

## Cropping pattern transitions in India's major seed spice producing states

M D Meena,\* S S Meena, S Lal, R D Meena, N K Choudhary & A K Kasotiya

ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan

\* Email: meenamurlidhar@gmail.com

Received 14 January 2026; Revised 22 July 2026; Accepted 30 July 2026

---

### Abstract

This study examines the long-term shift in cropping patterns in India and major seed-spice-producing states namely Gujarat, Madhya Pradesh, and Rajasthan, over the period 1984-85 to 2023-24. Using secondary data from official sources, the study evaluates changes in cropped area, value of output (VOP), growth, instability, and crop diversification through the Herfindahl–Hirschman Index and Crop Diversification Index. The results reveal a clear structural transformation in Indian agriculture, characterized by a gradual decline in the dominance of cereals and millets and a rising importance of high-value crops such as fruits and vegetables, condiments and spices, oilseeds, and fibers. At the national level, a widening gap between area and VOP share highlights increasing value intensification, particularly in horticulture and spices. State-level analysis shows region-specific diversification pathways: Gujarat exhibits strong market-led diversification toward oilseeds, fibers and seed spices; Madhya Pradesh demonstrates a transition towards oilseeds and horticultural crops; and Rajasthan reflects fodder and oilseed led value diversification under arid and semi-arid conditions, with notable expansion of seed spices. Declining Herfindahl indices and rising diversification indices across all regions confirm increasing crop diversification over time. The overall findings underscore a shift from a staple-oriented to a value-intensive agricultural system, with important implications for farm income growth, resource sustainability, and region-specific agricultural policy formulation.

**Keywords:** Crop diversification, Herfindhal Index, India, Gujarat, Madhya Pradesh, Rajasthan

---

### Introduction

Indian agriculture has experienced a significant structural transformation over the last four decades, driven by economic liberalization, changing demand, climate change, technological advancements and policy interventions. These interrelating factors have transformed land-use decisions and cropping patterns across agro-ecological

regions, gradually shifting agriculture from a subsistence farming system to a more market-driven production structure (Venkatesh 2021). The expansion of cereal production after Green Revolution has generated several sustainability concerns, including groundwater depletion, declining soil fertility, biodiversity loss, and increasing vulnerability to climatic risks. Consequently, diversification towards high-value crops has emerged as

an important strategy for improving farm profitability, enhancing resource-use efficiency, and strengthening agricultural resilience (Basantaray *et al.*, 2024).

Crop diversification has become one of the essential features of Indian agriculture in current scenario. It involves reallocating cultivated land from traditional crops towards high value crops with more economic returns including horticultural crops like fruits & vegetables, condiments & spices, fibres, and plantation crops (Kumar *et al.*, 2024). Diversification may occur through changes in crop composition, crop rotations, intercropping, or the introduction of commercially important crops suited to local agro-climatic conditions (Feliciano, 2018). Numerous studies have demonstrated that crop diversification contributes to higher farm income, improved employment opportunities, better nutritional outcomes, enhanced climate resilience, and reduced production risks under increasing climatic uncertainty (Joshi *et al.*, 2007; Chand, 2017; BIRTHAL *et al.*, 2019).

Among high-value crops, spices occupy a unique position in India's agricultural economy. India is the world's largest producer, consumer, and exporter of spices, catering a substantial share of the global spice demand. Although spices occupy only about 1.96 per cent of the country's gross cropped area and around 15.26 per cent of the horticultural area, they contribute nearly 9 per cent of India's agricultural exports and more than 40 per cent of horticultural exports, highlighting their considerable economic significance relative to the land they occupy. Within spices, seed spices including cumin, coriander, fennel, fenugreek, and ajwain, constitute most commercially important crops, covering approximately 2.04 million hectares (43.55% of total spice area) and producing about 2.10 million tonnes (17.54% of total spice production) during 2023-24 (Spices Board of India, 2025).

In India, cultivation of seed spices is geographically concentrated in the north-

western states of Rajasthan, Gujarat, and Madhya Pradesh, which together account for more than 90 per cent of national seed spice production. Their dominance is supported by favourable agro-climatic conditions, established production systems, expanding domestic and export demand, and comparatively higher economic returns (Meena *et al.*, 2020). The rapid expansion of seed spices cultivation in above states reflects cropping pattern changes, where farmers increasingly allocate land towards high-value horticultural crops especially fruits and vegetables and condiments and spices, in response to changing consumers and farmers preferences.

Although several studies have examined crop diversification in India and state levels, relatively few have analysed long-term cropping pattern transitions in the context of major seed spice producing states using recent data spanning four decades. Existing research has largely focused on aggregate diversification trends, has not compared changes in the share of cropped area with corresponding changes in the share of the total agricultural value of output across different crop groups. A comprehensive state level assessment integrating changes in cropped area, value of output, growth dynamics, instability, and diversification indices can provide important insights into the nature of agricultural transformation in major seed spice growing states.

Against this background, the present study investigates long-term cropping pattern transitions in India and its three major seed spice producing states namely, Rajasthan, Gujarat, and Madhya Pradesh, covering the period from 1984-85 to 2023-24. Specifically, the study evaluates changes in cropped area, value of output, growth performance, instability, and crop diversification.

## Materials and methods

This study is purely based on the secondary data compiled from different sources. Area under

different crops was sourced from Department of Agriculture and Farmers Welfare website ([www.upag.gov.in](http://www.upag.gov.in)), Agricultural Statistics at a Glance and Spices Board India (GoI, 2025). The value of produce/output (VOP) of different crops was compiled from different reports published by the National Statistical Office, Ministry of Statistics and Programme Implementation, Government of India during 1984-85 to 2023-24 (GoI, 2024 & 2025). The VOP on different base years *i.e.* 1981-82, 1993-94 and 2004-05, were adjusted to same base year 2011-12, using the official linking factors provided by the Office of the Economic Adviser (OEA) for the Primary Articles *i.e.* 1981-82 to 1993-94 is 2.478, 1993-94 to 2004-05 is 1.881 and 2004-05 to 2011-12 is 2.003. To facilitate the comparison, whole study period was divided into four equal sub periods *viz.* 1984-85 to 1993-94 (Period-1), 1994-95 to 2003-04 (Period-2), 2004-05 to 2013-14 (Period-3) and 2014-15 to 2023-24 (Period-4). The VOP for All India was analysed from 1984-85 to 2023-24, whereas for the major seed spices growing states *viz.* Gujarat, Madhya Pradesh, and Rajasthan (jointly contribute >90% to national seed spice area and production), were considered from 1993-94 to 2023-24 owing to the non-availability of data for earlier periods. All the crops were grouped under cereals & millets, total pulses, sugar crops, condiments and spices, fruits & vegetables, oilseeds, fibres, fodder crops and remaining were considered as others.

The Crop Diversification Index (CDI) is measured using the Herfindahl–Hirschman Index (HHI) because it is the most cited methods that measure the extent of crop diversification applied by many scholars (Barik and Bedamatta, 2024). Here index HHI was calculated using Equation (1):

$$HHI_t = \sum_{i=1}^n P_{it}^2 \quad \dots\dots (1)$$

Where,  $P_{it}$  is the share of a crop in total cropped area in the year 't'.

This index lies between zero (indicates higher diversification) and one (indicates perfect specialization *e.g.*, only one crop is cultivated). A decrease in the Herfindahl Index (HHI) indicates an increase in crop diversification. Further, Crop Diversification Index (CDI) was measured as one minus HHI, provides only the magnitude of diversification. CDI near to 0 indicates total crop specialization (*e.g.*, relying heavily on a single crop like paddy or wheat) and CDI near to one mean a perfect or maximum diversification (cultivating a wide variety of crops with equal area shares). Also, the direction of diversification was seen through the percentage share of different crop groups (Sharma *et al* 2023; Cracau & Duran, 2016).

### Growth rate analysis

The compound growth rate (CGR) was computed using formula:

$$Y_t = ab^t e^{ut} \quad \dots\dots\dots (1)$$

Where,

$Y_t$  = Area/ VOP in year 't'

a = Intercept

b = (1+g) regression coefficient

t = Time period in years

$u_t$  = Disturbance term for the year 't'

Taking natural log on both sides equation (1) becomes

$$\ln Y_t = \ln a + t \ln b + u_t$$

$$\text{Growth rate} = (\text{Antilog of } b - 1) * 100$$

### Instability analysis

The variations from trend was estimated using the Instability Index of the form:

Instability Index = Standard deviation of natural logarithm ( $Y_{t+1}/Y_t$ )

Where,

$Y_t$  = Area / VOP in current year 't', and

$Y_{t+1}$  = Area / production / productivity and export in next year 't+1'.

