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EVALUATING THE STATUS AND PROGRESS OF CROP DIVERSIFICATION FOR *KHARIF* SEASON IN RAJASTHAN INDIA FROM 1997-98 TO 2022-23

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ABSTRACT

A shift from less sustainable and profitable crop or cropping system to a more profitable and/or sustainable crop or cropping system. Agricultural diversification has meant that the farmers now concentrate on new areas of agriculture, growing alternative crops, rearing new breeds of livestock and adopting a new farming system. The study is based on secondary data that were collected for 22 types of crops spanning from 1997-98 to 2022-23. To calculate the diversification index, Herfindal index were used and to know the extent of diversification, proportional method were used that exhibit the real changes in area under various crops cultivation. Diversification index is summarized into 5 sub periods.

The index for last sub period (2018-19 to 2022-23) revealed that Jodhpur and Ganaganagar district is more diversified and Dholpur and Bharatpur districts are less or no diversified districts in out of 33 districts of Rajasthan. Traditional cereal crops like maize and bajra have seen differing patterns in terms of crop area changes; in certain areas, maize cultivation has increased while bajra cultivation has decreased. Notably, there were notable shifts in areas like Rajsamand and Udaipur, suggesting a move towards crops with high demand or output. In several regions, such as Ajmer and Churu, pulses increased, indicating a rising interest in food crops high in protein. In places like Banswara and Jhalawar, oilseeds especially soybeans gained traction, indicating their potential for commerce.

The tendency towards diversification was further influenced by the addition of commercial crops like guar seed and cluster beans, as well as fiber products like cotton. Positive changes in these crops were seen in districts like as Churu, Jodhpur, and Nagour, presumably as a result of shifting market needs and climate adaptability. Overall, farmers' progressive embrace of multi-cropping methods and resource optimization is reflected in Rajasthan's Kharif diversification.

Keywords **:** Crop, Diversification, cereals, pulses, oilseeds, fiber and commercial crops.

Introduction

Rajasthan state stand on first position with having 10.41 percent of total geographical area of India. In prospects of agriculture during the year 2022-23, Rajasthan have 28171106-hectare gross sown area and 18422557-hectare net sown area. It indicates the area sown twice is 9748549 hectares. The gross cropped area under all crops increased to 28171106 lakh hectares during 2022-23 from 27441850 hectares in 2021-22, showing an increase of 2.66 percent (Rajasthan Agriculture statistics at a galance 2023).

In gross cultivated area cereals occupied largest area (34.60 %) followed by oilseed and pulses with 25.34 percent and 19.69 percent respectively. Resulting total food grain have 54.29 percent of gross cultivated area. Fodder crop, condiments & spices and fibers have 11.55, 3.32 and 2.94 percent area under gross cultivation. In irrigated area oilseed occupied highest area 40.02 percent followed by cereals, pulses and

fibers with 29.56, 7.57 and 6.31 percent respectively (Rajasthan Agriculture statistics at a galance 2023).

A shift from less sustainable and profitable crop or cropping system to a more profitable and/or sustainable crop or cropping system. In another way the production of one or more crops and livestock on available resources is crop–livestock diversification (Asante *et al.,* 2018). Diversified farms can ensure food security, conserve biodiversity, improve dietary preference, increase household income, reduce vulnerability to shocks and create job opportunity (Moraine *et al.,* 2014; Liniger *et al.,* 2011).

Agricultural diversification has meant that the farmers now concentrate on new areas of agriculture, growing alternative crops, rearing new breeds of livestock and adopting a new farming system (Joshi *et al.,* 2006). Chaplin (2000) and Vyas (2006) perceived diversification as consisting of three stages. The first stage reflects a cropping system that shifts away from monoculture. The second stage involves the cultivation of more than one enterprise producing a variety of crops to meet the market at different times of the year. The third stage is mixed farming involving a shift of resources from one crop (or livestock) to a larger mix of crops (or livestock) or a mix of crops and livestock. Mixed production systems also enhance land productivity and improve water use efficiency (Liniger *et al.,* 2011, Berndes *et al.,* 2010). For this reason, Joshi *et al.* (2006) described agricultural diversification as connoting crop mix, enterprise mix and activity mix at the household level aimed at increasing household income and profit. Thus, crop diversification refers to the cultivation of two or more crop with the available productive resources. Similarly, livestock diversification is the rearing of two or more livestock types by the farmers given their available resources. Crop–livestock diversification is defined as the production of one or more crops and livestock with the available resources. Diversification in agriculture' has tremendous impact on the agro-socio-economic upliftment of resource-poor farming communities **(**Deogharia, 2018). In India, crop and livestock production systems are practiced by 86 per cent of smallholders. However, the choices available to farmers are limited by the availability of resources such as land, labor and capital.

Materials and Methods

The study is confined to 33 districts of Rajasthan for the 26-year period from 1997-98 to 2022-23. The present study is based on purely secondary data and conducted in the year 2024-25. Herfindhal Index was used to identify the diversification and index and proportional method was employed to find out the real diversified area in to the crops.

Theil (1967) used HI to determine the extent of crop diversification for the first time. It will be calculated by sum of squares of each crop proportion of acreage in the total area of cropping.

$$H.I. = \sum_{i=1}^{N} P_i^2$$

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i}$$

Where in reference to crop P represents crop proportion of i-th crop and N denotes total number of crops. Ai represent, area under i-th crop in hectare and $\sum_{i=1}^{n} A_i$ represent total cropped area in hectare i is 1,2,3 ….nth the number of crop.

Herfindahl Index range varies from 0 to 1. Its value is 0 when there is perfect diversification and its value is 1 when there is complete specialization of one crop. HI is inversely propositional to diversification (Asante *et al.* 2018, Sonawane *et al.* 2022, Pal and Kar 2012) means lower value indicates higher diversification level.

Proportional method

1. Proportion Formula (for Crop):

$$Proportion\ of\ Crop = \frac{Area\ under\ ith\ crop}{Total\ area\ under\ crops}$$

2. Proportional Method Formula for Calculating Real area of crop (hectare):

Real area of crop = Area under ith crop x Total area

Result and Discussion

The study discusses the diversification index of major *Kharif* season crop into five sub period in Rajasthan. Diversification is an integral part of the process of structural transformation of an economy (Singh *et al*. 2006). The table.1 presents an overview of agricultural data collected across different time periods for the Kharif season. During the Kharif season, data has been collected for 22 types of crops spanning from 1997-98 to 2022-23. The crops are classified into several categories, including cereals such as Rice, Bajra, Maize, Sorghum, and other minor Millets; Pulses like Arhar, Moth, Cow Pea, Moong (Green Gram), and Urad; Oilseeds such as Groundnut, Sesame, Castor, and Soybean; as well as forage crops like Cluster Bean. Additionally, fiber crops (Cotton and Sunhemp), commercial crops (Sugarcane and Guar Seed), and tuber crops (Sweet Potato) are included, reflecting the season's diversity and the importance of monsoon-dependent agriculture.

