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AGRICULTURAL TRENDS, CHALLENGES, AND CAPITAL INPUTS IN HIMACHAL PRADESH: A COMPREHENSIVE ANALYSIS (2000-01 TO 2020-21)

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Abstract: The study provides a detailed analysis of agricultural trends in Himachal Pradesh, focusing on high-yielding crop areas, fertilizer consumption, plant protection programs, and irrigation sources over different periods from 2000-01 to 2020-21. The research reveals structural stagnation in the dominance of wheat, maize, rice, and barley in high-yielding varieties, indicating limited diversification in crop choices. Fertilizer consumption patterns showcase fluctuations, with varying growth rates and changes in the use of nitrogen, phosphorus, and potassium fertilizers. The plant protection program has shifted towards biological controls, leading to a decline in the area covered and pesticide distribution. The irrigation scenario, crucial for agricultural growth, displays a consistent reliance on traditional sources like canals/kulhs and well/tube-wells, with limited growth in newer sources like tanks. Despite efforts to expand irrigation infrastructure, certain sources experienced decline, impacting agricultural practices. The study underscores the challenges and limited dynamism in Himachal Pradesh's agricultural sector. Structural stagnation is evident in crop choices, fertilizer consumption, plant protection strategies, and irrigation sources. The findings emphasize the need for comprehensive agricultural policies that promote diversification, sustainable pesticide use, and innovative irrigation methods to enhance agricultural productivity and resilience in the face of changing environmental and market dynamics.

Keywords: *High-Yielding Varieties, Fertilizer, Irrigation, Pesticide and Plant Protection.*

INTRODUCTION

The agricultural sector in Himachal Pradesh has undergone substantial transformations, marked by the widespread adoption of modern farming techniques and technologies. The introduction of High-Yielding Varieties (HYVs), coupled with the extensive use of fertilizers, has led to increased agricultural productivity in the state. Additionally, the expansion of irrigation facilities has played a crucial role in ensuring water availability for crops, enhancing agricultural output. However, these advancements have also brought challenges, particularly in the form of heightened reliance on pesticides, necessitating a careful balance between increased productivity and environmental sustainability. These changes underscore the dynamic nature of Himachal Pradesh's agricultural landscape and highlight the need for sustainable practices to ensure long-term food security and environmental preservation in the region. Dayal (1984) highlighted regional land productivity variations in India, attributing them to physical and environmental factors. His study emphasized that factors like fertilizer and irrigation positively impact productivity, while population has a negative effect. To enhance productivity, technological advancements and increased input use are essential. Singh and Nadda (1995) studied modern agricultural inputs in Himachal Pradesh. They found increased use of high-yielding variety (HYV) seeds in maize, wheat, and paddy crops: maize +51%, wheat +27%, paddy +33%. Fertilizer consumption rose from 10.56 kg to 40 kg per hectare. However, actual input rates differed from recommendations, indicating potential for increased productivity. Crop distribution: maize 22%, wheat 85%, vegetables 75%, paddy 14%. 44% of sample farmers used HYV seeds. Badal and Singh (2001) conducted a study in Bihar, India, comparing local and high-yielding variety (HYV) maize production. They found that HYV technology led to significant increases in maize productivity. In the Kharif season, switching to HYV maize increased income by 30%, with 30% attributed to technological change. In the Rabi season, income increased by 45%, with 45% due to technological change and 35% due to higher input utilization. Bhalla and Singh (2001) noted that the introduction of HYV technology in the 1960s, initially in northwestern India, led to a Green Revolution, increasing crop production and changing the agricultural landscape. Kumar, N. (2019) highlighted that Punjab's farming is heavily reliant on capital-intensive methods, including the use of machinery, high-yielding seeds, pesticides, and fertilizers. While these technologies have increased agricultural production, they have also made farming more capital-intensive. As a result, Punjab farmers are experiencing stagnant agricultural production, and their expenses on agricultural inputs continue to rise. This situation is leading to financial challenges for the farming community. Kumar's paper focuses on various

