

Comparative Economic Analysis of Maize Cultivation Practices in Sub-Mountainous Punjab and Himachal Pradesh

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Abstract

To understand regional differences in maize production, a comparative survey was conducted in adjoining areas of Punjab and Himachal Pradesh (H.P.). The primary data were collected from farmers in the districts of Ropar, Bilaspur, Una and Solan districts. In terms of variety selection, the most popular hybrids among farmers were Dekalb 9144 in Punjab and HiShell in H.P.. Among the cultivated varieties, Dekalb 9144 recorded the highest yield in both states, with 20.4 q/acre in Punjab and 18.8 q/acre in H.P. In both the states date of sowing did not show any significant effect on the yield in either state, although a large proportion of farmers preferred sowing later than the recommended date. Seed rate significantly influenced yield, but the yields at the recommended and higher-than-recommended seed rates were statistically similar in both states. Sowing method also affected productivity, with drill-sown maize achieving the highest yields—19.7 q/acre in Punjab and 17.0 q/acre in H.P. In Punjab, the number of irrigations ranged from 2 to 4, with most farmers applying three irrigations, whereas in H.P. it ranged from 0 to 2, with a large share of farmers cultivating maize under rainfed conditions. Overall economic analysis revealed that Punjab farmers attain better benefit cost ratio (2.07), as compared to H.P. (1.75). Based on these findings, there is a need to encourage timely sowing, promote drill-sowing methods, and strengthen extension support to optimize seed rates and irrigation practices to enhance maize productivity across both states.

Keywords: Comparative analysis, Economics, Maize, Himachal, Punjab

JEL Classifications: Q01, Q12, Q18, O13

Introduction

Maize which is often regarded as ‘Queen of cereals’, is the third largest food crop in India after rice and wheat. Apart from being used as maize grains can be used for various purposes such as feed for poultry, fodder for cattle, making starch, sweet corn, and several other industrial products. Out of 125 developing nations, 75 consider maize as a staple crop, and 70 per cent of the production comes from small land holdings (FAOSTAT, 2021a). Indian agriculture is mainly dominated by small and marginal farmers. Whereas in Punjab, majority of farmers are semi-medium and medium (62%), small and medium scale farmers account for 33 per cent, and large-scale farmers are 5.28 per cent (Gulati et al., 2021). In the adjoining state of H.P., majority of the farmers belong to marginal category (69.78%), followed by small (18.17%), semi-medium (8.84%), medium (2.87%), and large (0.34%) scale farmers (Anonymous, 2023). In Punjab, Ropar district is shares it border with H.P. in the North and North-East. Maize

is cultivated widely in the areas adjoining Himachal Pradesh in Ropar district. Conventional maize production areas of H.P. include Mandi, Chamba, Solan, Kangra, Bilaspur, Hamirpur, Kullu and Sirmour districts (Yadav et al., 2015). Some of the challenges faced by the farmers in one state influence the same in other state also. This is evident from the spread of Fall Armyworm (FAW), where FAW appeared in Punjab during 2019 and in 2020 spread to district Una of the H.P. which is adjoining to Punjab (Thakur and Sharma, 2024).

Maize cultivation in Punjab and Himachal Pradesh reflects a dynamic interaction of geography, climate, soil conditions, and local farming practices. The present study, “Economic analysis of Maize Cultivation Practices in Sub-mountainous Punjab and H.P.”, is important as maize is a strategic crop for food, feed, and livelihood security in these ecologically sensitive regions, where small and marginal farmers rely heavily on it. Despite its significance, there is limited empirical evidence on the diverse cultivation practices adopted under varying agro-climatic conditions of the sub- mountainous belts. This study is planned to fill that

gap by systematically analyzing varietal selection, sowing methods, irrigation methods, fertilization schedule, insect pests and disease management to understand their impact on productivity, profitability, and sustainability. It is particularly relevant in the context of ongoing policy efforts to promote maize as an alternative to paddy in Punjab and as a sustainable hill crop in H.P., thereby contributing to crop diversification and climate resilience. Hence, a survey study was conducted to assess the cultivation practices and challenges faced by farmers in Punjab and Himachal Pradesh. The novelty of this research lies in its comparative approach across two distinct states, its focus on practice-based evaluation rather than only yields or economics, and its potential to generate evidence-based recommendations for region-specific interventions and policy planning.