Table 1 : Descriptions of selected Kharif season crops for study in Rajasthan Diversification Index

***Kharif* Season Crop**								**Number**
Periods	Name of Cereals Crop	Name of Pulses Crop	Name of Oilseed Crop	Name of Forage Crop	Fiber	Commercial Crops	Tuber Crop	7
1997-98 To 2022-23	Rice, Bajra, Maize, Sorghum, Millets	Arhar, Moth, Cow Pea, Moong, Urad And Other Pulses	Groundnut, Sesame, Castor, Soybean	Cluster Bean	Cotton, Sun Hemp	Sugarcane, Guar Seed	Sweet Potato	22

The table 2 and figure 1 presents the Diversification Index of major Kharif season crops across different districts of Rajasthan over five sub-periods from 1997–98 to 2022–23. The diversification index is a numerical measure used to understand how varied the cropping patterns are in a particular region a lower index value suggests greater crop diversification, while a higher value indicates more concentration on fewer crops.

Across the observed periods, some districts such as Dholpur, Bharatpur, and Alwar consistently recorded higher diversification index values, indicating a relatively narrow cropping pattern. Dholpur, for instance, maintained values above 0.8 throughout all periods, reaching 0.929 in the most recent span (2018–19 to 2022–23), which points to a continued dependence on a few major crops (Peralmillet). On the other hand, districts like Jodhpur, Ganganagar, Bikaner and Hanumangarh, exhibited low diversification index values, especially in the earlier years, with Jodhpur decreasing to just 0.259 by 2022–23. This implies these districts have increasingly diversified their Kharif crop cultivation or rely on a more balanced mix of crops (Groundnut, Green gram and Rice).

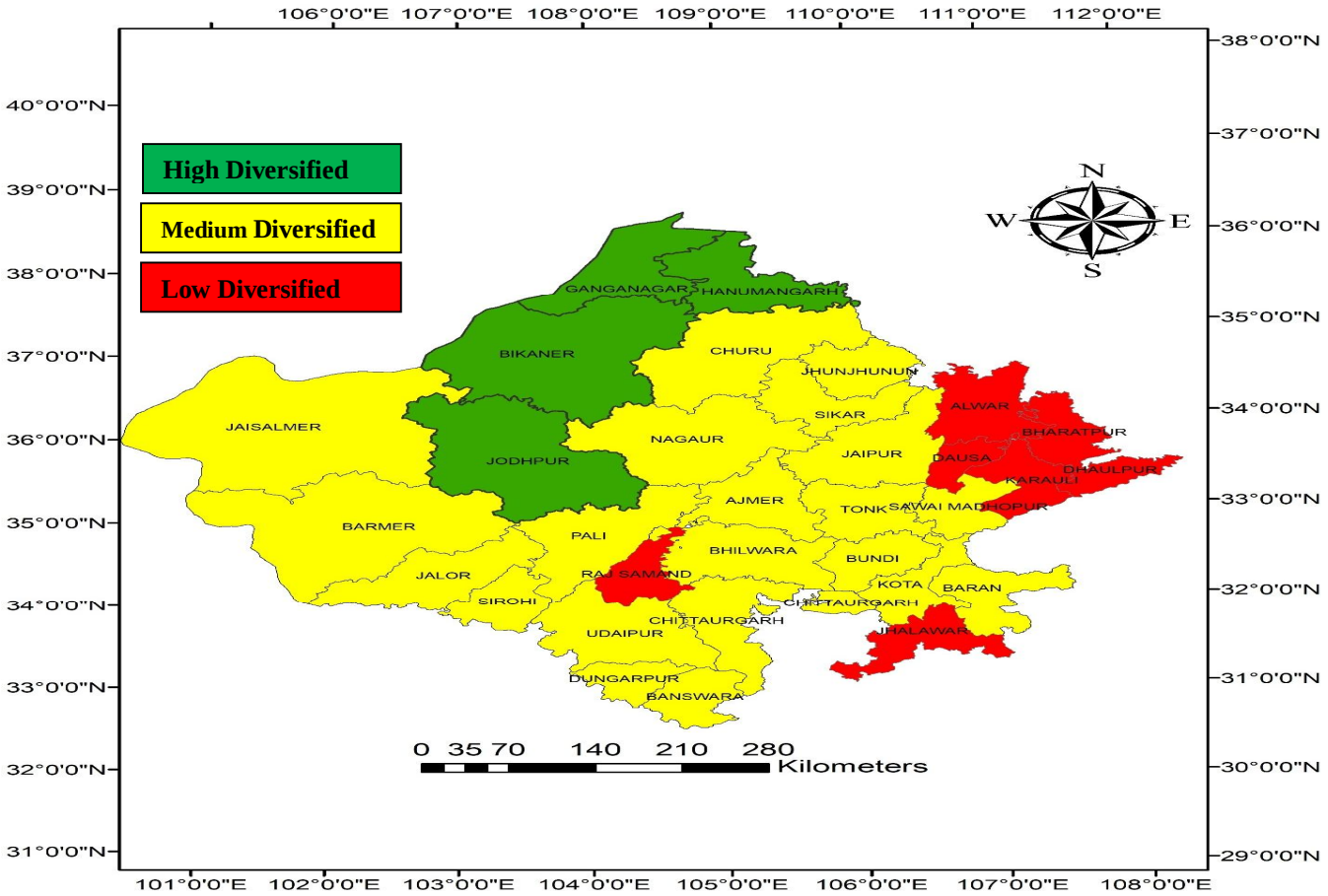

Fig. 1 : *Kharif* crop, high, medium and low diversified districts of Rajasthan

Some districts experienced notable fluctuations over time. For example, Baran showed a sharp rise in diversification index during 2008–09 to 2012–13 (0.810), followed by a decline to 0.600 in the latest period. Similarly, Rajsamand showed a general trend of increasing diversification index, moving from 0.681 to 0.779 across the years.