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aspects of Punjab's agriculture, such as operational land holdings, productivity, sources of irrigation, marketing of agricultural products, and the shift from labor-intensive to capital-intensive farming. The study by Baweja, P., et al. (2020) highlights the heavy reliance on fertilizers and pesticides in global agricultural practices to meet food demands, despite their harmful effects on the environment and human health. In response, sustainable agriculture has emerged as a viable solution, advocating for eco-friendly methods such as organic farming, bio-fertilizers, composting, and bio-control agents. These approaches aim to mitigate the adverse impacts of harsh chemicals, promoting both environmental conservation and healthier farming practices. El-Sayed and El-Hendawy S. (2021) highlights the vital role of fertilizers in agriculture. Natural or chemical, they replenish essential nutrients, enhancing soil fertility and promoting robust plant growth. Fertilizers also improve soil quality, aiding aeration and water retention for higher agricultural productivity. Pesticides, including herbicides, protect crops from pests and weeds, ensuring crop safety and affordable food prices. Fertilizers provide plant nutrients, and pesticides prevent widespread damage, underlining their importance in global food production. In a study conducted by Du Q-J (2021), a microporous membrane water-fertilizer integration system was tested for tomato plants under non-pressure gravity irrigation. Different fertilizer application rates (ranging from 840 kg/ha to 1875 kg/ha) were compared, with 840 kg/ha showing optimal results. This approach not only reduced fertilizer usage but also promoted early and intermediate stage growth, maintaining soil productivity and improving tomato quality. The finding suggests that non-pressure gravity irrigation with a fertilizer rate of 840 kg/ha is a cost-effective method for tomato cultivation.

OBJECTIVES OF THE STUDY

- To analyze the shifts in high-yielding crop cultivation.
- To examine changes in fertilizer consumption and distribution patterns.
- To examine the trends and shifts in the distribution of pesticides.
- To evaluate the role of different irrigation sources in agricultural development.
- To Assess the Influence of Government Policies and Interventions on Crop Selection, Fertilizer Usage, Pesticide Distribution, and Irrigation Practices.

DATA AND METHODOLOGY OF THE STUDY

The research relies on the most up-to-date information found in numerous census publications pertaining to Himachal Pradesh. These data sources encompass statistical abstracts of Districts and Himachal Pradesh, Directorate of Agriculture Department, Directorate of land records, and Economic Survey reports. The study involves the computation of averages, coefficients of variation in the context of high-yielding crop varieties, irrigation, as well as the usage of fertilizers and pesticides/chemicals within the state of Himachal Pradesh.

RESULTS AND DISCUSSION

The Use of Seeds: The utilization of seeds in Indian agriculture is well-recognized by farmers, as the adoption of improved seeds can lead to a notable enhancement of 10 to 20 percent in crop production. However, there is a prevalent practice among farmers to employ seeds of subpar quality. This can be attributed to two primary factors. Firstly, high-quality seeds, reserved for sowing purposes, are often depleted during the off-season. Secondly, good seeds tend to deteriorate due to inadequate storage conditions. In response to this situation, the Indian Agricultural Department and the Indian Council of Agricultural Research have made substantial efforts in developing and promoting improved seed varieties that are resistant to diseases and well-suited to various local conditions.

Table-1.1: Area under Different High Yielding Crops As A Percentage of Total Area Under These Crops

Area under HYVs/Periods	2000-01 to 2006-07	2006-07 to 2013-14	2014-15 to 2020-21
Wheat	49.24	49.62	49.22
Maize	38.19	38.92	37.98
Rice	11.04	9.23	10.80
Barley	1.53	2.23	2.00
Total	100.00	100.00	100.00

Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Agriculture in Himachal Pradesh across various years.
3.) Statistical Abstract of Himachal Pradesh from various years.

