Annals of Plant and Soil Research 26(3): 425-433 (2024)
https://doi.org/10.47815/apsr.2024.10380

Changes in the patterns of crop diversification in Haryana

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Received, May, 2024; Revised accepted, July, 2024

ABSTRACT

Crop diversification refers to the practice of cultivating a variety of crops on the same land over time or across a landscape. It's a move away from monoculture, where a single crop dominates a field or agricultural region. Recognizing the shifts in crop diversification trends through time and across different regions equips stakeholders with the knowledge to foster an agricultural system that is sustainable, robust, and fair. In the present study, the patterns of crop diversification analysed for the years 2011, 2015, and 2021. The variations in crop diversification patterns scrutinized for two distinct periods: from 2011 to 2015, and subsequently from 2015 to 2021. Gibb's-Martin Index is used to calculate the crop diversification index at the district level. The percentage of moderate districts in all the three years of analysis, that is, 2011, 2015 and 2021 is highest in Gibbs Martin Index, which is followed by low districts and high districts respectively. The high positive change in the Gibbs Martin Index is observed followed by negative change and no change respectively between the years 2011 and 2015, and 2015 and 2021. The findings indicate a substantial potential for expanding crop diversification initiatives in Haryana.

Keywords: Crop Diversification, Haryana, Gibbs Martin Index, Monoculture, Environment

INTRODUCTION

The practice of growing a range of crops on the same land throughout time or across a landscape is known as crop diversification. It represents a departure from monoculture, in which a field or other agricultural area is dominated by a single crop. Diversifications minimize risk if one crop fails due to pests, disease, or unfavourable weather, the impact on overall production and farmer income is lessened. Crop diversification also leads to improved soil health (Srivastava, 2023).Practices of monoculture can inadvertently set up perfect breeding grounds for certain pests and deteriorate soil quality (Rekwari *et al.*, 2024). On the other hand, diversification interrupts the continuity of pest life cycles, leading to environments that are less conducive to their proliferation. Additionally, different crops demand different levels of water, which highlights the importance of diversification in managing water resources efficiently. Diversification allows farmers to integrate water-efficient crops into their cropping systems, reducing overall water use. Diversification enables farmers to cultivate high-value crops like fruits, vegetables, and pulses, potentially increasing their income compared to traditional crops. When applied regionally, diversification can lead to a wider variety of crops being produced, contributing to a more diverse and nutritious diet for the population. Hazra (2001) studied the crop diversification in India. Crop Diversification is aimed to provide a wider choice in the production of variety of crops in a particular area to expand the production activities on various crops and to lessen the risk. Crop diversification in India is a shift from less remunerative crops to more remunerative crops. Acharya *et al.* (2011) economically analysed the concept of crop diversification in Haryana. Creation of basic facilities like markets, irrigation water, transportation, availability of fertilizer is essential for the concept of crop diversification to flourish. Lekha and Rana (2013) studied the pattern of crop diversification in Haryana. The concept of diversification of crop is opposite to the concept of specialization of crop. Growing a single crop in a particular area is termed as crop specialization whereas growing more than one crop in a particular area is termed as the concept of crop diversification. Kumar and Kumar (2018) studied diversification in agriculture as an opportunity for smallholders. Farmers require the access to credit facilities and proper agricultural training to practice the concept of crop diversification and to gain positive impact from

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the concept of crop diversification. Beillouin et al (2019) researched on the crop diversification strategies at the global scale. Diversifying the cropping system in an area go a long way in maintaining and enhancing the agricultural sustainability.

