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Spatio-temporal Consumption of Pesticide in Haryana, 1984-85 to 2016-17

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Abstract:

This study aims the spatio-temporal patterns of pesticide consumption in the agricultural landscape of Haryana, India, spanning from 1984-85 to 2016-17. Pesticide usage in agricultural practices has undergone significant changes over the past few decades, influenced by factors such as technological advancements, socio-economic dynamics, and environmental concerns. Understanding these patterns is crucial for sustainable agricultural practices and environmental management. Utilizing secondary data from statistical abstract of Haryana. The findings reveal notable temporal trends in pesticide consumption, with distinct phases of increase, stabilization, and slight decline observed during 1984-85 to 2016-17. Furthermore, significant spatial disparities are observed in pesticide usage across districts, reflecting variations in agricultural practices, cropping patterns, land-use dynamics, and socio-economic conditions. These disparities highlight the need for region-specific strategies to mitigate pesticide-related risks and promote sustainable agricultural practices. The study also examines the potential environmental and health implications associated with pesticide consumption. Overall, this research contributes to a comprehensive understanding of the spatio-temporal dynamics of pesticide consumption in Haryana, facilitating evidence-based sustainable agricultural practices aimed at enhancing productivity, environmental conservation, and human well-being.

Keywords: Pesticide consumption, Spatio-temporal analysis, Agricultural practices

Introduction

This part entails investigating the disparities in pesticide use throughout the various Haryana regions. Examining variables including farming methods, crop trends, land usage, and environmental aspects might be necessary to determine why some areas may use pesticides at higher or lower rates than others. The study of temporal consumption aims to examine the evolution of pesticide use between 1984–1985 and 2016–2017.

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This entails looking at patterns, trends, and oscillations in the rates of pesticide intake over various time intervals within the given time range. Temporal consumption patterns can be influenced by a variety of factors, including changes in farming techniques, technological improvements, regulatory regulations, and socioeconomic considerations (Rippy et al., 2017). Identification of trends and patterns in pesticide usage over time and across different regions within Haryana. Understanding the factors driving changes in pesticide consumption, such as shifts in agricultural practices, adoption of new technologies, changes in crop patterns, and socio-economic factors. Assessing the environmental impacts of pesticide usage and identifying regions or time periods where pesticide usage may have been particularly intensive, leading to potential environmental degradation (Chidya et al., 2018).

Analysis reveals a general upward trend in pesticide consumption over the entire period, reflecting increased reliance on chemical inputs in agriculture. Significant variations in pesticide consumption rates are observed across different districts and agro-climatic zones within Haryana. Some regions exhibit consistently higher pesticide usage, likely influenced by factors such as crop diversity, pest pressure, and economic factors. There is evidence of shifts in the types of pesticides used over time, with changes in the prevalence of insecticides, herbicides, fungicides, and other chemical formulations. This may reflect changes in pest management practices, crop types, and technological advancements (Agnihotri, 2000). Changes in agricultural practices, including the adoption of high-input intensive farming systems, mono-cropping, and mechanization, have contributed to the overall increase in pesticide consumption. Government policies and interventions, such as subsidies on pesticides, extension services, and regulatory measures, have influenced pesticide usage patterns over time. Changes in policy frameworks, including the introduction of Integrated Pest Management (IPM) strategies, may have influenced pesticide consumption trends. Increasing pesticide usage raises concerns about its environmental impacts, including soil degradation, water contamination, loss of biodiversity, and risks to human health. Monitoring and mitigating these impacts are critical for sustainable agricultural development (Abhilash & Singh, 2009). Advancements in pesticide formulations, application technologies, and pest-resistant crop varieties have influenced pesticide consumption patterns.

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Adoption of genetically modified (GM) crops with built-in pest resistance may have implications for pesticide usage. Despite efforts to track pesticide consumption, there may be data limitations, including underreporting, inaccuracies, and inconsistencies across different sources. Improving data collection and monitoring mechanisms is essential for robust analysis and informed decision-making (Shetty, 2004). There is an increasing need to support sustainable agricultural practices, such as organic farming, agroecological methods, and integrated pest management (IPM) techniques, given the health and environmental risks connected with pesticide use (Chahal et al., 2016).