Data Sources and Methodology

The study is based on primary data collected during 2023 to analyze maize cultivation practices in the adjoining areas of Punjab and H.P. A field survey was conducted in Ropar district of Punjab and Una district of the H.P. — two major maize-growing districts of their respective states (Kalia and Dhindsa, 2021; Anonymous, 2018). A total of 100 maize farmers, comprising 50 from each state, were selected for data collection using a purposive sampling approach. Information was gathered on various aspects of maize cultivation, including variety preference, seed rate,

plant protection measures, sowing methods, and irrigation practices. Table 1 outlines the major recommended practices for cultivation of maize crop in both the states by respective State Agriculture Universities (SAUs).

These recommended practices were considered as benchmark for analysing the farmers' practices. The mean data on yield was subjected to ANOVA in SPSS statistic 20, with post-hoc Duncan's Multiple Range Test (DMRT). Comparative economic analysis was performed on the basis of variable costs involved in production (Anonymous, 2025), working out gross returns on basis of market rate of the produce, calculating net returns by subtracting variable cost from gross returns, and finally working out benefit cost ratio by dividing net returns by variable cost.

Results and Discussion

The results and discussion have been organized into sub-sections covering variety preferences, sowing practices, sowing methods, plant protection measures adopted by the farmers and irrigation patterns. This structure facilitates a comparative understanding of maize cultivation trends between Punjab and H.P.

Selection of variety

Variety selection plays a critical role in determining the productivity and profitability of maize farms, as it reflects the adaptability of cultivars to the local environment.

Table 1: Recommendations for improved maize cultivation in Punjab and Himachal Pradesh

S. No.	Cultivation practice	Punjab	Himachal Pradesh
I.	Variety/ Hybrid	PMH 13, ADV 9293, JC 12, PMH 11, PMH 1, JC 4, PMH 2, Punjab baby corn 1 Punjab sweet corn 1, Pearl popcorn	Girija compost, Bajaura maize, HQPM-1, PMZ-4, Bajaura popcorn, Bajaura sweet corn, Palam Shankar Maize- 2
II.	Time of sowing	Last week of May to end of June	Upper hills- mid May to first week of June Mid hills- 20 May to mid June Lower hills- mid June to end June
III.	Weed management	Atrazine, Tembotrione, 2,4-D amine salt 58 SL	Basalin
IV	Water management	4-6 irrigations are required depending on the rainfall	Rainfed In event of no rainfall at the time of silking and tasseling then give one irrigation Mulching to conserve soil moisture and irrigation at tasselling and silking stage
V.	Nutrient management	35-50 kg N per acre 12-24 kg P ₂ O ₅ per acre 8-12 kg K ₂ O per acre	Low rainfall areas: 24-36 kg N per acre 12-18 kg P ₂ O ₅ per acre 8-12 kg K ₂ O per acre High rainfall areas: 32-48 kg N per acre 16-24 kg P ₂ O ₅ per acre 12-16 kg K ₂ O per acre

Farmers typically consider factors such as pest and disease tolerance, yield potential, and end use whether for human consumption or animal feed when selecting varieties. In this context figures 1 (a and b) and 2 (a and b) represent share of different cultivars under cultivation in Punjab and Himachal Pradesh, respectively. In Punjab, Dekalb 9144 was the most popular variety followed by Dekalb 8164, while in Himachal Pradesh also most farmers preferred Dekalb 9144 variety followed by HiShell in terms of area under cultivation. Additionally, a small proportion of farmers in both the states also grow indigenous maize varieties, which are well adapted to the local conditions and considered superior for human consumption .