Understanding the dynamics of crop diversification yields critical information for crafting effective agricultural policies, fostering sustainable farming methods beneficial to the environment, bolstering food security along with a more nutritious diet, and enhancing the economic stability and income of farmers. Knowledge of how these diversification trends change through periods and across different areas enables stakeholders to make choices that support a more sustainable, resilient, and fair agricultural framework. In Haryana, a key agrarian region in India, there has been a traditional emphasis on the cultivation of wheat and rice. However, recent shifts toward a broader spectrum of crop cultivation have been observed, driven by government initiatives, market demands, and environmental considerations. Despite the progress, some challenges persist like inadequate cold storage facilities and transportation networks that can hinder the marketing of perishable diversified crops, unpredictable prices for high-value crops and lack the knowledge or skills required to cultivate diversified crops effectively, leading to hesitation among farmers in adopting new practices. So, in brief the aim of present study was to analyse the trend and extent of diversification in Haryana. Keeping this background in view, the present investigation purposed the following objectives:

- To analyse the patterns of crop diversification for the period of 2011, 2015, and 2021 in Haryana.
- To examine the changes in crop diversification patterns from 2011 to 2015, and then from 2015 to 2021 in Haryana.
- To recommend strategies for the Government of Haryana to advance the process of crop diversification.

MATERIALS AND METHODS

Methodology

The value of the crop diversification index serves to depict spatial and temporal shifts in crop diversification patterns. The Gibb's-Martin Index is employed at the district level for determining this index. The following is the formula which is used for the calculation: -

Where $$GMI = 1 - \frac{\sum(X^2)}{(\sum X)^2}$$

X= percentage of area occupied by each individual crop in total cropped area.

The index value is classified into three categories: low diversification, moderate diversification, and high diversification. Based on these categories, the districts in Haryana have been segmented into three categories according to their level of crop diversification. The increase and decrease in the value of the index gives a pattern of crop diversification in Haryana. The value of the index is in the range of 0.10 to 0.90. Low diversification or specialization of crop is depicted by the value 0.10 whereas high diversification is depicted by the value 0.90. The districts of Haryana are grouped in three categories of low diversification, moderate diversification and high diversification for analysing the patterns of crop diversification based on their diversification value. The change in the values of diversification index of all the districts is analysed to understand the change in the crop diversification patterns. Subtracting the value of initial year with the year with which it is supposed to be compared is used to calculate the change. The results show three type of changes which are negative change, positive change and no change. Positive change means an increase in the diversification value and negative change means the decrease in the diversification value. No change shows that it is following the same trend for both the years. Table 1 shows the various crops areas which are used to calculate the Gibbs and Martins Index. The data is presented in the form of maps and tables to understand the patterns of crop diversification. Arc GIS software is used to make the maps related to crop diversification.

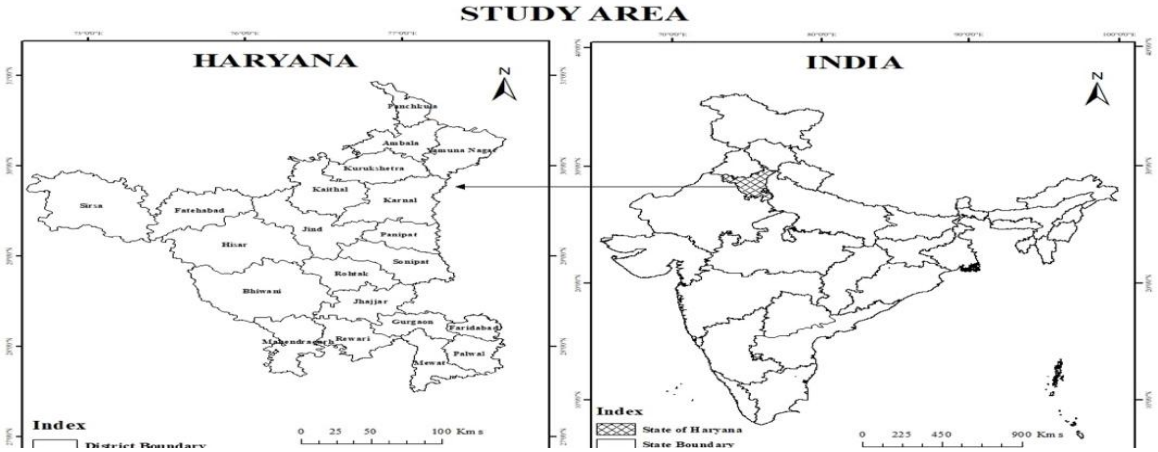
Study area: Haryana

The state of Haryana lies in the north of India. The state of Haryana was formed in 1966. The capital of Haryana is Chandigarh which is also the capital of the state of Punjab. The city Gurugram is the largest financial and technology hubs. Gurugram is also the fastest growing district of Haryana. Haryana is a state with 22 districts. Haryana's proximity to India's capital, New Delhi, means that a significant portion of

