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Impact of green revolution on cropping intensity of Punjab

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Abstract
The Green Revolution (mid-1960s onward) transformed Punjab's agriculture through high-yielding varieties (HYVs), expanded irrigation, fertilizer and mechanization. One measurable outcome was a large rise in cropping intensity (gross cropped area ÷ net sown area × 100). This paper analyses its impact on cropping intensity—defined as the number of crops grown per unit area per year—and explores spatial and temporal trends using quantitative data, diagrams, and maps. This paper shows that cropping intensity rose from roughly 126 percent in 1960-61 to about 195 percent by 2020—reflecting near-double cropping of most cultivable land. The findings indicate a marked, sustained increase in crop intensity across Punjab after the late 1960s, in all parts of the state of Punjab. Gains coincided with near-universal irrigation, adoption of wheat and paddy HYVs, and rapid mechanization; however, they were accompanied by groundwater depletion, soil nutrient imbalance, and narrowing crop diversity.

Keywords: Green revolution, cropping intensity, Punjab, irrigation, HYV seeds, mechanization, gross cropped area, net sown area

Introduction
Punjab, often called the "Granary of India," was the epicenter of the Green Revolution. With 83% of its land under agriculture, the state saw a dramatic shift in cropping patterns, particularly toward wheat and rice monoculture. Punjab has been central to India's Green Revolution since the late 1960s. The diffusion of HYV seeds, assured irrigation, chemical fertilizers, pesticides, credit, procurement at minimum support prices (MSP), and mechanization jointly increased yields and allowed multiple crops per year on the same land. Crop intensity—defined as the ratio of gross cropped area to net sown area—captures the extent of multiple cropping and land use intensification. This paper quantifies and explains the rise of crop intensity in Punjab, and discusses long-run sustainability.

Research Objectives
- Quantify change in cropping intensity across selected benchmark years.
- Identify main drivers (irrigation, HYVs, policy).
- Discuss agronomic, environmental and policy implications.

Data Source and Methodology
- **Data Sources:** Secondary published data from Punjab state statistical abstracts, Agro-Economic Research Centre (PAU) state profile, peer-reviewed analyses and aggregated studies that compile Statistical Abstract figures. Key sources used: AERC (PAU) state profile and Statistical Abstract-derived summaries, academic papers and compiled trend figures has been used for present research.
- **Methodology:** We compiled reported values of cropping intensity (%) from 1960's to 2020, for the decades (1960, 1970, 1980, 1990, 2000, 2010, 2020). Cropping intensity is reported by the sources as (Gross Cropped Area / Net Sown Area) × 100. We present the tabulated series and plot the trend to illustrate the long-term rise associated with the Green Revolution and subsequent decades.

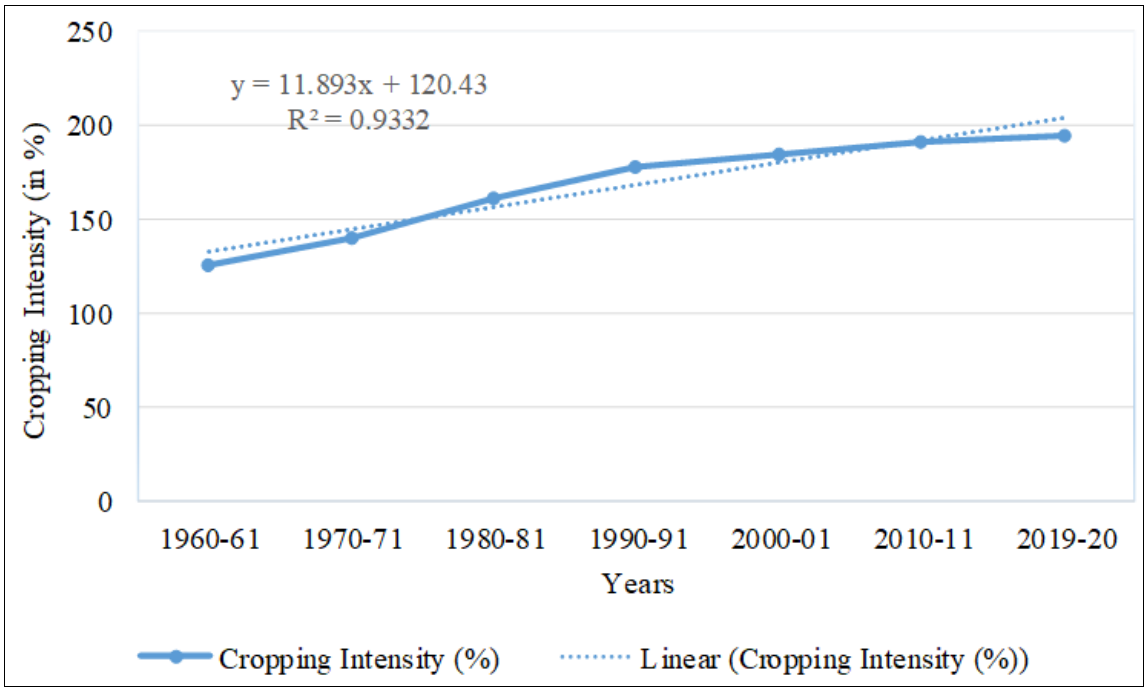
Discussion
The Green Revolution's package raised Cropping Intensity (CI) by converting single-crop systems into double-cropped wheat-paddy rotations on most irrigated land. While Cropping Intensity gains contributed to food security and rural incomes, they interacted with