Districts like Ajmer, Bhilwara, and Nagour displayed relatively stable values over the years with slight variations, indicating consistency in cropping patterns. Meanwhile, Jodhpur, Ganganagar and Hanumangarh recorded very low index values in the latest period, suggesting that these districts have managed to diversify their crop base significantly over time.

Pratapgarh (Became a district in year 2008) showed an increasing trend from 0.498 in 2008–13 to 0.608 in 2018–23, indicating a gradual movement toward more concentrated cropping. Overall, while some districts have moved toward higher diversification, others have become more crop-specific. These variations are likely influenced by local climatic conditions, soil fertility, irrigation facilities, and market access, which shape the feasibility of growing a wide range of crops. Understanding these patterns can help in identifying regions with potential for crop diversification and those that may require support in adopting a broader crop mix for sustainable agricultural development.

Table 2 : Diversification index of major *Kharif* season crop into five sub period in Rajasthan

Districts	1997-98 to 2002-23	2003-04 to 2007-08	2008-09 to 2012-13	2013-14 to 2017-18	2018-19 to 2022-23
Ajmer	0.536	0.527	0.470	0.421	0.441
Alwar	0.639	0.740	0.757	0.650	0.705
Banswara	0.574	0.596	0.613	0.516	0.466
Baran	0.625	0.669	0.810	0.659	0.600
Barmer	0.467	0.430	0.408	0.384	0.454
Bharatpur	0.820	0.905	0.902	0.713	0.896
Bhilwara	0.444	0.445	0.409	0.347	0.446
Bikaner	**0.243**	0.311	0.397	0.403	0.290
Bundi	0.442	0.428	0.410	0.368	0.387
Chittorgarh	0.403	0.445	0.495	0.411	0.454
Churu	0.376	0.332	0.336	0.335	0.366
Dausa	0.570	0.663	0.658	0.677	0.750
Dholpur	0.803	0.864	0.886	0.899	0.929
Dungarpur	0.660	0.734	0.722	0.534	0.480
Ganganagar	0.408	0.317	0.300	0.372	**0.261**
Hanumangarh	**0.260**	0.253	0.294	0.349	0.292
Jaipur	0.396	0.449	0.445	0.434	0.442
Jaisalmer	0.507	0.522	0.551	0.594	0.457
Jalore	0.483	0.433	0.371	0.342	0.399
Jhalawar	0.555	0.574	0.707	0.652	0.647
Jhunujunu	0.502	0.539	0.525	0.428	0.375
Jodhpur	0.386	0.385	0.357	0.264	**0.259**
Karoli	0.794	0.825	0.721	0.745	0.813
Kota	0.620	0.621	0.691	0.629	0.550
Nagour	0.339	0.366	0.373	0.358	0.406
Pali	0.406	0.345	0.305	0.314	0.362
Pratapgarh	-	-	0.498	0.570	0.608
Rajsamand	0.681	0.694	0.654	0.700	0.779
Swai Madhopur	0.404	0.569	0.484	0.398	0.377
Sikar	0.410	0.433	0.451	0.411	0.387
Sirohi	0.339	0.378	0.370	0.347	0.399
Tonk	0.398	0.438	0.385	0.406	0.415
Udaipur	0.714	0.703	0.733	0.673	0.602

In table 3, the real area and Annexure A1 represent proportional changes under Kharif cereals in Rajasthan between 1997–98 and 2022–23 shows a pattern of broad stability in total cereal acreage but significant internal shifts among individual cereal crops, driven by rainfall variability, irrigation

expansion, land-use changes, and market behaviour. State agricultural statistics indicate that the total cereals area stood at 97.46 lakh hectares in 2022–23, compared to 91.45 lakh hectares in 2021–22, showing persistent dominance of cereals in the state's cropping structure despite inter-annual fluctuations (Agricultural Statistics at a glance 2022-23). Within this total, Kharif cereals accounted for 64.04 lakh hectares in 2022-23, up from 61.03 lakh hectares the previous year, showing that the Kharif cereals portfolio has remained central to the state's agrarian system (Rajasthan Agricultural Statistics at a glance 2022-23). The long-term data series (1997-98 onward), available in the crop-district-season dataset, confirm that Rajasthan's cereal area has generally remained in the mid-90 to high-90 lakh ha range, reflecting structural stability.

However, within this stable envelope, the composition of cereals has changed substantially. Long-term studies find that bajra (pearl millet) the largest Kharif cereal in Rajasthan has maintained a relatively stable area (44–47 lakh ha), while jowar (sorghum) and some minor millets have steadily declined since the early 2000s. Conversely, maize area has shown moderate growth, aided by better rainfall years, improved seed technologies, and stronger feed/processing demand; for example, maize area in 2023 was 0.96 million ha compared to 0.95 million ha in 2022. This demonstrates a crop-substitution process inside the Kharif cereals group, where farmers retain drought-resilient cereals but adjust among them based on profitability and climatic reliability.

These shifts are strongly influenced by structural constraints, especially shrinking farm sizes and land fragmentation. As reported in the Agricultural Census, average operational holdings in Rajasthan have reduced over time, making farmers adopt less risky, low-input cereals suited for smaller plots (Agricultural Census of India (2015-16)). In addition, Rajasthan's agriculture remains predominantly rain-fed, and net sown area still fluctuates with monsoon variability; thus, adoption of drought-tolerant cereals such as bajra and maize remains a rational risk-mitigation strategy. Irrigation expansion has been uneven across crops: while wheat and bajra benefit from canal and groundwater irrigation, other Kharif cereals remain rainfall-dependent, limiting large-scale acreage increases. Market forces also contribute as crop economics shift due to price trends, MSP coverage, and input availability, farmers often diversify toward more remunerative pulses and oilseeds, moderating the long-term growth of some cereals.

The long-term change (1997–98 to 2022–23) in Rajasthan's Kharif cereal area is best described as "stable total area + shifting internal composition." Bajra has remained dominant; jowar and smaller millets declined; maize gained moderately; and total cereal acreage continues to be anchored by rainfall patterns and land-use dynamics. The patterns reflect farmers' adaptation to climate stress, irrigation limitations, changing landholding structures, and evolving market incentives, thereby shaping the cereal landscape of Rajasthan over twenty-five years.