Table 1: Various crops area taken to calculate Gibbs and Martins Index

Various crops area taken to calculate Gibbs and Martins Index**:**
Total Cereals Area
Total Pulses Area
Total Oilseeds Area
Total Sugarcane Area
Total Fruits Area
Total Vegetable Area

the state is included in the National Capital Region (NCR). The districts falling in NCR get funds from the central NCR development plans. The neighbouring states of Haryana are Punjab, Rajasthan, Uttarakhand, Uttar Pradesh and Himachal Pradesh. Haryana is often cited as one of the most economically advanced states in India. The map of Haryana and its location in India is shown in Map 1.



Map1: Study Area

RESULTS AND DISCUSSION

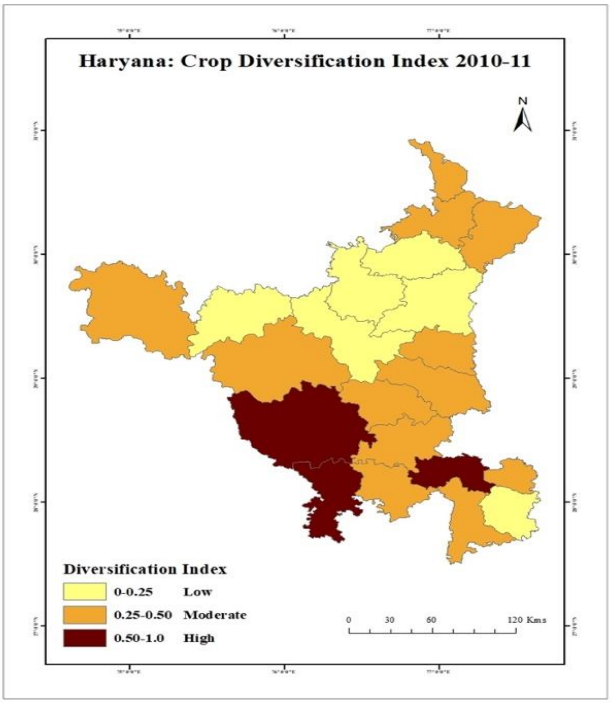
Patterns of Crop Diversification in 2011

Table 2 shows the Gibbs Martin Index in Haryana 2010-11. Map 2 shows the Gibbs Martin Index in Haryana 2010-11. The districts of Bhiwani, Mahendragarh and Gurugram have high crop diversification index in 2010-11. The districts of Sirsa, Panchkula, Ambala, Yamuna Nagar, Hisar, Panipat, Sonipat, Rohtak, Jhajjar, Rewari, Nuh, and Faridabad in Haryana are categorized under the moderate crop diversification index. Whereas the districts of Palwal, Fatehabad, Jind, Kaithal, Karnal, Kurukshetra have low crop diversification index. Bhiwani, Mahendragarh and Gurugram have high crop diversification index because of many reasons. These districts are closer to major cities like Delhi and Gurugram itself. The easier access to urban markets made it more profitable for farmers to cultivate high-value crops like fruits, vegetables, and flowers that have a shorter shelf life and require quicker transportation to consumers. These districts have also benefited from enhanced infrastructure development, including improvements in roads, railways, and storage facilities. This reduced transportation costs and post-harvest losses, making diversification more attractive for farmers.