To minimize the negative effects of pesticide usage in Haryana and promote sustainable agriculture, it is imperative to conduct ongoing research and monitoring of pesticide consumption trends in conjunction with focused policy interventions and farmer education initiatives (Subash et al., 2018). Continuous monitoring and evaluation of pesticide consumption patterns, along with rigorous assessment of their environmental and health impacts, are essential for informed decision-making and adaptive management. Regular review of policies, regulations, and agricultural practices can help identify opportunities for improvement and innovation in pest management strategies (De et al., 2014).

Achieving long-term sustainability in pesticide use requires a holistic approach that considers ecological, economic, and social dimensions of agriculture. Balancing the need for pest control with environmental conservation, human health protection, and economic viability is essential for ensuring sustainable agricultural development in Haryana (Yadav, 2010). Over-reliance on certain pesticides may lead to the development of pest resistance, necessitating higher pesticide application rates or the use of alternative, often more potent, chemical formulations. Monitoring pesticide resistance and promoting diversified pest management strategies are crucial for sustainable pest control (Tiwana et al., 2009).

Objectives

i. To analyze the temporal trends in pesticide consumption in Haryana from 1984-85 to 2016-17.
ii. To study the spatial distribution of pesticide usage across different districts of Haryana over the study period.

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Database & Methodology

The present study is based on the secondary data on pesticide consumption from relevant governmental sources such as the Department of Agriculture and Farmers Welfare, Government of Haryana, and non-governmental organizations involved in agricultural research and development for period of 1984-85 to 2016-17. To visualize and analyze the spatial distribution of pesticide consumption across different districts of Haryana. For generating thematic maps have been used for temporal trends and spatial disparities in pesticide usage. Employ time-series analysis to identify temporal patterns and trends in pesticide usage. Examine the research and literature currently available to learn about the possible effects that pesticide use in agricultural techniques may have on the environment and human health. To identify gaps and areas for improvement in current policies, the research has been suggested evidence-based recommendations for promoting sustainable pesticide use. Provide recommendations for policymakers, agricultural stakeholders, and farmers to promote sustainable pesticide management practices and enhance the resilience of Haryana's agricultural sector.

Result & Discussion

Spatio Pattern of Pesticides Consumption in Haryana: 1984-85

The table 1 presents the spatio-temporal analysis of pesticide consumption in different districts of Haryana for the year 1984-85, with data represented in tonnes. However, it's important to note that the pesticide consumption values for some districts (Jhajjar, Fatehabad, Kaithal, Nuh, Palwal, Panipat, and Rewari) are not provided in the table. Among the listed districts, Kamal had the highest pesticide consumption at 556 tonnes, followed by Kurukshetra at 524 tonnes, and Sirsa at 360 tonnes. Other districts such as Hisar, Sonipat, Ambala, and Panchkula also recorded substantial pesticide usage, ranging from 298 to 340 tonnes. On the other hand, districts like Mahendragarh, Bhiwani, Rohtak, and Faridabad had relatively lower pesticide consumption, with values ranging from 58 to 152.04 tonnes. The total pesticide consumption for all listed districts combined was 3,607.04 tonnes in the specified year. This data provides insight into the spatial distribution of pesticide usage within Haryana during the given time frame, highlighting variations in consumption levels across different districts.

