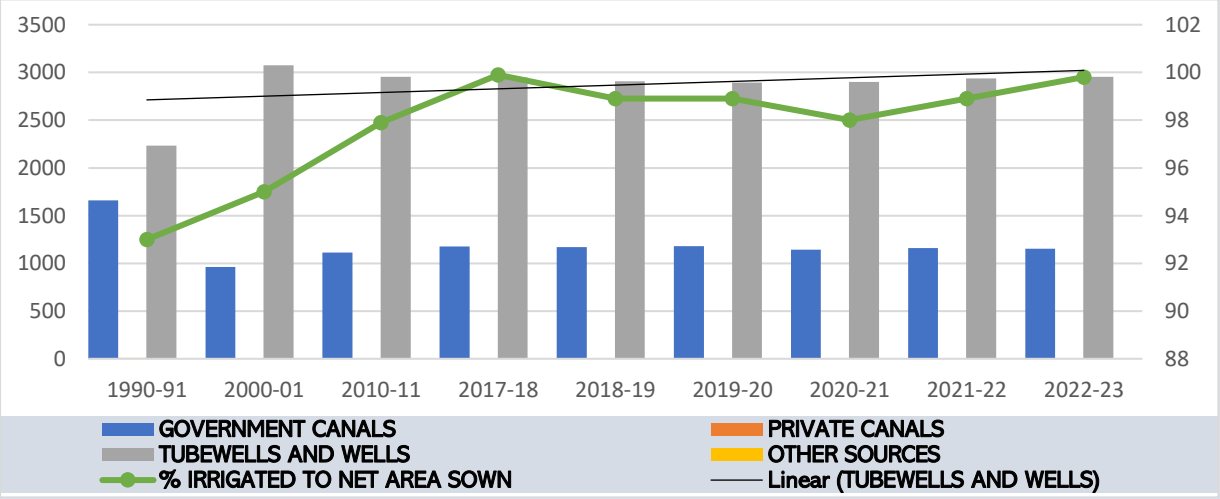
The intensification of rice and wheat cultivation was attributed to the availability and expansion of high-yielding varieties, rural electrification and power subsidies, government support in marketing, and favourable agricultural price policy (Gill, 1999). Due to these measures, the average productivity of rice increased substantially from 1,186 kg/ha in 1966-67 to 4,341 kg/ha in 2022-23, while that of wheat increased from 901 kg/ha to 4,710 kg/ha during the same period (Govt Of Punjab, 2023).

1.2 Shift in Irrigation Patterns

Rice is a water-intensive crop and is primarily grown in the state's irrigated regions. The origins of rice cultivation in Punjab can be traced to waterlogging in the command areas of the canal irrigation, which prompted farmers to shift to rice cultivation in those regions.

Figure 2: Sources of Irrigation in Punjab

(In Thousand Hectares)



Source: Government of Punjab, Statistical Abstract of Punjab (Various Issues)

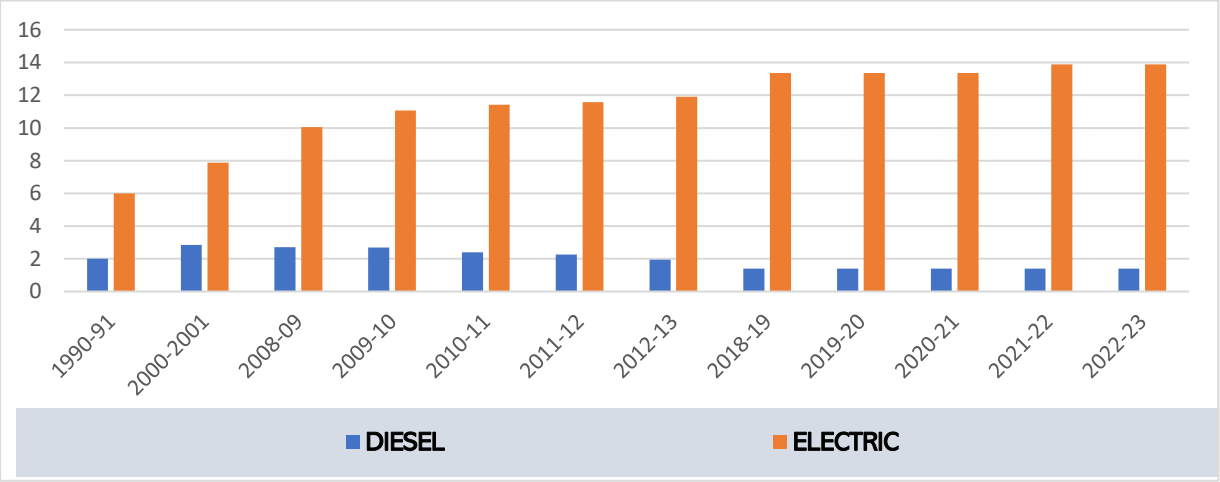
As public investment in rural development, especially irrigation and flood control, declined in the aftermath of the structural adjustment and stabilisation programme,

the area irrigated under canal irrigation declined across the country. Punjab too witnessed this trend. The shift in irrigation from canal irrigation to tube wells was more pronounced after 1997, when Punjab announced free electricity for agriculture. The area under government canals decreased sharply from 1660 thousand hectares in 1990 to 962 thousand hectares in just a decade of the electricity pricing reforms. As a proportion of the total irrigated area, the area under canal irrigation almost halved, from 42.5% to 23.8%, during the same period (Figure 2). This was accompanied by a simultaneous increase in the share of area under tube-well irrigation, which rose from 57.1% to 76.1% during the same period. Thereafter, the share of government canals and tube-wells has remained relatively stable at 28% and 71%, respectively.

The cultivation of rice is a water-intensive activity; hence, the expansion of tube-well irrigation, which is considered a more reliable and flexible irrigation resource, led to a specialisation in rice-wheat cropping, with a shift away from the traditional wheat-maize cultivation (Sarkar, 2014).

Figure 3: Tube-Wells Usage in Punjab

(In Lakhs)



Source: Government of Punjab, Statistical Abstract of Punjab (Various Issues)

As a result, the per hectare intensity of tube-wells per net sown area has increased from 0.047 in 1970-71 to 0.19 in 1990-91 and further to 0.36 in 2020-21. The shift to assured irrigation also helped increase cropping intensity and irrigation intensity, as well as crop yields, to become the highest in the country. The cropping intensity in Punjab increased from 118.9% in 1980-81 to 140.25% in 2022-23, while the irrigation intensity inched closer to 100% (Appendix Table 1).

The Role of Power Subsidy

The provision of subsidised electricity was always an integral component of the State policy for extracting groundwater, facilitating the expansion of the Green Revolution, stabilising yields, increasing agricultural production, and raising farm incomes. The proliferation of tube-well irrigation was also aided by the rural electrification in the state and the power subsidy for agricultural purposes. Rural electrification in the state was completed by the year 1975. This led to a gradual shift away from diesel-operated pumps to electric pumps. The shift from metered tariffs to flat-rate electricity charges to free electricity also incentivised this transition. All these policy measures facilitated the shift to paddy cultivation.

Table 1: Power Subsidy in Punjab

Year	Rs Crore	Rs per Hectare
1996–97	899	2129
1997–98	1189	2806
2001–02	1177	2767
2002–03	1013	2411
2003-04	788	
2008–09	2265	5430
2009–10	2805	6746
2010–11	2737	6581
2011–12	3750	9071
2012–13	4606	11099
2013–14	4699	11335
2014–15	4933	11976
2015–16	4847	13256
2016–17	5400	13075
2017–18	6084	14750
2018–19	5733	13922
2019–20	6060	14717
2020–21	8275	20095

SOURCE: Government of Punjab, Statistical Abstract of Punjab (Various Issues)

Despite a steep hike in the electricity charges in 1994-95, Punjab decided to make electricity free for agricultural purposes in 1997-98. As a result, the power subsidy in Punjab rose from Rs 899 crore in 1996-97 to Rs 1,189 crore in the following year (Table 1). The free electricity for agriculture led to unchecked groundwater extraction, which in turn resulted in many previously productive wells running dry, prompting farmers to utilise submersible pumps further. It was estimated that the cost of running a submersible pump was Rs 165-200 per hour. However, the provision of free electricity led farmers to incur a one-time investment of around Rs. 1,80,000 in submersible pumps (Sarkar & Das, 2014).

In 2002, the Punjab Government decided to withdraw the power subsidy for agriculture, resulting in a decline in this value for three consecutive years, reaching Rs 788 crore in 2003-04. Consequently, the diesel engines made a comeback in the

early 2000s, as electricity rationing began in the state, followed by erratic power supply. The power subsidy was in effect from 2002 to 2006. Thereafter, the power subsidy in the State continued to escalate and is estimated at Rs 8275 crore or Rs 20,095 per hectare of cropped area in 2020-21(Table 1).

Table 2: Instability Index of Paddy

State	2000s	2010s	2020s
Andhra Pradesh	8.7	8.7	6.7
Assam	6.6	6.9	30.8
Bihar	30.7	25.5	9.1
Chhattisgarh	43.5	22.4	5.4
Haryana	8.9	4.6	10.5
Karnataka	21.2	7.1	2.6
Madhya Pradesh	33.4	11.2	13.8
Odisha	35.9	19.8	15.8
Punjab	3.4	5.1	2
Tamil Nadu	17.5	41.8	5.1
Telangana	-	9.1	3.8
Uttar Pradesh	11.7	8.8	3
West Bengal	3.6	3	0.6
All-India	9.3	2.6	1.1

Source: Price Policy of Kharif Crops 2024-25

However, the power subsidy and the irrigation subsidy have garnered appreciative results. The assured irrigation network has helped stabilise yields in the state, as Punjab accounts for the lowest instability in paddy cultivation, ranking second only to West Bengal (Table 2).

Trade and Sustainability

The Food and Agriculture Organisation (FAO) defines sustainable agriculture as "the management and conservation of the resource base and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations." Such sustainable development is environmentally non-degrading, technically appropriate, economically-viable and socially acceptable.

Many environmentalists observe that rice is a highly water-intensive crop (requiring 22-25 irrigations per four months) and has the highest irrigation and electricity subsidy per unit hectare of cultivation than any other crop (Gulati et al, 1990; Bhullar and Siddhu, 2007).

Bouman et al. (2007) estimated that producing 1 kilogram of rice required 3,000-5,000 litres, which was approximately two to three times the water requirement of any other irrigated crop. Hence, Punjab's intensive cropping pattern of rice and wheat, facilitated by electrification and power subsidies, has resulted in the

unbridled extraction of resources, such as groundwater and electricity (Sarkar, 2014). Another report by the CACP (2015-16) observed that Punjab ranked poorly in terms of water-use efficiency, as it consumed approximately 5337 litres of water to cultivate a kilogram of rice, compared to only 2605 litres in West Bengal. This, it is claimed has led to an unprecedented ecological and environmental disaster leading to degradation of resources, depleting groundwater resources, water logging, declining soil fertility and micro-nutrient deficiency leading to pest infestation and weed growth, soil salinity and pollution through crop residue burning and emission of green-house gases (Shiva, 1991; Chand, 1999).