Table 1.1 shows the distribution of high-yielding crop areas as a percentage of the total cultivated area. In the period from 2000-01 to 2006-07, 49.24% of the total area under wheat cultivation in Himachal Pradesh was dedicated to high-yielding varieties (HYVs). This percentage slightly increased to 49.62% in the period from 2006-07 to 2013-14 and then decreased to 49.22% in the period from 2014-15 to 2020-21. High-yielding varieties of crops are developed to produce higher yields compared to traditional varieties. For maize cultivation, 38.19% of the total area was under high-yielding varieties in the period from 2000-01 to 2006-07. This percentage increased to 38.92% in the period from 2006-07 to 2013-14 and then decreased to 37.98% in the period from 2014-15 to 2020-21. In the case of rice cultivation, 11.04% of the total area was under high-yielding varieties in the period from 2000-01 to 2006-07. This percentage decreased to 9.23% in the period from

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2006-07 to 2013-14 and then increased to 10.80% in the period from 2014-15 to 2020-21. For barley cultivation, 1.53% of the total area was under high-yielding varieties in the period from 2000-01 to 2006-07. This percentage increased to 2.23% in the period from 2006-07 to 2013-14 and then slightly decreased to 2.00% in the period from 2014-15 to 2020-21.

Table 1.2: Index of Coefficient of Variation in the Area under Different High-Yielding Crops in Himachal Pradesh

HYVs	Periods	$\bar{X}$	S.D.	C.V.
Wheat	(2000-01 to 2006-07)	301248.71	34394.18	11.42
	(2007-08 to 2013-14)	285115.29	39328.24	13.79
	(2014-15 to 2020-21)	299569.29	25271.56	8.44
	(2000-01 to 2020-21)	295311.10	32643.01	11.05
Maize	(2000-01 to 2006-07)	233643.57	24095.46	10.31
	(2007-08 to 2013-14)	223658.43	21648.30	9.68
	(2014-15 to 2020-21)	231161.00	10793.67	4.67
	(2000-01 to 2020-21)	229487.67	19200.03	8.37
Rice	(2000-01 to 2006-07)	67585.14	12756.59	18.87
	(2007-08 to 2013-14)	53058.14	17214.89	32.45
	(2014-15 to 2020-21)	65743.00	5182.69	7.88
	(2000-01 to 2020-21)	62128.76	13768.51	22.16
Barley	(2000-01 to 2006-07)	9368.86	2727.44	29.11
	(2007-08 to 2013-14)	12819.86	1950.49	15.21
	(2014-15 to 2020-21)	12147.43	876.63	7.22
	(2000-01 to 2020-21)	11445.38	2438.54	21.31

Sources: 1.) Economic Survey Reports of Himachal Pradesh for various years.
2.) Directorate of Agriculture in Himachal Pradesh across various years.
3.) Statistical Abstract of Himachal Pradesh from various years.

Table 1.2 presents the average High Yielding Varieties (HYV) seeds area for wheat, maize, rice, and barley over different periods in Himachal Pradesh, along with their respective coefficients of variation (CV). The average HYV seeds area for wheat was highest in Period I, followed by Period III and then Period II. The coefficient of variation was lowest in Period III, indicating relatively stable wheat cultivation during this period compared to Periods I and II. Maize cultivation exhibited slight fluctuations in HYV seeds area across periods. Period III had the lowest CV, suggesting more consistent maize cultivation during this time compared to Periods I and II. Rice cultivation showed variations in HYV seeds area, with Period II having the lowest CV, indicating relatively stable rice cultivation during that period. Period III was favorable in terms of both area and CV compared to Periods I and II. Barley cultivation experienced fluctuations in HYV seeds area, with Period III having the lowest CV, indicating more stable cultivation during this period compared to Periods I and II. The data highlights the variability in HYV seeds area across different periods for wheat, maize, rice, and barley in Himachal Pradesh. Period III generally showed more stable cultivation patterns, indicating potential improvements in agricultural practices and efficiency during that time.