institutions (MSP, free/flat-rate power for tubewells) to favor water-intensive crops. The state of Punjab experienced very rapid positive change in the Cropping Intensity with the introduction of Green Revolution technology, from 1960's to 2020.

Table 1: Cropping Intensity (in Percentage) in State of Punjab From 1960-61 to 2019-2020.

Year	Cropping Intensity (%)
1960-61	126
1970-71	140
1980-81	161
1990-91	178
2000-01	185
2010-11	191
2019-20	195

Source: S.A.P. 1961, 1971, 1981, 1991, 2001, 2011, 2020



Source: S.A.P. 1961, 1971, 1981, 1991, 2001, 2011, 2020

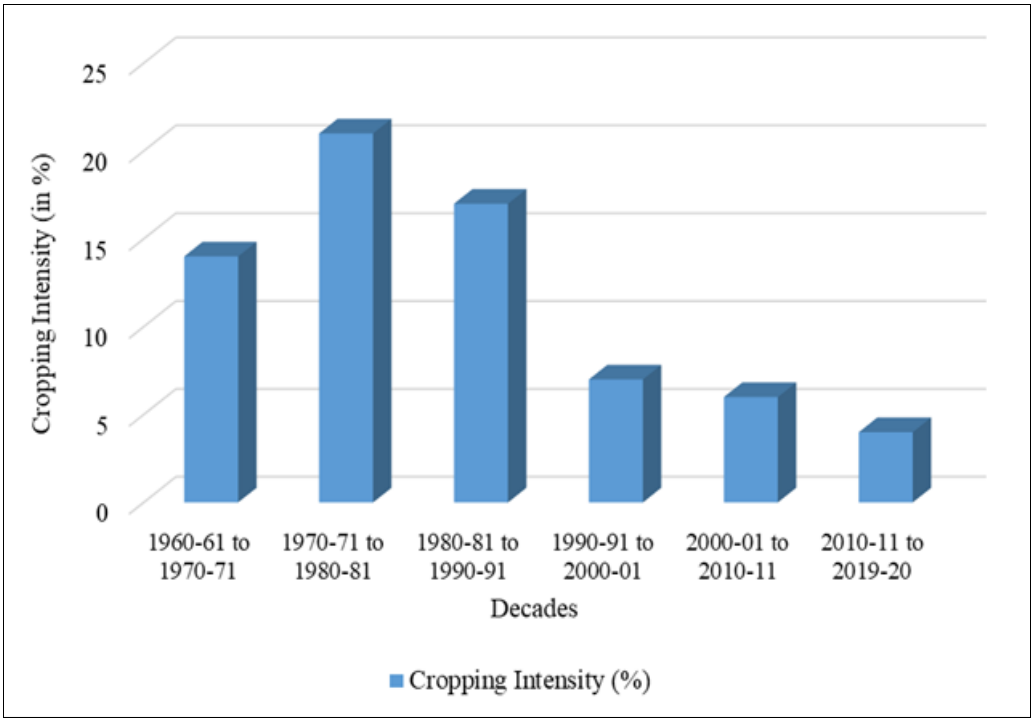
Fig 1: Cropping Intensity (in Percentage) in State of Punjab From 1960-61 to 2019-2020.

Table 2: Change in Cropping Intensity (in Percentage) in State of Punjab from 1960-61 to 2019-2020.

Decades	Cropping Intensity (%)
1960-61 to 1970-71	+14
1970-71 to 1980-81	+21
1980-81 to 1990-91	+17
1990-91 to 2000-01	+7
2000-01 to 2010-11	+6
2010-11 to 2019-20	+4
Overall Change	+69

Source: S.A.P. 1961, 1971, 1981, 1991, 2001, 2011, 2020

Table 1, and figure 1, shows that cropping Intensity (CI) shows an increasing trend in the state of Punjab during the study period. Cropping intensity was recorded 126 percent during the decade of 1960-61, that is the pre-Green Revolution period. But after the introduction of Green Revolution, cropping intensity dramatically increase during the next three decades, and recorded 178 percent during the decade of 1990-91. Cropping intensity recorded 52 percent increase in these initial decades of Green Revolution, in the State of Punjab. Figure 1 also shows that, upto 1990-91 the change in cropping intensity has more than the average trend line of change in state of Punjab.