At the same time, the sharply declining groundwater levels have led to the competitive deepening of tubewells in search of water for irrigation. It was estimated that the average depth of tube-wells in Punjab increased from 49 feet in 1969-70 to 128 feet in 2013 (Ghuman, 2015). This poses a financial burden on the cultivators and raises the costs of production, making agricultural production unviable. Chand (1999) estimated that the water table in Punjab was declining at a rate of 0.23 cm per annum. If this trend continued unabated for 15 years, it would require the introduction of 2 lakh submersible pumps, which would incur costs of Rs 5,000 per hectare of net sown area, or Rs 2000 crore at current prices. The Government of Punjab Report (2013) also stated that a majority of the districts in Punjab had a draft of groundwater that was over 1.6 to 2.8 times the recharge potential of the land.

This section examines the veracity of these claims.

According to the Central Groundwater Board's Report on Dynamic Groundwater Resources of India (2024), Punjab has the highest level of groundwater extraction[4]. However, there has been a perceptible improvement as the degree or the level of groundwater extraction, which stood at 172% in 2015, has declined in recent years to 163.76% in 2023 and further to 156.87% in 2024. Despite the gradual improvement, this still indicates that the annual groundwater consumption is much higher compared to its annual recharge.

The CWGB's report (2024) also observed that states that pioneered the Green Revolution tended to have greater groundwater exploitation. In Punjab, of the 118 blocks assessed, 53 blocks (45%) were found to be over-exploited in 1984. By 1995, this number had increased to 62 blocks, or 52.5% of the total blocks, compared to 110 blocks, or 84%, in 2011. Table 3 shows that, in recent years, the proportion of overexploited blocks has also declined modestly, accounting for 75%

[4] The groundwater extraction of 100 indicates that the annual consumption of groundwater is equal to the annual recharge potential and any value greater than 100 reflects consumption above the recharge potential of that region.

of the total assessed blocks. It has also been observed that 14 of the 26 reported districts have shown an improvement or a decline in the level of water extraction in the year 2024 (Appendix Table 2).

Table 3: Categorisation of Assessment Units based on the 'Stage of Groundwater Extraction' in Punjab

	GWRA 2011		GWRA 2017		GWRA 2020		GWRA 2022		GWRA 2023		GWRA 2024	
Category	**No. of AUs**	**% of AUs**	**No. of AUs**	**% of AUs**	**No. of AUs**	**% of AUs**	**No. of AUs**	**% of AUs**	**No. of AUs**	**% of AUs**	**No. of AUs**	**% of AUs**
Safe	22	16.0	22	16.0	17	11.0	17	11	20	13.1	22	14.4
Semi-critical	2	1.5	5	4.0	10	7.0	15	10	13	8.5	12	7.8
Critical	4	2.9	2	1.0	6	4.0	4	3	3	2.0	4	2.61
Overexploited	110	84.0	109	79.0	117	78.0	117	76.5	117	76.45	115	75.2
Saline												
Total Number of AU's	138		138		150		153		153		153	

Note: *The 'Stage of Ground Water Extraction' is computed as the ratio of 'Annual Ground Water Extraction' to 'Annual Extractable Ground Water Resource' and is usually expressed in percentage.
**Based on the stage of extraction, the assessment units are categorised as Safe (<= 70 %), Semi-Critical (>70 % and <=90 %), Critical (>90 % and <=100%) and Over-Exploited (>100 %).
***AU-Assessed Units

Thus, while the water-table situation is serious but not alarming and most districts in Punjab are exhibiting a general tendency of an improvement in the level of ground-water extraction.

Similarly, it was also claimed that the combined evapo-transpiration of rice-wheat was 1030 mm which laid the basis for growing calls to diversify away from the cultivation of this crop. However, it was observed that the annual water consumption requirement of sugar cane is 1,600 mm, of cotton-wheat rotation 1,065 mm, of moong-sunflower 1,150 mm, and of moong-winter maize rotation 1,115 mm, compared to 1,030 mm of wheat-rice rotation. Thus, a shift away from the rice-wheat crop cultivation would not make much difference to the existing demand on the ground water resources (Shergill, 2007).

Soil Degradation

The rice-wheat cropping pattern is considered "extremely exhaustive" and depleting because it heavily draws on scarce resources, such as water and soil nutrients. Nambiar and Ghosh (1984) estimated that one cycle of rice-wheat depletes the soil of NPK nutrients to the tune of 501.6 kg/hectare to produce 4 tonnes of wheat and 5.2 tonnes of rice.

Punjab accounts for the highest consumption of fertiliser per hectare of gross cropped area in the country. Part of the problem is also that other alternative crops, such as Bt cotton, require higher dosages of insecticides and pesticides because many pests have become resistant to these insecticides.[5].

As opposed to the recommended NPK ratio of 4:2:1, Punjab's fertilizer consumption has been highly skewed rising from 18:7:1 in 1980-81 to 58:22:1 in 1990-91 and 44:12:1 (Table 4). Although, this ratio has moderated over time to 23:5:1 in 2022-23, it is still very high leading to ecological problems like soil salinity (Table 4).

Table 4: Consumption of Fertilizers in Punjab

(In Thousand Nutrient Tonnes)

YEAR	N	P	K	TOTAL NPK	NPK RATIO	DECADAL GROWTH
1980-81	526	207	29	762	18:7:1	
1990-91	877	328	15	1220	58:22:1	4.82
2000-01	1008	282	23	1313	44:12:1	0.74
2010-11	1403	435	73	1911	19:6:1	3.82
2020-21	1496	384	58	1938	26:7:1	0.14
2021-22	1574	366	67	2004	23:5:1	

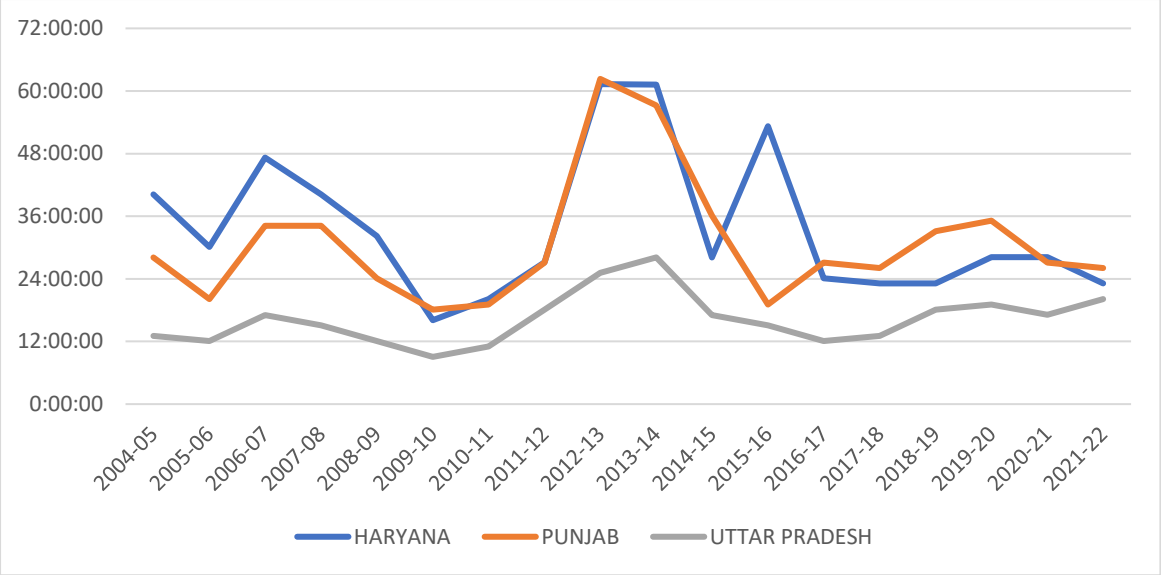
Source: Government of Punjab, Statistical Abstract of Punjab (Various Issues)

However, this disconcerting tendency is not restricted only to Punjab or to the cultivation of paddy but it is the predicament faced by the other Green Revolution states as well. Figure 4 shows that the skewed NPK ratio is a common characteristic of the other states that pioneered the Green Revolution like Haryana whose NPK ratio remains either comparable or worse than Punjab for most of the period under analysis.

Hence, all these tendencies reinforce the claim that while it is true that the current agricultural practices are unsustainable and warrant attention but not alarming or do not pose an imminent threat to the continuation of the rice-wheat cropping pattern.

[5] The insecticide use has increased from 0.5 kg per hectare in 2006 to 1.20 kg per hectare in 2015 (Compson, 2017).

Figure 4: NPK Ratio for Various Green Revolution States



SOURCE; GOI, Agricultural Statistics at a Glance (Various Issues)

Early Plans to Diversify and the Challenges to Diversification

The extensive cultivation of water-intensive rice has posed an ecological and environmental catastrophe for Punjab. Hence, policymakers recognised the need to restructure the state's agricultural policy and emphasised agricultural diversification as a means to shift cultivation from the exhaustive rice-wheat cultivation pattern to other high-value crops. It was observed that rice cultivation was better suited to the eastern region of the country, while wheat cultivation was favoured in states like Punjab and Haryana.

- The first attempt in this regard was the Expert Committee on Diversification of Agriculture in Punjab (1986), chaired by S.S. Johl, which recommended crop diversification and the reduction of area under rice-wheat by 20% to other high-value crops. This entailed a central grant of Rs 1,280 crore to facilitate the switch. The Panel recommended that such a shift would lead to a reduction of 8 million tonnes of rice and wheat, but would help the State exchequer save approximately Rs 7,000 crore in procurement through MSP and Rs 2,000 crore incurred on handling charges. On the issue of subsidised electricity, the Committee acknowledged the need for power subsidies, with the caveat that water pricing should at least reflect the actual scarcity value of water. However, this met with little success as none of these recommendations were implemented (Sarkar and Das, 2014).
- This was followed by another diversification report of agriculture in 2002, the Expert Committee on Agricultural Production Pattern Adjustment Programme in Punjab, headed again by S.S. Johl, that reiterated this demand of shifting a million hectares of land to the cultivation of less water-consuming crops like oilseeds and pulses. It was proposed to compensate those farmers to the extent of Rs 12,500 per hectare for diversifying away

from paddy cultivation. This diversification drive (2002-07) also failed to yield the desired results, as the diversification away from paddy stood at 0.25 million hectares, instead of the much more ambitious plan.