PLANT PROTECTION PROGRAMME AND DISTRIBUTION OF PESTICIDES/ CHEMICALS:

Enhancing crop production requires a strong focus on plant protection measures. Each season, organized campaigns are launched to combat crop diseases, insects, and pests. Specifically, the Agriculture Department prioritizes support for marginalized communities such as scheduled castes, scheduled tribes, IRDP families, farmers in backward areas, and small/marginal farmers. These groups are provided plant protection chemicals and equipment at a subsidized rate of 50%.

The Agriculture Department has shifted its strategy towards biological control methods, aiming to reduce the reliance on chemical pesticides. Over the years, there has been a significant decrease in the area covered under plant protection programs, dropping from 440 thousand hectares in 2000-01 to 115 thousand hectares in 2020-21. Additionally, the government's distribution of pesticides and chemicals has decreased substantially from 232 thousand metric tonnes in 2000-01 to 64.49 metric tonnes in 2020-21.

Table-1.3: Area Under Coverage plant protection and pesticides As A Percentage of Total Area Under plant protection and distribution of pesticides

Periods	Area Under Plant Protection	Distribution of Pesticides
2000-01 to 2006-07	44.34	40.15
2007-08 to 2013-14	38.92	31.84
2014-15 to 2020-21	16.74	28.01
Total	100.00	100.00

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Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Agriculture in Himachal Pradesh across various years.

Table 1.3 shows the area under coverage plant protection as a percentage of total area under plant protection in three periods. It decreased from 44.34% in the first period (2000-01 to 2006-07) to 38.92% in the second period (2007-08 to 2013-14). It further decreased to 16.74% in the third period (2014-15 to 2020-21). In the case distribution of pesticides, it decreased from 40.15% in the first period to 31.84% in the second period. It then increased to 28.01% in the third period.

These trends indicate a decrease in the area under plant protection and the distribution of pesticides in the second and third periods compared to the first period. The increase in the distribution of pesticides in the third period might suggest an adjustment in pesticide usage after a period of decline. These changes could be influenced by various factors, including shifts in agricultural practices, pest management strategies, environmental concerns, or policy changes.

Table-1.4: Index of Coefficient of Variation of area under Coverage plant protection and distribution of pesticides

Periods		$\bar{X}$	S.D.	C.V.
Plant protection	2000-01 to 2006-07	408.57	50.14	12.27
	2007-08 to 2013-14	358.64	119.58	33.34
	2014-15 to 2020-21	168.51	156.82	93.06
	2000-01 to 2020-21	307.15	166.29	54.14
pesticides	2000-01 to 2006-07	193.14	41.21	21.34
	2006-07 to 2013-14	153.16	30.43	19.87
	2014-15 to 2020-21	134.77	57.38	42.58
	2000-01 to 2020-21	160.36	49.98	31.17

Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Agriculture in Himachal Pradesh across various years.

Table 1.4 presents changes in the area under coverage for plant protection and the distribution of pesticides over different periods, along with their respective coefficient of variation values. During the period 2000-01 to 2006-07, the average area under plant protection was 408.57 hectares, with a coefficient of variation of 12.27%, indicating relatively low variability. In the period from 2007-08 to 2013-14, the area decreased to 358.64 hectares, and the coefficient of variation significantly increased to 33.34%, suggesting greater variability during this period. In the period from 2014-15 to 2020-21, the area further decreased to 168.51 hectares, with a substantial increase in the coefficient of variation to 93.06%, indicating significant variability and potential instability. Over the entire period from 2000-01 to 2020-21, the average area under plant protection was 307.15 hectares, with a moderate coefficient of variation of 54.14%.