Higher standard deviation indicates the more instability (Chand & Raju 2008).

## Results and discussion

### Seed spices cultivation in India

Seed spices cultivation in India has expanded remarkably over the past four decades, reflecting the growing commercial importance of these high-value crops. During the period from 1984-85 to 2024-25, the area, production, and productivity of seed spices registered compound annual growth rates (CAGR) of 3.63, 6.08, and 2.36 percent, respectively. The cultivated area increased more than fourfold, from 5.51 lakh ha in 1984-85 to 25.05 lakh ha in 2024-25, clearly indicating a sustained shift in farmers' preference towards seed spices cultivation. Production exhibited more than tenfold increase, rising from 2.47 lakh tonnes to 25.14 lakh tonnes over the same period, reflecting the combined effects of area expansion and yield enhancement through technological advancements in varieties, crop

management, and production practices (Figure 1). The expansion of cultivated area was the principal driver of production growth during the earlier decades of 1980s and 1990s, thereon improvements in productivity contributed increasingly to production gains in post 2000 period (Meena *et al.*, 2025).

The figure 2 depicts a steady expansion in the area under condiments and spices in India as well as in major growing states over the reference periods from TE 1984-85 to TE 2023-24. At the national level, the area increased markedly from about 2.21 million hectares in TE 1984-85 to 4.70 million hectares in TE 2023-24, indicating a strong long-term growth in spice cultivation. Among the states, Rajasthan shows the most pronounced increase, with area rising from around 0.25 million hectares in 1984-85 TE to about 1.02 million hectares in 2023-24 TE, due to expansion of cumin cultivation mainly, reflecting its growing prominence as a spice-producing state. Gujarat also recorded a consistent rise, from 0.12 to 0.69 million hectares, while Madhya Pradesh shows moderate growth from 0.15 to 0.33 million hectares mainly comes from coriander cultivation. The figure highlights a clear structural shift towards expansion of condiments and spices growth trends.

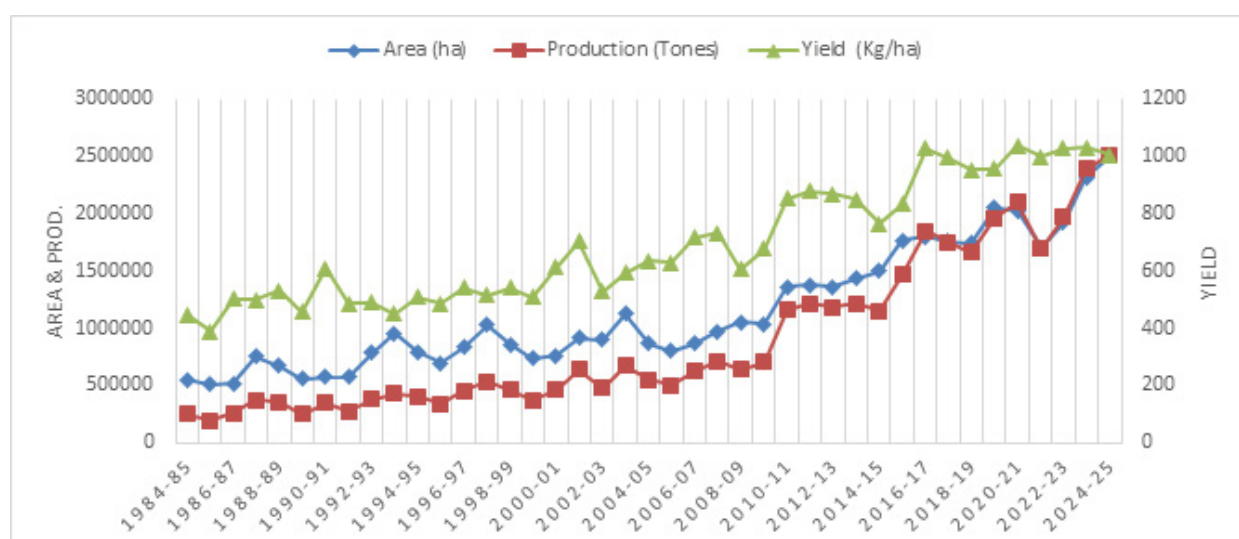


Fig. 1. Trends in seed spices area, production and yield in India

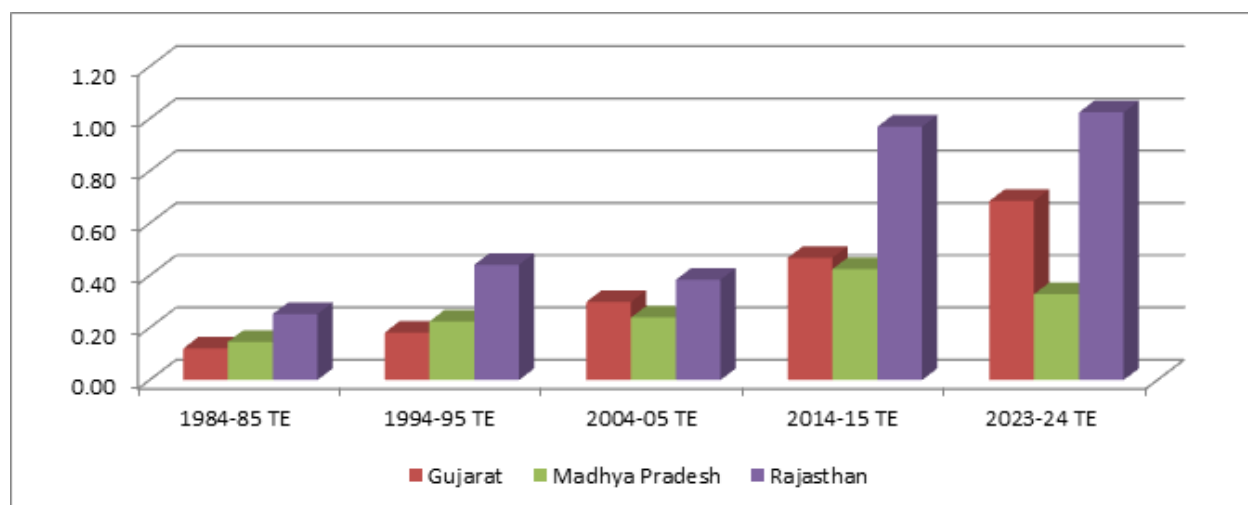


**Fig. 2.** Area (million ha) of condiments and spices in major growing states.

Seed spices cultivation in India is geographically concentrated, with Madhya Pradesh, Rajasthan, and Gujarat, collectively accounting for more than 90% of the national area and production of major seed spices. Table 1 shows that coriander cultivation is dominated by Madhya Pradesh, which contributes 50.77% of the cultivated area and 52.87% of total production, followed by Gujarat (22.24% area and 23.77% production) and Rajasthan (12.43% area and 12.93% production). Cumin cultivation is exclusively confined to Rajasthan and Gujarat, with Rajasthan accounting for 60.93% of the cultivated area, whereas Gujarat contributes a higher production share (58.27%) despite occupying only 38.90% of the area, due to relatively higher productivity. Similarly, fennel cultivation is concentrated primarily in Gujarat, which accounts for 77.01% of the cultivated area and 86.18% of total production, while Rajasthan contributes 20.50% of the area and 12.00% of production. Fenugreek cultivation is mainly concentrated in Rajasthan (46.09% of the area) and Madhya Pradesh (38.45% of the area); however, Madhya Pradesh records the highest production share (50.51%), followed by Rajasthan (36.08%), due to comparatively higher productivity. The strong regional concentration of these crops highlights the comparative agro-climatic advantage of these states.