Table 2: Gibbs Martin Index in Haryana 2010-11

Haryana 2010-11: Gibbs Martin Index		
Categories	Districts	Their Index
0.1-0.25, Low	Kurukshetra	0.24
	Kaithal	0.06
	Karnal	0.23
	Palwal	0.19
	Jind	0.1
	Fatehabad	0.17
0.25-0.50, Moderate	Ambala	0.33
	Panchkula	0.44
	Yamunanagar	0.47
	Panipat	0.25
	Sonipat	0.27
	Rohtak	0.35
	Jhajjar	0.33
	Faridabad	0.39
	Nuh	0.43
	Rewari	0.49
	Hisar	0.43
	Sirsa	0.31
0.50-0.9, High	Gurugram	0.52
	Mahendragarh	0.54
	Bhiwani	0.55

Source: Department of Land Records, Haryana; Department of Horticulture, Government of Haryana



Map 2: Crop Diversification Index 2010-11

Patterns of Crop Diversification in 2015

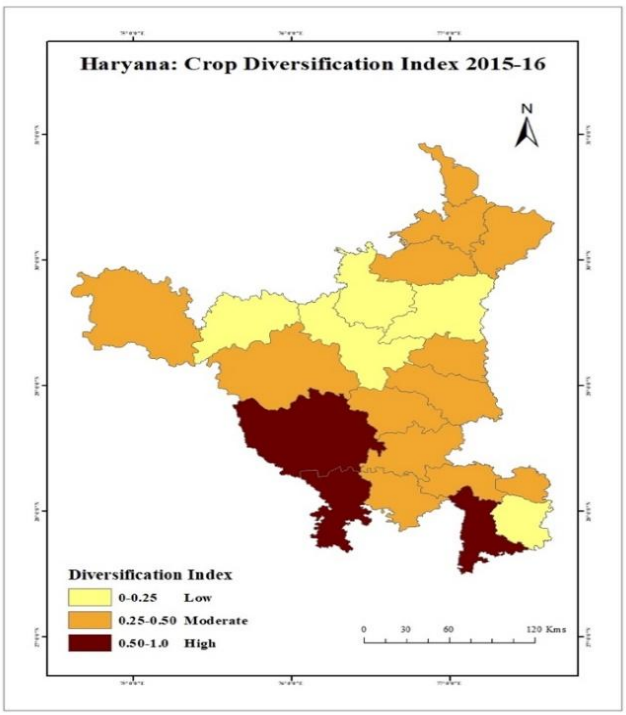
Table 3 shows the Gibbs Martin Index in Haryana 2015-16.

Table 3: Gibbs Martin Index 2015-16

2015-16 Gibbs Martin Index		
Categories	Districts	Their Index
0.1-0.25, Low	Kaithal	0.07
	Karnal	0.24
	Palwal	0.17
	Jind	0.11
	Fatehabad	0.19
0.25-0.50, Moderate	Ambala	0.36
	Panchkula	0.46
	Yamunanagar	0.48
	Kurukshetra	0.29
	Panipat	0.37
	Rohtak	0.35
	Faridabad	0.39
	Gurugram	0.49
	Rewari	0.49
	Hisar	0.41
	Sirsa	0.28
	Sonipat	0.3
	Jhajjar	0.3
0.50-0.9, High	Mahendragarh	0.52
	Bhiwani	0.55
	Nuh	0.5

Source: Department of Land Records, Haryana; Department of Horticulture, Government of Haryana

Map 3 shows the Gibbs Martin Index in Haryana 2015-16. The districts of Bhiwani, Mahendragarh and Gurugram have high crop diversification index in 2015-16. The districts of Sirsa, Panchkula, Ambala, Yamuna Nagar, Hisar, Panipat, Sonipat, Rohtak, Jhajjar, Rewari, Nuh, Faridabad, and Kurukshetra in Haryana are classified with a moderate crop diversification index. Whereas the districts of Palwal, Fatehabad, Jind, Kaithal and Karnal have low crop diversification index. As we can clearly see that the district of Kurukshetra has shifted from being low in crop diversification index in 2010-11 to being moderate in 2015-16. The primary drivers for the moderate crop diversification index in these districts include changing consumer preferences and increasing demand for fruits, vegetables, and other diversified crops in nearby urban centers, prompting farmers in Kurukshetra and surrounding areas to meet this demand.