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Spatio Pattern of Pesticides Consumption in Haryana: 1990-91

In 1990-91, the spatio-temporal analysis of pesticide consumption in Haryana showed a notable increase compared to the previous year. The total pesticide consumption for the state reached 5,166 tonnes. However, data for pesticide consumption in Fatehabad, Jhajjar, Kaithal, Nuh, Palwal, Panipat, and Rewari were not provided. Among the districts for which data is available, Kurukshetra had the highest pesticide consumption, amounting to 829 tonnes, followed closely by Kamal at 808 tonnes, and Hisar at 688 tonnes. Sirsa and Sonipat also recorded substantial pesticide usage, with consumption values of 680 tonnes and 364 tonnes, respectively. Ambala and Panchkula had equal pesticide consumption of 345 tonnes each, while Jind followed closely with 325 tonnes. Faridabad, Gurugram, Bhiwani, and Mahendragarh recorded comparatively lower pesticide consumption levels, with values ranging from 127 to 208 tonnes. Rohtak had the lowest pesticide consumption among the listed districts, at 127 tonnes.

Spatio Pattern of Pesticides Consumption in Haryana: 1995-96

In 1995-96, the spatio-temporal analysis of pesticide consumption in Haryana demonstrated a total consumption of 5,100 tonnes. However, data for pesticide consumption in Fatehabad, Jhajjar, Nuh, and Palwal were not provided. With 608 tonnes consumed of pesticides, Sirsa had the greatest usage among the listed districts, followed closely by Hisar with 604 tonnes. While Kamal and Panipat registered consumption values of 402 and 342 tonnes, respectively, Kaithal recorded a large pesticide usage of 432 tonnes. Sonipat used 340 tons, following closely behind. Kurukshetra had 307 tons of pesticide use, compared to 321.7 tonnes in Faridabad. 292 tonnes and 289 tonnes, respectively, were consumed in Jind and Bhiwani. Between 129 and 270 tonnes were consumed in Yamuna Nagar, Rewari, Rohtak, Ambala, and Panchkula. With 129 tons and 118 tonnes, respectively, Mahendragarh and Gurugram showed comparatively lower levels of pesticide consumption.

Spatio Pattern of Pesticides Consumption in Haryana: 2000-01

The results of the spatiotemporal study of pesticide consumption in Haryana in 2000–01 showed that 5,024 tons were consumed. Sirsa consumed the most pesticides (599 tonnes), followed by Kaithal (425 tonnes) and Kamal (396 tonnes).

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Table 1: Spatio-temporal Analysis of Pesticides Consumption in Haryana, 1984-85 to 2016-17

(In Tonnes)

Sr. No.	Districts	1984-85	1990-91	1995-96	2000-01	2005-06	2010-11	2015-16	2016-17
1.	Ambala	298	345	152	150	115	155	158	155
2.	Bhiwani	97	142	289	284	201	299	305	300
3.	Faridabad	152.04	208	321.70	158	126	105	103	100
4.	Fatehabad	-	-	-	324	549	110	115	115
5.	Gurugram	268	164	118	58	58	22	20	20
6.	Hisar	340	688	604	271	252	420	430	430
7.	Jhajjar	-	-	-	72	73	67	68	65
8.	Jind	208	325	292	287	224	180	185	185
9.	Kaithal	-	-	432	425	254	304	305	300
10.	Kamal	556	808	402	396	323	462	462	200
11.	Kurukshetra	524	829	307	307	270	240	245	385
12.	Mahendragarh	58	141	129	127	102	33	35	35
13.	Nuh	-	-	-	58	58	22	20	20
14.	Palwal	-	-	-	158	126	105	103	100
15.	Panipat	-	-	342	338	294	398	390	460
16.	Panchkula	298	345	152	150	115	155	158	155
17.	Rewari	-	-	181	177	140	7	10	10
18	Rohtak	136	127	160	85	106	48	50	50
19.	Sirsa	360	680	608	599	728	360	362	350
20.	Sonipat	312	364	340	334	291	280	278	275
21.	Yamuna Nagar	-	-	270	266	246	290	300	300
	Total	**3,607.04**	**5,166**	**5,100**	**5,024**	**4,651**	**4,062**	**4,102**	**4,010**

Source: Statistical Abstract of Haryana, 2018.