- In 2006, the Punjab State Farmers' Commission also echoed a similar sentiment of diversification.
- Another diversification drive with the support of the Union Government worth Rs.7500 crore was attempted in 2013 when the Committee for Formulation of Agriculture Policy for Punjab State aimed at diversification of 12 lakh hectares away from rice cultivation to other alternative crops in the next five years like maize, cotton, pulses, soybean and sugarcane6. The Committee also recommended shifting to the cultivation of high-value crops and a more prominent role for livestock and animal husbandry through a greater increase in public investment in building infrastructure and research and development. The same report recommended a threefold increase in the area under sugarcane without any reference to the existing sugar mills. Similarly, the area under maize was proposed to be increased by about four times without considering any demand-side considerations (Singh, 2013). Similarly, fruit and vegetable crops accounted for less than 2 per cent of the total cropped area in Punjab in the nineties. This dismal figure still remains around 3 per cent in 2022-23 as these crops were not competitive in terms of relative profitability compared to wheat and paddy.
- Under the Rashtriya Krishi Vikas Yojana in 2013-14, the Centre allocated Rs 224.5 crore of the Rs 500 crore in the Crop Diversification Plan in the Green Revolution states.
- In 2014, about Rs 500 crore were allocated for crop diversification in states like Punjab, Haryana and western Uttar Pradesh, but were discontinued soon after.
- In 2019, a much lower Rs 60.5 crore was allocated under the National Horticulture Mission to shift 1 million hectares of area under paddy to other crops.
- The Central Government has also launched a new scheme, "Per Drop More Crop," to incentivise micro-irrigation to improve water-use efficiency.
- Another route of crop diversification was pursued through contract farming, which encouraged agro-industries, developed infrastructure for the easy marketing of other commodities, and explored the possibilities of boosting agri-exports (Singh & Sidhu, 2004).
- The Punjab Preservation of Sub-soil Water Act (2009) prohibits the sowing of paddy before May 10th and its transplantation before 15 June to save a month's water lost on account of subsoil abstraction and evaporation.
- It is also contentious whether to diversify cultivation of rice and wheat away from high-yielding states like Punjab and Haryana to lower-yielding states like Assam, Bihar, Chhattisgarh and Orissa. It is estimated that there are approximately 43 districts outside Punjab and Haryana, covering around 12 million hectares, where yields are less than 1 tonne per hectare (CACP, 2015). Similarly, it is claimed that states like West Bengal,

[6] The action plan included increasing the area under cotton and basmati cultivation by 2 lakh hectares each; maize by 4 lakh hectares, sugar cane by 1.70 lakh hectares, pulses 0.70 lakh hectares, fruits and vegetables by 0.85 lakh hectares, agro-forestry by 1.45 lakh hectares and green fodder by 0.50 lakh hectares

Odisha, Bihar, and eastern Uttar Pradesh are better suited for the adoption of high-yielding varieties due to their agro-climatic conditions and aquifer systems. However, these states lack the requisite infrastructure, such as rural roads and a well-functioning market system (Kahlol & Singh, 1984). Hence, the Government needs to support and facilitate the development of requisite infrastructure, including good-quality inputs, supportive marketing incentives, and infrastructure for these states to shift to rice-wheat cultivation or ensure guaranteed returns higher than those of rice and wheat to diversify to alternate crops.

- Given the unsustainable water use practices and the groundwater exploitation, the Punjab Government initiated a new scheme, "Paani Bachao Paise Kamao scheme" in 2018. Under this scheme, a farmer is entitled to a fixed quota of electricity. If the farmer consumes less than this fixed limit, they are rewarded at the rate of Rs 4 per kWh of electricity for every unit saved, which is transferred to them through their Direct Benefit Transfer.
- Similar to this, the government has also tried to encourage several water-saving techniques like micro irrigation, direct seeding of paddy, and rooftop rainwater harvesting. However, the impact of these measures has been limited (Ghuman, 2015). The Punjab Government is also encouraging direct seeding of paddy by providing Rs 1500 per acre and has introduced three varieties of paddy that are less water consuming (Punjab Economic Survey, 2022-23).

In summary, most ambitious crop diversification plans proposed in Punjab have not yielded the desired results.

Cost of Cultivation

This section analyses the costs and returns of a few major crops grown in Punjab and compares them with all-India figures. The net returns and gross returns are estimated as the difference between the gross value of output and the cost of production[7] of the crop and the Cost C2[8] and Cost A2+FL[9] respectively made available by the Commission on Agricultural Costs and Prices (CACP).

Rice and Wheat are the most "State-protected crops" due to their centrality to ensuring food sovereignty in the nation and the dependence of the vast majority of the farming community for their livelihood (Dev and Rao, 2010). In 2022-23, these crops accounted for around 80 million hectares or 40% of the gross cropped area.

No other crop in the state has been able to compete with wheat and paddy on the grounds of assured profitability (Sharma, R.K., 1998) with rice being the most

[7] The gross value of output of the crop is computed as the sum of the value of the main product and the value of the by-product per hectare.

[8] The Cost C2 is the comprehensive cost of production, encompassing all paid-out expenses, the imputed value of unpaid family labor, rentals, and interest foregone on owned land and fixed capital.

[9] The Cost A2+FL is the total cost of production, encompassing the direct costs incurred by farmers (A2) plus the imputed value of unpaid family labor.

economically remunerative crop primarily due to significantly higher yields, lower production costs, lower risks with an assured market price, due to which its cultivation is preferred over other crops.

Rice

Rice was one of the important crops that was central to the Green Revolution. The use of HYV seed varieties of rice in Punjab led to a large-scale diversification of the area under rice cultivation, prompting a significant increase in both the rates of growth of production and yields. As the Green Revolution gained momentum, the growth of rice, measured by all parameters—area, production, and yields —grew at a rate vastly outpacing the national average (Table 5).

However, the nineties saw a decline in the growth rate of rice throughout the country, but more sharply in Punjab, where the growth rate halved. Thereafter, both the production and yields of rice have stagnated in the state as well as the country. The stagnating yields and decline in rice production in Punjab have been accompanied by other states, such as West Bengal, Telangana, and Uttar Pradesh, which have outperformed the state in terms of production.

Table 5: Growth of Rice

(In per cent)

Period	Punjab			India		
	Area	Production	Yield	Area	Production	Yield
1960-61 to 1970-71	5.6	11.6	5.5	0.97	2.02	1.04
1970-71 to 1980-81	11.7	16.7	4.5	0.66	2.42	1.75
1980-81 to 1990-91	5.5	7.2	1.7	0.62	3.31	2.68
1991-92 to 1999-2000	2.6	3.5	0.8	0.46	1.35	0.89
2001-02 to 2010-11	0.8	1.7	0.9	-0.4	1.2	1.6
2011-12 to 2019-20	1.1	2.6	1.5	0.66	2.63	1.95
2020-21 to 2023-24	0.3*	-0.2	-0.2	1.47	3.48	1.98

Source: GOI, Agricultural Statistics at A Glance and Government of Punjab, Statistical Abstract of Punjab (Various Issues)
Note: * = The figures for Punjab are for the year 2021-22.

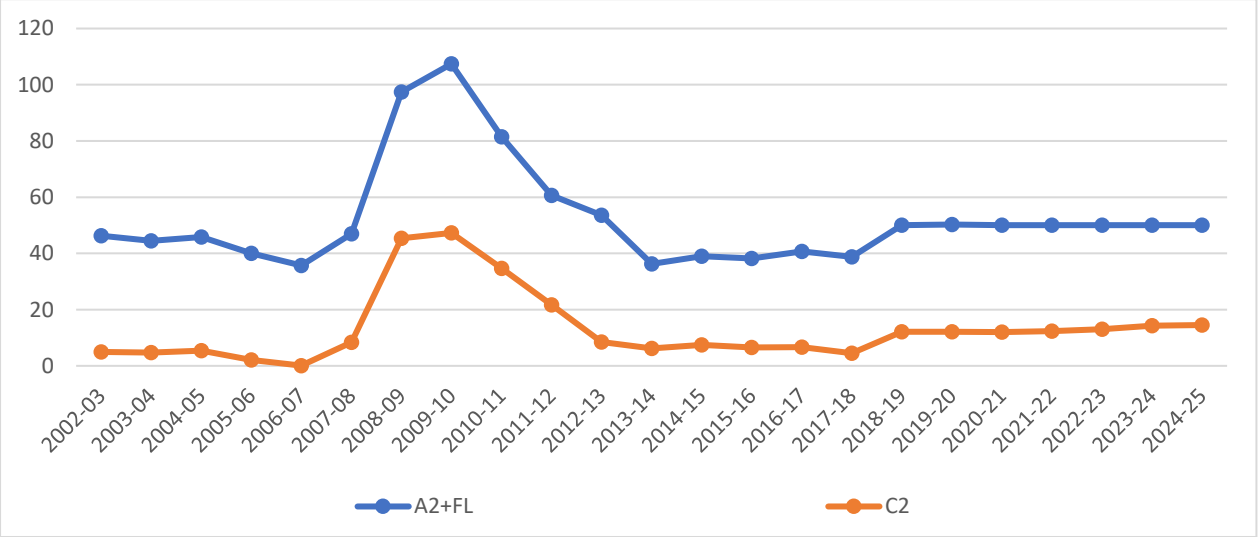
We next examine the returns of paddy cultivation, both over the minimum support price and the gross value of output.

One of the many recommendations of the National Commission on Farmers (2004) headed by M.S. Swaminathan was that the Minimum Support Prices (MSPs) of crops should be fixed at 50% of the C2 cost of cultivation at the national level. Figure 5 shows

that the minimum support prices for paddy have been set so low that, for the majority of the period under analysis, the MSP has inched close to the cumulative cost of production (C2). As a result, the margins over cost C2 remained significantly below 10% throughout 2002-03 and 2017-18, except for a brief period characterised by a global rise in the price of agricultural commodities after 2007-08, during which these margins shot up to 45%. Thereafter, these margins stabilised around 12%. However, even during the period of global price rise, the MSP of rice did not meet the mandated level of 50% over costs C2.

Figure 5: Returns over MSP: Paddy (All India)

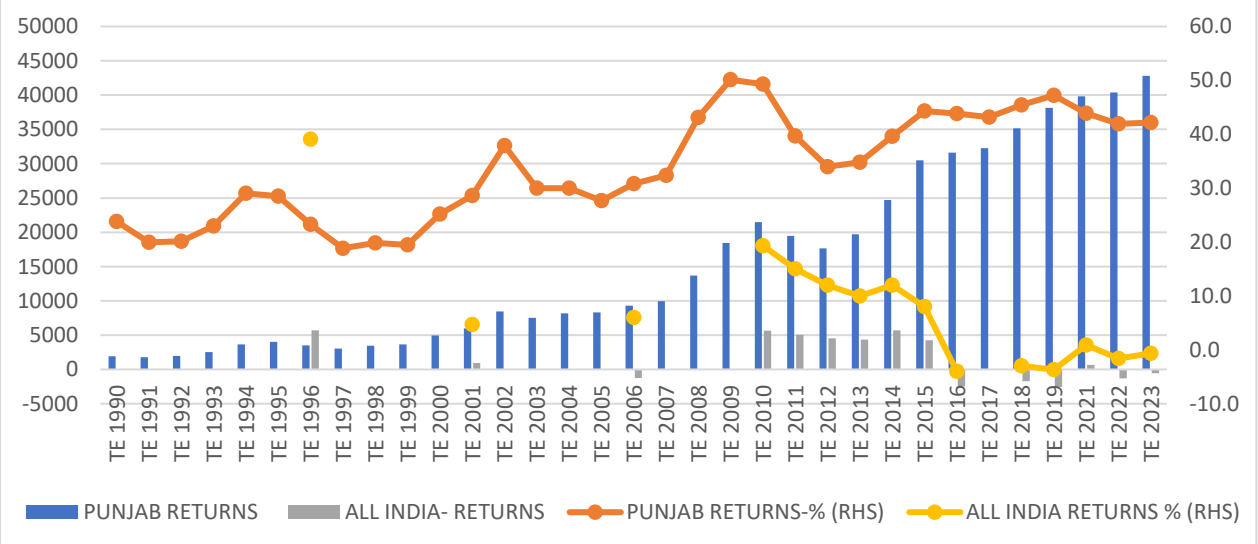
(In per cent)



Source: Estimated from the Price Policy of Kharif Crops, CACP (Various Issues

Figure 6: Returns on Cultivation: Rice

(in Rs/Ha)



Source: Estimated from the Price Policy of Kharif Crops, CACP (Various Issues)

A comparison of net returns, or the difference between the gross value of output and the cost C2 in Punjab and All-India, shows that the All-India returns for rice were higher than in Punjab only for the year 1995-96. However, for the entire period of analysis, the returns on rice in Punjab not only widely exceeded the All-India figure but also their returns over cost C2 inched closer to the mandated level of 50% over the comprehensive cost C2 (Figure 6). In sharp contrast, the All-India returns over costs C2 have declined persistently after 2009-10 and have turned negative.