A comparison of yields across different varieties, Dekalb 9144 emerged as high yielding variety with 20.4 q/acre , significantly outperforming other varieties whose yields ranged between 15 and 19 q/acre (Table 2). A similar pattern was observed in Himachal Pradesh, where Dekalb 9144 also recorded the highest yield at 18.8 q/acre, followed by NK 7750 at 17.3 q/acre; both these yields were significantly different from each other and higher than those of the remaining varieties.

Indigenous maize varieties recorded the lowest yield

at 8.7 q/acre, indicating a substantial yield gap compared with improved hybrids. The consistently lower yields in H.P., despite cultivation of the same high-yielding varieties, underline the need for region-specific agronomic interventions and policy support to address environmental and resource constraints. This disparity can be attributed to the environment of Una district in HP, which is characterized by undulating topography, low mountains, low to moderate rainfall, high temperatures, and limited irrigation facilities. These factors have led to the widespread cultivation of maize but also result in lower soil fertility and, consequently, a lower yield index (Kaur et al., 2022).

Regarding the source of seed, majority of the respondent farmers (92%) in Punjab depend upon the private dealers, while 8 per cent obtain from State Agriculture Department (Fig. 3). In contrast, in H.P. all of the surveyed farmers were relied entirely on private dealers for their maize seed requirements .

Time of Sowing

In both the states, the majority of farmers sow maize later than recommended indicated in package of practices for the crop (Fig. 4), as most farmers initiate sowing with the onset of the monsoon For further analysis, sowing time was

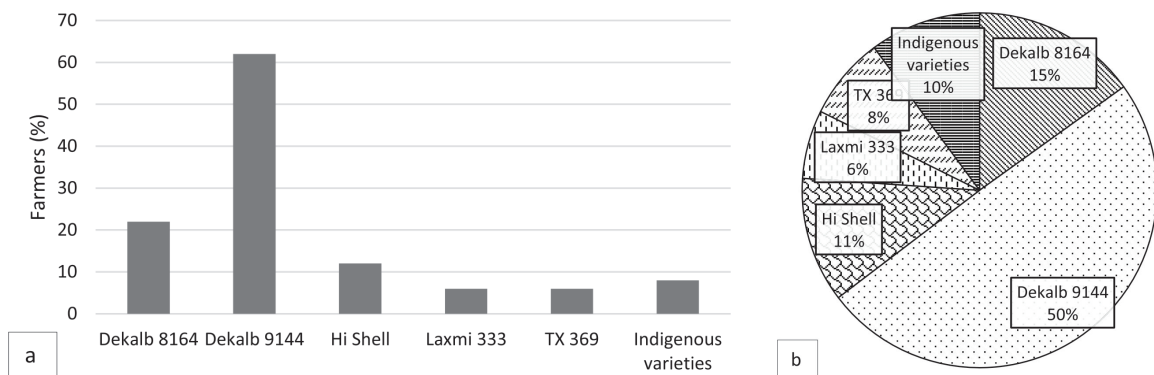


Fig. 1. Popular maize varieties among farmers of Punjab in terms of number (a) and area (b)