### Structural transformation in cropping pattern and value of output in India

Indian agriculture has seen a significant structural transformation in last one and half decades, driven by changing consumption and trade demand. Although the country's net sown area declined marginally from 143 million ha in 1983-84 to 139 million ha in 2023-24, the gross cropped area increased from 179 to 218 million ha, resulting in an increase in cropping intensity from 123 to 157 percent with increasing irrigation coverage in the country. The overall GVO from the agriculture and allied sector in India has shown steady growth from ₹1,908 thousand crore in 2011-12 to ₹2,949 thousand crore in 2023-24, marking an overall increase of approximately 54.6%. The GVO from crop sector has also grown from ₹1,191 thousand crore in 2011-12 to ₹1,595 thousand crore in 2023-24. In spite of being the largest contributor in agriculture and allied sectors, a decline in the contribution of crop sub-sector has been observed from 62.4% in 2011-12 to 54.1% in 2023-24 due to faster growth in livestock, forestry and logging and fishing and aquaculture sub-sectors (GoI, 2025). The composition of crop sector VOP has undergone changes over the period. During this period, India's horticulture sector expanded considerably and now contributes nearly

**Table 1.** Crop-wise area and production of major seed spice cultivation in India during 2024-25

| Major Spice | State          | Area (Ha.) | Production (Ton) | Area share (%) | Prod. share (%) |
|-------------|----------------|------------|------------------|----------------|-----------------|
| Coriander   | Madhya Pradesh | 318331     | 459650           | 50.77          | 52.87           |
|             | Gujarat        | 139475     | 206655           | 22.24          | 23.77           |
|             | Rajasthan      | 77932      | 112438           | 12.43          | 12.93           |
|             | Assam          | 31371      | 34694            | 5.00           | 3.99            |
|             | West Bengal    | 12082      | 16125            | 1.93           | 1.85            |
|             | Orissa         | 20402      | 12953            | 3.25           | 1.49            |
|             | Uttar Pradesh  | 7452       | 4813             | 1.19           | 0.55            |
|             | Total          | 627008     | 869443           | 100.00         | 100.00          |
| Cumin       | Gujarat        | 425671     | 421775           | 38.90          | 58.27           |
|             | Rajasthan      | 666761     | 300000           | 60.93          | 41.45           |
|             | Total          | 1094382    | 723795           | 100.00         | 100             |
| Fennel      | Gujarat        | 100000     | 210000           | 77.01          | 86.18           |
|             | Rajasthan      | 26622      | 29237            | 20.50          | 12.00           |
|             | Madhya Pradesh | 1526       | 2722             | 1.18           | 1.12            |
|             | West Bengal    | 855        | 947              | 0.66           | 0.39            |
|             | Uttar Pradesh  | 820        | 690              | 0.63           | 0.28            |
|             | Total          | 129858     | 243666           | 100.00         | 100.00          |
| Fenugreek   | Madhya Pradesh | 56521      | 114585           | 38.45          | 50.51           |
|             | Rajasthan      | 67746      | 81838            | 46.09          | 36.08           |
|             | Gujarat        | 8033       | 15155            | 5.46           | 6.68            |
|             | Haryana        | 1365       | 2730             | 0.93           | 1.20            |
|             | Uttaranchal    | 780        | 2124             | 0.53           | 0.94            |
|             | West Bengal    | 2681       | 3272             | 1.82           | 1.44            |
|             | Total          | 147000     | 226853           | 100.00         | 100.00          |

Source: Spices Board of India, 2025.

33 per cent to the Agriculture Gross Value Added (GVA), thereby playing a pivotal role in ensuring nutritional security, generating rural employment, diversifying farm enterprises, and enhancing farmers' incomes (Jain and Pal, 2026).

Table 2 presents the comparative shares of major crop groups in gross cropped area and VOP during TE 1984-85 to TE 2023-24. The results reveal a gradual structural transformation of Indian agriculture from a cereal-centric production system towards a more diversified and value-oriented crop economy. Although cereals and millets continue to occupy nearly half of the gross cropped area, the relatively

faster expansion of fruits and vegetables and condiments and spices, reflects an increasing orientation towards high-value horticultural crops. The widening divergence between the share in cropped area and the corresponding share in total crop sector VOP across crop groups supports the concept of intensive agricultural diversification, wherein growth within the crop sector is increasingly driven by value enhancement rather than expansion of cultivated land (Sharma *et al.*, 2023). This indicates structural transformation through a gradual reallocation of land towards high-value crops and, more importantly, through a faster increase in their contribution to the total value of crop production.

Cereals and millets continued to account for almost 50 per cent of the gross cropped area throughout the study period, registered non-significant growth. In contrast, the value of output from cereals recorded a significant annual growth of 16.16 per cent; however, their share in the total crop sector VOP declined substantially from 40.22 to 26.81 per cent, indicating that the growth of the crop economy has increasingly been driven by faster expansion of high-value crops. Similar structural changes have been reported by Chand (2017) and Birthal *et al.* (2015).

Pulses maintained a relatively stable share of gross cropped area (12-13%) with a modest but significant annual area growth of 0.37 per cent. Although the value of pulse production increased significantly (16.57% CGR), their share in the total crop sector VOP decreased over the period. The relatively slower structural transformation of pulses reflects persistent productivity constraints, climatic risks, and market uncertainties despite continued policy emphasis on improving domestic pulse production and nutritional security (Reddy, 2009; Ali & Gupta, 2012). Oilseeds emerged as another important diversified crop group, with their share in gross cropped area increasing from 10.93 to 14.89 per cent and registering a significant annual area growth of 0.90 per cent. Their value of output also recorded a CGR of 16.60 per cent, with their share in the total crop sector VOP decreasing to 8.92 per cent during TE 2023-24. The increase in value share remained lower than the expansion in cultivated area, suggesting that improvements in productivity and value realization have not kept pace with area expansion. These findings broadly corroborate the observations of Gulati and Saini (2016), who emphasized the need for technological advancement and market reforms to enhance the profitability of oilseed cultivation.

The most notable structural transformation was observed in horticultural crops namely

fruits and vegetables and condiments and spices. Fruits and vegetables recorded significant highest annual growth in cultivated area (1.97%) and in value of output (20.26%). Consequently, their share in the total crop sector VOP increased remarkably from 11.46 to 27.70 per cent, far exceeding the increase in their cropped area share from 3.25 to 5.67 per cent. Similarly, condiments & spices emerged as second fastest-growing commercial crop groups, recording a significant annual area growth of 1.77 per cent and a VOP growth of 20.00 per cent. Their share in the total crop sector VOP more than doubled from 2.34 to 5.75 per cent over the study period. The substantially higher growth in both area and value clearly demonstrates that these crop groups have become the principal drivers of value-led growth within the Indian agriculture crop sector.

The rapid transformation towards fruits and vegetables and condiments and spices can largely be attributed to their increasing demand backed by farmers preference and government supports (Pavani *et al.*, 2025). Technological improvements through the development of high-yielding varieties, hybrid seeds, micro-irrigation, protected cultivation, improved crop management practices and mechanization have enhanced productivity and profitability. Investments in cold-chain infrastructure, post-harvest management, food processing, quality certification, traceability systems and organized retail networks have further strengthened market integration and value realization (Saxena *et al.*, 2015 and Tiwari *et al.*, 2021). Collectively, these factors have accelerated the transition from low-value staple production towards commercially oriented, high-value agriculture. These results support the earlier findings for future agricultural development strategies with greater investment in high-value crop systems through research and development, improved planting material, precision cultivation practices, post-harvest infrastructure, cold-chain logistics,

processing industries, export promotion, quality certification, traceability mechanisms and efficient value-chain integration.