This is because the input subsidies ensured that production costs were kept low. At the same time, the guaranteed price support scheme and the strong market infrastructure in Punjab gave rice a competitive edge over other states, helping it maintain comfortable profitability margins.

Wheat

The wheat crop was another beneficiary of the Green Revolution, which led to a significant increase in wheat production and yields nationwide, with states like Punjab spearheading this growth. This growth moderated in the 1970s and 1980s, and more sharply in the 1990s, with the growth rate in Punjab remaining comparable to the all-India average. However, thereafter, the growth rate of wheat in Punjab has decelerated sharply, falling behind the national average.

Punjab, today, accounts for approximately 15% of the country's total wheat production.

Table 6: Growth of Wheat

(in per cent)

PERIOD	PUNJAB			INDIA		
	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
1960-61 to 1970-71	5.1	11.4	6	3.5	8	4.4
1970-71 to 1980-81	2	4.1	2	2	4.3	2.2
1980-81 to 1990-91	1.5	4.7	3.1	0.8	4.3	3.4
1990-91 to 2000-01	0.4	2.5	2.1	0.6	2.4	1.7
2000-01 to 2010-11	0.3	0.4	0.3	1.2	2.2	1
2011-12 to 2020-21	0.1	0.4	0.4	0.7	2.4	1.7

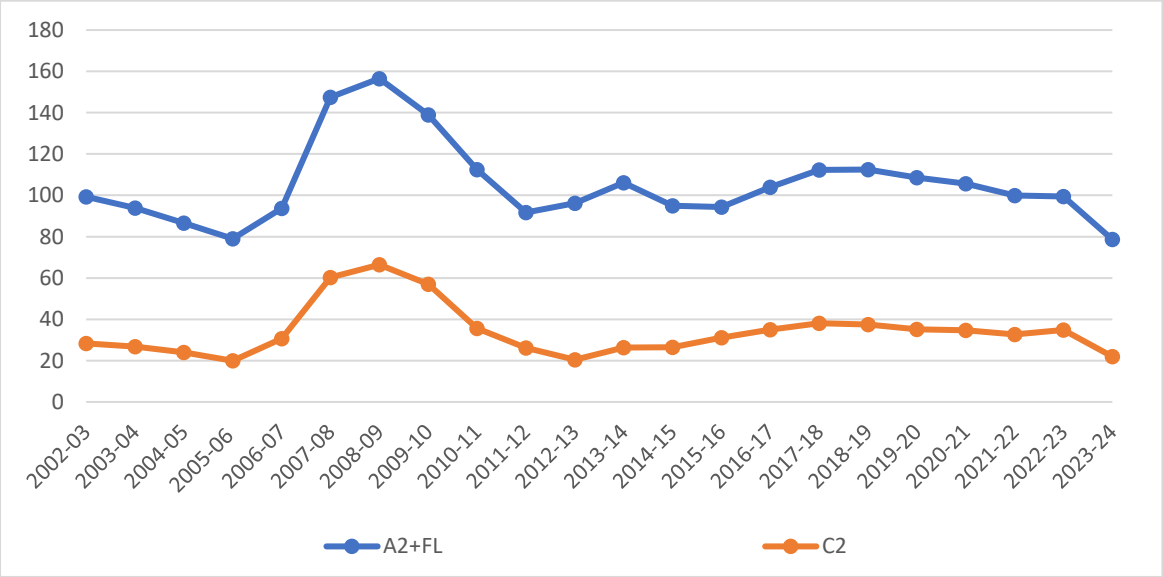
2020-21 to 2023-24	-0.2	-1.8	-1.6	0.7	1.1	0.4

Source: GOI, Agricultural Statistics at A Glance and Government of Punjab, Statistical Abstract of Punjab (Various Issues)
Note *=The figures for Punjab are for the year 2021-22

A cursory glance at the margins between the minimum support price and the cost of cultivation of wheat C2 indicates that these margins have narrowed from about 28.3% in 2002-03 to 19.9% in 2005-06 (Figure 7). However, as global prices for primary commodities increased after 2006-07, this figure grew from 31% in 2006-07 to a peak of 66% in 2008-09 and remained around 57% in the following year before falling drastically to 20% by 2012-13. In the following years, this figure hovered around that level before finally settling to 22% by 2023-24.

Figure 7: Returns on Wheat over MSP **(INDIA)**

(In per cent)



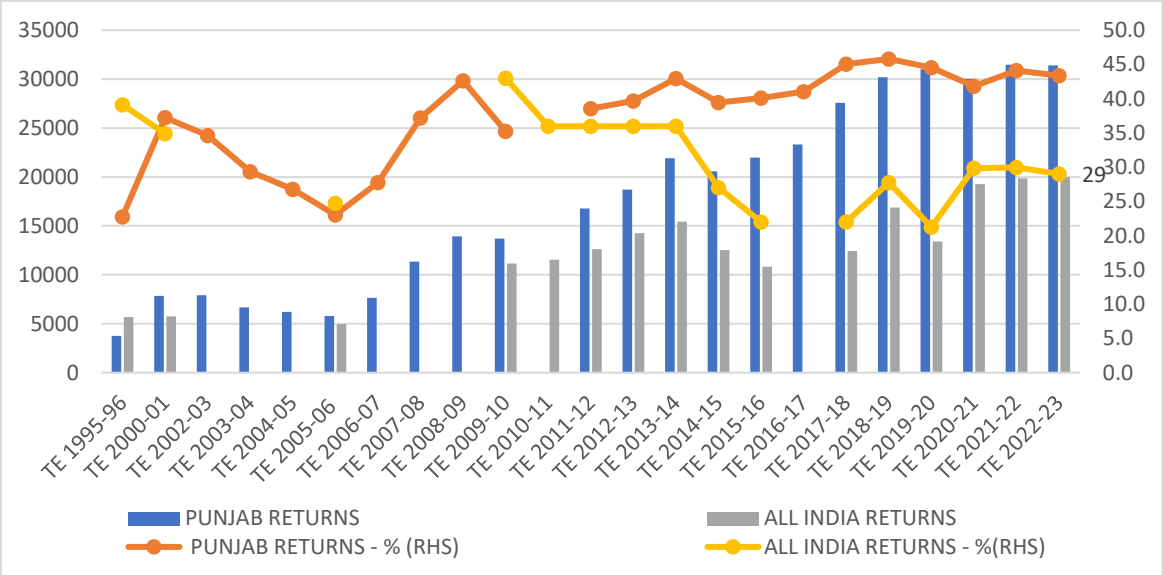
Source: CACP, Price Policy on Rabi Crops (Various Issues)

We next compare the net margins on wheat cultivation in Punjab with those of the country as a whole. The net returns on wheat cultivation in Punjab remained comparable to those prevalent nationwide for the majority of the analysis period. However, after TE 2011-12, there is a stark divergence in the returns in Punjab and the national average.

In the period post TE 2011-12, while the returns in Punjab remained stable around 45% over the cost C2, the all-India yields declined from about 45% in TE 2011-12 to about 29% by TE 2023-24 (Figure 8).

Figure 8: **Returns on Wheat Cultivation**

(In Rs/Ha)



Source: Estimated from CACP, Price Policy for Rabi Crops (Various Issues)

Rapeseed And Mustard

Rapeseed and Mustard were the primary oilseeds grown in Punjab. However, this crop bore the brunt of the Green Revolution as the acreage under this crop shrank to divert agricultural land towards the HYV varieties of crops. However, this saw a brief turnaround in the 1970s when both the growth rates of acreage and output rebounded, outpacing the all-India average (Table 8).

Thereafter, while the acreage under rapeseed and mustard in Punjab registered negative growth, even the growth of output and yields petered out. This trend was not reflected at the national level, as despite fluctuations, growth remained robust.

Table 7: Growth of Rapeseed and Mustard

(In per cent)

PERIOD	PUNJAB			INDIA		
	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
1960-61 to 1970-71	-0.38	0.5		1.4	2.4	3.9
1970-71 to 1980-81	2.8	3.1		2.2	1.5	-0.6
1980-81 to 1990-91	-6.6	-1.1	5.87	3.5	8.6	4.9
1991-92 to 2000-01	-2.24	2.8	1.96	-2.5	-2.2	0.3
2001-02 to 2010-11	-5.27	1.0	0.71	4.4	6.9	2.2
2011-12 to 2019-20	0	1.3	2.01	-0.3	2.2	2.5
2020-21 to 2023-24	-	-1.3	0.87	11.1	9.1	-1.8

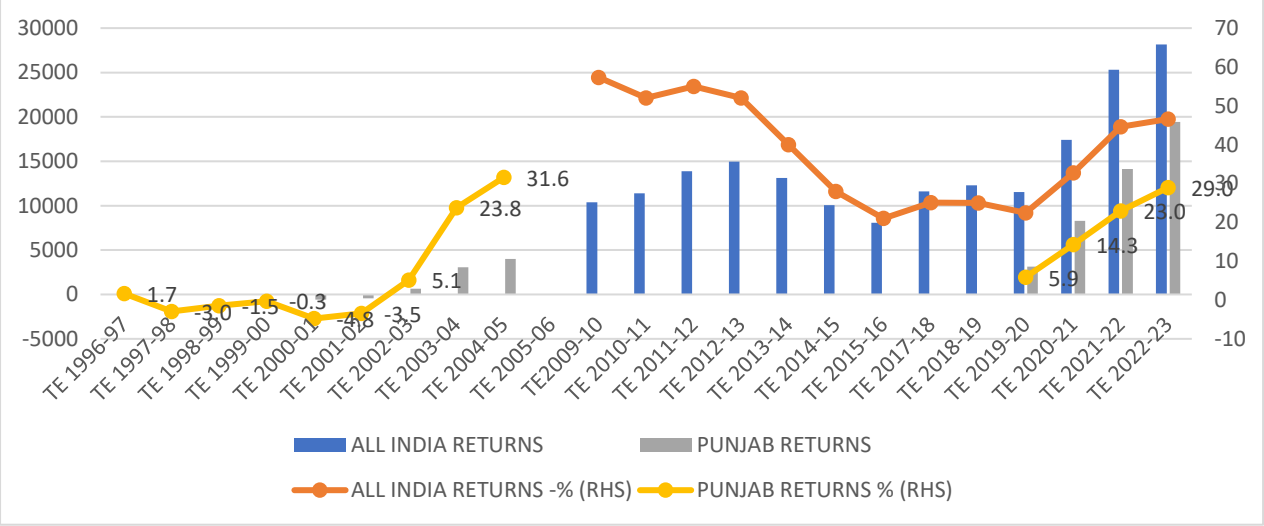
Source: GOI, Agricultural Statistics at A Glance and Government of Punjab, Statistical Abstract of Punjab (Various Issues)

Despite being one of the traditional crops of Punjab, the returns on rapeseed and mustard have remained highly volatile and still account for less than 1% of the country's total production. The government encouraged the cultivation of these crops through programmes like the Technological Mission on Oilseeds and Pulses in the eighties, Integrated Scheme of Oilseeds, Oil Palm and Maize (ISOPOM) in 2004-05, and the National Mission on Oilseeds in 2014-15, however, it has failed to meet the desired objectives.