Source: S.A.P. 1961, 1971, 1981, 1991, 2001, 2011, 2020

Fig 2: Change in Cropping Intensity (in Percentage) in State of Punjab From 1960-61 to 2019-2020.

In the next decades the Cropping intensity also shows an increasing trend, but the rate of increase is slowing down in every decade after 1990-91. The state of Punjab has recorded only 17 percent increase in Cropping Intensity (CI) during next three decades, that is from 1990-91to 2019-20, shown in the figure 2. Overall Punjab has recorded 69 percent increase in the cropping intensity, from pre-Green Revolution period to 2019-20, shown in table 2. The main cause behind the increase in cropping intensity is that the land put to non-agricultural land use is increasing with increase in population and the area under fallow land, barren land and uncultivable land is declining. Thus, the further expansion of area horizontally is extremely limited in Punjab and this has led to intense cropping on the land. Cropping Intensity can be analyzed by keeping in mind that its spatio-temporal variation is dependent upon numerous physical, economic and technological factors like topography, agriculturally suitable climate, soil fertility, availability of irrigation facilities, size of land holding, role of farm mechanization, produce marketing facilities and the economic status of the farmers.

Drivers of Increased Cropping Intensity (CI) in the State of Punjab

- **Expansion of Irrigational Facilities (tube wells + canal):** Near to the whole agricultural land under irrigation in Punjab (99% of net sown area irrigated in recent decades) enabled reliable for double-cropping. Large increases in private tube wells (from tens of thousands to more than 14 lakh tube wells by 2019-20) supported this cropping intensification in the state of Punjab.
- **Adoption of HYV seeds and inputs**: Rapid adoption of HYVs of wheat and rice varieties raised per-season yields and made multiple crops per year economically attractive.
- **Government Policy supports (MSP, procurement, electricity):** Minimum support prices, procurement mechanisms and subsidized/free electricity for pumping reduced risks and promoted rice-wheat specialization and higher cropping intensity.
- **Mechanization & commercialization:** Mechanization (tractors, combine harvesters) reduced labor/time constraints, enabling tighter crop rotations and faster turnaround between crops.

Consequences of Increase in Crop Intensity

a. Positive Outcomes

- Large increases in cereal production and food security contribution (Punjab became a national breadbasket).
- Higher yields per hectare and farm incomes (for many landholders, especially in early decades).

b. Negative Outcomes (Environmental & socio-economic costs)

- Intensive paddy cultivation and pump irrigation led to fast drawdown of groundwater levels; annual water demand exceeded natural renewable supplies.
- Heavy fertilizer/pesticide use and monoculture reduced soil health and increased production costs/risks.
- Rice-wheat dominance reduced area under pulses, oilseeds, coarse cereals and horticulture—affecting dietary diversity and resilience.
- Yield growth slowed in later decades; structural challenges for smallholders and agrarian distress have been documented.

Recommendation

a) Promote crop diversification (maize, millets, pulses, horticulture) with assured markets and incentives to reduce groundwater stress and improve nutrition.
b) Incentivize less water-intensive crops, direct sowing of rice (DSR), and use of sprinkle irrigation, etc.
c) Shift from blanket electricity subsidies to metered and

targeted approaches, assured Minnimum Support Price (MSP) on diversified crops, other than wheat-rice monocrops.

d) Strengthen soil health cards, integrated pest management, and farmer advisory to sustain productivity without degrading resources.

Conclusion

The Green Revolution brought a profound transformation in Punjab's agricultural landscape, with cropping intensity emerging as one of its most visible outcomes. Before the 1960s, Punjab's farmers largely relied on single cropping due to limited irrigation and traditional practices. With the introduction of high-yielding varieties of wheat and rice, widespread tube-well irrigation, mechanization, and government procurement policies, the state rapidly shifted towards a rice-wheat double-cropping system. As a result, cropping intensity increased dramatically, surpassing the national average and stabilizing at some of the highest levels in India. The Green Revolution radically increased cropping intensity in Punjab (roughly from 126 percent in 1960-61 to 195 percent by the 2020s).

This expansion of multiple cropping ensured Punjab's position as the "food bowl of India," significantly enhancing food security and rural incomes. At the same time, it led to heavy dependence on water-intensive paddy, extensive use of fertilizers, and intensive land use, creating long-term sustainability challenges. Overall, the Green Revolution firmly established high cropping intensity as a hallmark of Punjab's agriculture, yielding remarkable production gains but also underscoring the urgent need for diversification and sustainable practices in the future.

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