The Herfindahl-Hirschman Index (HHI) was estimated to examine the extent of crop concentration in India including major seed spice growing states i.e. Gujarat, Madhya

**Table 2.** Trends in area, share to gross cropped area, value of output (2011–12 constant prices), and value share across major crop groups in India

| Crop                      | Particulars     | 1984-85<br>TE | 1994-95<br>TE | 2004-05<br>TE | 2014-15<br>TE | 2023-24<br>TE | CGR                | Instability |
|---------------------------|-----------------|---------------|---------------|---------------|---------------|---------------|--------------------|-------------|
| Total cereals & millets   | Area (Lakhs ha) | 1042.46       | 1015.75       | 977.31        | 1003.26       | 1091.45       | 0.06 <sup>d</sup>  | 1.54        |
|                           | Area (% share)  | 59.12         | 54.39         | 52.86         | 50.67         | 49.88         |                    |             |
|                           | VOP (Crore Rs)  | 2199          | 16022         | 41196         | 332145        | 415060        | 16.16 <sup>a</sup> | 2.31        |
|                           | VOP (% share)   | 40.22         | 36.20         | 31.38         | 27.05         | 26.81         |                    |             |
| Total pulses              | Area (Lakhs ha) | 228.02        | 237.54        | 232.48        | 225.86        | 278.52        | 0.37 <sup>a</sup>  | 4.34        |
|                           | Area (% share)  | 12.93         | 12.72         | 12.57         | 11.41         | 12.73         |                    |             |
|                           | VOP (Crore Rs)  | 384           | 2645          | 6143          | 54931         | 79553         | 16.57 <sup>a</sup> | 2.93        |
|                           | VOP (% share)   | 7.02          | 5.98          | 4.68          | 4.47          | 5.14          |                    |             |
| Sugar crops               | Area (Lakhs ha) | 31.08         | 39.79         | 45.49         | 55.10         | 66.54         | 1.59 <sup>a</sup>  | 6.16        |
|                           | Area (% share)  | 1.76          | 2.13          | 2.46          | 2.78          | 3.04          |                    |             |
|                           | VOP (Crore Rs)  | 488           | 3329          | 8078          | 74480         | 95624         | 16.30 <sup>a</sup> | 2.60        |
|                           | VOP (% share)   | 8.93          | 7.52          | 6.15          | 6.07          | 6.18          |                    |             |
| Condiments and spices     | Area (Lakhs ha) | 21.87         | 27.51         | 30.55         | 34.68         | 46.96         | 1.77 <sup>a</sup>  | 5.98        |
|                           | Area (% share)  | 1.24          | 1.47          | 1.65          | 1.75          | 2.15          |                    |             |
|                           | VOP (Crore Rs)  | 128           | 1422          | 5031          | 49591         | 89069         | 20.00 <sup>a</sup> | 2.96        |
|                           | VOP (% share)   | 2.34          | 3.21          | 3.83          | 4.04          | 5.75          |                    |             |
| Total fruits & vegetables | Area (Lakhs ha) | 57.28         | 72.45         | 93.64         | 99.40         | 124.16        | 1.97 <sup>a</sup>  | 1.36        |
|                           | Area (% share)  | 3.25          | 3.88          | 5.06          | 5.02          | 5.67          |                    |             |
|                           | VOP (Crore Rs)  | 626           | 8278          | 32044         | 314515        | 428962        | 20.26 <sup>a</sup> | 2.92        |
|                           | VOP (% share)   | 11.46         | 18.71         | 24.41         | 25.61         | 27.70         |                    |             |
| Total oilseeds            | Area (Lakhs ha) | 192.69        | 275.06        | 264.74        | 289.22        | 325.89        | 0.90 <sup>a</sup>  | 3.74        |
|                           | Area (% share)  | 10.93         | 14.73         | 14.32         | 14.61         | 14.89         |                    |             |
|                           | VOP (Crore Rs)  | 554           | 5147          | 12354         | 104627        | 138160        | 16.60 <sup>a</sup> | 2.65        |
|                           | VOP (% share)   | 10.13         | 11.63         | 9.41          | 8.52          | 8.92          |                    |             |
| Total fibres              | Area (Lakhs ha) | 85.06         | 87.18         | 93.59         | 133.59        | 133.46        | 1.44 <sup>a</sup>  | 5.14        |
|                           | Area (% share)  | 4.82          | 4.67          | 5.06          | 6.75          | 6.10          |                    |             |
|                           | VOP (Crore Rs)  | 224           | 2010          | 5136          | 80221         | 73738         | 18.61 <sup>a</sup> | 3.04        |
|                           | VOP (% share)   | 4.09          | 4.54          | 3.91          | 6.53          | 4.76          |                    |             |
| Fodder crops              | Area (Lakhs ha) | 80.66         | 84.14         | 76.03         | 94.05         | 70.08         | 0.00 <sup>a</sup>  | 4.28        |
|                           | Area (% share)  | 4.57          | 4.51          | 4.11          | 4.75          | 3.20          |                    |             |
|                           | VOP (Crore Rs)  | 520           | 2851          | 8241          | 31943         | 55456         | 13.67 <sup>a</sup> | 2.50        |
|                           | VOP (% share)   | 9.50          | 6.44          | 6.28          | 2.60          | 3.58          |                    |             |

Source: Authors estimation from data compiled from Spices Board of India, DACNET, GoI.

Note: a, b, c and d represent level of significance at 1, 5, 10 % and not significant, respectively.

Pradesh and Rajasthan. The declining HHI across all regions indicates a gradual shift towards a more diversified cropping pattern, except for a slight increase in Madhya Pradesh during 2014-15 to 2023-24 (Figure 3). Gujarat consistently recorded the lowest HHI, confirming it as the most diversified state, followed by Rajasthan, while Madhya Pradesh remained relatively more concentrated (Kumar & Gupta, 2015). Over the study period, HHI declined from 0.24 to 0.17 in Gujarat, 0.38 to 0.34 in Madhya Pradesh, 0.32 to 0.24 in Rajasthan, and 0.37 to 0.31 at the national level. Crop diversification improves farm income opportunities, reduces production and market risks, enhances resource-use efficiency, and strengthens resilience to climate variability and price fluctuations (Primov *et al.*, 2025).

The Crop Diversification Index (CDI) exhibited a consistent upward trend across all regions (Figure 4). Gujarat recorded the highest increase, from 0.76 to 0.83, followed by Rajasthan (0.68 to 0.76), Madhya Pradesh (0.62 to 0.66), and India (0.63 to 0.69), indicating a progressive broadening of crop portfolios. This transformation has been driven by expanding market opportunities, irrigation development, technological advancements, and the availability of high-yielding, disease-resistant and climate-resilient short-duration varieties,

particularly in horticultural crops, which have accelerated diversification and sustained agricultural growth in India (Sharma, 2023).

### Change in cropping pattern and value intensification in Gujarat

The results presented in Table 3 reveal a marked structural transformation in Gujarat's agriculture during 1994-95 to 2023-24. The area under cereals and millets declined from 38.18 lakh ha (34.85%) to 31.51 lakh ha (21.68%), recording a significant negative CGR of -0.63 per cent, indicating continued reallocation of land towards more remunerative crops under expanding irrigation, technological progress and favourable market incentives in the state. In contrast, oilseeds maintained their strategic importance despite a marginal decline in area share from 27.12 to 22.71 per cent, with cultivated area increasing to 33.01 lakh ha (CGR: 0.49%), reflecting Gujarat's comparative advantage in oilseed production supported by strong processing industries and market linkages (Meena *et al.*, 2018). Fibre crops, dominated by cotton, recorded one of the fastest expansions, with area share increasing from 11.40 to 17.40 per cent and a CGR of 2.69 per cent, driven by technological improvements, hybrid cotton adoption and robust textile value chains (Narayanamoorthy, 2013; Meena, 2017).

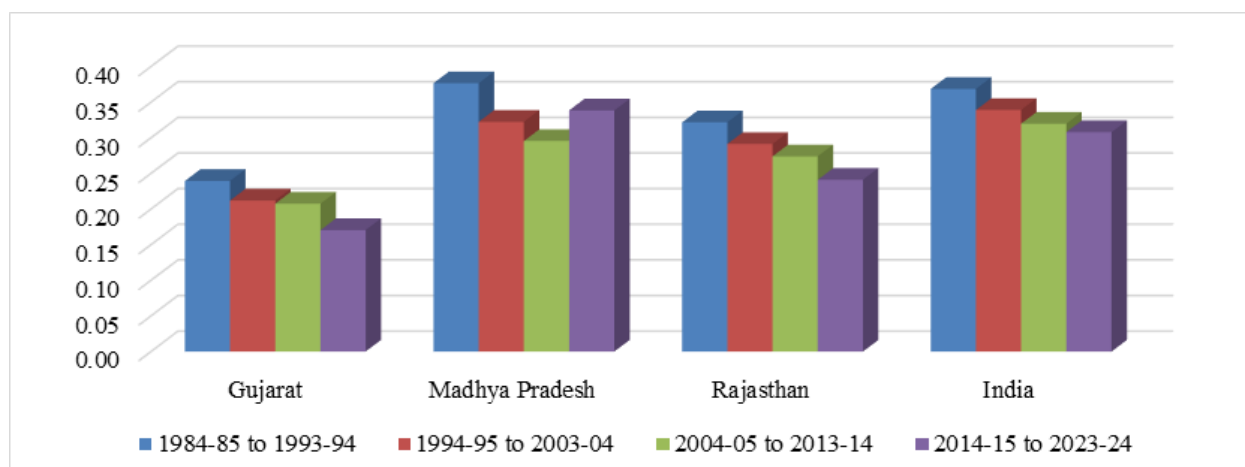


**Fig. 3.** Trends in the Herfindahl-Hirschman Index (HHI) of cropping patterns in India and major seed spice growing states, 1984-85 to 2023-24.