During TE 1997, the net returns over cost C2 in Punjab stood at a dismal 1.7%, and even this low figure turned negative over the period from TE 1997 to TE 2002, before showing an increase for the period from TE 2003 to TE 2005 (Figure 9). The data is unavailable for a few years. The returns again show an upward trend, growing from 5.9% in TE 2020 to 29% in TE 2023.

Figure 9: Returns on Rapeseed and Mustard

(In Rs/ha)



Source: Estimated from CACP, Price Policy for Rabi Crops (Various Issues)

However, there is a significant disparity in the returns on cultivation in Punjab compared to the national average. The returns in Punjab remained largely negative, and even in recent years, when there was a turnaround in this trend, these margins remained only about 30% in contrast to the national average of 45% (Figure 8).

Cotton

Cotton, in Punjab, was considered one of the main crops for diversification away from paddy cultivation. The American variety of the cotton crop exhibited resilience and robust growth until the nineties at the expense of the desi variety. At the national level, too, both the production and yields exhibited strong growth (Table 9).

The desi variety of cotton showed brief signs of revival during the 2000s due to the introduction of the Bt. Cotton variety that briefly displaced the American variety. However, this brief reprieve was followed by a secular decline in growth, which also befell the American variety in the subsequent period.

Table 8: Growth of Cotton

(In per cent)

PERIOD	PUNJAB						INDIA		
	COTTON (AMERICAN)			COTTON (DESI)					
	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
1960-61 to 1970-71	-1.4	2.6	4	-0.9	1.4	2.3	0	-1.6	-1.6
1970-71 to 1980-81	9	6.9	-1.9	5.9	-5.5	-3.3	0.3	3.9	3.7
1980-81 to 1990-91	2.4	6.4	3.9	-15.1	-6.5	1.7	-0.5	3.4	4.0
1990-91 to 2000-01	-5.6	-6.5	-1.0	6.1	10	3.7	1.4	-0.3	-1.7
2000-01 to 2010-11	2.8	6.8	4	-19.7	-18.5	1.5	2.8	13.2	10.1
2011-12 to 2019-20	-6.2	-5.5	0.7	-12.8	-12.6	0.4	1.7	0.7	-1.0
2020-21 to 2023-24	-0.2	-25.4	-33.9	-34.9	-38.8	-15.3	-1.5	-2.7	-1.1

Source: GOI, Agricultural Statistics at A Glance and Government of Punjab, Statistical Abstract of Punjab (Various Issues)

Earlier, cotton was grown in southern Punjab, where it faced stiff competition from rice. By 2010, most of the cotton-growing districts, except Hoshiarpur and Bathinda, had become wheat-rice crop regions (Sarkar and Das, 2014). India has lost access to its cotton seeds due to the spread of Bt Cotton, a genetically modified variant introduced to contain the pesticide Bacillus thuringiensis bacterium (Shiva, 2012). The area under cotton has also fluctuated because of the American bollworm infestation[10]. This coerced farmers to shift to rice cultivation to get stable yields and incomes (Rangi & Sidhu, 2004). Due to this, Punjab today accounts for approximately 2% of the country's total cotton production.

The returns on cotton have fluctuated widely during the period of analysis. Between 1985-86 and 2001, the cost C2 of cotton increased almost nine times. The price of

[10] Within four years of Monsanto introducing its first generation of GM cotton in 2006, the pink bollworm had become resistant to it in western India prompting Monsanto to introduce a second generation of seeds but in the next few years it had become resistant to it as well (Compson,2017).

cotton seeds in India has increased by over 80,000% from Rs. 5-9 per kilogram to Rs. 1,600 for 450 grams since the entry of Monsanto in 1998.[11]

During TE (Triennium Ending) 1990-91, the returns on cotton over cost C2 stood at an impressive 53.3% and despite a narrowing of returns, still promised a return of over 30% (Figure 10). The increase in the prices of primary products during 1996, following trade liberalisation and globalisation, lured many farmers into cultivating cotton.

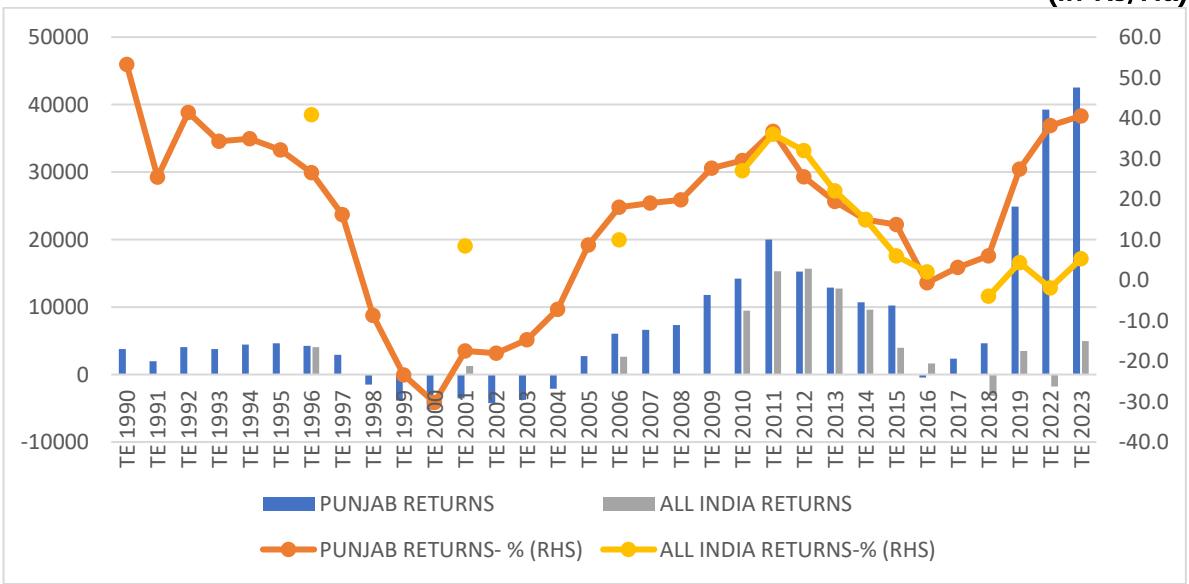
Thereafter, the prices of cotton crashed massively, and the net returns turned negative for the period TE 1998 to TE 2004. Schemes like the Technology Mission on Cotton (2000) and the revamped National Food Security Mission-Commercial Crops (Cotton) (2007) and the introduction of BT Cotton (2002-05) helped reverse this trend as returns gradually increased from 8.7% in TE 2005 in 36% in TE 2011 but this was followed by a subsequent decline to -0.6% in TE 2016. This was also because, in 2015, the whitefly destroyed two-thirds of the cotton crop, resulting in a loss of approximately $629 million (Compson, 2017).

In recent years, the returns have shown an appreciable increase, growing from 3.1% in TE 2017 to 40.5% in TE 2022-23.

The all-India returns largely remained negative for the majority of the period under analysis, with a brief reprieve during the period of a rise in global primary commodities, before nosediving again into losses.

Figure 10: Returns on Cultivation of Cotton

(In Rs/Ha)



Source: Computed from CACP, Price Policy on Kharif Crops (Various Issues)

[11] https://www.navdanya.org/latest-news-at-navdanya/538-monsanto-vs-indian-farmers

Hence, it is the fluctuating yields and returns of cotton that have rightfully earned it the title of "killer crop", as it has pushed many farmers to suicide[12]. By 2017, approximately 27% of the area under cotton cultivation in Punjab and Haryana had declined, and many farmers had shifted to cultivating indigenous varieties of cotton, which are cheaper and less susceptible to pests (Compson, 2017). Shiva (2012) reported that approximately 95% of cotton seeds were controlled by an American corporation, Monsanto, which has undermined seed sovereignty and pushed many farmers to suicide due to the hefty patent fees or royalty payments[13] they incur on these seeds. Moreover, seed sovereignty is critical to attaining food sovereignty. Seed sovereignty is a comprehensive term that refers to the freedom of farmers to save, breed, exchange, and have access to open-source seeds[14]. This is essentially an outcome of the WTO's Trade-Related Intellectual Property Rights, which allows the patenting of genetically modified seeds. India was compelled to introduce the patent on seeds due to a dispute with the US in 2004. Under the US-India Knowledge Initiative on Agriculture, many states are pressured into signing agreements with Monsanto.

Maize

Maize recorded robust growth both in the state of Punjab and the country during the sixties, but this growth faltered in the following decade. This growth rebounded at the national level but continued to remain sluggish in Punjab in the eighties.

[12] A study by Navdanya estimated that by 2016 about 3 lakh farmers had committed suicide by 2016 of which 84% were attributed to the use of Monsanto's cotton seeds. https://www.navdanya.org/latest-news-at-navdanya/538-monsanto-vs-indian-farmers

[13] The price of Monsanto seeds also varies across states, a 450 gm packet of Monsanto seeds was priced at Rs 830 in Maharashtra, Rs 930 in Andhra Pradesh, Gujarat, Karnataka, Telangana and Tamil Nadu while the same cost Rs1000 in Punjab, Haryana and Rajasthan. Similarly, the trait fees charges per packet were Rs 122.96 and Rs 183.46 for Bt Bollgard I and Bollgard II seeds respectively. These prices were later homogenized by introducing the Cotton Seed Price (Control) Order to Rs 635 per packet of BollGard I and and Rs 800 for Bollgard II with no trait fees for Bollgard I and Rs 49 for the second variant respectively (Business Standard, 2016).

[14] https://www.aljazeera.com/opinions/2012/2/6/the-seed-emergency-the-threat-to-food-and-democracy

Table 9: Growth of Maize

(in per cent)

PERIOD	PUNJAB			INDIA		
	AREA	PRODUCTION	YIELD	AREA	PRODUCTION	YIELD
1960s-61 to 1970-71	5.4	8.8	3.2	2.9	6.3	3.3
1970-71 to 1980-81	-3.7	-3.4	0.3	0.3	-0.7	-1.0
1980-81 to 1990-91	-6.8	-5.9	1.1	-0.2	2.6	2.7
1991-92 to 1999-2000	-1.3	3.3	4.6	1.1	3	1.8
2001-02 to 2010-11	-1.8	0.8	2.9	2.6	6.1	3.4
2011-12 to 2019-20	-2.4	-2.3	-0.1	1.5	3.8	2.3
2020-21 to 2023-24	-7	1.9	9.5	4.4	6	1.6

Source: GOI, Agricultural Statistics at a Glance and Government of Punjab, Statistical Abstract of Punjab (Various Issues)

This trend was briefly reversed in the nineties, but while maize continued to register strong growth at the all-India level, growth continued to languish in Punjab.