Map 3: Crop Diversification Index 2015-16

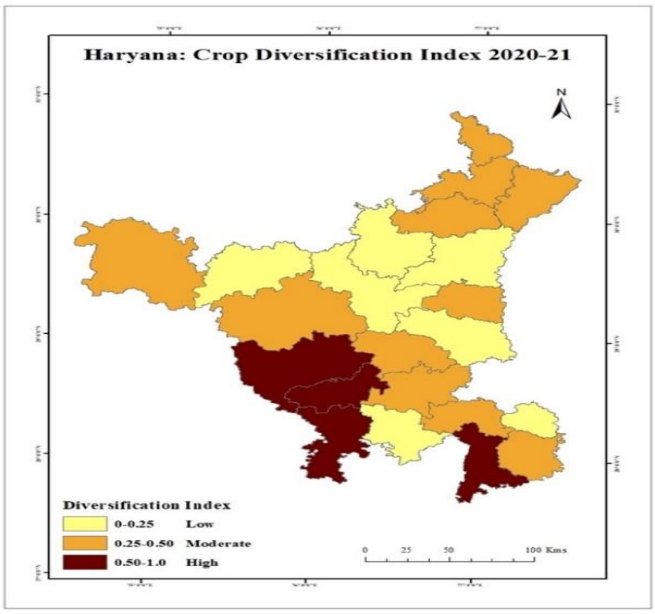
Patterns of Crop Diversification in 2021

Table 4 shows the Gibbs Martin Index in Haryana 2020-21. Map 4 shows the Gibbs Martin Index in Haryana 2020-21. The districts of Bhiwani, Charkhi Dadri, Mahendragarh and Nuh have high crop diversification index in 2020-21. The districts of Panchkula, Ambala, Yamunanagar, Kurukshetra, Panipat, Sirsa,

Table 4: Gibbs Martin Index 2020-21

2020-21 Gibbs Martin Index		
Categories	Districts	Their Index
0.1-0.25, Low	Faridabad	0.24
	Fatehabad	0.23
	Jind	0.13
	Kaithal	0.08
	Karnal	0.18
	Rewari	0.22
	Sonipat	0.17
0.25-0.50, Moderate	Ambala	0.31
	Gurugram	0.42
	Hisar	0.43
	Jhajjar	0.33
	Kurukshetra	0.28
	Palwal	0.41
	Panchkula	0.33
	Rohtak	0.37
	Sirsa	0.33
	Yamunanagar	0.43
	Panipat	0.4
0.50-0.9, High	Bhiwani	0.58
	Charkhi Dadri	0.53
	Mahendragarh	0.55
	Nuh	0.5

Source: Department of Land Records, Haryana; Department of Horticulture, Government of Haryana



Map 4: Crop diversification Index 2020-21

Hisar, Rohtak, Jhajjar, Gurugram and Palwal have moderate crop diversification index. Whereas the districts of Rewari, Faridabad, Kaithal, Karnal, Fatehabad, Jind, Sonipat have low crop diversification index. The primary reason for the low crop diversification index in these districts is attributed to unsuitable agro-climatic and soil conditions, compounded by historically low levels of crop diversification in these areas. Whereas the districts of Bhiwani, Charkhi Dadri, Mahendragarh, Nuh have historically high patterns of Crop diversification.