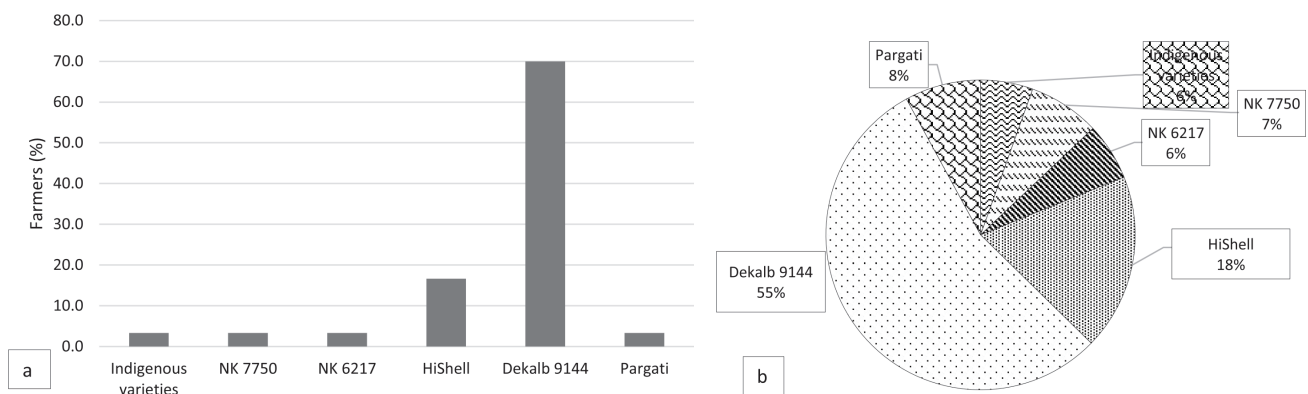
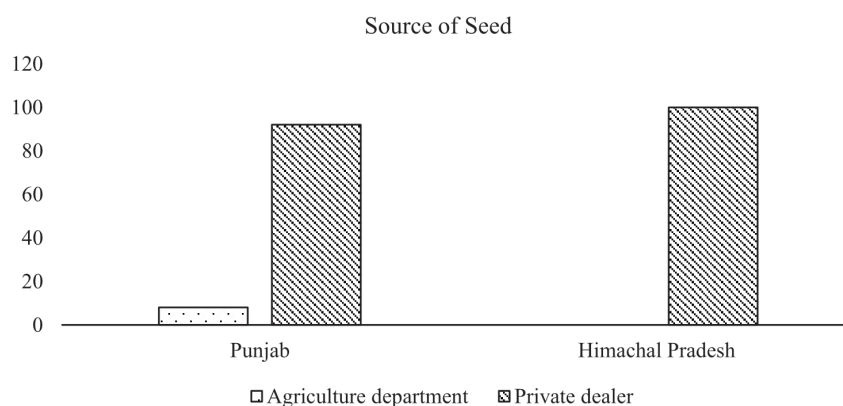


Fig. 2. Popular maize varieties among farmers of Himachal Pradesh in terms of number (a) and area (b)

Table 2: Yield (q/acre) of different varieties in Punjab and Himachal Pradesh

Variety	Punjab	Variety	Himachal Pradesh
Dekalb 8164	19.0 ^{ab}	Indigenous varieties	8.7 ^c
Dekalb 9144	20.4 ^a	NK 7750	17.3 ^{ab}
HiShell	18.8 ^{ab}	Dekalb 9144	18.8 ^a
Laxmi 333	18.3 ^{ab}	NK 6217	16.4 ^{ab}
TX 369	18.0 ^b	HiShell	16.3 ^{ab}
Indigenous varieties	15.4 ^c	Pragati	14.3 ^b
Mean	18.31	Mean	15.5

Note: Mean values followed by different alphabets differ significantly at $p=0.05$

**Fig. 3 Source of seed purchase by the farmers**

classified into three categories—early sown, recommended time, and late sown based on the guidelines as presented in Table 1. In case of H.P., lower hills region was considered as recommended sowing time because the surveyed areas lie in this region. Time of sowing had no significant effect on yield of maize in surveyed farmers of Punjab with 18.6, 19.2, and 19.6 q/acre yield in early sown, recommended time, and late sown crop, respectively (Table 3). In Himachal Pradesh, maize sown at recommended time had highest yield (16.6 q/acre) which was statistically similar to late sown (16.2 q/acre), and both of these were significantly higher than the early sown maize (12.8 q/acre).

Seed Rate

Seed rate had a significant influence over yield of maize at both the states with highest and statistically similar yield with seed rate at recommended and higher than recommended levels (Table 4). In Punjab, yield at recommended and higher than recommended seed rate was 19.7 and 19.6 q/acre, while in Himachal Pradesh these values were 16.6 and 17.2 q/acre, respectively. These figures emphasize the importance of using recommended seed rates as higher ones have no significant impact in increasing the yield. This approach will be crucial in proper crop management as well as in reducing cost of