Table 3 : Real area (hectare) changes of cereals for period 1997-98 to 2022-23 in Rajasthan

Districts	Cereals					
	Rice	**Bajra**	**Maize**	**Sorghum**	**Millets**	**Total Cereals**
Ajmer	-139.27	-17177.79	-42808.16	5113.86	0.00	-55011.35
Alwar	-0.50	115013.71	-768.49	-1408.59	0.00	82551.97
Banswara	-23385.97	12.00	995.06	-1773.66	-3775.60	-27928.16
Baran	20064.08	-3673.12	-15012.32	-26445.15	0.00	-25066.51
Barmer	0.00	0.00	0.00	0.00	0.00	0.00
Bharatpur	0.00	0.00	0.00	0.00	0.00	0.00
Bhilwara	771.59	0.00	0.00	0.00	0.00	0.00
Bikaner	0.00	0.00	0.00	0.00	0.00	0.00
Bundi	16538.52	494.71	-22606.11	-14884.46	0.00	-20457.34
Chittorgarh	105.77	65.00	26929.26	4546.78	0.00	31646.80
Churu	0.00	-201647.28	0.00	0.00	0.00	-201647.28
Dausa	0.00	42315.58	-6737.40	-2377.77	0.00	33200.42
Dholpur	-1690.53	11946.83	0.00	-457.28	0.00	9799.02
Dungarpur	-14950.69	29.00	3675.93	-1465.52	-3861.22	-16572.50
Ganganagar	-784.64	3050.55	-146.12	-451.48	0.00	1668.31
Hanumangarh	-2590.42	-76102.21	15.00	-680.94	0.00	-79358.57
Jaipur	0.00	47580.96	-12857.65	13917.57	0.00	48640.88
Jaisalmer	0.00	-147864.75	0.00	-3782.76	0.00	-151647.51

Jalore	0.00	132470.33	3.00	1563.32	440.00	134476.65
Jhalawar	6471.96	-133.35	-31541.94	-33569.74	0.00	-58773.06
Jhunujunu	0.00	-10879.35	3.00	5.00	0.00	-10871.35
Jodhpur	0.00	-264975.68	3.00	19635.36	0.00	-245337.32
Karoli	-1373.85	20049.68	-1040.82	-922.88	0.00	16712.13
Kota	25863.36	64.00	-13640.59	-27283.28	0.00	-14996.52
Nagour	0.00	-123978.75	-543.84	3251.92	0.00	-121270.68
Pali	0.00	-137994.35	9493.91	76549.97	0.00	-51950.47
Pratapgarh	-1445.06	-26.49	-15269.67	-459.58	-15.63	-17216.42
Rajsamand	-353.84	776.08	9131.25	553.10	0.00	10106.59
Swai Madhopur	4280.82	20021.24	-1448.05	-15501.34	0.00	7352.67
Sikar	0.00	10364.73	-94.05	-20.41	0.00	10250.27
Sirohi	0.00	-8401.34	-15914.69	-3116.18	-2029.03	-29461.24
Tonk	5.00	12299.51	-18651.67	-26290.74	11.00	-32626.89
Udaipur	3717.00	-29004.59	132626.19	-72142.14	1.00	35197.47

Table 4 : Real area (hectare) changes of pulses for period 1997-98 to 2022-23 in Rajasthan

Districts	Pulses						
	Arhar	**Moth**	**Cow pea**	**Moong**	**Urad**	**Other Kharif Pulses**	**Total Pulses**
Ajmer	0.00	-3322.04	3.00	73203.14	18529.42	-4124.45	84289.07
Alwar	-2284.99	0.00	0.00	-0.03	0.00	-0.05	-2327.73
Banswara	-3114.18	-90.88	0.00	-159.31	-36927.66	-178.63	-40470.66
Baran	-218.91	0.00	0.00	-2143.27	15440.82	-32.84	13045.81
Barmer	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bharatpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bhilwara	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bikaner	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bundi	-349.08	0.00	2.00	-1550.09	76998.48	6.00	75107.30
Chittorgarh	-463.12	0.00	0.00	-221.09	-22233.81	-200.07	-23118.08
Churu	0.00	49367.10	8.00	342855.85	1.00	5199.14	397431.10
Dausa	-1771.60	-804.60	0.00	-517.86	-501.34	-1156.92	-4752.32
Dholpur	-3207.51	-73.09	0.00	-268.50	-731.76	-138.06	-4418.92
Dungarpur	-1004.32	0.00	0.00	-218.66	-19868.24	-391.06	-21482.29
Ganganagar	-53.99	1118.44	0.00	85016.52	-436.79	-23.57	85620.61
Hanumangarh	1.00	10158.36	5.00	36457.56	-28.69	-38.79	46554.45
Jaipur	-2729.31	-5949.90	0.00	71225.36	-5646.05	-14152.91	42747.19
Jaisalmer	0.00	12470.00	0.00	44674.95	0.00	0.00	57144.95
Jalore	0.00	78.00	0.00	97739.50	1.00	24.00	97842.50
Jhalawar	-1823.50	0.00	0.00	-692.27	-18211.94	-161.43	-20889.14
Jhunujunu	-87.99	-4279.75	1.00	8984.31	0.00	-2838.04	1779.53
Jodhpur	0.00	-124051.68	1.00	166284.81	0.00	-8.56	42225.57
Karoli	-556.42	-118.95	0.00	-40.57	-429.48	-40.42	-1185.84
Kota	-172.34	0.00	0.00	-1754.87	19410.80	-61.02	17422.57
Nagour	0.00	-138330.16	2.00	354579.26	14.00	-16567.56	199697.55
Pali	0.00	-63011.64	1.00	144926.55	587.00	-6713.93	75788.98
Pratapgarh	-1579.10	0.00	0.00	-60.63	-3759.70	-34.07	-5433.51
Rajsamand	0.00	0.00	0.00	-167.00	-1548.30	-1081.79	-2797.08
Swai Madhopur	-810.53	-479.91	0.00	-1173.02	14916.69	-47.28	12405.95
Sikar	-294.14	-8135.44	195.00	42418.63	0.00	-31836.07	2347.99
Sirohi	-894.47	1.00	1.00	-3809.30	709.86	-4748.62	-8740.52
Tonk	-133.07	0.00	0.00	23876.41	40901.68	-65.47	64579.56
Udaipur	1612.48	0.00	0.00	-36083.18	-5433.37	-14.92	-39918.99

The table 4 displays the changes in the real area (in hectares) and Annexure A2 represent proportional changes under the cultivation of various pulses across different districts of Rajasthan between 1997-98 and 2022-23. It highlights increases or decreases in area for specific pulses such as Arhar, Moth, Cowpea, Moong,

Urad, and other Kharif pulses, as well as the total pulse cultivation area change in each district.

