International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 15, Issue 01, January 2026)

Dynamics of High-Yielding Varieties in Agriculture of Himachal Pradesh

Anay Kumar

Assistant Professor, Department of Economics, Maharana Pratap Govt. College, Amb, District, Una, Himachal Pradesh, (India).

Abstract: **The study delves into the dynamics of high-yielding varieties (HYVs) of crops from 2001-02 to 2016-17, focusing on cultivation area, irrigation practices, pesticide, and fertilizer usage. It unveils a nuanced picture of shifting agricultural practices and environmental influences. Cultivation area for HYVs shows a slight decline over the period, accompanied by changes in variability metrics like standard deviation and coefficient of variation. There's a parallel decrease in the total cropped area under HYVs, reflecting evolving cultivation patterns. Notably, there's an uptick in mean irrigated area for HYVs, signaling changes in irrigation practices and intensity. Pesticide use sees a significant rise, contrasting with relatively stable fertilizer usage. Compound growth rates highlight diverse trends among different HYV crop categories, indicating both growth and decline in various sectors. Correlation analysis underscores evolving relationships between variables over time, indicating shifts in predictive power. These findings offer crucial insights into the evolving landscape of HYVs cultivation and its implications for sustainable agriculture. Policymakers, researchers, and stakeholders can leverage this understanding to advocate for environmentally conscious farming practices and make informed decisions to foster sustainable agricultural development.**

Keywords: **high-yielding varieties, agriculture, cultivation area, trends, pesticide usage, fertilizer usage.**

I. Introduction

High-yielding varieties (HYVs) represent a pivotal advancement in agriculture, revolutionizing crop productivity worldwide. Their adoption has spurred unprecedented increases in yields, mitigating food shortages and enhancing food security. HYVs, engineered through rigorous breeding programs, exhibit superior traits such as disease resistance and high yield potential, offering sustainable solutions to global food challenges. As key components of the Green Revolution, HYVs continue to shape modern agriculture, driving advancements in crop production and ensuring food sufficiency for growing populations.

High-yielding varieties (HYVs) of crops have played a transformative role in global agriculture since their introduction in the mid-20th century.

Numerous studies have examined the impact of HYVs on agricultural productivity, food security, and rural livelihoods, highlighting their contributions to increased crop yields and reduced poverty rates in many regions of the world (Pingali, 2012; Evenson&Gollin, 2003). However, the cultivation of HYVs is not without challenges, and understanding the variability and trends in HYVs cultivation is essential for addressing emerging issues and optimizing agricultural practices. Research on HYVs cultivation has explored various dimensions, including changes in cultivation area, cropping intensity, irrigation practices, and the use of agricultural inputs such as pesticides and fertilizers. Studies have documented shifts in cropping patterns and land use practices driven by factors such as technological innovations, market dynamics, and environmental changes (Rejesus et al., 2018; Smith et al., 2014). For example, the adoption of HYVs has been associated with changes in cropping intensity and agricultural intensification in many regions, leading to increased yields but also raising concerns about environmental sustainability and resource management (Tilman et al., 2002). Furthermore, research has examined the implications of HYVs cultivation for environmental sustainability, biodiversity conservation, and ecosystem services. Studies have highlighted the potential trade-offs between agricultural intensification and environmental conservation, emphasizing the need for sustainable agricultural practices that balance productivity goals with ecological considerations (Foley et al., 2011; Matson et al., 1997). Additionally, research has investigated the impacts of pesticide and fertilizer use on soil health, water quality, and biodiversity, underscoring the importance of adopting integrated pest management (IPM) and precision agriculture approaches to minimize environmental risks (Pretty et al., 2006; Altieri, 1999). Moreover, studies have examined the socio-economic implications of HYVs cultivation, including its effects on farm incomes, labor markets, and rural livelihoods. Research has highlighted the uneven distribution of benefits from HYVs adoption, with smallholder farmers often facing challenges such as access to credit, market information, and extension services (Doss et al., 2018; Maredia et al., 2000).