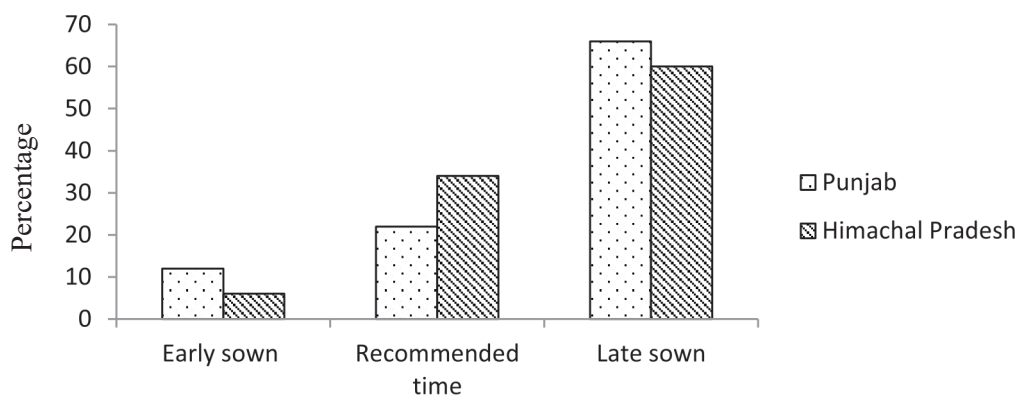
**Fig. 4 Percentage of farmers sowing maize at different times**

Table 3: Effect of sowing date on yield of maize

Time of sowing	Punjab	Himachal Pradesh
Early sown	18.6 ^a	12.8 ^b
Recommended time	19.2 ^a	16.6 ^a
Late sown	19.6 ^a	16.2 ^a
Mean	19.1	15.5

Note: Mean values followed by different alphabets differ significantly at $p=0.05$

Table 4: Effect of seed rate on yield of maize

Seed rate	Punjab	Himachal Pradesh
Less than recommended	16.3 ^b	11.2 ^b
Recommended	19.7 ^a	16.6 ^a
Higher than recommended	19.8 ^a	17.2 ^a
Mean	18.8	15.5

Note: Mean values followed by different alphabets differ significantly at $p=0.05$

production involved in purchase of seed.

Method of Sowing

Two main methods followed by farmers at both states is broadcasting and through seed drill (Fig. 5). Method of sowing also influenced the maize yield with the highest yield obtained under drill sown maize both in Punjab (19.7 q/acre) and H.P. (17 q/acre) in Table 5. In case of broadcasting method of sowing, the seed distribution is uneven where some places have dense plant stand while others have sparse plants (Kaur and Vashist, 2016, Sharma and Saxena, 2022, Bagula et al., 2022). This uneven distribution of plants in field affects utilization of resources as well as poses difficulty in farm operations. Without proper management the plant growth and yield are affected, when compared with drill sowing where seed placed at proper depth and at proper spacing facilitates best resource utilization, optimum plant growth, reduced lodging, and ease in farm operations.

Plant Protection

Insect pests and weed management are two important aspects of plant protection operations in maize. For insect pest management, farmers mostly rely on insecticide sprays (Fig. 6). Most of the surveyed farmers of Punjab went for 1-3 sprays for controlling insect population, while Himachal Pradesh farmers didn't go for more than 2 sprays for insect pest management. A very small proportion of farmers (5%) gave no pesticide application for insect pest control.

Weed management in maize is done through chemical means as well as cultural methods in fig. 7. A small percentage of farmers (6%) in Himachal Pradesh practised hand hoeing for weed management while a considerable share of farmers (44%) did not opt for any method of weed management. In contrast no farmer of Punjab opted for cultural method of weed control. Atrazine and Laudis were popular chemicals for weed management in both states, with the latter being most widely used.