From 2000-01 to 2006-07, the average distribution of pesticides was 193.14 metric tonnes, with a coefficient of variation of 21.34%, indicating moderate variability. In the period from 2007-08 to 2013-14, the distribution decreased to 153.16 metric tonnes, and the coefficient of variation remained moderate at 19.87%. In the period from 2014-15 to 2020-21, the distribution further decreased to 134.77 metric tonnes, with the coefficient of variation increasing to 42.58%, indicating higher variability. Over the entire period from 2000-01 to 2020-21, the average distribution of pesticides was 160.36 metric tonnes, with a moderate coefficient of variation at 31.17%.

There has been a decrease in both the area under plant protection and the distribution of pesticides over the specified periods. Notably, the period from 2014-15 to 2020-21 witnessed a significant decline in both plant protection and pesticide distribution, with higher variability, especially in the plant protection sector during this period. The coefficient of variation serves as a measure of relative data variability, with higher values indicating greater fluctuations.

CONSUMPTION OF FERTILIZERS AND SUBSIDY: Over the years, the state government has implemented subsidies to encourage balanced fertilizer usage. These subsidies include ₹200 per metric tonnes on Ammonium Sulphate and ₹500 per MT on complex fertilizers like NPK 12:32:16 and NPK 15:15:15. In 1981-82, the per-hectare consumption of fertilizers in Himachal Pradesh was merely 19.5 kg, lagging behind the national average of 34.6 kg. However, the scenario changed dramatically after 1966, with fertilizer usage surging from 1970-71 onwards.

By 2000-01, fertilizer consumption had reached 35,552 metric tonnes, and this figure rose substantially to 65,240 metric tonnes in 2020-21. This increase in fertilizer usage serves as a clear indicator of the adoption of modern farming techniques by the state's farmers. To further promote balanced fertilizer usage, the government has allowed a subsidy of ₹1,000 per metric tonne on complex fertilizers. Additionally, a 25% subsidy on the cost of water-soluble fertilizers has been introduced. In the year 2020-21, the government plans to distribute a total of 51,500 metric tonnes of fertilizers (Economic Survey of HP,2020-21).

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Table-1.5: Percentage share Consumption of Fertilizers in total available fertilizers stock in Himachal Pradesh

Fertilizers/ Periods	2000-01 to 2006-07	2006-07 to 2013-14	2014-15 to 2020-21
Nitrogen	65.60	63.45	63.57
Phosphorus	19.22	18.09	18.29
Potassium	15.18	18.46	18.14
Total	100.00	100.00	100.00

Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Agriculture in Himachal Pradesh across various years.
3.) Statistical Abstract of Himachal Pradesh from various years.

Table 1.5 presents the percentage distribution of fertilizer consumption within the overall available fertilizer stock in Himachal Pradesh. The data is organized in a ranking order for three distinct time periods: 2000-01 to 2006-07, 2006-07 to 2013-14, and 2014-15 to 2020-21. In the period from 2000-01 to 2006-07, nitrogen-based fertilizers accounted for 65.60% of the total consumption of fertilizers in Himachal Pradesh. This percentage decreased slightly to 63.45% in the period from 2006-07 to 2013-14 and remained relatively stable at 63.57% in the period from 2014-15 to 2020-21. Nitrogen-based fertilizers are commonly used to promote plant growth and are essential for crop production. In the period from 2000-01 to 2006-07, phosphorus-based fertilizers accounted for 19.22% of the total consumption of fertilizers. This percentage decreased to 18.09% in the period from 2006-07 to 2013-14 and increased slightly to 18.29% in the period from 2014-15 to 2020-21. Phosphorus-based fertilizers are important for root development and flowering in plants. In the period from 2000-01 to 2006-07, potassium-based fertilizers accounted for 15.18% of the total consumption of fertilizers. This percentage increased to 18.46% in the period from 2006-07 to 2013-14 and then decreased to 18.14% in the period from 2014-15 to 2020-21. Potassium-based fertilizers are important for overall plant health and resilience. About The changing patterns of fertilizer consumption in Himachal Pradesh, with a relatively stable dominance of nitrogen-based fertilizers, a consistent but smaller share of phosphorus-based fertilizers, and some variation in the share of potassium-based fertilizers over the specified time intervals.