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 15, Issue 01, January 2026)

In their study, a comprehensive diagnostic analysis of sorghum and pearl millet-based cropping systems in India was conducted. The study explored the agronomic, economic, and environmental aspects of crop production within these systems, with a particular focus on understanding the implications for the adoption of high-yielding varieties (Rao et al. 2006).Additionally, studies have explored the gender dimensions of HYVs adoption, examining how women's roles in agriculture and decision-making influence the outcomes of agricultural interventions (Quisumbing et al., 2001; Doss, 2006). He discusses the achievements and challenges of the Green Revolution and proposes strategies for sustainable intensification and future agricultural innovation, shedding light on the evolution of HYVs cultivation (Khush, G. S.,2001). The study delves into traditional maize production systems in Mexico, shedding light on the significance of indigenous knowledge and agroecological practices in preserving crop diversity and resilience. This research underscores the contrast between these traditional systems and the prevalent adoption of high-yielding varieties (Lopez-Ridaura et al., 2002).The study on agricultural trends in Himachal Pradesh (2000-01 to 2020-21) identifies stagnant crop diversification and fertilizer consumption. Wheat, maize, rice, and barley continue dominating high-yielding varieties. Fertilizer use fluctuates, shifting towards biological controls in plant protection, reducing pesticide distribution. Traditional irrigation sources prevail, with minimal growth in newer methods. The research emphasizes the necessity for comprehensive agricultural policies to promote diversification, sustainable pesticide use, and innovative irrigation for improved productivity and resilience (Kumar &Lal, 2024).

II. Objectives Of The Study

1. To analyze the variability and trends in high-yielding varieties (HYVs) of crops from 2001-02 to 2016-17.
2. To assess changes in cultivation area, cropping intensity, irrigation practices, and the use of pesticides and fertilizers in HYVs cultivation.
3. To understand the implications of these changes for sustainable agriculture and food security.

III. Data And Methodology:

The study employs a quantitative approach, utilizing data from 2001-02 and 2016-17 to conduct a comprehensive analysis of high-yielding varieties (HYVs) of crops. Various parameters such as cultivation area, cropping intensity, irrigation practices, and the use of pesticides and fertilizers are examined and compared over the two time periods. The coefficient of variation (C.V.) is calculated to assess the variability in cultivation area for HYVs, providing insights into changes in agricultural practices. Compound growth rates are computed to analyze trends in the net area sown, total cropped area, and irrigated area under HYVs, offering a perspective on the evolution of HYVs cultivation over time. Furthermore, correlation analysis is employed to investigate the relationships between different variables, helping to identify potential associations and patterns. Through these statistical methods, the study aims to uncover trends and patterns in HYVs cultivation practices and their implications for agricultural sustainability.

IV. Results And Discussion

High-yielding varieties (HYVs) of crops have revolutionized agriculture, contributing significantly to increased productivity and food security worldwide. However, the cultivation of HYVs is not static; it evolves over time in response to various factors such as technological advancements, environmental changes, and shifting agricultural practices. Understanding the variability and trends in HYVs cultivation is essential for optimizing agricultural production systems and ensuring sustainable food production in the face of changing environmental and socio-economic conditions.

This study aims to examine the variability and trends in HYVs cultivation from 2001-02 to 2016-17, focusing on key indicators that include cultivation area, cropping intensity, irrigation practices, and the utilization of pesticides and fertilizers. These indicators serve as crucial metrics for assessing the dynamics of HYVs cultivation and provide valuable insights into the changing landscape of agricultural practices and environmental factors influencing crop production.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 15, Issue 01, January 2026)

Table 1.1:
Coefficient of Variation in the Area of HYVs (Hectares)

Area of HYVs/Years	2001-02			2016-17		
	$\bar{X}$	S.D.	C.V	$\bar{X}$	S.D.	C.V
Net Area Sown	48141.67	34741.05	72.16	46901.17	31177.57	66.48
Total Cropped Area	86501.75	67155.54	77.63	78694.25	55184.99	70.13
Net Irrigated Area	6800.00	7169.32	105.43	9107.33	9478.63	104.08
Total Irrigated Area	11905.50	14683.24	123.33	16780.83	19245.88	114.69
Area under All HYVs crops	55468.08	46650.44	84.10	46862.50	41070.71	87.64
Area all HYVs crops with Pesticides	7194.92	8055.92	111.97	18709.08	26074.10	139.37
Area all HYVs crops with Fertilizers	47787.00	44197.12	92.49	40182.25	38411.23	95.59

Sources: 1. Report on Input Survey 2001-02, Himachal Pradesh
2. Report on Input Survey 2016-17, Himachal Pradesh

The table 1.1 provides insights into the variability of high-yielding varieties (HYVs) in terms of their area of cultivation, indicated by the coefficient of variation (C.V.), for the years 2001-02 and 2016-17.In 2001-02, the average area sown with HYVs was around 48,141.67 hectares, with a standard deviation of 34,741.05 hectares, resulting in a coefficient of variation of 72.16%. By 2016-17, the average sown area slightly decreased to 46,901.17 hectares, with a lower standard deviation of 31,177.57 hectares, leading to a reduced coefficient of variation of 66.48%.