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Panipat and Sonipat reported using 338 and 334 tons of pesticides, respectively, while 324 tonnes were consumed in Fatehabad. Kurukshetra came in second with 307 tonnes, while the consumption levels of Jind and Bhiwani were 287 and 284 tonnes, respectively. Hisar registered 271 tonnes of consumption, while Yamuna Nagar and Rewari reported 266 and 177 tonnes of consumption, respectively. Palwal and Faridabad had equal pesticide consumption levels at 158 tonnes each, while Ambala and Panchkula had consumptions of 150 tonnes each. Mahendragarh recorded a consumption of 127 tonnes, while Rohtak, Jhajjar, Nuh, and Gurugram had relatively lower pesticide consumption levels, ranging from 58 to 85 tonnes. This data illustrates the distribution of pesticide usage across different districts of Haryana in 2000-01, indicating variations in consumption levels and potential changes in agricultural practices, crop patterns, and socio-economic factors (Map 1).

Spatio Pattern of Pesticides Consumption in Haryana: 2005-06

In 2005-06, the spatio-temporal analysis of pesticide consumption in Haryana revealed a total consumption of 4,651 tonnes. Among the listed districts, Sirsa had the highest pesticide consumption, with 728 tonnes, followed by Fatehabad at 549 tonnes and Kamal at 323 tonnes. Panipat and Sonipat recorded pesticide usage values of 294 tonnes and 291 tonnes, respectively, while Kurukshetra had a consumption of 270 tonnes. Kaithal and Hisar followed closely with 254 tonnes and 252 tonnes, respectively, and Yamuna Nagar recorded a consumption of 246 tonnes. Jind and Bhiwani had consumption levels of 224 tonnes and 201 tonnes, respectively. Rewari had a consumption of 140 tonnes, while Palwal and Faridabad had equal pesticide consumption levels at 126 tonnes each. Ambala and Panchkula had consumptions of 115 tonnes each. Rohtak had a consumption of 106 tonnes, while Mahendragarh, Jhajjar, Nuh, and Gurugram had relatively lower pesticide consumption levels, ranging from 58 to 102 tonnes (Map 2).

Spatio Pattern of Pesticides Consumption in Haryana: 2010-11

The spatiotemporal analysis of pesticide consumption in Haryana during 2010–11 revealed 4,062 tons of overall consumption. The district with the largest pesticide consumption among those on the list was Kamal, with 462 tonnes, followed by Hisar with 420 tonnes and Panipat with 398 tonnes.