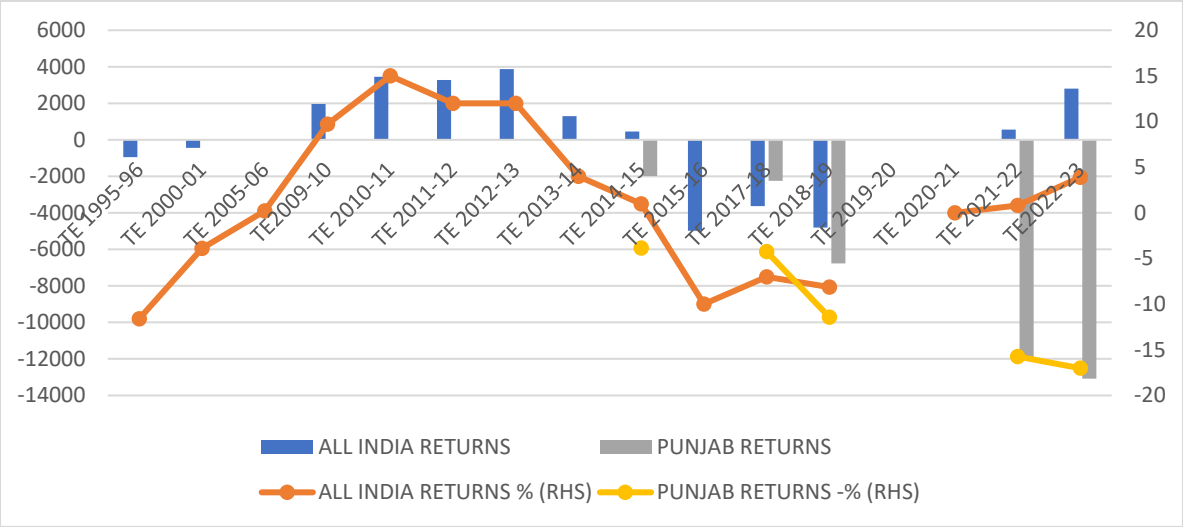
Punjab, today, accounts for less than 2% of the country's total maize production. Data on the cultivation costs of maize in Punjab are available only for the period after TE 2015.

Throughout the analysis, the net returns over cost C2 remained negative (Figure 11).

Both the Johl Committees in 1986 and 2002, as well as the latest Committee in 2013, had recommended diversification away from the rice-wheat cropping pattern to the traditional wheat-maize pattern of Punjab. However, since the returns on maize cultivation are running into losses, this is not a viable option for diversification.

Figure 11: Returns on the Cultivation of Maize

(In Rs/Ha)



Source: Computed from CACP, Price Policy on Kharif Crops (Various Issues)

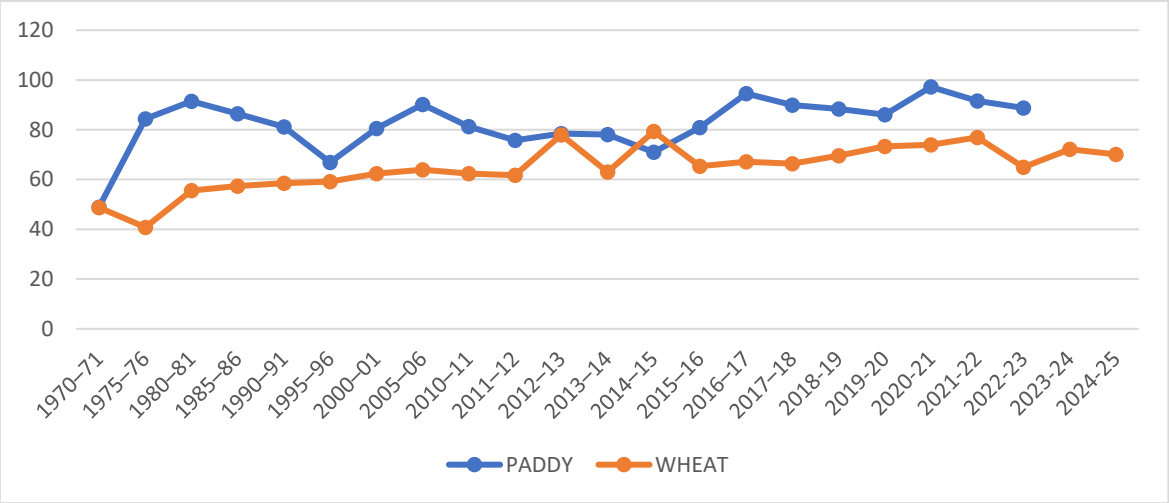
In sum, the Minimum Support Prices (MSP) and the input subsidies have played an instrumental role in ensuring the commercial viability of production by guaranteeing remunerative returns over the costs of production. It is these support prices and the subsidies that have not only helped rice and wheat gain a competitive edge over the other crops but also makes the cultivation of these crops profitable in Punjab, the highest amongst other states as well as the national average. In fact, the next best alternative to the rice-wheat crop combination in Punjab which is cotton offers much lower and volatile returns.

Procurement Policy

Another crucial element of the State's Green Revolution strategy was ensuring food security for consumers while also ensuring assured incomes for producers through a procurement policy at remunerative prices. The government's procurement policy, which guaranteed prices, incentivized farmers to shift to the cultivation of crops like rice and wheat.

Figure 12: Procurement as % of Production in Punjab

((In per cent)



Source: Statistical Abstract of Punjab and Price Policy for Kharif Crops and Price Policy for Rabi Crops (Various Issues)

However, the procurement of paddy varies significantly across states. Since the initiation of the Green Revolution, the procurement policy by design favoured states like Punjab and Haryana. In 1970-71, the procurement of both paddy and wheat as a proportion of production stood close to 48.8% (Figure 12). However, within a short five-year span, this ratio shot up steeply to 84.4% and further to 91.4% by 1980-81. The corresponding figures for wheat first declined to 40.8% in 1975-76 and then grew to 55.6% in 1980-81 (Figure 12).

Thereafter, with the initiation of neoliberal reforms, this ratio declined consistently to a nadir of 66.9% in 1995-96 for rice, while continuing to grow for wheat. Over the next decade, this ratio peaked again at 90.2% in 2005-06, due to the initiation of various food security schemes, including the Mid-Day Meal Scheme and the Antyodaya Anna Yojana. However, it then declined consistently to 71% in 2014-15. The procurement policy for rice in the state received a boost again after 2014-15, following the implementation of the National Food Safety Act (2013), which resulted in this ratio hovering around 90%. The corresponding figures for wheat remained around 70%.

Hence, Punjab is rightfully attributed as the "granary of the nation" because, despite accounting for only 1.5% of the country's geographical area, its contribution to the central pool of food stocks remains significant. In 1980-81, Punjab accounted for 45.3% of the rice's central pool and approximately 73% of the Centre's wheat pool (Table 10); however, over the recent years, that share has halved. The latest estimates suggest that wheat procurement has decreased significantly over the last year; however, Punjab still accounts for half of the share in the central pool.

Table 10: Punjab's Contribution to the Central Pool

(In Lakh Tonnes)

YEAR	RICE		WHEAT	
	CONTRIBUTION TO CENTRAL POOL	AS % OF TOTAL	CONTRIBUTION TO CENTRAL POOL	AS % OF TOTAL
1980-81	25.2	45.3	42.8	73
1990-91	48.2	41	67.5	61
2000-01	69.4	33.3	94.2	57.6
2010-11	86.3	25.3	102.1	45.4
2017-18	118.33	30.98	117.06	37.97
2018-19	118.34	25.53	126.92	35.46
2019-20	108.76	20.92	129.12	37.82
2020-21	135.89	20.62	127.14	32.61
2021-22	125.48	21.18	132.22	30.5
2022-23	122.01	21.45	96.45	51.32

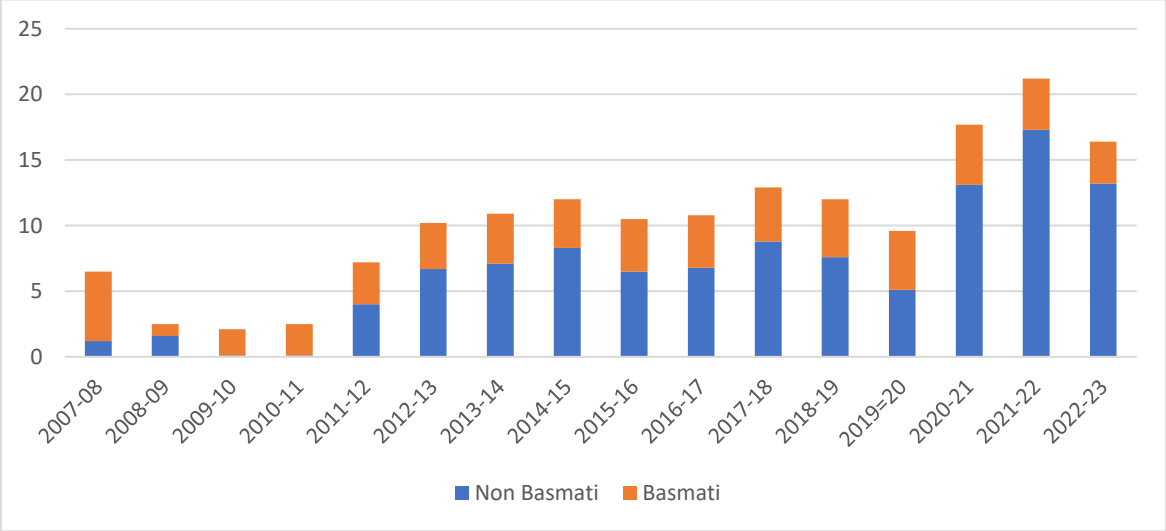
SOURCE: Government of Punjab, Statistical Abstract of Punjab (Various Issues)

Trade and MSP: A Comparison of Cost of Production, MSP and International Prices

India is one of the world's largest exporters of rice. India exports both basmati and standard varieties of rice. Figure 13 illustrates the composition of the country's rice exports.

Figure 13: **Composition of Rice Exports of India**

(In Million Tonnes)



Source: CACP, Price Policy for Kharif Crops (Various Issues)

India's rice exports declined by a third from 6.5 million tonnes in 2007-08 to 2.1 million tonnes in 2009-10. The proportion of basmati exports constituted over 80% of rice exports in 2007-08, and this figure reached about 96% by 2010-11, as India banned the exports of non-basmati rice to insulate domestic consumers from rising global price fluctuations. As restrictions were relaxed, rice exports increased and remained at approximately 12 million tonnes until the 2019-20 fiscal year, then grew further to 21.2 million tonnes in 2021-22. The share of basmati rice in total exports declined from 44% in 2011-12 to 30.8% in 2014-15.

The rice exports were constrained for two years due to lower global commodity prices, sluggish demand and other challenges faced on account of meeting minimum residual limits with the exports of basmati rice. When normal exports resumed in 2017-18, the share of exports of basmati rice remained low at 31.8%. Following the global pandemic in 2019-20, rice exports were reduced significantly of which basmati rice exports accounted for over 46% of the total rice exports. Thereafter, while the exports of rice have increased significantly to about 20 million tonnes, the share of basmati exports have plummeted to 19.5% (Figure 13).