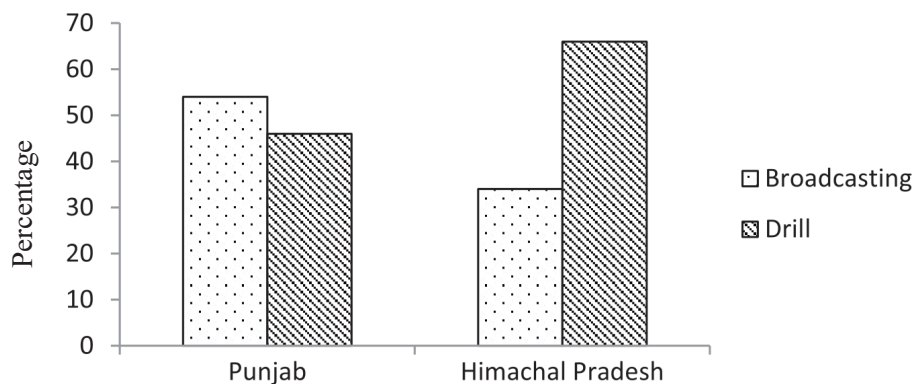
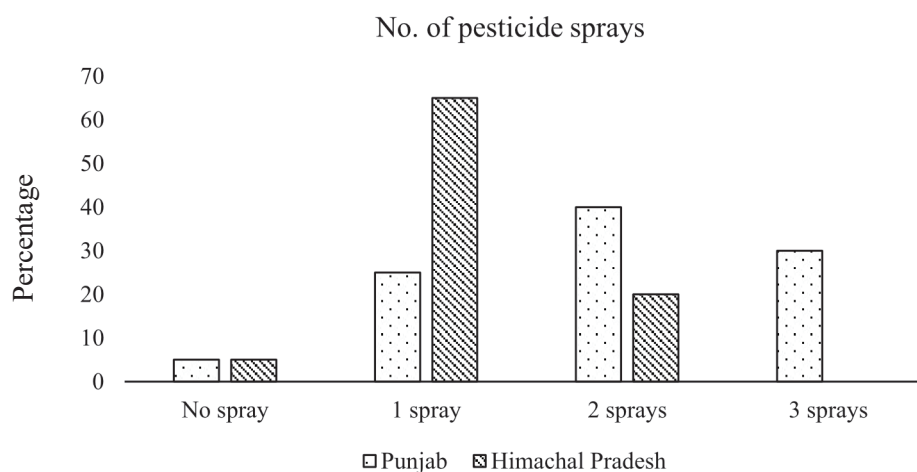
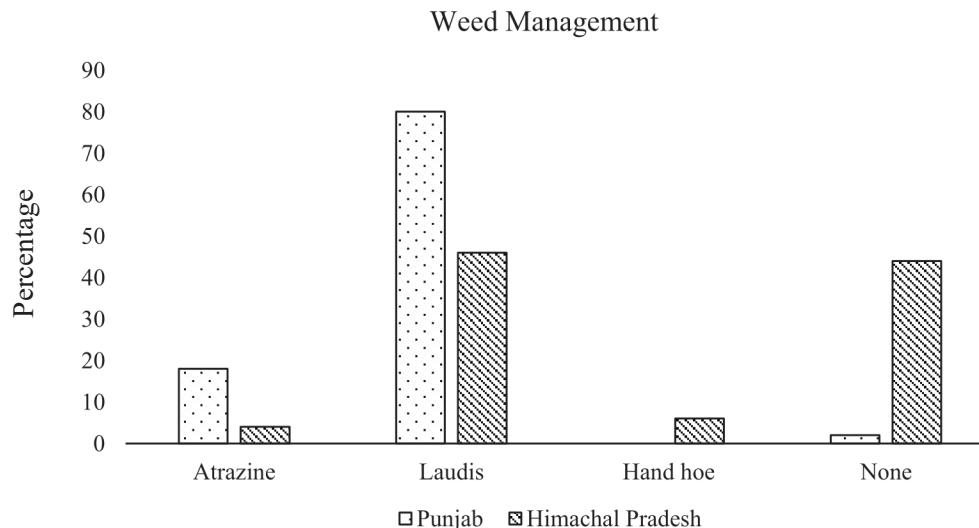


Fig. 5 Sowing method of maize adopted by farmers of Punjab and Himachal Pradesh

Table 5: Effect of method of sowing on yield of maize

Method of sowing	Punjab	Himachal Pradesh
Broadcast	17.5 ^b	13.9 ^b
Drill	19.7 ^a	17.0 ^a
Mean	18.8	15.5