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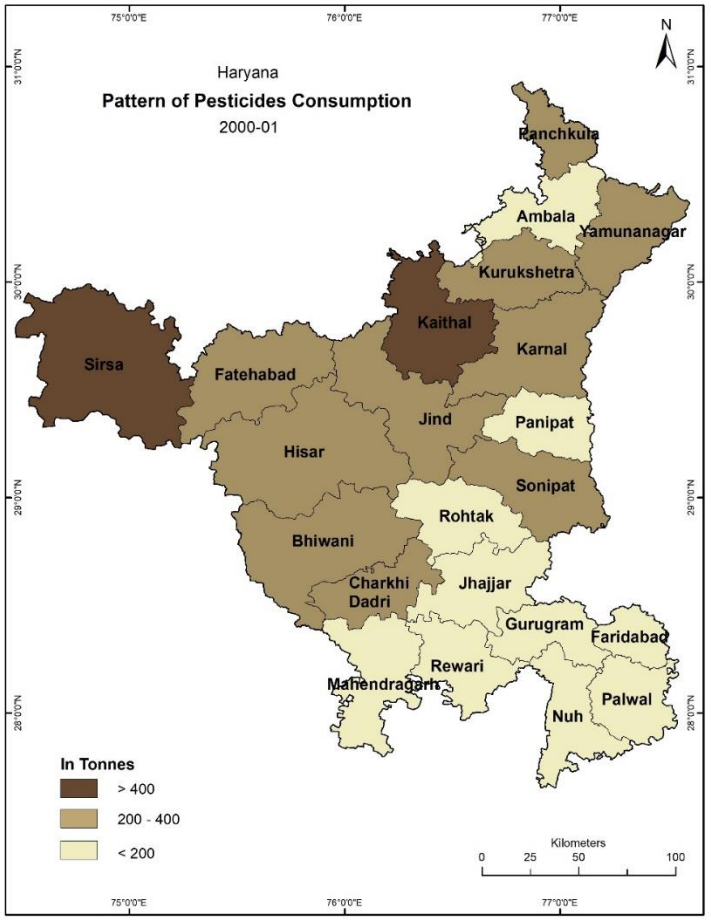
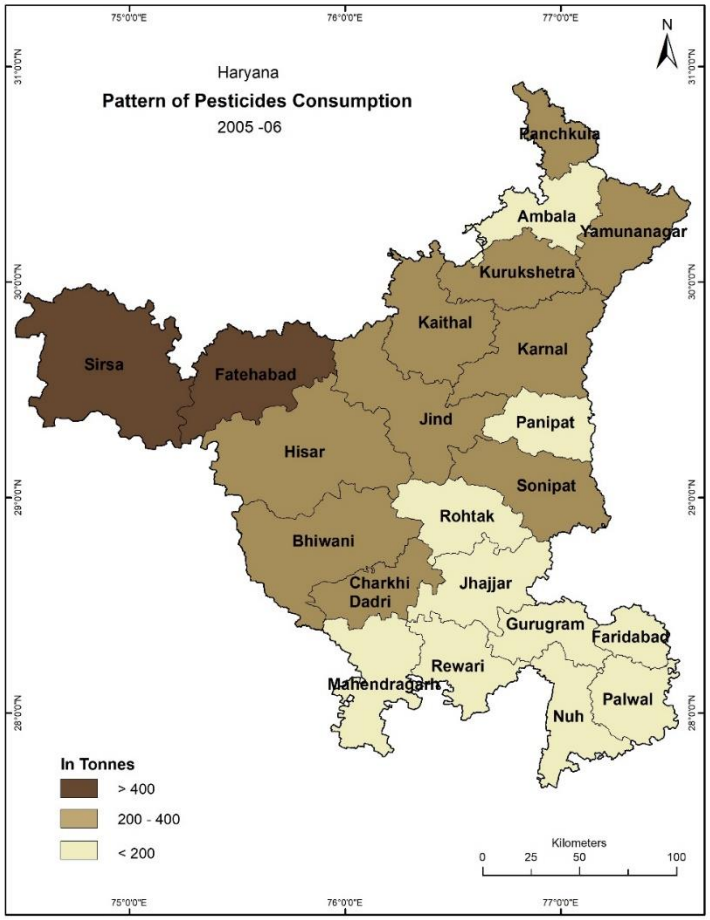


Source: Based on table 1.

Map 1



Source: Based on table 1.

Map 2

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It was found that Bhiwani consumed 299 tons of pesticides, but Sirsa and Kaithal had figures of 360 and 304 tonnes, respectively. Kurukshetra consumed 240 tons, but Yamuna Nagar and Sonipat consumed 290 and 280 tonnes, respectively. 180 tons were consumed in Jind. Pesticide consumption levels were equal in Ambala and Panchkula at 155 tonnes each, and equal in Fatehabad, Palwal, and Faridabad at 110 tonnes each. The usage of pesticides in Jhajjar was 67 tonnes, whilst the levels in Rohtak, Mahendragarh, Nuh, and Gurugram were comparatively lower, ranging from 22 to 48 tons. With 7 tons used, Rewari has the least amount of pesticides (Map 3).