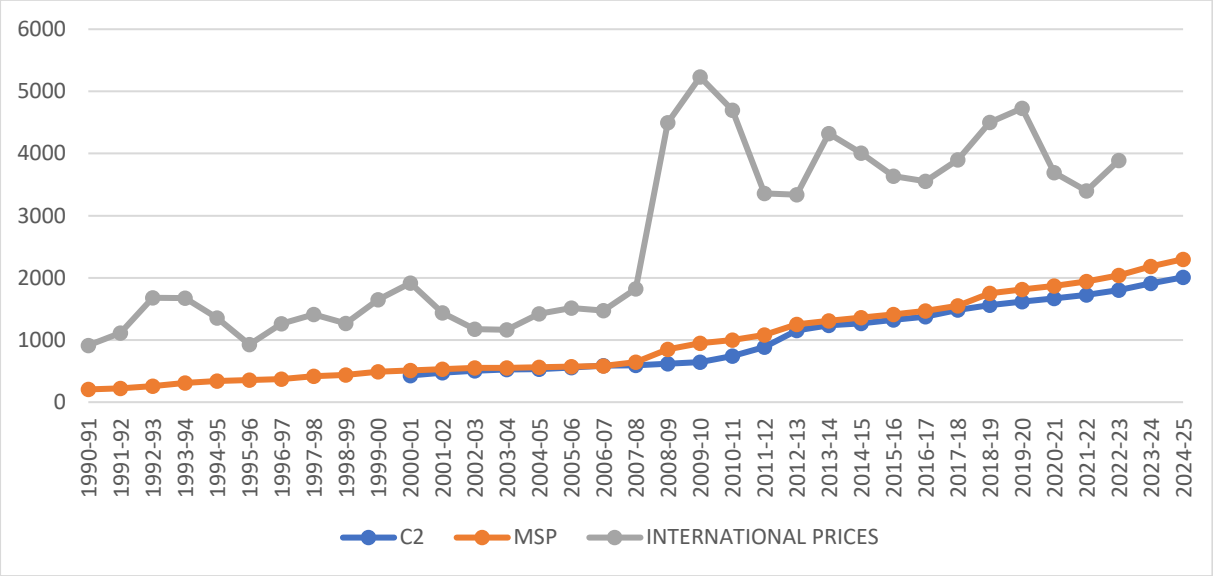
Earlier, the cultivation of the basmati variety of rice, which is less water-intensive, was concentrated primarily in the districts of Amritsar and Gurdaspur. However, today, this has expanded from 1.04 lakh ha in 2000-01 to 8.62 lakh ha in 2014-15 due to the introduction of high-yielding varieties of basmati rice.[15] Thereafter, despite the area under basmati rice cultivation declining to 6.4 lakh hectares in 2024-25, Punjab currently contributes 40% of the total basmati exports[16].

[15] https://www.newindianexpress.com/nation/2025/Apr/16/geopolitical-concerns-spark-fears-of-decline-in-basmati-cultivation-in-punjab

[16] https://www.newindianexpress.com/nation/2025/Apr/16/geopolitical-concerns-spark-fears-of-decline-in-basmati-cultivation-in-punjab

Figure 14: Paddy: Cost of Production, MSP And Unit Export Prices

(In Rs/Qtl)



Source: CACP, Price Policy for Kharif Crops (Various Issues)
Note: The International Prices are the unit prices of exports and are derived from dividing the value of the exports by the quantity of exports.

Figure 14 compares the cost of cultivation (C2), the minimum support prices, and the unit export prices of rice. In the case of rice, the minimum support prices barely covered the costs of cultivation (C2) except during the period of a global rise in the price of primary commodities from 2007 to 2012 and again in recent years. In contrast, despite fluctuations, a distinct divergence emerged between the unit export prices and the costs of cultivation, as well as the minimum support prices. Between 1990-91 and 2006-07, while the minimum support price of rice was rising gradually and averaged around Rs 407/quintal, the average unit export price was over three times that figure at Rs 1347/quintal. This stark disparity widened further when the average unit export price of rice surged to Rs 5,231/quintal in 2009-10, amid the global rise in agricultural prices, while the MSP increased to only Rs 950/quintal.

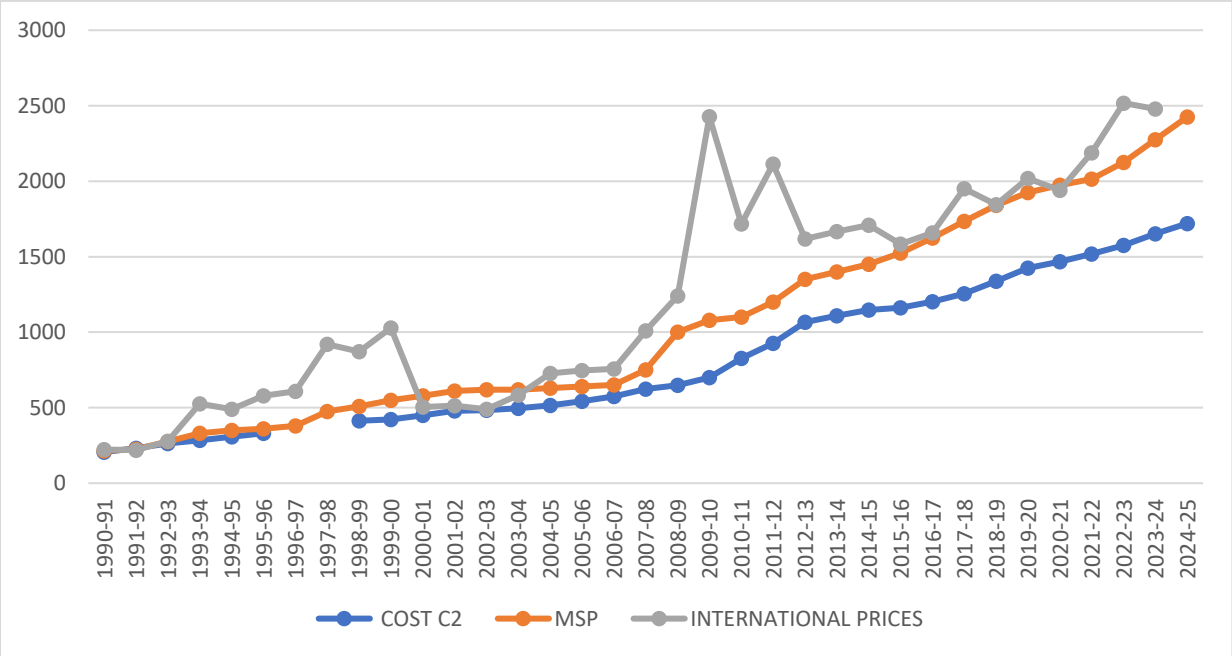
Even when global prices moderated, the gap between the minimum support prices and the unit export price of rice deepened, as the minimum support prices did not keep pace with international prices. While the minimum support price of rice registered a tardy rise, averaging only Rs 1,570 per quintal, the average prices for the period 2012-13 to 2022-23 averaged Rs 3,861 per quintal.

As per the CACP report (2023-24), India's major export destination for basmati rice were Iran (25.3%), Saudi Arabia (17.1%), Iraq (12.3%) and UAE (6.5%) while the

same for non-basmati rice were Bangladesh (9.4%), Benin (8.8%), Nepal (8.1%) and Senegal (6.3%)

Figure 15: Wheat: Cost of Production, MSP And Unit Export Prices

(In Rs/Qtl)

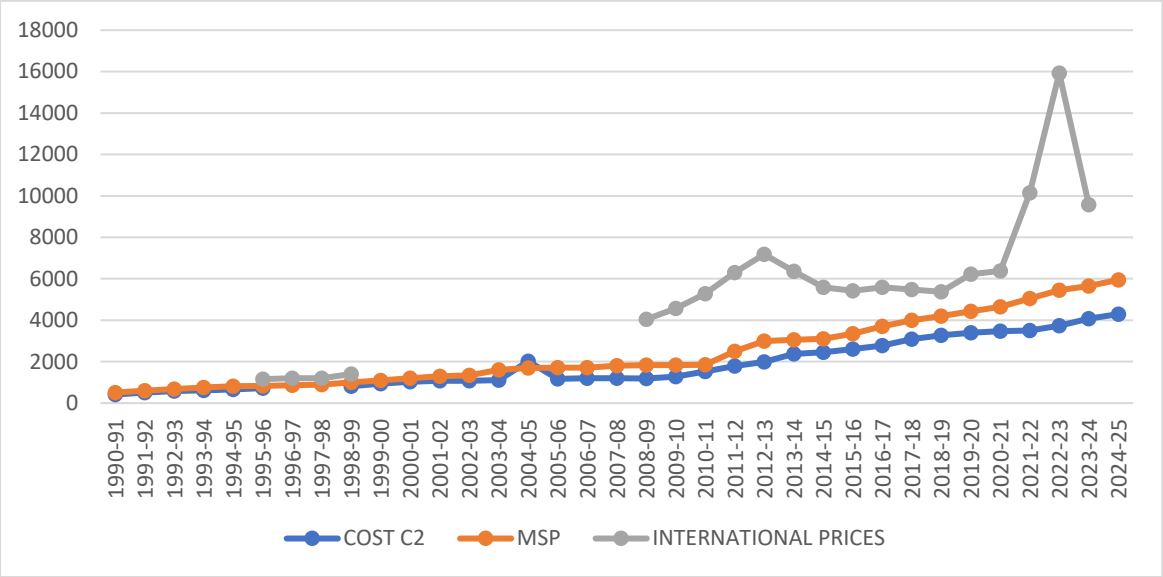


Source: CACP, Price Policy for Rabi Crops (Various Issues)
Note: The International Prices are the unit prices of exports and are derived from dividing the value of the exports by the quantity of exports.

Between 1990-91 and 1993-94, the C2 cost of cultivation, the minimum support price and the unit export price for wheat remained almost comparable. While the minimum support price and the cost of cultivation continued to move closely, the unit export price started to rise from Rs 278/qtl in 1992-93 to Rs 1,029/qtl in 1999-00, while the MSP continued to trail, growing from Rs 275/qtl to Rs 550/qtl. However, this was followed by a massive crash in international prices, which fell below the minimum support prices and barely kept pace with the cost of cultivation.

The three series started to drift apart gradually after 2003-04 and then more perceptibly after 2006-07. The margin between the C2 cost of cultivation and the MSP grew from 13.2% in 2006-07, peaked at 54.1% in 2009-10, and settled at about 40% by 2024-25. In contrast, the unit export prices of wheat increased from Rs 758 per quintal in 2006-07 to Rs 2,428 in 2009-10, then moderated to Rs 2,115 per quintal in 2011-12. However, thereafter, the unit export prices have fluctuated widely and have sometimes fallen at par or even lower than the domestic minimum support price.

Figure 16: Rapeseed and Mustard: Cost of Production, MSP And Unit Export Prices (In Rs/Qtl)

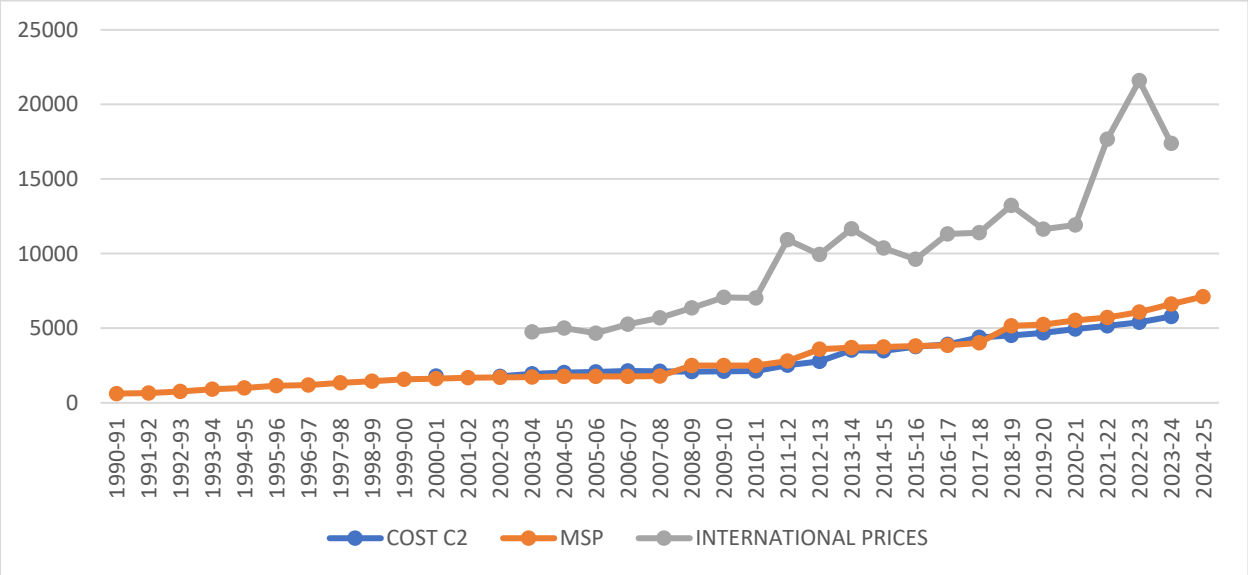


Source: CACP, Price Policy for Rabi Crops (Various Issues)
Note: The International Prices are the unit prices of exports and are derived from dividing the value of the exports by the quantity of exports.