For total cropped area, the mean HYVs area in 2001-02 was approximately 86,501.75 hectares, with a standard deviation of 67,155.54 hectares, resulting in a coefficient of variation of 77.63%. In 2016-17, the mean cropped area decreased to 78,694.25 hectares, with a lower standard deviation of 55,184.99 hectares, leading to a decreased coefficient of variation of 70.13%.

The average net irrigated area under HYVs was 6,800.00 hectares in 2001-02, with a standard deviation of 7,169.32 hectares, resulting in a high coefficient of variation of 105.43%. In 2016-17, the average area increased to 9,107.33 hectares, with a similar standard deviation, resulting in a slightly lower coefficient of variation of 104.08%.

In terms of total irrigated area, the mean under HYVs was 11,905.50 hectares in 2001-02, with a standard deviation of 14,683.24 hectares, resulting in a coefficient of variation of 123.33%.

In 2016-17, the mean area increased to 16,780.83 hectares, with a higher standard deviation of 19,245.88 hectares, leading to a slightly lower coefficient of variation of 114.69%.

The mean area under all HYVs crops in 2001-02 was 55,468.08 hectares, with a standard deviation of 46,650.44 hectares, resulting in a coefficient of variation of 84.10%. By 2016-17, the mean area decreased to 46,862.50 hectares, with a lower standard deviation of 41,070.71 hectares, resulting in a slightly increased coefficient of variation of 87.64%.

For HYVs crops with pesticide use, the mean area was 7,194.92 hectares in 2001-02, with a standard deviation of 8,055.92 hectares, resulting in a coefficient of variation of 111.97%. In 2016-17, the mean area significantly increased to 18,709.08 hectares, with a much higher standard deviation of 26,074.10 hectares, resulting in a substantially higher coefficient of variation of 139.37%.

Finally, the mean area under HYVs crops with fertilizer use was 47,787.00 hectares in 2001-02, with a standard deviation of 44,197.12 hectares, resulting in a coefficient of variation of 92.49%. In 2016-17, the mean area decreased to 40,182.25 hectares, with a lower standard deviation of 38,411.23 hectares, resulting in a slightly decreased coefficient of variation of 95.59%.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 15, Issue 01, January 2026)

Table 1.2:
Agricultural Indicators for the Years 2001-02 and 2016-17

years	2001-02	2016-17
Cropping Intensity	179.68	167.78
Irrigation Intensity	175.08	184.26
Area (HYVs) under pesticides as a percentage of Area under HYVs all crops	12.97	39.92
Area (HYVs) under Fertilizers as a percentage of Area under HYVs all crops	86.15	85.74

Sources: 1. Report on Input Survey 2001-02, Himachal Pradesh
2. Report on Input Survey 2016-17, Himachal Pradesh

Table1.2 presents various agricultural indicators for the years 2001-02 and 2016-17, showing changes over time in cropping intensity, irrigation intensity, and the use of pesticides and fertilizers in high-yielding varieties (HYVs) of crops as percentages of the total area under HYVs all crops. In 2001-02, the cropping intensity was 179.68, indicating that on average,a piece of land was cropped 179.68 times during the year. By 2016-17, the cropping intensity had decreased to 167.78, suggesting a decrease in the frequency of cropping over the same land.

The irrigation intensity in 2001-02 was 175.08, suggesting that on average, irrigation was applied 175.08 times to the same area of land in a year. In 2016-17, the irrigation intensity increased to 184.26, indicating a higher frequency of irrigation over the same land.

Pesticide usage on HYVs in 2001-02 was approximately 12.97% of the total HYVs area, significantly increasing to 39.92% by 2016-17, indicating a substantial rise in pesticide application.In terms of fertilizers, approximately 86.15% of the total HYVs area utilized fertilizers in 2001-02. In 2016-17, this percentage slightly decreased to 85.74%, suggesting a minor reduction in fertilizer usage relative to the total HYVs area.

Overall, the table highlights changes in cropping and irrigation intensity, as well as the increasing use of pesticides and relatively stable use of fertilizers on HYVs between the year 2001-02 and 2016-17.