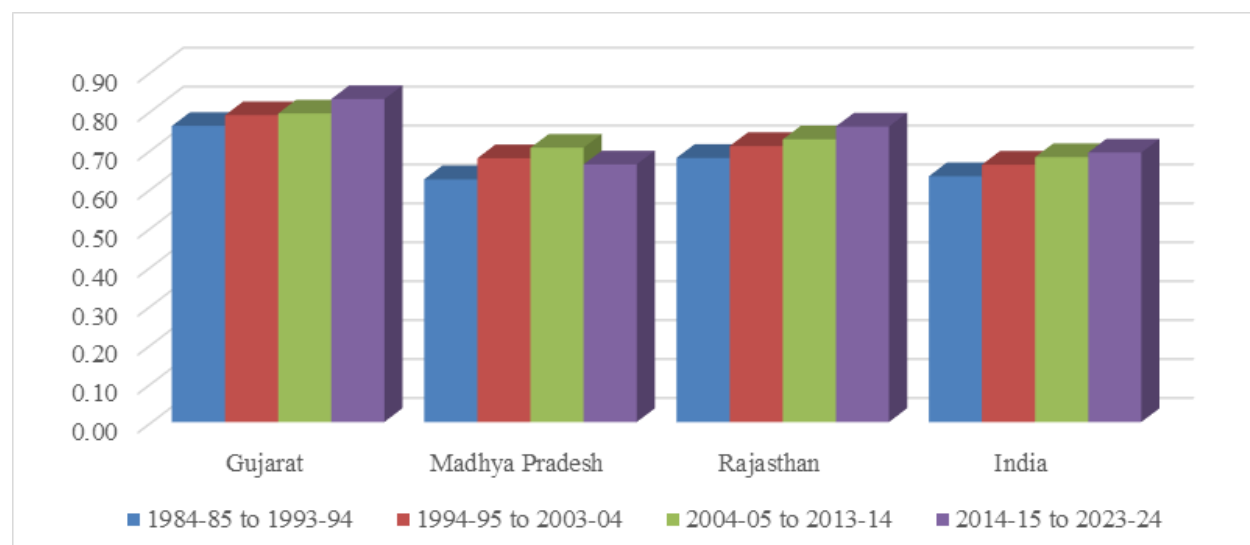


**Fig. 4.** Trends in the crop diversification index in India and major seed spice states, 1984-85 to 2023-24.

Pulses exhibited only modest growth (CGR: 0.60%), with their area share remaining around 9 per cent, suggesting continued competition from relatively more profitable commercial crops.

The most significant transformation occurred in horticultural crops. The area under fruits and vegetables expanded nearly five-fold from 2.26 to 11.67 lakh ha, registering a CGR of 5.52 per cent, while condiments and spices increased from 1.82 to 6.85 lakh ha with a CGR of 5.00 per cent, reflecting Gujarat's increasing specialization in high-value horticulture and seed spices. Despite occupying only 4.71 per cent of the gross cropped area, condiments and spices increased their share in the total crop sector VOP from 5.52 to 9.03 per cent and recorded the highest annual VOP growth (22.26%) among all crop groups, followed by fruits and vegetables (20.66%) and fibres (19.37%). These trends highlight the growing importance of spices in driving value addition within the state's crop sector. The rapid expansion has been supported by improved market access, cold-chain infrastructure, private investment in horticultural value chains. Gujarat has well-developed seed spice marketing and processing ecosystem,

particularly Unjha is one of India's largest seed spice trading and processing hubs. Factors responsible for crop diversification were studied by Pandey *et al.* (2025) and found that rainfall positively influenced diversification in Gujarat during 2001-02 to 2023-24.

#### **Structural change in cropping pattern and value intensification in Madhya Pradesh**

Madhya Pradesh is mainly a food grain and oilseed growing state with around 69 per cent of its gross cropped area devoted to food-grains and 26 per cent to oilseeds (TE 2023-24). The acreage and the production of wheat and soybean have significantly increased over the period. Table 4 reveals a gradual structural transformation in Madhya Pradesh's crop sector during 1994-95 to 2023-24. The area under cereals remained statistically unchanged (CGR: -0.23%, non-significant), accounting for 40 to 52 per cent of the gross cropped area, while their share in the total crop sector VOP declined sharply from 51.38 to 30.41 per cent. Oilseeds emerged as the principal diversified crop group, recording a significant area growth of 2.45 per cent per annum and expanding their cultivated area from 50.89 to 78.78 lakh ha. In contrast, pulses remained an important

**Table 3.** Trends in area, share to gross cropped area, value of output (2011–12 constant prices), and value share across major crop groups in Gujarat

| Crop                      | Particulars     | 1994-95 TE | 2004-05 TE | 2014-15 TE | 2023-24 TE | CGR                | Instability |
|---------------------------|-----------------|------------|------------|------------|------------|--------------------|-------------|
| Total cereals & millets   | Area (Lakhs ha) | 38.18      | 31.97      | 35.33      | 31.51      | -0.63 <sup>a</sup> | 1.16        |
|                           | Area (% share)  | 34.85      | 28.79      | 27.81      | 21.68      |                    |             |
|                           | VOP (Crore Rs)  | 515        | 688        | 9451       | 10667      | 14.70 <sup>a</sup> | 3.00        |
|                           | VOP (% share)   | 24.64      | 13.52      | 9.33       | 8.50       |                    |             |
| Total pulses              | Area (Lakhs ha) | 9.14       | 7.99       | 8.72       | 14.03      | 0.60 <sup>a</sup>  | 2.52        |
|                           | Area (% share)  | 8.35       | 7.19       | 6.86       | 9.65       |                    |             |
|                           | VOP (Crore Rs)  | 153        | 155        | 2076       | 6863       | 17.81 <sup>a</sup> | 3.80        |
|                           | VOP (% share)   | 7.30       | 3.04       | 2.05       | 5.47       |                    |             |
| Sugar crops               | Area (Lakhs ha) | 2.00       | 2.62       | 2.55       | 2.12       | 1.24 <sup>a</sup>  | 2.29        |
|                           | Area (% share)  | 1.83       | 2.36       | 2.01       | 1.46       |                    |             |
|                           | VOP (Crore Rs)  | 236        | 499        | 2911       | 3498       | 11.73 <sup>a</sup> | 2.41        |
|                           | VOP (% share)   | 11.30      | 9.80       | 2.87       | 2.79       |                    |             |
| Condiments and spices     | Area (Lakhs ha) | 1.82       | 2.56       | 4.44       | 6.85       | 5.00 <sup>a</sup>  | 3.84        |
|                           | Area (% share)  | 1.66       | 2.30       | 3.49       | 4.71       |                    |             |
|                           | VOP (Crore Rs)  | 115        | 198        | 7632       | 11329      | 22.26 <sup>a</sup> | 3.82        |
|                           | VOP (% share)   | 5.52       | 3.88       | 7.53       | 9.03       |                    |             |
| Total fruits & vegetables | Area (Lakhs ha) | 2.26       | 3.68       | 5.97       | 11.67      | 5.52 <sup>a</sup>  | 2.81        |
|                           | Area (% share)  | 2.07       | 3.31       | 4.70       | 8.03       |                    |             |
|                           | VOP (Crore Rs)  | 426        | 882        | 21161      | 28825      | 20.66 <sup>a</sup> | 2.30        |
|                           | VOP (% share)   | 20.38      | 17.33      | 20.88      | 22.98      |                    |             |
| Total oilseeds            | Area (Lakhs ha) | 29.70      | 29.88      | 29.54      | 33.01      | 0.49 <sup>a</sup>  | 1.11        |
|                           | Area (% share)  | 27.12      | 26.91      | 23.25      | 22.71      |                    |             |
|                           | VOP (Crore Rs)  | 828        | 939        | 20371      | 28537      | 16.99 <sup>a</sup> | 4.06        |
|                           | VOP (% share)   | 39.60      | 18.44      | 20.10      | 22.75      |                    |             |
| Total fibres              | Area (Lakhs ha) | 12.49      | 17.68      | 27.75      | 25.29      | 2.69 <sup>a</sup>  | 1.91        |
|                           | Area (% share)  | 11.40      | 15.92      | 21.84      | 17.40      |                    |             |
|                           | VOP (Crore Rs)  | 435        | 912        | 27038      | 23260      | 19.37 <sup>a</sup> | 3.32        |
|                           | VOP (% share)   | 20.81      | 17.91      | 26.68      | 18.54      |                    |             |
| Fodder crops              | Area (Lakhs ha) | 12.05      | 10.53      | 9.40       | 18.26      | 1.13 <sup>a</sup>  | 2.88        |
|                           | Area (% share)  | 11.00      | 9.48       | 7.40       | 12.56      |                    |             |
|                           | VOP (Crore Rs)  | 119        | 271        | 1959       | 4019       | 15.57 <sup>a</sup> | 2.63        |
|                           | VOP (% share)   | 2.91       | 2.15       | 0.90       | 1.52       |                    |             |

Source: Authors estimation from data compiled from Spices Board India, DACNET, GoI.