The data for rapeseed and mustard is not available for a few years. For the years, for which data is available, the unit export price, cultivation cost C2, and the minimum support price moved closely (Figure 16). Between 1998-99 and 2002-03, the minimum support prices maintained an average margin of 20% over the cost of cultivation. These margins increased up to 55% in 2008-09 and, after some fluctuations, remained around that level till 2012-13. The unit export prices also followed in tandem, registering a spike during the global increase in agricultural prices, which moderated in the following years. In recent years, export prices have again risen to Rs 15,923/quintal in 2022-23, which is three times the minimum support price and almost five times the cost of cultivation.

Figure 17: Cotton: Cost of Production, MSP and Unit Export Prices

(In Rs/Qtl)



Source: Price Policy for Kharif Crops (Various Issues)

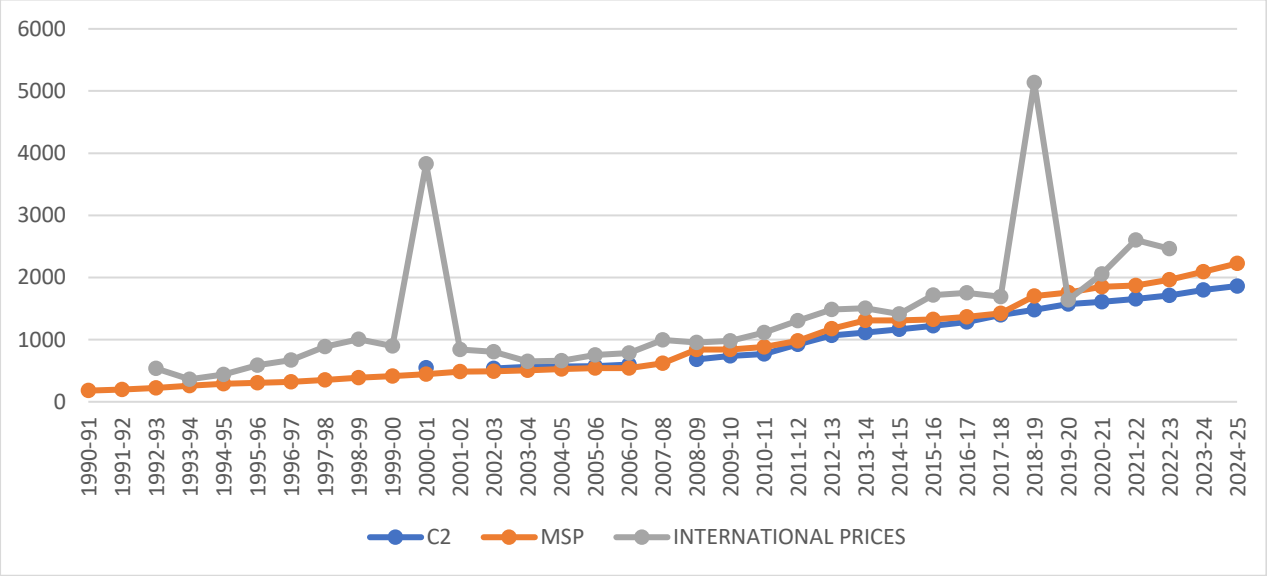
Note: The International Prices are the unit prices of exports and are derived from dividing the value of the exports by the quantity of exports.

For cotton, the minimum support price fell short of the cost of cultivation for as long as the 2007-08 season (Figure 17). This trend was reversed with the global rise in the price of primary commodities, and the MSP was gradually increased to cover the costs incurred during cultivation. However, the margins remained bleak, averaging less than 10% except for the 2012-13 period, when they peaked at 30%. This positive development was also short-lived, regressing into negative figures by 2017-18, but was revived thereafter to maintain only meagre margins of 10-12% over the costs of cultivation.

However, international prices widely outpaced domestic prices by almost three times, approaching four times the minimum support prices between 2011-12 and 2022-23.

Figure 18: Maize: Cost of Production, MSP And Unit Export Prices

(In Rs/Qtl)



Source: Price Policy for Kharif Crops (Various Issues)

Note: The International Prices are the unit prices of exports and are derived from dividing the value of the exports by the quantity of exports.

In the early nineties, the unit export prices of maize were comparable to the minimum support prices received by the farmers (Figure 18). With the opening up of global trade, unit export prices began to rise sharply in 2000-01, mainly due to a high export value accompanied by a decline in export volume. A massive slump followed this, and the three price series moved in close tandem. This pattern was interrupted again in 2019-20 with a significant surge in export prices, resulting from a decline in production in major maize-producing countries such as Argentina, Ukraine, and the USA (CACP, 2021-22).

In sum, it was observed that the Minimum Support Prices (MSP) that prevailed in the country were found to be much lower as compared to the prices prevailing in the international markets for the majority of the period under consideration. And were hence not "unsustainable" or inflated in the globally integrated world. It also opens up the vast potential of basmati rice exports in the global markets.

Conclusion

In summary, once hailed as the breadbasket of the country, Punjab's agricultural sector today is ailing and faces significant ecological and technological challenges. Most of these problems were attributed to the wheat-rice cropping pattern that was found to be extremely extractive and environmentally degrading. This paper set out to investigate these claims and explore the possibilities of the cultivation of paddy in Punjab. The Green Revolution led to a significant shift in irrigation patterns, from

canal irrigation to tube wells, and from the traditional maize-wheat cultivation to the more prevalent rice-wheat cultivation (Sarkar and Das, 2014). This was facilitated by the provision of rural electrification, free electricity, and input subsidies which have led to soil and environmental degradation, soil salinity, waterlogging, and unchecked extraction, resulting in plummeting groundwater levels (Chand, 1999). However, in the recent years there has been an improvement in the level of water extraction across a majority of the districts in Punjab along with a decline in the proportion of the overexploited blocks.

Under the current policy regime of high yields, coupled with subsidised inputs, assured procurement, and a favourable agricultural price policy, rice—a low-risk, low-value crop—will continue to be the most remunerative crop in Punjab, making it difficult to diversify away from paddy cultivation. Therefore, the sustainable approach to this problem would be allow for paddy cultivation in areas with rain water harvesting facilities supported by assured and regulated water for irrigation through dams and canals as per the crop requirements and expansion beyond the catchment areas.

In fact, unlike many other crops, the domestic procurement price or the minimum support price for rice is significantly lower than the price obtained in the international market. Hence, the experts recommend that Punjab, instead of diversifying away from rice, should focus on the production of basmati rice, which is not only less water-intensive and has a shorter cycle than the non-basmati variety but also has greater export potential and faces stiff competition from other WTO members (Govt of Punjab, 2013). However, these face stringent export restrictions due to the minimum residual limits of pesticides imposed by the European Union (Kallummal, 2017). Hence, this would require greater public investment in strengthening the research and extension services (Govt. of Punjab, 2023).

Many recent committees have suggested diversifying crops to include maize, pulses, oilseeds, and fruits and vegetables. Moreover, most of these crops seem like a viable option because of India's import dependence on these crops as well as the tendency of crops like pulses to enhance soil fertility and productivity by fixing nitrogen into the soil – this seems like an environment friendly approach to reduce the dependence on chemical fertilisers. However, in the absence of a requisite infrastructure, availability of good quality inputs at subsidised prices, assured and remunerative returns these recommendations do not hold much ground. The

challenges of paddy cultivation are further compounded by climate change, which can be mitigated through sustainable water management practices and the adoption of new, water-efficient varieties of rice, such as CR Dhan 801 and CR Dhan 802.

The threat of sustainability poses a significant challenge for paddy cultivation. However, shifting away from paddy cultivation itself is not feasible, as it supports the livelihood of a vast majority of the state and poses challenges to the nation's food security, especially given Punjab's significant contribution to the central pool and its critical role in ensuring food sovereignty in the country (Shergill, 2007, Kallummal, 2025). At the same time, ensuring agricultural sustainability is a fundamental precondition for the long-term viability of agriculture, sustaining farmer incomes, and addressing the broader issue of farmer welfare.

Thus, the agricultural strategy in Punjab must integrate agricultural viability with productivity and sustainability, in the form of resource conservation and environmental preservation, while ensuring remunerative returns to cultivators through greater public investment in better technology adoption and infrastructure, and also capital formation.

APPENDIX

Appendix Table 1: Agricultural Performance of Punjab

(Base TE 1969-70=100)

YEAR	NET AREA SOWN	CROPPING INTENSITY	AREA UNDER CROPS	YIELDS	CROPPING PATTERN	AGRICULTURAL PRODUCTION	PRODUCTIVITY PER HECTARE OF NET SOWN AREA
1980-81	107.87	118.94	128.29	138.84	102.43	171.52	173.7
1990-91	121.57	130.46	144.6	187.01	93.96	269.55	229.24
2000-01	122.13	137.83	153.98	220.78	98.19	332.02	298.79
2010-11	123	139.3	157.34	236.85	100.57	371.92	331.81
2015-16	122.91	140.59	158.08	235.54	103.88	370.63	344.02
2016-17	123.2	139.95	157.74	256.36	103.94	411.63	372.89
2017-18	123.2	140.66	158.92	262.03	105.62	426.73	389.27
2018-19	123.82	140.16	159.32	259.4	105.96	420.5	385.24
2019-20	124.49	140.78	159.86	253.06	106.53	414.37	379.54
2020-21	125.19	140.41	160.3	261.24	106.84	428.82	391.89
2021-22	124.8	139.43	160.1	240.9	106.64	397.94	358.17
2022-23 (P)	123.86	140	160.52	242.5	107.24	420.76	364.73

Source: Statistical Abstract of Punjab (Various Issues)

Appendix Table 2: District-wise Stage of Ground-water Extraction In Punjab

(in %)

DISTRICTS	1995	2011	2020	2024
Amritsar	107	180	167	177
Barnala		204	211	219
Bathinda		119	107	109
Faridkot		160	138	122
Fateh Garh Sahib		210	202	207
Fazilka			78	62
Ferozepur		147	133	111
Gurdaspur		127	124	136
Hoshiarpur		102	102	116
Jalandhar	178	231	257	255
Kapurthala	259	234	220	213
Ludhiana	123	167	211	222
Malerkotla				303
Mansa		208	154	103
Moga		202	250	229
Muktsar		69	43	23
Mohali		103		
Nawan Shahr		115	117	
Pathankot			53	51
Patiala	138	196	226	214
Ropar		110	100	
Rupnagar				96
S.A.S			105	127
SBS				122
Sangrur	150	283	301	313
Tarn Raran		182	193	192

Source: Central Ground Water Board of India, National Compilation on Dynamic Ground Water Resources of India, (Various Issues)

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