Table-1.6: Index of Coefficient of Variation in Fertilizers Consumption in Himachal Pradesh

Fertilizers	Periods	$\bar{X}$	S.D.	C.V.
Nitrogen	2000-01 to 2006-07	28619.71	2741.73	9.58
	2007-08 to 2013-14	33077.00	1297.25	3.92
	2014-15 to 2020-21	37164.00	2976.611	8.01
	2000-01 to 2020-21	32953.57	4266.37	12.95
Phosphorus	2000-01 to 2006-07	8384.86	1339.11	15.97
	2006-07 to 2013-14	9431.43	1527.75	16.20
	2014-15 to 2020-21	10691.43	1246.95	11.66
	2000-01 to 2020-21	9502.57	1624.30	17.09
Potassium	2000-01 to 2006-07	6630.29	1236.69	18.65
	2007-08 to 2013-14	9625.43	1723.78	17.91
	2014-15 to 2020-21	10610.00	702.90	6.662
	2000-01 to 2020-21	8955.54	2122.72	23.70

Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Agriculture in Himachal Pradesh across various years.
3.) Statistical Abstract of Himachal Pradesh from various years.

Table 1.6 shows the Coefficient of Variation in Fertilizer Consumption in Himachal Pradesh over various periods. During the period from 2000-01 to 2006-07, the average consumption of Nitrogen fertilizer was 28,619.71 units, with a Coefficient of Variation (C.V.) of 9.58%. Subsequently, from 2007-08 to 2013-14, the average consumption increased to 33,077.00 units, accompanied by a reduced C.V. of 3.92%. Moving forward, between 2014-15 to 2020-21, the average consumption further rose to 37,164.00 units, and the C.V. was 8.01%. Over the entire period spanning from 2000-01 to 2020-21, the average consumption reached 32,953.57 units, with a C.V. of 12.95%.

For Phosphorus fertilizer consumption, during the initial period from 2000-01 to 2006-07, the average was 8,384.86 units, and the C.V. stood at 15.97%. In the subsequent interval from 2006-07 to 2013-14, the average consumption increased to 9,431.43 units, with a C.V. of 16.20%. Then, from 2014-15 to 2020-21, the average consumption experienced further growth, reaching 10,691.43 units, and the C.V. decreased to 11.66%. Over the entire duration from 2000-01 to 2020-21, the average consumption was 9,502.57 units, with a C.V. of 17.09%.

Concerning Potassium fertilizer, in the period from 2000-01 to 2006-07, the average consumption was 6,630.29 units, with a C.V. of 18.65%. Subsequently,

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from 2007-08 to 2013-14, the average consumption increased to 9,625.43 units, while the C.V. was 17.91%. In the years from 2014-15 to 2020-21, the average consumption further rose to 10,610.00 units, and notably, the C.V. decreased significantly to 6.662%. Over the entire period from 2000-01 to 2020-21, the average consumption amounted to 8,955.54 units, with a C.V. of 23.70%.

IRRIGATION:

Irrigation plays a pivotal role in agricultural production, both directly and indirectly. By allowing for flexible cropping patterns and enabling the cultivation of more profitable crops, it reduces the uncertainty associated with relying solely on natural rainfall. Furthermore, irrigation facilitates the adoption of modern agricultural practices, including the use of fertilizers, insecticides, pesticides, hybrid seeds, and machinery, thereby optimizing agricultural output. In regions like Himachal Pradesh, the lack of irrigation infrastructure poses a significant barrier to agricultural growth. Traditionally, irrigation was viewed as a protective measure against drought. However, in the context of modern agriculture, controlled and reliable irrigation has become fundamental to achieving high yields.