Note: a, b, c and d represents level of significance at 1, 5, 10 % and not significant respectively.

component of the rainfed production system but exhibited almost stagnant area growth (0.08%), with their share in cropped area declining from 20.19 to 16.35 per cent, consistent with increasing competition from relatively more remunerative crops. Fibre crops showed only marginal expansion, whereas fodder crops declined drastically (CGR: -6.62%) owing to increasing competition for cultivable land. Overall, the gross cropped area increased from 244.42 to 301.44 lakh ha, registering a modest annual growth of 0.86 per cent with low instability as a result of expansion of assured irrigation, especially through tube-wells and modern canal systems, is the most critical driver. Water availability reduces the risk of crop failure and allows farmers to grow high yielding varieties (George and Sharma, 2023).

Although MP is one of the major food grain producing state of India, there has been an increasing trend towards the cultivation of horticultural crops as a cash crop. The most notable transformation was observed in fruits and vegetables. Occupying only 1.21 per cent of the gross cropped area, they recorded the highest VOP growth (23.15% per annum) among all crop groups and contributed 31.08 per cent of the total crop sector VOP in TE 2023-24, surpassing cereals. Similarly, condiments and spices expanded at a significant annual rate of 2.02 per cent and registered the second-highest VOP growth (22.55%), increasing their share in crop VOP from 2.97 to 11.52 per cent while occupying only 1.09 per cent of the cropped area. These results clearly demonstrate a pronounced decoupling between land allocation and value generation, with horticultural crops generating disproportionately higher economic returns per unit of land than traditional field crops. Agriculture growth in Madhya Pradesh was highest (14.2% during 2009-10 to 2014-15) in India, was mainly contributed through expanded irrigation backed by reliable power supplies, a strong procurement system with bonus over MSP for wheat, and all-weather

roads to connect farmers to markets (Gulati *et al.*, 2021).

### **Structural change in cropping pattern and value diversification in Rajasthan**

Table 5 highlights a gradual structural transformation in Rajasthan's crop sector during 1994-95 to 2023-24. The gross cropped area increased from 191 in TE 1993-94 to 278 lakh ha in TE 2023-24, registering a significant annual growth of 1.36 per cent with 1.39 instability, reflecting expansion of irrigation and improved land-use intensity. Although cereals and millets continued to dominate the cropping pattern, their share in the gross cropped area declined substantially from 45.18 to 33.89 per cent, despite a marginal increase in cultivated area (CGR: 0.30%), indicating gradual diversification towards more remunerative crops (Verma *et al.*, 2023; Meena *et al.*, 2023). Oilseeds emerged as the fastest expanding major field crops, with area increasing from 34.88 to 69.03 lakh ha mainly towards soyabean and groundnut in Kharif and rapeseed & mustard in rabi season, resulting area share rising from 17.50 to 24.86 per cent (CGR: 2.70%), consistent with the oilseed-led diversification reported for arid and semi-arid regions. Pulses also recorded significant growth (CGR: 1.89%) while maintaining about 10.50 per cent of the cropped area, although relatively higher instability reflects the sensitivity of rainfed pulse cultivation to climatic variability (Birthal *et al.*, 2019). Livestock farming is a cornerstone of Rajasthan's agricultural economy, contributing significantly to farm income, employment generation, nutritional security, and resilience to climatic risks. According to the 20th Livestock Census (Government of India, 2025), Rajasthan accounts for 10.58 per cent of India's total livestock population, making it the second-largest livestock-rearing state in the country. Reflecting the sector's importance, fodder crops area increased from 43 to 59 lakh ha, continue to occupy a substantial share of the state's agricultural land, accounting for 21.23 per cent of the gross cropped area.

**Table 4.** Trends in area, share to gross cropped area, value of output (2011–12 constant prices), and value share across major crop groups in Madhya Pradesh

| Crop                      | Particulars     | 1994-95 TE | 2004-05 TE | 2014-15 TE | 2023-24 TE | CGR                | Instability |
|---------------------------|-----------------|------------|------------|------------|------------|--------------------|-------------|
| Total cereals & millets   | Area (Lakhs ha) | 125.79     | 77.84      | 95.45      | 157.59     | -0.23 <sup>d</sup> | 1.20        |
|                           | Area (% share)  | 51.47      | 40.21      | 40.34      | 52.28      |                    |             |
|                           | VOP (Crore Rs)  | 1684       | 1424       | 26265      | 45821      | 15.93 <sup>a</sup> | 2.60        |
|                           | VOP (% share)   | 51.38      | 26.45      | 28.10      | 30.41      |                    |             |
| Total pulses              | Area (Lakhs ha) | 49.35      | 43.92      | 46.19      | 49.28      | 0.08 <sup>d</sup>  | 1.26        |
|                           | Area (% share)  | 20.19      | 22.69      | 19.52      | 16.35      |                    |             |
|                           | VOP (Crore Rs)  | 802        | 919        | 13055      | 16732      | 14.61 <sup>a</sup> | 2.69        |
|                           | VOP (% share)   | 24.47      | 17.07      | 13.96      | 11.10      |                    |             |
| Sugar crops               | Area (Lakhs ha) | 0.61       | 0.71       | 1.03       | 1.54       | 2.15 <sup>a</sup>  | 3.96        |
|                           | Area (% share)  | 0.25       | 0.36       | 0.44       | 0.51       |                    |             |
|                           | VOP (Crore Rs)  | 18         | 35         | 502        | 938        | 17.60 <sup>a</sup> | 3.72        |
|                           | VOP (% share)   | 0.55       | 0.65       | 0.54       | 0.62       |                    |             |
| Condiments and spices     | Area (Lakhs ha) | 2.24       | 2.16       | 3.55       | 3.29       | 2.02 <sup>a</sup>  | 3.55        |
|                           | Area (% share)  | 0.92       | 1.12       | 1.50       | 1.09       |                    |             |
|                           | VOP (Crore Rs)  | 97         | 180        | 4273       | 17367      | 22.55 <sup>a</sup> | 4.06        |
|                           | VOP (% share)   | 2.97       | 3.35       | 4.57       | 11.52      |                    |             |
| Total fruits & vegetables | Area (Lakhs ha) | 2.31       | 2.11       | 3.72       | 3.64       | 2.14 <sup>a</sup>  | 2.71        |
|                           | Area (% share)  | 0.95       | 1.09       | 1.57       | 1.21       |                    |             |
|                           | VOP (Crore Rs)  | 399        | 571        | 25408      | 46827      | 23.15 <sup>a</sup> | 2.46        |
|                           | VOP (% share)   | 12.16      | 10.61      | 27.18      | 31.08      |                    |             |
| Total oilseeds            | Area (Lakhs ha) | 50.89      | 54.87      | 76.38      | 78.78      | 2.45 <sup>a</sup>  | 0.71        |
|                           | Area (% share)  | 20.82      | 28.35      | 32.28      | 26.14      |                    |             |
|                           | VOP (Crore Rs)  | 899        | 1305       | 17929      | 18959      | 13.77 <sup>a</sup> | 2.43        |
|                           | VOP (% share)   | 27.42      | 24.23      | 19.18      | 12.58      |                    |             |
| Total fibres              | Area (Lakhs ha) | 4.92       | 5.71       | 5.77       | 6.35       | 0.35 <sup>a</sup>  | 0.97        |
|                           | Area (% share)  | 2.01       | 2.95       | 2.44       | 2.11       |                    |             |
|                           | VOP (Crore Rs)  | 71         | 135        | 3279       | 2684       | 18.23 <sup>a</sup> | 3.35        |
|                           | VOP (% share)   | 2.15       | 2.50       | 3.51       | 1.78       |                    |             |
| Fodder crops              | Area (Lakhs ha) | 8.05       | 6.05       | 3.91       | 0.35       | -6.62 <sup>a</sup> | 3.74        |
|                           | Area (% share)  | 3.29       | 3.13       | 1.65       | 0.12       |                    |             |
|                           | VOP (Crore Rs)  | 277        | 438        | 1349       | 136        | -0.62 <sup>d</sup> | 2.79        |
|                           | VOP (% share)   | 8.45       | 8.14       | 1.44       | 0.09       |                    |             |

Source: Authors estimation from data compiled from Spices Board India, DACNET, GoI.