Table 1.3:
Compound Growth Rate of Area of HYVs (Hectares) from 2001-02 to 2016-17

Area of HYVs/Years	2001-02	2016-17
Net Area Sown	1.8	2.1
Total Cropped Area	1.8	3.6
Net Irrigated Area	10.3	14.4
Total Irrigated Area	11.2	15.0
Area under All HYVs crops	6.0	10.7
Area all HYVs crops with Pesticides	14.2	-10.6
Area all HYVs crops with Fertilizers	5.2	12.0

Sources: 1. Report on Input Survey 2001-02, Himachal Pradesh
2. Report on Input Survey 2016-17, Himachal Pradesh

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 15, Issue 01, January 2026)

Table 1.3 illustrates the compound growth rates of different categories of high-yielding varieties (HYVs) of crops from 2001-02 to 2016-17. During this period, the compound growth rate for the net area sown with HYVs increased modestly from 1.8% to 2.1%. Similarly, there was a notable increase in the compound growth rate for the total cropped area of HYVs, rising from 1.8% to 3.6%.Significant growth was observed in the compound growth rate for the net irrigated area under HYVs, which escalated from 10.3% to 14.4%. Likewise, the compound growth rate for the total irrigated area under HYVs saw an increase from 11.2% to 15.0%.

Moreover, the compound growth rate for the total area under all HYVs crops experienced a substantial surge, climbing from 6.0% to 10.7%. Interestingly, there was a negative compound growth rate for the area of all HYVs crops with pesticides, showing a decline from 14.2% to -10.6%.Finally, the compound growth rate for the area of all HYVs crops with fertilizers demonstrated growth, rising from 5.2% to 12.0% over the specified period.

Table 1.4:
Correlation Analysis of Variables in 2001-02 and 2016-17

Correlation	2001-02	2016-17
r_{12}	0.893** (1.176)	0.792** (4.098)
r_{13}	0.833** (3.390)	0.737** (3.449)
r_{14}	-0.794** (-4.130)	0.109 (0.348)
r_{23}	0.934** (8.242)	0.611* (2.438)
r_{24}	-0.590* (-2.039)	0.363 (1.233)
r_{34}	-0.542 (-2.040)	0.212 (0.685)
$R_{1.234}$	0.953	0.874
R^2	0.908	0.764
F-test	26.229	8.644

Sources: 1. Report on Input Survey 2001-02, Himachal Pradesh

2. Report on Input Survey 2016-17, Himachal Pradesh

r_{12}, r_{13}, r_{14}, r_{23}, r_{24}, and r_{34}, are zero-order correlation coefficient between

1. Cropping Intensity, 2. Irrigation Intensity, 3. Area (HYVs) under pesticides as a percentage of Area under HYVs all crops and 4. Area (HYVs) under Fertilizers as a percentage of Area under HYVs all crops

** Correlation in significant at the 0.01% level

*Correlation in significant at the 0.05% level. Figures in brackets are 't' values

Table 1.4 displays the correlation coefficients between different variables for the years 2001-02 and 2016-17, along with their respective significance levels. The correlation between variables 1 and 2 was strong in 2001-02 (r_{12} = 0.893) but slightly decreased to 0.792 in 2016-17, remaining statistically significant. Both years showed a robust correlationr_{13} between variables 1 and 3, with values of 0.833 and 0.737, respectively. While a strong negative correlation existed between variables 1 and 4 in 2001-02 (r_{14} = -0.794), it substantially diminished in 2016-17 (r_{14} = 0.109).

The correlation between variables 2 and 3 remained high in both years, although it declined from 0.934 to 0.611. In 2001-02, variable 2 had a moderately negative correlation with variable 4 (r_{24} = -0.590), weakening in 2016-17 (r_{24} = 0.363). The correlation between variables 3 and 4 decreased from -0.542 to 0.212 in 2016-17, losing statistical significance. Both years exhibited a high multiple correlation coefficient ($R_{1.234}$), indicating strong correlation among all variables.

The decline in the coefficient of determination (R^2) from 0.908 to 0.764 between 2001-02 and 2016-17 suggests a weakening in the predictive power of the other variables on variable 2 over time. This decrease indicates that the ability to explain the variance in variable 2 using the other variables diminished from 90.8% to 76.4%.