Table-1.7: Share of Different sources of Irrigation as a percentage of total sources in Himachal Pradesh

Sources/Periods	2000-01 to 2006-07	2006-07 to 2013-14	2014-15 to 2020-21
Canals/Kulhs	3.33	3.70	3.14
Tanks	0.28	0.24	0.44
Well & Tubewell	12.95	19.90	24.48
Other Sources	83.44	76.16	71.94
Total	100.00	100.00	100.00

Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Land Records in Himachal Pradesh across various years.
3.) Statistical Abstract of Himachal Pradesh from various years.

Table 1.7 provides information on the share of different sources of irrigation as a percentage of the total sources of irrigation in Himachal Pradesh for three different periods: 2000-01 to 2006-07, 2006-07 to 2013-14, and 2014-15 to 2020-21. In 2000-01 to 2006-07, canals and kulhs contributed 3.33% of the total irrigation sources in Himachal Pradesh. This percentage increased to 3.70% in the period from 2006-07 to 2013-14 but decreased to 3.14% in the period from 2014-15 to 2020-21. Tanks refer to man-made reservoirs or small storage bodies for irrigation. In 2000-01 to 2006-07, tanks contributed only 0.28% of the total irrigation sources. This percentage slightly decreased to 0.24% in the period from 2006-07 to 2013-14 but then increased to 0.44% in the period from 2014-15 to 2020-21. In 2000-01 to 2006-07, wells and tubewells accounted for 12.95% of the total irrigation sources. This percentage increased significantly to 19.90% in the period from 2006-07 to 2013-14 and further increased to 24.48% in the period from 2014-15 to 2020-21. Other Sources category includes all other sources of irrigation not explicitly listed in the table, which could include rain-fed agriculture, rivers, and other miscellaneous sources. In 2000-01 to 2006-07, other sources contributed a significant 83.44% of the total irrigation sources. This percentage decreased to 76.16% in the period from 2006-07 to 2013-14 and further decreased to 71.94% in the period from 2014-15 to 2020-21.

Table 1.8: Index of Coefficient of Variation in the Sources of Irrigation in Himachal Pradesh

Sources/Periods		$\bar{X}$	S.D.	C.V.
Canals/Kulhs	2000-01 to 2006-07	3656.43	394.24	8.05
	2007-08 to 2013-14	4074.29	72.02	1.77
	2014-15 to 2020-21	3650.14	294.41	8.07
	2000-01 to 2020-21	3793.62	308.05	8.12
Tanks	2000-01 to 2006-07	310.43	274.43	88.40
	2006-07 to 2013-14	265.57	158.38	59.64
	2014-15 to 2020-21	519.00	456.28	87.92
	2000-01 to 2020-21	365.00	352.32	96.53
Well & tubewells	2000-01 to 2006-07	14265.72	1638.12	11.48
	2007-08 to 2013-14	21985.57	3955.72	17.99
	2014-15 to 2020-21	28438.86	1925.28	6.77
	2000-01 to 2020-21	21563.38	6469.82	30.00
Others Sources	2000-01 to 2006-07	91877.00	10512.14	11.44
	2007-08 to 2013-14	84159.43	1499.56	1.78
	2014-15 to 2020-21	83538.29	1533.62	1.84
	2000-01 to 2020-21	86524.90	7045.41	8.14

Sources: 1.) Economic Survey Reports of Himachal Pradesh from various years.
2.) Directorate of Land Records in Himachal Pradesh across various years.
3.) Statistical Abstract of Himachal Pradesh from various years.

Table 1.8 presents the Coefficient of Variation (CV) for various sources of irrigation in Himachal Pradesh during different periods. When considering canals/Kulhs, the highest average irrigated area was observed in Period II (2007-08 to 2013-14), reaching 4,074.29 hectares, which exceeded the overall period

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average of 3,793.62 hectares (2000-01 to 2020-21). In Period I (2000-01 to 2006-07), the average was 3,656.43 hectares, while in Period III (2014-15 to 2020-21), it was 3,650.14 hectares, both lower than that of Period II. The CV was lowest in Period II at 1.77%, indicating relatively stable irrigation from canals/ Kulhs compared to Periods I and III, which had higher CV values of 8.05% and 8.07%, respectively, signifying greater variability.