A notable increase in pulse cultivation was observed in districts such as Churu, Nagour, Jodhpur, Jalore, Ganganagar, Hanumangarh, and Tonk. Churu, for instance, saw a significant rise with over 397,000 hectares added, largely due to the expansion in Moong and Moth areas. Similarly, Nagour and Jodhpur also recorded large net gains of 199,697.55 and 42,225.57 hectares, respectively, with a major contribution from Moong cultivation. Jalore and Tonk showed impressive increases of over 97,000 and 64,000 hectares, again led primarily by Moong and Urad pulses.

Some districts like Ajmer, Jaipur, Pali, and Ganganagar also witnessed considerable area expansion. Ajmer experienced a net increase of over 84,000 hectares, largely attributed to Moong and Urad, while Jaipur added around 42,000 hectares. In Pali, Moong cultivation saw a significant boost, despite reductions in Moth and other pulses. On the other hand, several districts witnessed a decline in pulse cultivation area. Banswara saw the largest decrease, with over 40,000 hectares lost, mainly due to reductions in Urad. Other districts like Jhalawar, Dungarpur, Chittorgarh, and Udaipur also showed substantial declines,

Farm-level agricultural diversification refers to the process by which individual farmers shift from reliance on a single crop or agricultural activity to multiple crops, livestock, or other income-generating farming enterprises. This can include growing a variety of food and commercial crops, integrating crop and livestock farming, adopting horticulture, aquaculture, agroforestry, or engaging in value-added activities such as processing and direct marketing.

The goal of diversification at the farm level is typically to reduce risk, improve income stability, enhance resource use efficiency, and respond to changing market demands, climatic conditions, and policy environments. It reflects a strategic decision by the farmer to make better use of available land, labor, and capital by spreading production across different agricultural outputs, driven by falling areas under Urad and Moong. Dausa, Dholpur, and Sirohi similarly recorded negative changes in total area.

Some districts showed negligible or no change, such as Barmer, Bharatpur, Bhilwara, and Bikaner, indicating either stable cultivation patterns or minimal pulse production in these regions. The table reflects significant regional disparities in pulse area changes over the 25-year period. While certain districts have embraced pulse cultivation especially Moong others have reduced or stagnated, possibly due to factors like climate, water availability, or local crop preferences.

Table 5 : Real area (hectare) changes of oilseeds for period 1997-98 to 2022-23 in Rajasthan

Districts	Oil seeds				
	Groundnut	**Sesame**	**Castor**	**Soybean**	**Total**
Ajmer	-8643.78	-4173.31	154.00	-100.08	-12763.18
Alwar	-11.45	-61.80	0.00	-0.01	-128.53
Banswara	146.08	-115.15	-6.42	65205.01	65229.52
Baran	-4872.76	-516.55	-10.95	17403.95	12003.70
Barmer	0.00	0.00	0.00	0.00	0.00
Bharatpur	0.00	0.00	0.00	0.00	0.00
Bhilwara	0.00	0.00	0.00	0.00	0.00
Bikaner	0.00	0.00	0.00	0.00	0.00
Bundi	-2927.69	-1866.57	0.00	-33844.43	-38638.69
Chittorgarh	-16421.35	-2936.44	0.00	22695.33	3337.54
Churu	58560.53	3337.50	11.00	0.00	61909.04
Dausa	-13927.67	3024.17	0.00	0.00	-10903.50
Dholpur	-1295.40	-379.95	0.00	0.00	-1675.36
Dungarpur	-61.70	59.90	-101.82	39913.13	39809.51
Ganganagar	-1599.10	-165.60	82.29	0.00	-1682.41
Hanumangarh	8768.06	-1130.85	171.02	0.00	7808.23
Jaipur	-29310.16	-729.20	-24.82	4.00	-30060.19
Jaisalmer	37303.44	1587.20	7504.00	0.00	46394.64
Jalore	25004.48	10934.16	90217.00	0.00	126155.64
Jhalawar	-6363.96	-512.38	-12.63	87180.94	80291.97
Jhunujunu	12083.28	133.93	271.00	0.00	12488.21
Jodhpur	161713.21	-30459.64	25877.42	0.00	157130.98

Karoli	-8205.69	-3659.68	0.00	16.00	-11849.37
Kota	-1483.09	-162.03	1.00	3242.37	1598.25
Nagour	19964.99	-26906.66	58.69	8.00	-6874.97
Pali	-4057.27	50149.17	11192.15	9.00	57293.06
Pratapgarh	-1030.77	-856.92	1.00	26262.85	24376.16
Rajsamand	-2948.90	-630.84	0.00	365.00	-3214.74
Swai Madhopur	-29093.39	24201.12	0.00	2325.39	-2566.88
Sikar	17486.87	-500.32	0.00	1.00	16987.56
Sirohi	19706.16	-95.68	21284.80	0.00	40895.28
Tonk	-15828.45	5746.20	17.00	-429.29	-10494.53
Udaipur	-25144.63	-1028.75	51.00	42006.65	15884.27

The table 5 presents data on changes in the real area (in hectares) and Annexure A3 represent proportional changes under oilseed cultivation across various districts in Rajasthan from 1997–98 to 2022–23. It covers four major oilseeds: Groundnut, Sesamum, Castor, and Soybean, along with the total area change for each district.

Several districts experienced significant increases in oilseed cultivation. Jodhpur saw the largest positive change, with a total increase of 157,130.98 hectares, largely due to a rise in groundnut and castor cultivation. Jalore also reported a substantial gain of over 126,000 hectares, primarily from the expansion of castor and sesamum areas. Similarly, Banswara, Jhalawar, and Dungarpur recorded notable increases in soybean cultivation, reflecting a shift towards this crop in southern Rajasthan. Sirohi, Churu, and Jaisalmer also showed positive trends, especially in castor and groundnut areas. In contrast, some districts experienced major declines in oilseed cultivation. Jaipur showed the highest decrease, losing over 30,000 hectares. Ajmer, Bundi, and Sawai Madhopur also recorded substantial reductions, mainly in groundnut and soybean areas. These declines may be due to changing land-use patterns or shifts to other crops.