Spatio Pattern of Pesticides Consumption in Haryana: 2015-16

In 2015-16, the spatio-temporal analysis of pesticide consumption in Haryana indicated a total consumption of 4,102 tonnes. Among the listed districts, Kamal had the highest pesticide consumption, with 462 tonnes, followed by Hisar at 430 tonnes and Panipat at 390 tonnes. Sirsa, Kaithal, and Bhiwani recorded pesticide usage values of 362 tonnes, 305 tonnes, and 305 tonnes, respectively, while Yamuna Nagar had a consumption of 300 tonnes. Sonipat had a consumption level of 278 tonnes, while Kurukshetra had a consumption of 245 tonnes. Jind recorded a consumption of 185 tonnes. Ambala and Panchkula had equal pesticide consumption levels at 158 tonnes each, while Fatehabad, Palwal, and Faridabad had equal consumptions of 115 tonnes each. Jhajjar had a consumption of 68 tonnes, while Rohtak, Mahendragarh, Nuh, and Gurugram had relatively lower pesticide consumption levels, ranging from 20 to 50 tonnes. Rewari had the lowest pesticide consumption at 10 tonnes (Map 4).

Spatio Pattern of Pesticides Consumption in Haryana: 2016-17

In 2016-17, the spatio-temporal analysis of pesticide consumption in Haryana revealed a total consumption of 4,010 tonnes. Among the listed districts, Panipat had the highest pesticide consumption, with 460 tonnes, followed by Hisar at 430 tonnes and Kurukshetra at 385 tonnes. Sirsa, Kaithal, and Bhiwani recorded pesticide usage values of 350 tonnes, 300 tonnes, and 300 tonnes, respectively, while Yamuna Nagar and Sonipat had a consumption of 300 tonnes each (Map 5).

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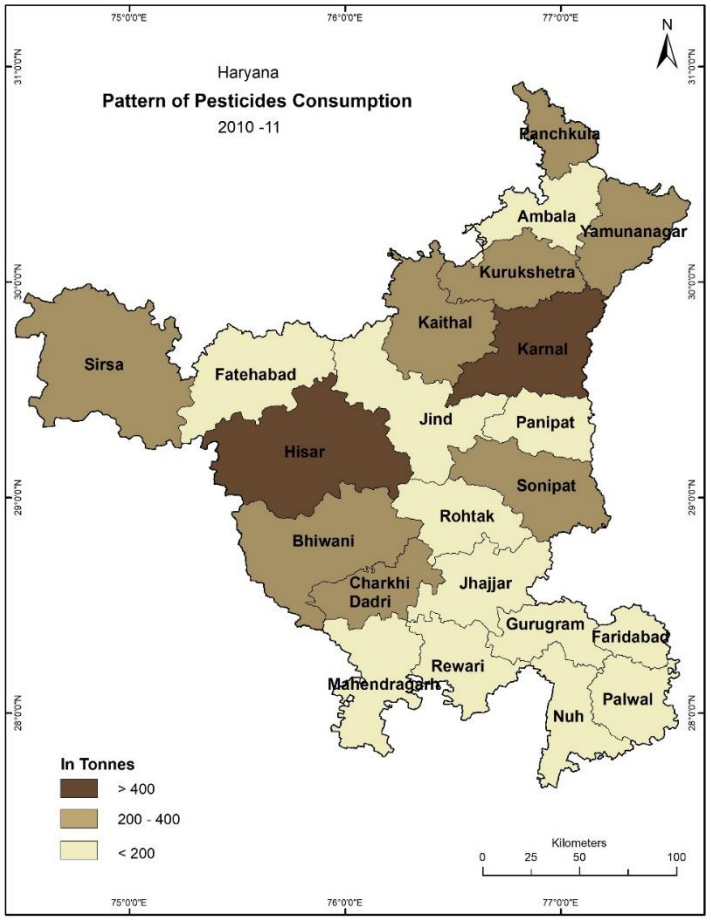
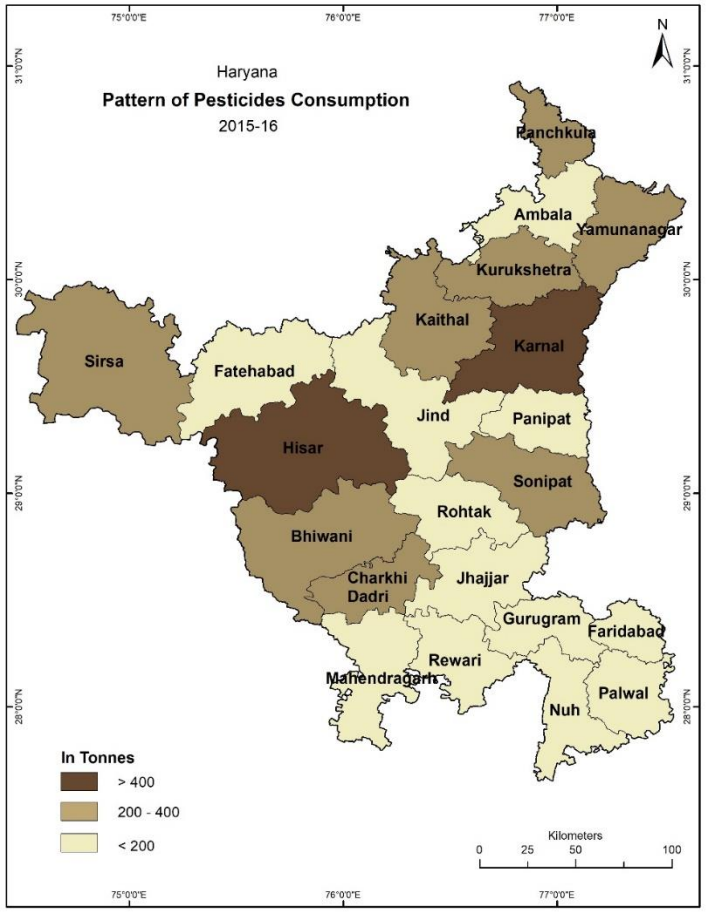