Changes in the patterns of crop diversification between 2011 and 2015

The increase in crop diversification can be attributed to several factors, including:

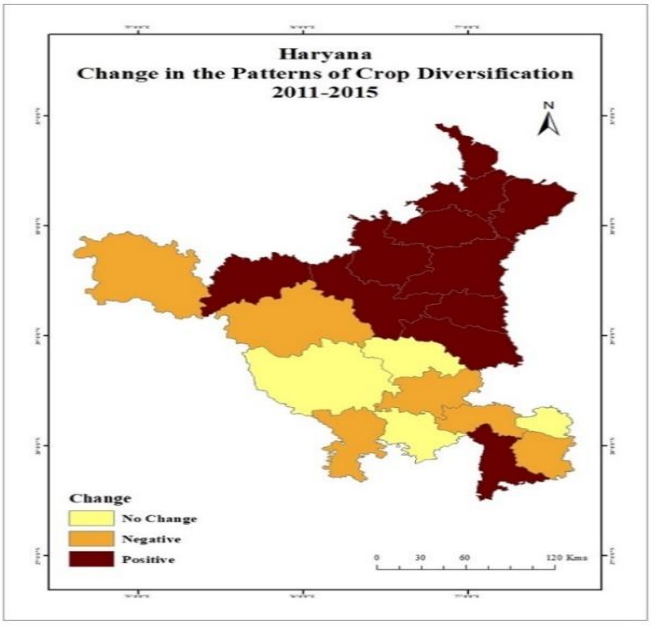
- **Government initiatives:** Schemes promoting diversification, such as the National Horticulture Mission (NHM) and various state-specific programs in Haryana, have played a significant role in encouraging farmers to shift towards cultivating high-value crops including fruits, vegetables, flowers, and pulses.
- **Market access:** Improved infrastructure (roads, storage facilities) have made it easier to transport perishable diversified crops to nearby urban markets with growing demand.
- **Environmental factors:** Water scarcity and soil health concerns are pushing farmers towards water-efficient and less soil-depleting crops.

Table 5 shows the Change in Gibbs Martin Index in the districts of Haryana from 2011 to 2015. Map 5 shows the Change in Gibbs Martin Index in the districts of Haryana from 2011 to 2015. The districts of Panchkula, Ambala, Yamuna Nagar, Kurukshetra, Karnal, Jind, Panipat, Sonipat, Fatehabad, Nuh, and Kaithal experienced positive changes in crop diversification patterns from 2011 to 2015. Conversely, the districts of Sirsa, Hisar, Mahendragarh, Jhajjar, Gurugram, and Palwal displayed negative trends in crop diversification during the same period. Meanwhile, Bhiwani, Rohtak, Rewari, and Faridabad saw no significant changes in diversification. This analysis highlights that northern Haryana has demonstrated a positive shift towards crop diversification. Factors such as increased demand for high-value crops like fruits, vegetables, and flowers, coupled with enhanced infrastructure, cold storage facilities, and targeted diversification initiatives and government schemes, have enabled farmers in these districts to capitalize on these lucrative markets.

Table 5: Change in Gibbs Martin Index from 2011 to 2015

Change in Gibbs Martin Index from 2011 to 2015			
Districts	Positive change	Negative change	No change
Kurukshetra	0.05		
Kaithal	0.01		
Karnal	0.01		
Palwal		-0.02	
Jind	0.01		
Fatehabad	0.02		
Ambala	0.03		
Panchkula	0.02		
Yamunanagar	0.01		
Panipat	0.12		
Sonipat	0.03		
Rohtak			0
Jhajjar		-0.03	
Faridabad			0
Nuh	0.07		
Rewari			0
Hisar		-0.02	
Sirsa		-0.03	
Gurugram		-0.03	
Mahendragarh		-0.02	
Bhiwani			0

Source: Department of Land Records, Haryana; Department of Horticulture, Government of Haryana



Map 5: Change in the patterns of crop diversification 2011-2015

Changes in the patterns of crop diversification between 2015 and 2021

Here's a breakdown of the potential reasons for the recent increase in crop diversification in Haryana:

- **Urbanization and Rising Income:** The expansion of cities near Haryana has led to a rising demand for high-value crops such as fruits, vegetables, flowers, and pulses. This increase is due to the urban population's growing preference for diverse and healthy food options. Farmers are better positioned to capitalize on this due to:
  - **Improved Infrastructure:** Better roads and transportation networks make it easier to deliver these perishable goods to consumers.
  - **Cold Storage Facilities:** Increased availability of cold storage facilities helps to reduce spoilage and extends the shelf life of these crops.
- **Diversification Programs:** The Haryana governments have introduced programs specifically targeted at promoting crop diversification. These involve:
  - **Financial incentives:** Subsidies for seeds, fertilizers, and other essential inputs for cultivating diversified crops are being provided to support and encourage farmers to expand their range of agricultural products.
  - **Market linkages:** Helping farmers to connect with buyers and distributors in nearby urban centres.
  - **Price support:** Offering minimum support prices for diversified crops to make them more financially attractive.
- **Farmer Knowledge and Risk Management:** Growing awareness among farmers of the benefits associated with crop diversification, such as diminished risk from pests and market price fluctuations, is motivating them to adopt these practices more broadly.
- **Research and Development:** The development of drought-resistant and water-efficient varieties of high-value crops is enhancing the viability of diversification for farmers in Haryana, making it an increasingly attractive option.

Table 6 shows the change in Gibbs Martin Index in the districts of Haryana from 2015 to 2021. Map 6 shows the Change in Gibbs Martin Index in the districts of Haryana from 2015 to 2021. The map analysis reveals significant trends in crop diversification across Haryana

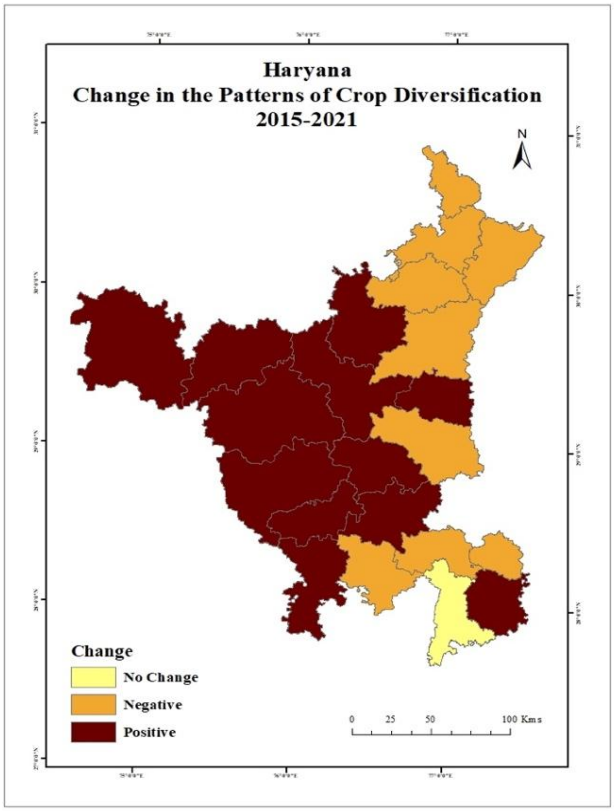
Table 6: Change in Gibbs Martin Index from 2015 to 2021

Change in Gibbs Martin Index from 2015 to 2021			
Districts	Positive change	Negative change	No change
Kaithal	0.01		
Karnal		-0.06	
Palwal	0.24		
Jind	0.02		
Fatehabad	0.04		
Ambala		-0.05	
Panchkula		-0.13	
Yamunanagar		-0.05	
Kurukshetra		-0.01	
Panipat	0.03		
Rohtak	0.02		
Faridabad		-0.15	
Gurugram		-0.07	
Rewari		-0.27	
Hisar	0.02		
Sirsa	0.05		
Sonipat		-0.13	
Jhajjar	0.03		
Mahendragarh	0.03		
Bhiwani	0.03		
Nuh			0
Charkhi Dadri	0.53		

Source: Department of Land Records, Haryana; Department of Horticulture, Government of Haryana

from 2015 to 2021. Districts such as Sirsa, Fatehabad, Hisar, Bhiwani, Charkhi Dadri, Mahendragarh, Jhajjar, Rohtak, Jind, Kaithal, Panipat, and Palwal have exhibited positive changes in their crop diversification patterns. In contrast, Nuh shows no change during this period. Meanwhile, districts like Rewari, Gurugram, Faridabad, Sonipat, Panchkula, Ambala, Yamuna Nagar, Kurukshetra, and Karnal have experienced a decline in crop diversification. Western Haryana, in particular, has demonstrated a notable positive shift in crop diversification, driven primarily by an increased demand and production of fruits, especially citrus fruits, which thrive in the region's favorable agro-climatic conditions.