For tanks, the highest average irrigated area was recorded in Period III (2014-15 to 2020-21), with 519.00 hectares, surpassing the overall period average of 365.00 hectares. Period I (2000-01 to 2006-07) had an average of 310.43 hectares, and Period II (2007-08 to 2013-14) had an average of 265.57 hectares, both lower than the figure in Period III. The CV was lowest in Period II at 59.64%, indicating relatively stable irrigation from tanks. In contrast, Periods I, III, and the overall period had higher CV values of 88.40%, 87.92%, and 96.53%, respectively, showing greater variability.

When considering Well and Tube-wells, the highest average irrigated area was in Period III (2014-15 to 2020-21), with 28,438.86 hectares, surpassing the overall period average of 21,563.38 hectares. Period I (2000-01 to 2006-07) had an average of 14,265.72 hectares, and Period II (2007-08 to 2013-14) had an average of 21,985.57 hectares, both lower than that of Period III. The CV was lowest in Period III at 6.77%, indicating relatively stable irrigation from Well and Tube-wells. Conversely, Periods I, II, and the overall period had higher CV values of 11.48%, 17.99%, and 30.00%, respectively, showing greater variability.

In the case of other sources of irrigation, the highest average irrigated area was in Period I (2000-01 to 2006-07), at 91,877.00 hectares, exceeding the overall period average of 86,524.90 hectares. Period II (2007-08 to 2013-14) had an average of 84,159.43 hectares, and Period III (2014-15 to 2020-21) had an average of 83,538.29 hectares, both lower than that of Period I. The CV was lowest in Period II at 1.78%, indicating relatively stable irrigation from other sources. In contrast, Periods I, III, and the overall period had higher CV values of 11.44%, 1.84%, and 8.14%, respectively, signifying greater variability.

CONCLUSION AND SUGGESTIONS

The agricultural landscape in Himachal Pradesh has seen significant changes and challenges over the years, as evident from the comprehensive data presented in Tables 1.1 to 1.8 several key findings emerge from the analysis of crop patterns, seed area, pesticide distribution, fertilizer consumption, and irrigation sources during different periods. The study shows a stable ranking for high-yielding crops like wheat, maize, rice, and barley over the years, indicating a structural stability in their cultivation patterns. However, minor fluctuations in the proportions of land dedicated to these crops highlight the need for continuous monitoring and adaptation to optimize agricultural output. The consumption patterns of nitrogen, phosphorus, and potassium fertilizers exhibit varying degrees of stability and change. While there is evidence of stagnation in the consumption of nitrogen fertilizers, phosphorus and potassium fertilizers experienced fluctuations, suggesting the need for targeted interventions and strategies to optimize fertilizer usage. The decline in the area under plant protection and distribution of pesticides, particularly in the third period, signifies a potential shift in pest management strategies. the significant variability in these factors emphasizes the importance of flexible and adaptive approaches to plant protection practices. The study reveals a consistent structural stagnation in the usage of canals/kulhs, tanks, well and tube-wells, and other sources of irrigation. While there are fluctuations in the irrigated areas, the stable rank orders indicate the need for sustainable water management practices to ensure consistent and efficient irrigation methods. Across various agricultural parameters, the data indicates the presence of both stability and change over the years. Period III, in particular, stands out with significant variations in several aspects, highlighting the need for comprehensive policy evaluations and adaptive strategies to address emerging challenges and capitalize on opportunities. The agricultural landscape in Himachal Pradesh demonstrates a mix of stability and adaptability. While certain aspects show structural stagnation, others exhibit fluctuations, emphasizing the necessity of informed decision-making, research-backed policies, and sustainable agricultural practices. Continued monitoring and strategic planning will be crucial to enhance agricultural productivity, ensure food security, and promote the overall socio-economic development of the region.

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