Note: Mean values followed by different alphabets differ significantly at $p=0.05$

**Fig. 6 Number of pesticide sprays by farmers to manage insect pests****Fig. 7 Weed management practices in maize fields**

Irrigation

In Punjab maize is raised as an irrigated crop, while in Himachal Pradesh it is mostly raised as a rainfed crop with irrigation application on need basis at critical growth stages of crop. Most of the farmers in Punjab (70%) gave three irrigations to the crop (Fig. 8). On the other hand, in Himachal Pradesh most of the farmers (70%) did not give any irrigation to the crop, while small share of farmers gave

single irrigation (25%) or two irrigations (5%) on need basis.

Comparative costs and return structure of maize in Punjab vis-à-vis Himachal Pradesh

The comparative analysis of maize production in Punjab and Himachal Pradesh is presented in Table 6. Variable cost is higher in Punjab (Rs. 13,525) as compared to H.P.(Rs. 11,720), but owing to higher grain yield (18.8 q/ acre) and better market price (Rs. 2,210), gross returns are higher in

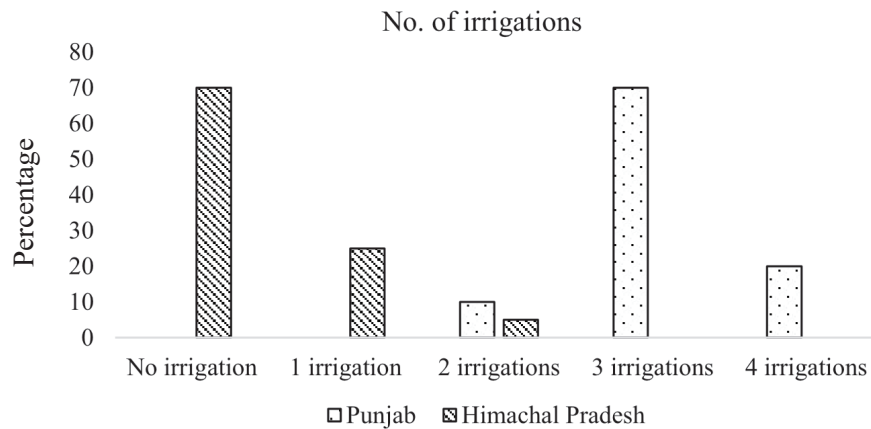


Fig. 8 Number of irrigations in maize fields

Table 6: Comparative economic analysis of production practices in Punjab and Himachal Pradesh

Parameter	Punjab	Himachal Pradesh
Variable Cost (Rs./ acre)	13,525	11,720
Grain yield (q/ acre)	18.8	15.5
Rate (Rs./ quintal)	2,210	2,080
Gross Returns (Rs./ acre)	41,548	32,240
Net Returns (Rs./ acre)	28,023	20,520
Benefit Cost Ratio	2.07 : 1	1.75 : 1

Punjab (Rs. 41,549/-). Upon further analysis, benefit cost ratio was higher in Punjab (2.07) as compared to H.P. (1.75).

Conclusions and Policy Implications

The maize cultivation practices in adjoining areas of Punjab and H.P. were found to be quite diverse in aspects of seed rate, time of sowing, weed control etc. The major differences were in case of method of sowing where share of farmers opting for drill sowing was higher in H.P. than in Punjab. Also farmers in H.P. largely depended on rainfall as mode of irrigation, with small share of farmers going for 1-2 irrigation on need basis. Easy availability of irrigation facilities in Punjab leads to farmers applying two-four irrigations in Punjab, than just depending on rainfall. A large proportion of H.P. farmers (50%) opted for cultural methods of weed control or no weed control at all. While their counterparts in Punjab cent per cent depended on herbicides for weed control. Overall, it can be concluded that timely sowing, proper seed rate, drill sowing, and optimized irrigation schedule can aid in getting highest productivity out of maize cultivation. Such comparative studies can help in picking out best and ecologically sound, and area specific practices for achieving sustainable crop production.

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