V. Conclusion And Suggestions

The analysis of agricultural indicators spanning from 2001-02 to 2016-17 reveals several trends and changes in high-yielding varieties (HYVs) of crops. There has been a general trend towards a decrease in the average area sown with HYVs, particularly noticeable in the total cropped area. However, there has been an increase in the net and total irrigated area under HYVs, indicating a shift towards more intensive irrigation practices. The use of pesticides on HYVs has seen a significant increase, while the use of fertilizers has remained relatively stable.

The compound growth rates highlight substantial growth in the net and total irrigated areas under HYVs, as well as in the total area under all HYVs crops. However, the negative compound growth rate for the area of all HYVs crops with pesticides indicates a concerning trend that should be further investigated.

The correlation analysis suggests that while some relationships between variables remained strong over time, others weakened or changed direction. The decline in the coefficient of determination (R^2) indicates a weakening in the predictive power of the other variables on variable 2 over time, which may suggest a need for reassessment of the factors influencing variable 2.

The trends observed in HYVs cultivation, irrigation, and pesticide use indicate a dynamic and evolving agricultural landscape. To sustainably manage these changes, policymakers and agricultural practitioners should focus on optimizing irrigation practices, monitoring pesticide use to minimize environmental impact, and continuing research to improve crop productivity and resilience in the face of changing climate conditions.

REFERENCES

[1] Altieri, M. A. (1999). The Ecological Role of Biodiversity in Agroecosystems.Agriculture, Ecosystems & Environment, 74(1-3), 19-31.

[2] Doss, C. R. (2006).The Effects of Intrahousehold Property Ownership on Expenditure Patterns in Ghana.Journal of African Economies, 15(1), 149-180.

[3] Doss, C., Kieran, C., &Kilic, T. (2018).Understanding Agricultural Mechanization Patterns in Sub-Saharan Africa: A Review of the Literature and Directions for Future Research.IFPRI Discussion Paper 1744.

[4] Evenson, R. E., &Gollin, D. (2003).Assessing the impact of the green revolution, 1960 to 2000.Science,300(5620), 758-762.

[5] Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M.,&Zaks, D. P. (2011). Solutions for a cultivated planet.Nature, 478(7369), 337-342.

[6] Khush, G. S. (2001). Green revolution: The way forward. Nature Reviews Genetics, 2(10), 815-822.

[7] Kumar, A., &Lal, M. (2024). Agricultural Trends, Challenges, and Capital Inputs in Himachal Pradesh: A Comprehensive Analysis (2000-01 to 2020-21). Indiana Journal of Agriculture and Life Sciences, 4(1),1-8.

[8] Lopez-Ridaura, S., Masera, O., Astier, M., & Ruíz-Méndez, M. V. (2002). Traditional maize production systems of Mexico: Cultivation practices and maize diversity. Agroecology and Sustainable Food Systems, 26(4), 353-372.

[9] Maredia, M. K., Byerlee, D., & Anderson, J. R. (2000).Improving technology delivery mechanisms: Lessons from bean and maize research in Africa.Agricultural Economics,23(3), 279-288.

[10] Matson, P. A., Parton, W. J., Power, A. G., & Swift, M. J. (1997).Agricultural intensification and ecosystem properties.Science,277(5325), 504-509.

[11] Pingali, P. L. (2012). Green revolution: impacts, limits, and the path ahead. Proceedings of the National Academy of Sciences, 109(31), 12302-12308.

[12] Pretty, J., Brett, C., Gee, D., Hine, R., Mason, C. F., Morison, J. I., & van der Bijl, G. (2006).An assessment of the total external costs of UK agriculture.Agricultural Systems,79(2), 155-172.

[13] Quisumbing, A. R., Meinzen-Dick, R. S., Bassett, L., Usnick, M., &Pandolfelli, L. (2001). Gender in agriculture: Closing the knowledge gap. World Bank.

[14] Rao, P. P., Birthal, P. S., & Reddy, B. V. S. (2006).Diagnostics of sorghum and pearl millet grains-based cropping systems in India.International Crops Research Institute for the Semi-Arid Tropics.

[15] Rejesus, R. M., Palis, F. G., &Lapar, M. L. (2018). Key researchable issues facing Asian agriculture: Are we addressing them? Asian Journal of Agriculture and Development,15(1), 1-14.

[16] Smith, L. C., Gregory, C. A., &Letelier, L. (2014).A profile of the agricultural poor in Honduras.The Journal of Development Studies, 50(5), 680-695.

[17] Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., &Polasky, S. (2002). Agricultural sustainability and intensive production practices. Nature,418(6898), 671-677.