Source: Based on table 1.

Map 3



Source: Based on table 1.

Map 4

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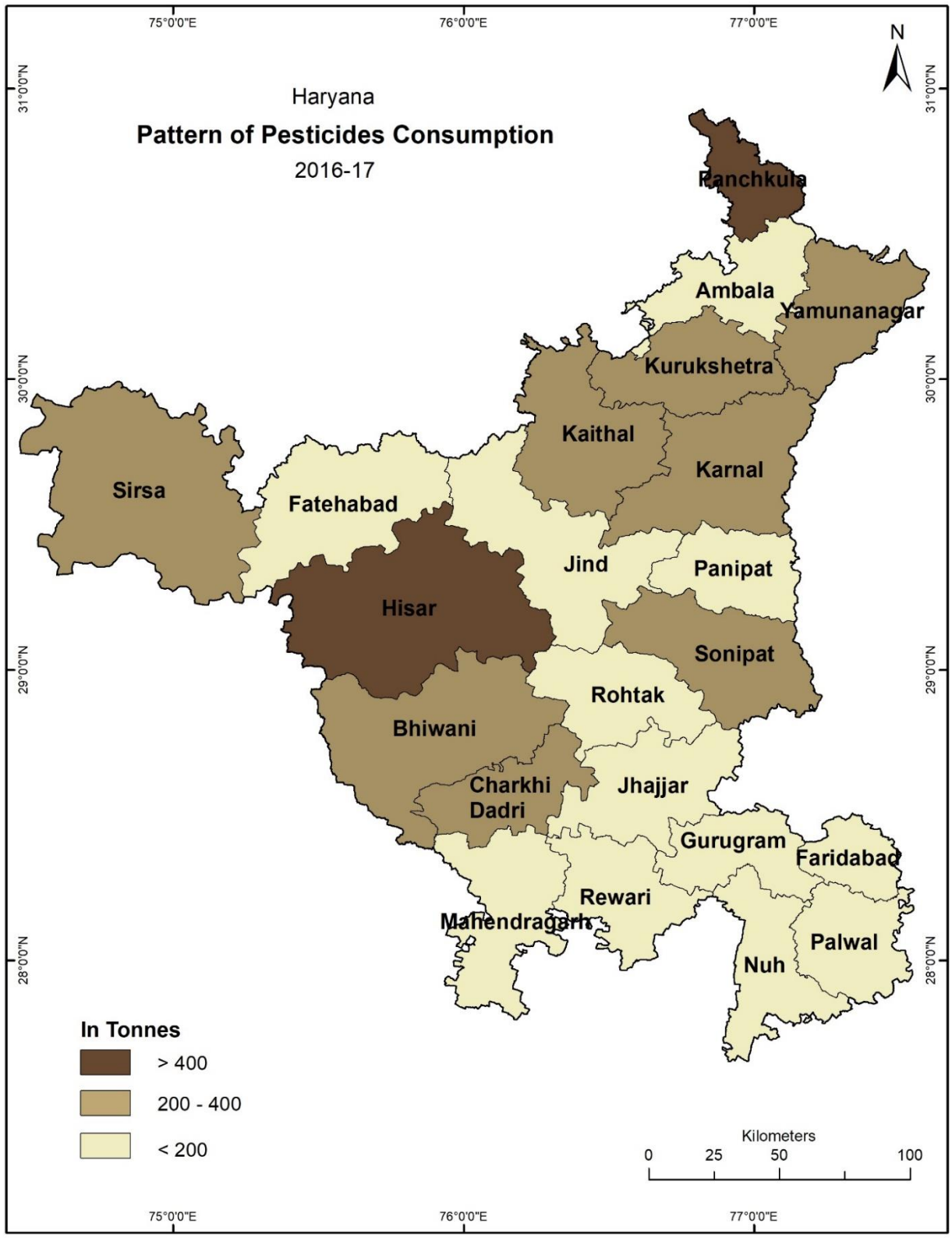