Soybean emerged as a leading contributor to the increase in oilseed area in districts like Banswara, Jhalawar, Dungarpur, Udaipur, and Pratapgarh, indicating its growing importance. Castor cultivation also expanded significantly in Jalore, Sirohi, and Jodhpur, showing increased interest in this crop in western parts of the state.

While some districts like Barmer, Bharatpur, Bhilwara, and Bikaner reported no change in oilseed area, others such as Nagaur and Kota had a mix of increases and decreases across different crops. A few districts like Pali and Tonk saw increases in sesamum and castor, offsetting declines in groundnut and soybean. The data highlights a dynamic shift in oilseed cultivation patterns in Rajasthan over the 25-year period. While traditional oilseed crops like groundnut have seen declines in many areas, newer crops like soybean and castor have gained ground, leading to overall increases in select districts. These trends reflect changing agricultural preferences and possibly adaptation to regional agro-climatic conditions.

Table 6 : Real area (hectare) changes of major fiber, commercial, forage and tuber crop for period 1997-98 to 2022-23 in Rajasthan

Districts	**Fiber**		**Commercial**		**Forage**	**Tuber Crop**
	Cotton	**Sun hemp**	**Sugar Cane**	**Guar Seed**	**Cluster Bean**	**Sweet Potato**
Ajmer	-13953.63	0.00	-191.97	-2504.01	147.00	-11.93
Alwar	4620.43	0.00	-0.43	-5321.17	0.00	0.00
Banswara	4622.56	30.00	-999.06	-488.20	0.00	4.00
Baran	0.00	0.00	4.00	13.00	0.00	0.00
Barmer	0.00	0.00	0.00	0.00	0.00	0.00
Bharatpur	0.00	0.00	0.00	0.00	0.00	0.00
Bhilwara	0.00	0.00	0.00	0.00	0.00	0.00
Bikaner	0.00	0.00	0.00	0.00	0.00	0.00
Bundi	23.00	0.00	-15691.62	-77.77	0.00	-264.88
Chittorgarh	4841.39	18.00	-1711.68	-15014.97	0.00	1.00
Churu	15411.25	0.00	0.00	-281549.10	8445.00	0.00
Dausa	3.00	0.00	0.00	-17547.59	0.00	0.00
Dholpur	13.00	1.00	7.00	-3594.18	0.00	-131.56
Dungarpur	53.65	0.00	-535.02	-1273.36	0.00	0.00

Ganganagar	-221892.70	0.00	-2087.94	137375.81	998.32	0.00
Hanumangarh	-103785.47	0.00	32.00	150895.55	-22146.18	0.00
Jaipur	-206.92	0.00	-455.60	-60746.36	57.00	24.00
Jaisalmer	-522.40	0.00	0.00	44384.29	4246.03	0.00
Jalore	229.58	0.00	0.00	-343921.98	-14807.39	25.00
Jhalawar	-143.15	0.00	-194.48	1.00	0.00	-293.13
Jhunujunu	17629.09	0.00	0.00	-21054.49	24.00	5.00
Jodhpur	74906.99	0.00	0.00	-63305.48	34378.26	1.00
Karoli	0.00	0.00	14.00	-3556.81	0.00	-134.12
Kota	0.00	4.00	-743.68	-3261.96	0.00	-22.66
Nagour	67495.80	0.00	3.00	-139705.52	709.78	-54.96
Pali	8431.89	3.00	0.00	-89448.64	-86.98	-30.83
Pratapgarh	-1647.11	0.00	1.00	-80.12	0.00	0.00
Rajsamand	1654.62	5.00	139.00	-5893.39	0.00	0.00
Swai Madhopur	0.00	1.00	-794.02	-16340.29	1.00	-59.44
Sikar	-228.14	0.00	-23.41	-31265.03	1905.63	25.12
Sirohi	-3605.69	0.00	1.00	822.92	28.00	60.24
Tonk	39.55	0.00	-491.07	-20967.73	0.00	-38.88
Udaipur	1821.67	44.00	-183.03	-12818.26	0.00	-27.12

The table 6 presents the real change in area (in hectares) and Annexure A4 represent proportional changes under cultivation for selected fiber, commercial, forage, and tuber crops across various districts in Rajasthan between 1997–98 and 2022–23. The fiber crops considered are cotton and sun hemp; the commercial crops include sugarcane, guar seed, and cluster bean; while sweet potato represents the tuber crop. Cotton cultivation shows highly varied trends. Some districts like Ganganagar (-221,892.70 ha) and Hanumangarh (-103,785.47 ha) recorded a significant decline in cotton area, possibly due to shifts in water availability or crop preference. On the other hand, districts such as Jodhpur (74,906.99 ha), Nagour (67,495.80 ha), and Churu (15,411.25 ha) saw large increases in cotton cultivation, indicating favorable growing conditions or market demand in those regions.

Sunhemp cultivation remained negligible across most districts, with only small increases seen in areas like Udaipur (44.00 ha), Chittorgarh (18.00 ha), and Bharatpur (0.00 ha), reflecting its limited role in cropping patterns. Sugarcane area mostly declined, with Bundi experiencing a large drop of 15,691.62 ha. Ganganagar (-2,087.94 ha) and Chittorgarh (-1,711.68 ha) also recorded notable declines, which may be linked to resource-intensive cultivation requirements. However, some minor increases were observed, such as in Hanumangarh (+32.00 ha) and Rajsamand (+139.00 ha).

Guar seed, a prominent crop in arid regions, showed a mixed pattern. While some districts like Hanumangarh (+150,895.55 ha) and Ganganagar (+137,375.81 ha) saw major gains, others such as Jalore (-343,921.98 ha) and Nagour (-139,705.52 ha) saw steep declines, possibly due to crop rotation or soil condition changes. Cluster bean showed an increase in districts such as Jodhpur (+34,378.26 ha) and Churu (+8,445.00 ha), while declining sharply in Hanumangarh (-22,146.18 ha) and Jalore (-14,807.39 ha). Sweet potato cultivation remained minor overall, with slight positive changes in Sirohi (+60.24 ha) and Jodhpur (+1.00 ha), but saw moderate reductions in places like Jhalawar (-293.13 ha) and Bundi (-264.88 ha). Overall, the cropping pattern across Rajasthan has undergone significant changes over the 25-year period, influenced by regional preferences, agro-climatic conditions, and economic viability.