Note: a, b, c and d represents level of significance at 1, 5, 10 % and not significant respectively.

**Table 5.** Trends in area, share to gross cropped area, value of output (2011–12 constant prices), and value share across major crop groups in Rajasthan

| Crop                      | Particulars     | 1994-95 TE | 2004-05 TE | 2014-15 TE | 2023-24 TE | CGR                | Instability |
|---------------------------|-----------------|------------|------------|------------|------------|--------------------|-------------|
| Total cereals & millets   | Area (Lakhs ha) | 90.07      | 84.83      | 94.37      | 94.10      | 0.30 <sup>a</sup>  | 1.39        |
|                           | Area (% share)  | 45.18      | 45.49      | 38.10      | 33.89      |                    |             |
|                           | VOP (Crore Rs)  | 899        | 1304       | 18711      | 21429      | 15.00 <sup>a</sup> | 2.19        |
|                           | VOP (% share)   | 29.37      | 28.41      | 18.70      | 15.72      |                    |             |
| Total pulses              | Area (Lakhs ha) | 20.17      | 21.95      | 21.10      | 29.16      | 1.89 <sup>a</sup>  | 3.95        |
|                           | Area (% share)  | 10.12      | 11.77      | 8.52       | 10.50      |                    |             |
|                           | VOP (Crore Rs)  | 353        | 330        | 5867       | 10452      | 16.21 <sup>a</sup> | 4.70        |
|                           | VOP (% share)   | 11.54      | 7.19       | 5.87       | 7.67       |                    |             |
| Sugar crops               | Area (Lakhs ha) | 0.23       | 0.07       | 0.06       | 0.04       | -5.65 <sup>a</sup> | 9.94        |
|                           | Area (% share)  | 0.12       | 0.04       | 0.02       | 0.01       |                    |             |
|                           | VOP (Crore Rs)  | 21.55      | 8.96       | 97.81      | 75.97      | 7.79 <sup>a</sup>  | 4.76        |
|                           | VOP (% share)   | 0.70       | 0.20       | 0.10       | 0.06       |                    |             |
| Condiments and spices     | Area (Lakhs ha) | 4.41       | 5.16       | 8.34       | 10.25      | 3.76 <sup>a</sup>  | 3.49        |
|                           | Area (% share)  | 2.21       | 2.77       | 3.37       | 3.69       |                    |             |
|                           | VOP (Crore Rs)  | 233        | 246        | 3463       | 5097       | 15.68 <sup>a</sup> | 3.56        |
|                           | VOP (% share)   | 7.61       | 5.37       | 3.46       | 3.74       |                    |             |
| Total fruits & vegetables | Area (Lakhs ha) | 0.76       | 1.12       | 1.65       | 2.09       | 3.57 <sup>a</sup>  | 1.89        |
|                           | Area (% share)  | 0.38       | 0.60       | 0.67       | 0.75       |                    |             |
|                           | VOP (Crore Rs)  | 63         | 127        | 1868       | 3871       | 17.38 <sup>a</sup> | 3.88        |
|                           | VOP (% share)   | 2.04       | 2.76       | 1.87       | 2.84       |                    |             |
| Total oilseeds            | Area (Lakhs ha) | 34.88      | 36.11      | 48.86      | 69.03      | 2.70 <sup>a</sup>  | 2.11        |
|                           | Area (% share)  | 17.50      | 19.36      | 19.73      | 24.86      |                    |             |
|                           | VOP (Crore Rs)  | 677        | 1409       | 18775      | 29995      | 16.96 <sup>a</sup> | 3.06        |
|                           | VOP (% share)   | 22.09      | 30.69      | 18.77      | 22.01      |                    |             |
| Fibres                    | Area (Lakhs ha) | 5.00       | 3.96       | 4.89       | 8.69       | 1.35 <sup>a</sup>  | 2.97        |
|                           | Area (% share)  | 2.51       | 2.13       | 1.98       | 3.13       |                    |             |
|                           | VOP (Crore Rs)  | 178        | 114        | 3224       | 5574       | 19.61 <sup>a</sup> | 4.46        |
|                           | VOP (% share)   | 5.81       | 2.49       | 3.22       | 4.09       |                    |             |
| Fodder crops              | Area (Lakhs ha) | 42.94      | 31.68      | 65.48      | 58.96      | 1.18 <sup>a</sup>  | 4.18        |
|                           | Area (% share)  | 21.54      | 16.99      | 26.44      | 21.23      |                    |             |
|                           | VOP (Crore Rs)  | 394        | 651        | 5225       | 29218      | 14.75 <sup>a</sup> | 3.58        |
|                           | VOP (% share)   | 12.88      | 14.18      | 5.22       | 21.44      |                    |             |

Source: Authors estimation from data compiled from Spices Board of India, DACNET, GoI.

Note: a,b, c and d represents level of significance at 1, 5, 10 % and not significant respectively.

Among high-value crops, condiments and spices expanded significantly from 4.41 to 10.25 lakh ha (CGR: 3.76%), reflecting Rajasthan's growing specialization in seed spices due to higher comparative advantage (Meena *et al.*, 2020). Fruit cultivation in Rajasthan has transformed from a challenge into a profitable venture and recorded rapid area growth (CGR: 3.57%). The state dominates India's citrus sector. High-tech irrigation and government subsidies are driving this shift toward high-value, drought-tolerant crops. The significant determinants of diversification in the state are landholding size, irrigation and fertilizer consumption (Kiran and Punia, 2025). Kalra and Singh (2025) showed that total cropped area and HYV seed distribution positively and significantly influenced crop diversification in Rajasthan.

The comparison between cropped area and value of output (VOP) indicates a clear process of value intensification. By TE 2023-24, cereals and millets occupied 33.89 per cent of the cropped area but contributed only 15.72 per cent to the total crop sector VOP, reflecting relatively low value realization. In contrast, fodder crops accounted for 21.23 per cent of the cropped area and generated 21.44 per cent of crop VOP, underscoring the economic significance of livestock-linked agriculture in Rajasthan. Oilseeds remained another major value contributor, accounting for 22.01 per cent of crop VOP from 24.86 per cent of the cropped area. Condiments and spices occupied 3.69 per cent of the cropped area, and contributed 3.74 per cent of crop VOP, was comparatively lower than Gujarat due to low yield in cumin, fennel and fenugreek. Fruits and vegetables generated 2.84 per cent of crop VOP from just 0.75 per cent of the cropped area, indicating considerably higher returns per unit of land. Fibre crops also recorded strong value growth (19.61% per annum), reflecting increasing diversification towards emerging commercial crops. Overall, the findings indicate that Rajasthan is gradually transitioning consistently with the broader

structural transformation of Indian agriculture.

The transformation of Rajasthan's agriculture has been driven by a combination of irrigation expansion by Indira Gandhi Canal Project and groundwater irrigation in eastern and southern Rajasthan, increased adoption of micro-irrigation through financial assistance in PMKSY, promotion of horticulture under the Mission for Integrated Development of Horticulture, technological advancements, market integration, policy support, and changing consumer demand. Improved production technologies, have enabled farmers to diversify towards high-value crops such as fruits, vegetables, and seed spices (Swain *et al.*, 2014; Modi & Gopinath, 2019).