Malik and Singh (2002) economically analyzed the concept of crop diversification. As the economy of Haryana is an agriculture-based economy, therefore the concept of crop diversification is a necessity not an alternative. Cereal production alone cannot sustain the development and the growth of the economy. Gehlot and Kaur (2015) studied crop diversification for sustainable agricultural development in Haryana, India.



Map 6: Change in the patterns of crop diversification 2015-2021

The natural resources in Haryana are depleting at an alarming rate. Crop diversification emerges as an only alternative solution for sustainable development in the state of Haryana. Mittal and Hariharan (2016) researched the concept of crop diversification by agro-climatic zones of India along with their trends and drivers. The research highlighted the importance of crop diversification as a risk mitigating strategy and a means to improve income for the farmers. Crop diversification can prove as a risk mitigating strategy not only for the farmers to deal with future uncertainties but could also act as an adaptive measure to manage climate risk. Bhatia *et al.* (2020) studied the extent of crop diversification in Haryana. Their study revealed that the shift in the area towards specific crops was because of crops profitability, irrigation water availability and favorable government policies. Bansal *et al.* (2020) researched the technological factors and the socio-economic constraints for crop diversification in Haryana. Lack of proper marketing facilities, lack of technical know-how, lack of training and field demonstration, lack of proper soil testing facility, illiteracy and lack of

access of credit are the various constraints to the process of crop diversification. Therefore, the process of crop diversification must be implemented keeping the area-based constraints and their solutions in mind.

CONCLUSION

The percentage of moderate districts in all the three years of analysis, that is, 2011, 2015 and 2021 is highest in Gibbs Martin Index, which is followed by low districts and high districts respectively. The high positive change in the Gibbs Martin Index is observed followed by negative change and no change respectively between the years 2011 and 2015, and 2015 and 2021. The findings indicate a significant potential for expanding crop diversification initiatives in Haryana. Though the cropping pattern in Haryana is changing towards crop diversification but the change is still slow because of many factors. The most dominant one of that factor is that the state of Haryana has been historically a state which focussed on the traditional cereals and food grains production. Therefore, many farmers of Haryana are still reluctant to adopt the new diversification measures. The government and the policy makers can play a huge role in making favourable crop diversification polices for the farmers of Haryana. In an effort to promote diversity in agriculture and reduce reliance on the conventional wheat and rice cropping system, the Haryana government has rolled out numerous initiatives in recent years. Among these, the 'Mera Pani-Meri Virasat Scheme' stands out by offering farmers a subsidy of Rs. 7,000 for every acre that they convert from rice to alternative crops, including maize, cotton, millets, pulses, and various fruits and vegetables. This initiative has proven effective in both encouraging crop variety and conserving water resources. Looking ahead, the administration could consider establishing specialized markets for these diverse crops or creating direct links between farmers and major retail chains and food processors. This will improve market access for farmers growing high-value crops. The government should also aim to build more cold storage facilities to reduce spoilage of perishable fruits and vegetables, for encouraging diversification towards these crops. The government should also boost the development of processing units for diversified crops like pulses and oilseeds. This might create additional income streams for farmers by adding value to their produce. Schemes offering subsidies on inputs like fertilizers, pesticides, and micro-irrigation equipment can make diversification more accessible to farmers by reducing initial costs. Promoting the farmers produce organizations (FPOs) can help farmers collectively bargain for better prices, access inputs, and improve marketing linkages. This will empower farmers and incentivizes diversification.

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