Conclusion

Crop diversification in Rajasthan during the Kharif season has shown a varied but generally beneficial trend throughout the years. The diversification index decreased in several areas, indicating an increase in crop variety. Better distribution of Kharif crops was seen in districts like Jodhpur, Ganganagar, Hanumangarh and Bikaner, which may have been influenced by crop promotion programs and improvements in farming techniques. Some districts, like Bharatpur and Dholpur, on the other hand, continuously had high index values, indicating that they were still less diversified and probably relied on only one or two primary crops. Traditional cereal crops like maize and bajra have seen differing patterns in terms of crop area changes, in certain areas, maize cultivation has increased while bajra cultivation has decreased. Notably, there were notable shifts in areas like Rajsamand and Udaipur, suggesting a move towards crops with high demand or output. In several regions, such as Ajmer and Churu,

pulses increased, indicating a rising interest in food crops high in protein. In places like Banswara and Jhalawar, oilseeds especially soybeans gained traction, indicating their potential for commerce. The tendency towards diversification was further influenced by the addition of commercial crops like guar seed and cluster beans, as well as fiber products like cotton. Positive changes in these crops were seen in districts like as Churu, Jodhpur, and Nagour, presumably as a result of shifting market needs and climate adaptability. Overall, farmers' progressive embrace of multi-cropping methods and resource optimization is reflected in Rajasthan's Kharif diversification.

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Annexure

Table A1 : Proportional area changes of cereals from 1997-98 to 2022-23 in Rajasthan

Districts	Cereals					
	Rice	Bajra	Maize	Sorghum	Millets	Total Cereals
Ajmer	0.000	-0.041	-0.101	0.012	0.000	-0.130
Alwar	0.000	0.293	-0.002	-0.004	0.000	0.210
Banswara	-0.095	0.000	0.004	-0.007	-0.015	-0.113
Baran	0.062	-0.011	-0.046	-0.081	0.000	-0.077
Barmer	0.000	0.057	0.000	0.001	0.000	0.059
Bharatpur	-0.013	0.125	-0.001	-0.030	0.000	0.082
Bhilwara	0.002	0.005	-0.004	0.109	0.000	0.112
Bikaner	0.000	-0.241	0.000	-0.002	0.000	-0.243
Bundi	0.069	0.002	-0.095	-0.063	0.000	-0.086
Chittorgarh	0.000	0.000	0.082	0.014	0.000	0.096
Churu	0.000	-0.182	0.000	0.000	0.000	-0.182
Dausa	0.000	0.216	-0.034	-0.012	0.000	0.169
Dholpur	-0.016	0.115	0.000	-0.004	0.000	0.094
Dungarpur	-0.120	0.000	0.029	-0.012	-0.031	-0.133
Ganganagar	-0.001	0.004	0.000	-0.001	0.000	0.002
Hanumangarh	-0.003	-0.090	0.000	-0.001	0.000	-0.094
Jaipur	0.000	0.084	-0.023	0.025	0.000	0.086
Jaisalmer	0.000	-0.185	0.000	-0.005	0.000	-0.190
Jalore	0.000	0.209	0.000	0.002	0.001	0.213
Jhalawar	0.019	0.000	-0.092	-0.098	0.000	-0.172
Jhunujunu	0.000	-0.030	0.000	0.000	0.000	-0.030
Jodhpur	0.000	-0.201	0.000	0.015	0.000	-0.187
Karoli	-0.010	0.141	-0.007	-0.007	0.000	0.118
Kota	0.103	0.000	-0.054	-0.109	0.000	-0.060
Nagour	0.000	-0.096	0.000	0.003	0.000	-0.094
Pali	0.000	-0.285	0.020	0.158	0.000	-0.107
Pratapgarh	-0.008	0.000	-0.082	-0.002	0.000	-0.093
Rajsamand	-0.004	0.010	0.114	0.007	0.000	0.126
Swai Madhopur	0.029	0.134	-0.010	-0.104	0.000	0.049
Sikar	0.000	0.022	0.000	0.000	0.000	0.022
Sirohi	0.000	-0.061	-0.115	-0.023	-0.015	-0.213
Tonk	0.000	0.040	-0.061	-0.086	0.000	-0.106
Udaipur	0.017	-0.135	0.618	-0.336	0.000	0.164

Table A2 : Proportional area changes of pulses from 1997-98 to 2022-23 in Rajasthan

Districts	Pulses						
	Arhar	Moth	Cow pea	Moong	Urad	Other Kharif Pulses	Total Pulses
Ajmer	0.000	-0.008	0.000	0.173	0.044	-0.010	0.199
Alwar	-0.006	0.000	0.000	0.000	0.000	0.000	-0.006
Banswara	-0.013	0.000	0.000	-0.001	-0.150	-0.001	-0.164
Baran	-0.001	0.000	0.000	-0.007	0.048	0.000	0.040
Barmer	0.000	-0.017	0.000	-0.001	0.000	0.000	-0.018
Bharatpur	-0.019	-0.002	0.000	-0.001	-0.002	-0.001	-0.025
Bhilwara	0.000	0.000	0.000	0.009	0.070	-0.006	0.073
Bikaner	0.000	-0.078	0.000	0.024	0.000	0.000	-0.054
Bundi	-0.001	0.000	0.000	-0.007	0.323	0.000	0.315
Chittorgarh	-0.001	0.000	0.000	-0.001	-0.068	-0.001	-0.070
Churu	0.000	0.044	0.000	0.309	0.000	0.005	0.358
Dausa	-0.009	-0.004	0.000	-0.003	-0.003	-0.006	-0.024
Dholpur	-0.031	-0.001	0.000	-0.003	-0.007	-0.001	-0.042
Dungarpur	-0.008	0.000	0.000	-0.002	-0.159	-0.003	-0.172
Ganganagar	0.000	0.002	0.000	0.120	-0.001	0.000	0.121
Hanumangarh	0.000	0.012	0.000	0.043	0.000	0.000	0.055