## Conclusion

The study clearly establishes that Indian agriculture has undergone a structural transformation in cropping patterns over the last four decades. At the national level, while cereals, oilseed and pulses continue to occupy a substantial share of cropped area due to food security considerations, their contribution to the value of output has declined sharply. In contrast, fruits & vegetables and condiments & spices and fibre crops generate a disproportionately higher share of agricultural value despite limited land allocation. The state-level analysis highlights region-specific diversification pathways. Rajasthan, Gujarat, and Madhya Pradesh share a common trend of declining cereal dominance, they have followed distinct diversification pathways. Gujarat represents a horticulture and spice-led value intensification model, strongly integrated with markets. Rajasthan reflects a livestock- and fodder-led diversification model, complemented by seed-spice specialization. Madhya Pradesh follows a balanced transition, anchored in oilseeds and pulses with gradual movement towards high-value crops like fruits, vegetables and seed spices. A steady expansion in the area under spices in India as well as in major growing states has seen from 1984-85 TE to 2023-24 TE.

Overall, the findings show a clear structural shift towards expansion of condiments and spices, particularly in Rajasthan and Gujarat, contributing significantly to the national growth trend.

### Policy implication

Differentiated policy approach is essential. Gujarat's success in oilseeds, fibres, and seed spices, Madhya Pradesh's strength in oilseeds and pulses, and Rajasthan's livestock- and spice-led diversification highlight the need for agro-climatic and market-aligned crop strategies. Given the rising contribution of condiments and spices to VOP, especially in Gujarat and Rajasthan, targeted interventions in quality seed supply, varietal improvement, export facilitation, value addition and price risk management should be strengthened to enhance farmers' income from seed spices. In Rajasthan, fodder crops contribute significantly to value through livestock systems, policies should support integrated crop–livestock models, recognizing fodder as an important component of agricultural value rather than a residual crop. Existing cereal-centric price support mechanisms need reorientation toward horticultural crops, would better align incentives with evolving cropping patterns.

### References

- Barik P & Bedamatta R 2024 Crop diversification in India (1990–2016): Implications for the eastern and northeastern states. *Asia-Pacific J. Rural Dev.* 34(1): 53–76.
- Basantaray A K, Acharya S & Patra T 2024 Crop diversification and income of agricultural households in India: An empirical analysis. *Discover Agriculture* 2: Article 8.
- Birthal P S, Negi D S & Jha A K 2015 Income sources of farm households in India. *Agric. Econ. Res. Rev.* 28: 1–12.
- Birthal P S, Roy D & Negi D S 2019 Assessing the impact of crop diversification on farm incomes in India. *Agric. Econ.* 50: 1–13.
- Chand R & Raju S S 2008 Instability in Indian agriculture. NITI Aayog, New Delhi.
- Chand R 2017 Doubling farmers' income: Rationale, strategy and action plan. NITI Aayog, New Delhi.
- Cracau D & Durán Lima J E 2016 On the normalized Herfindahl-Hirschman index: A technical note. *Int. J. Food Syst. Dyn.* 7(4): 382–386.
- Feliciano D 2018 A review of the contribution of crop diversification to sustainable development. *Sustain. Dev.* 27(2): 208–230.
- George A & Sharma P 2023 Spatial and temporal pattern of crop concentration and diversification and its determinants in Madhya Pradesh. *Indian J. Econ. Dev.* 19(1): 1–16.
- Government of India 2024 Agricultural Statistics at a Glance 2024.
- Government of India 2025 20th Livestock Census: All India Report. Ministry of Fisheries, Animal Husbandry & Dairying, Government of India.
- Government of India 2025 Land Use Statistics at a Glance 2023–24.
- Government of India 2025 Statistical Report on Value of Output From Agriculture And Allied Sectors.
- Gulati A & Saini S 2016 From Plate to Plough: Agricultural Diversification in India. NITI Aayog, New Delhi.
- Gulati A, Rajkhowa P, Roy R & Sharma P 2021 Performance of agriculture in Madhya Pradesh. In: Gulati A, Roy R & Saini S (eds), *Revitalizing Indian Agriculture and Boosting Farmer Incomes*. Springer, Singapore, pp. 145–174.
- Jain R K & Pal R K 2026 NAAS Newsletter. 26(1): 1.
- Joshi P K, Gulati A, Birthal P S & Tewari L 2007 Agriculture diversification in South Asia: Patterns, determinants and policy implications. *Econ. Polit. Wkly.* 42: 2457–2467.
- Kalra L & Singh R 2025 Marginal impact of determinants affecting crop diversification in the state of Rajasthan using Tobit regression approach. *Plant Arch.* 25(Suppl. 2): 640–646.

- Kiran R & Punia M 2025 Land use pattern, crop diversification and crop combination regions: A district-level study in Rajasthan. *J. Land Rural Stud.* 13(2): 197–219.
- Kumar S & Gupta S 2015 Crop diversification towards high-value crops in India: A state-level empirical analysis. *Agric. Econ. Res. Rev.* 28(2): 339–350.
- Kumar C R, Nayak C & Pradhan A K 2024 Status and determinants of crop diversification: Evidence from Indian states. *Lett. Spat. Resour. Sci.* 17(1): 1–18.
- Meena L K, Meena S N, Meena G L, Bairwa S L, Kumari M, Rahman M & Sen C 2023 Nature and extent of crop diversification in Rajasthan: District-wise analysis. *Econ. Aff.* 68(Special Issue): 1873–1878.
- Meena M D, Lal G, Meena S S & Meena N K 2018 Production and export performances of major seed spices in India during pre and post-WTO period. *Int. J. Seed Spices* 8(1): 21–30.
- Meena M D, Lal G, Khan M A, Meena R D, Meena S S & Mishra B K 2020 Cumin and coriander cultivation: An economic analysis. *Int. J. Seed Spices* 10(2): 74–79.
- Meena M D 2017 Economics and efficiency in groundnut vis-à-vis cotton cultivation: A DEA approach. *J. Oilseeds Res.* 34(3): 154–160.
- Meena M D, Khunt K A & Meena H N 2018 Costs and returns in groundnut cultivation: A spatio-temporal analysis. *Indian J. Econ. Dev.* 14(4): 587–599.
- Meena M D, Lal S, Choudhary N, Kumar S, Meena S S, Meena R D & Kasotiya A K 2025 Sources of growth to seed spices in India: A decomposition analysis. *Int. J. Seed Spices* 15(1): 101–111.
- Modi A & Gopinath P 2019 Changes in cropping pattern in Rajasthan: 1957 to 2017. *Indian J. Agric. Econ.* 74: 45–58.
- Narayanamoorthy A 2013 Profitability of cotton cultivation in India. *Indian J. Agric. Econ.* 68: 1–15.
- Pandey D, Garde Y, Thorat V, Varshney N, Wadkar S & Shrivastava A 2025 Dimensions of crop diversification in Gujarat. *Indian J. Econ. Dev.* 21(3): 409–422.
- Pavani M, Sivaramane N, Suseela K, Sivanarayana G & Ramesh D 2025 Transforming Indian horticulture: An overview of government initiatives from production to export. *Indian J. Agric. Mark.* 39(3): 172–186.
- Primov A, Kuhn L, Bobojonov I 2025 Crop diversification and its effect on farm income: Evidence from a farm survey in Uzbekistan. *J. Soc. Econ. Dev.*
- Reddy A A 2009 Pulses production technology: Status and way forward. *Econ. Polit. Wkly.* 44: 73–80.
- Saxena R, Chand R & Simmi R 2015 Estimates and analysis of farm income in India. *Econ. Polit. Wkly.* 50(22).
- Sharma H R 2023 Patterns, sources and determinants of agricultural growth in India. *Indian J. Agric. Econ.* 78(1): 26–70.
- Spices Board India 2025 Spices Statistics at a Glance 2024–25. Ministry of Commerce & Industry, Government of India.
- Swain M, Kalamkar S S, Ojha M K & Sharma S 2014 Agricultural diversification towards horticulture in Rajasthan: Prospects and challenges. *Agric. Situ. India* 71(3): 9–19.
- Tiwari R, Singh A & Sharma P 2021 Issues and strategies in horticulture marketing in India. *Indian J. Agric. Mark.* 35(2): 145–152.
- Venkatesh P 2021 Dynamics of cropping pattern shifts in India. *Agric. Econ. Res. Rev.* 34: 1–12.
- Verma B L, Kumawat R C & Kumar D 2023 Spatio-temporal changes in cropping pattern in the state of Rajasthan, India. *Asian J. Agric. Ext. Econ. Sociol.* 41: 22–34.