Source: Based on table 1.

Map 5

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Kamal had a consumption level of 200 tonnes, while Jind recorded a consumption of 185 tonnes. Ambala and Panchkula had equal pesticide consumption levels at 155 tonnes each, while Fatehabad, Palwal, and Faridabad had equal consumptions of 115 tonnes each. Jhajjar had a consumption of 65 tonnes, while Rohtak, Mahendragarh, Nuh, and Gurugram had relatively lower pesticide consumption levels, ranging from 20 to 50 tonnes. Rewari had the lowest pesticide consumption at 10 tonnes.

Conclusion

The total pesticide consumption fluctuated over the years, with variations observed in different periods. Despite fluctuations, there seems to be a general increasing trend in pesticide usage over the decades. Panipat, Hisar, and Kurukshetra consistently had high pesticide usage during 1984-85 to 2016-17. Districts such as Fatehabad, Palwal, Faridabad, Nuh, and Gurugram generally had lower pesticide consumption levels throughout the years. There were fluctuations in pesticide consumption within certain districts over time, possibly reflecting changes in agricultural practices, and crop patterns. The importance of monitoring and regulating pesticide usage to ensure sustainable agricultural practices and minimize environmental and health risks. It highlights the need for targeted involvements and policies aimed at promoting responsible pesticide management practices, encouraging the adoption of integrated pest management strategies, and reducing reliance on chemical pesticides. The increasing trend in pesticide consumption raises concerns about potential environmental degradation, including soil and water contamination, as well as adverse impacts on human health and biodiversity. Sustainable alternatives and practices, such as organic farming and biological pest control methods, may need to be promoted to mitigate these concerns. In conclusion, the spatio-temporal analysis of pesticide consumption in Haryana underscores the complex interplay of agricultural, socio-economic, and environmental factors influencing pesticide usage. It emphasizes the importance of adopting holistic approaches to pesticide management that prioritize sustainability, environmental protection, and human well-being. Some suggestions for further study have given below:

- To encourage widespread adoption of IPM practices that emphasize the use of multiple pest management strategies, including biological control, crop rotation, use of resistant crop varieties, and targeted pesticide applications.

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- To provide incentives and technical assistance to farmers for implementing diversified farming practices, such as intercropping, agroforestry, and integrated crop-livestock systems.

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