Jaipur	-0.005	-0.011	0.000	0.126	-0.010	-0.025	0.076
Jaisalmer	0.000	0.016	0.000	0.056	0.000	0.000	0.072
Jalore	0.000	0.000	0.000	0.155	0.000	0.000	0.155
Jhalawar	-0.005	0.000	0.000	-0.002	-0.053	0.000	-0.061
Jhunujunu	0.000	-0.012	0.000	0.025	0.000	-0.008	0.005
Jodhpur	0.000	-0.094	0.000	0.126	0.000	0.000	0.032
Karoli	-0.004	-0.001	0.000	0.000	-0.003	0.000	-0.008
Kota	-0.001	0.000	0.000	-0.007	0.078	0.000	0.070
Nagour	0.000	-0.107	0.000	0.275	0.000	-0.013	0.155
Pali	0.000	-0.130	0.000	0.299	0.001	-0.014	0.156
Pratapgarh	-0.008	0.000	0.000	0.000	-0.020	0.000	-0.029
Rajsamand	0.000	0.000	0.000	-0.002	-0.019	-0.014	-0.035
Swai Madhopur	-0.005	-0.003	0.000	-0.008	0.100	0.000	0.083
Sikar	-0.001	-0.017	0.000	0.090	0.000	-0.068	0.005
Sirohi	-0.006	0.000	0.000	-0.028	0.005	-0.034	-0.063
Tonk	0.000	0.000	0.000	0.078	0.133	0.000	0.210
Udaipur	0.008	0.000	0.000	-0.168	-0.025	0.000	-0.186

Table A3 : Proportional area changes of Oilseeds from 1997-98 to 2022-23 in Rajasthan

Oil seeds					
Districts	**Groundnut**	**Sesame**	**Castor**	**Soybean**	**Total**
Ajmer	-0.020	-0.010	0.000	0.000	-0.030
Alwar	0.000	0.000	0.000	0.000	0.000
Banswara	0.001	0.000	0.000	0.265	0.265
Baran	-0.015	-0.002	0.000	0.054	0.037
Barmer	0.003	-0.007	0.033	0.000	0.029
Bharatpur	-0.005	-0.013	0.000	0.000	-0.018
Bhilwara	-0.038	-0.016	0.000	0.016	-0.039
Bikaner	0.109	-0.026	0.000	0.000	0.084
Bundi	-0.012	-0.008	0.000	-0.142	-0.162
Chittorgarh	-0.050	-0.009	0.000	0.069	0.010
Churu	0.053	0.003	0.000	0.000	0.056
Dausa	-0.071	0.015	0.000	0.000	-0.056
Dholpur	-0.012	-0.004	0.000	0.000	-0.016
Dungarpur	0.000	0.000	-0.001	0.319	0.319
Ganganagar	-0.002	0.000	0.000	0.000	-0.002
Hanumangarh	0.010	-0.001	0.000	0.000	0.009
Jaipur	-0.052	-0.001	0.000	0.000	-0.053
Jaisalmer	0.047	0.002	0.009	0.000	0.058
Jalore	0.040	0.017	0.143	0.000	0.199
Jhalawar	-0.019	-0.001	0.000	0.255	0.235
Jhunujunu	0.033	0.000	0.001	0.000	0.035
Jodhpur	0.123	-0.023	0.020	0.000	0.119
Karoli	-0.058	-0.026	0.000	0.000	-0.084
Kota	-0.006	-0.001	0.000	0.013	0.006
Nagour	0.015	-0.021	0.000	0.000	-0.005
Pali	-0.008	0.103	0.023	0.000	0.118
Pratapgarh	-0.006	-0.005	0.000	0.141	0.131
Rajsamand	-0.037	-0.008	0.000	0.005	-0.040
Swai Madhopur	-0.195	0.162	0.000	0.016	-0.017
Sikar	0.037	-0.001	0.000	0.000	0.036
Sirohi	0.143	-0.001	0.154	0.000	0.296
Tonk	-0.051	0.019	0.000	-0.001	-0.034
Udaipur	-0.117	-0.005	0.000	0.196	0.074

Table A4 : Proportional area changes of major fiber, commercial forage and tuber crop from 1997-98 to 2022-23 in Rajasthan

Districts	**Fiber**		**Commercial**		**Forage**	**Tuber Crop**
	Cotton	**Sun hemp**	**Sugar Cane**	**Guar Seed**	**Cluster Bean**	**Sweet Potato**
Ajmer	-0.033	0.000	0.000	-0.006	0.000	0.000
Alwar	0.012	0.000	0.000	-0.014	0.000	0.000
Banswara	0.019	0.000	-0.004	-0.002	0.000	0.000
Baran	0.000	0.000	0.000	0.000	0.000	0.000
Barmer	0.000	0.000	0.000	-0.071	0.000	0.000
Bharatpur	0.015	0.000	-0.006	-0.044	0.000	-0.004
Bhilwara	0.002	0.000	-0.002	-0.147	0.000	0.000
Bikaner	-0.017	0.000	0.000	0.271	-0.040	0.000
Bundi	0.000	0.000	-0.066	0.000	0.000	-0.001
Chittorgarh	0.015	0.000	-0.005	-0.046	0.000	0.000
Churu	0.014	0.000	0.000	-0.254	0.008	0.000
Dausa	0.000	0.000	0.000	-0.089	0.000	0.000
Dholpur	0.000	0.000	0.000	-0.034	0.000	-0.001
Dungarpur	0.000	0.000	-0.004	-0.010	0.000	0.000
Ganganagar	-0.312	0.000	-0.003	0.193	0.001	0.000
Hanumangarh	-0.123	0.000	0.000	0.179	-0.026	0.000
Jaipur	0.000	0.000	-0.001	-0.107	0.000	0.000
Jaisalmer	-0.001	0.000	0.000	0.056	0.005	0.000
Jalore	0.000	0.000	0.000	-0.544	-0.023	0.000
Jhalawar	0.000	0.000	-0.001	0.000	0.000	-0.001
Jhunujunu	0.049	0.000	0.000	-0.058	0.000	0.000
Jodhpur	0.057	0.000	0.000	-0.048	0.026	0.000
Karoli	0.000	0.000	0.000	-0.025	0.000	-0.001
Kota	0.000	0.000	-0.003	-0.013	0.000	0.000
Nagour	0.052	0.000	0.000	-0.108	0.001	0.000
Pali	0.017	0.000	0.000	-0.184	0.000	0.000
Pratapgarh	-0.009	0.000	0.000	0.000	0.000	0.000
Rajsamand	0.021	0.000	0.002	-0.074	0.000	0.000
Swai Madhopur	0.000	0.000	-0.005	-0.109	0.000	0.000
Sikar	0.000	0.000	0.000	-0.067	0.004	0.000
Sirohi	-0.026	0.000	0.000	0.006	0.000	0.000
Tonk	0.000	0.000	-0.002	-0.068	0.000	0.000
Udaipur	0.008	0.000	-0.001	-0.060	0.000	0.000