

Agricultural Transformation and Crop Diversification in Maharashtra: An Empirical Analysis

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Abstract: *This study aims to investigate the agricultural transformation and crop diversification in Maharashtra from 2011-12 to 2024-25, based on secondary data. The statistical tools used to analyse the data are Compound Growth Rate (CGR), Herfindahl Index (HI), and Coefficient of Variation (CV). The results of the study reveal a substantial change in the pattern of crops, with crops like ragi, soybean, and gram showing a higher rate of growth, with a CGR of 89.17%, 50.92%, and 58.01%, respectively. The Herfindahl Index, which depends on area, varies from 0.092 to 0.141, which indicates a moderate degree of diversification, whereas the HI based on production is higher, i.e., 0.521, which reflects a strong degree of concentration in crops, mainly sugarcane, which accounts for over 70% of total production. The CV, which exceeds 100% for most crops, reflects a higher degree of instability in agricultural production, which may be attributed to various climatic factors. The study concludes that the agricultural scenario of Maharashtra reflects a higher degree of growth, but simultaneously, the sustainability of agricultural production, water scarcity, and instability in agricultural production are also of concern, which need to be addressed for the overall growth of the agricultural sector..*

Keywords: Crop Diversification, Agricultural Transformation, Cropping Pattern, Maharashtra, Herfindahl Index, Compound Growth Rate

I. INTRODUCTION

Agriculture plays a crucial role in the economy of Maharashtra, contributing significantly to employment, income generation, and rural development. A large proportion of the state's population depends directly or indirectly on agriculture for their livelihood. The sector supports agro-based industries such as sugar, textiles, and food processing, thereby strengthening the overall economic structure. Maharashtra is one of the leading producers of crops like sugarcane, cotton, soybean, and horticultural products, which also contribute to exports and value addition. Despite industrial growth, agriculture remains the backbone of rural Maharashtra and ensures food security and economic stability.

Chand R. (1996) analysed changes in cropping patterns in India and found that diversification is influenced by irrigation, technology, and market demand. The study emphasized that farmers tend to shift towards high-value crops to maximize income. Joshi P. K. et al. (2004) examined agricultural diversification in South Asia and concluded that diversification plays a key role in increasing farm income and reducing risk. The study also highlighted the importance of infrastructure and policy support. Birthal P. S.. (2015) studied crop diversification and its impact on sustainability and found that diversification improves resource use efficiency and enhances rural livelihoods. However, the study also pointed out regional disparities in diversification patterns.



Concept of Agricultural Transformation

Agricultural transformation refers to the structural change in agriculture from traditional subsistence farming to modern, commercial, and market-oriented agriculture. It includes changes in cropping pattern, adoption of advanced technology, increased use of irrigation, and shift towards high-value crops. In Maharashtra, this transformation is evident through the increasing cultivation of commercial crops such as sugarcane, fruits, and vegetables. The transformation process aims to improve productivity, income, and efficiency, but it also creates challenges related to sustainability and resource use.

Crop Diversification

Crop diversification is important for sustainable agricultural development in Maharashtra, particularly during times of climatic uncertainties and resource scarcity. It implies a move from monoculture to a diverse pattern of crops, which will provide economic stability to farmers through a diversified income base, helping them to overcome the risks of price fluctuations and climatic changes. From an economic point of view, crop diversification will improve the profitability of farmers, especially through the cultivation of high-value crops, which will create employment in the rural areas. From a biological point of view, crop diversification will improve soil fertility, prevent soil degradation, and provide food security, which are important for maximizing profits, minimizing risks, and maintaining a balance in nature.

II. RESEARCH GAP

Despite a plethora of research on agricultural development in Maharashtra, a lot of research gaps have been identified, especially in terms of recent structural changes in agriculture in the state, along with the challenges faced post-2020. Some of the limitations identified in previous research on agricultural development in Maharashtra are that they failed to provide an in-depth study on the effects of crop diversification on the income of farmers, along with the lack of district-level research, which is very important in order to accommodate regional differences in agricultural development. Additionally, previous research on agricultural development in Maharashtra was carried out using very basic analytical tools, which are not sufficient to understand the agricultural changes in the state. Therefore, this research aims to fill the identified gaps in previous research by providing an empirical study on agricultural development in Maharashtra.

III. OBJECTIVES OF THE STUDY

- To analyse changes in cropping pattern in Maharashtra.
- To measure the level of crop diversification.
- To study the impact of diversification on income and productivity.

IV. DATA AND METHODOLOGY

Sources of Data

The current study is based on the secondary data collected from various reliable government and institutional sources from the year 2011 to 2025. The collected data includes information on the crop area, production, yield, and other relevant agricultural indicators for Maharashtra.

Analysis of data:

This study uses quantitative and analytical research methods in the context of agricultural transformation and crop diversification in Maharashtra. The following statistical and econometric tools have been used in this study for analysis.



Compound Growth Rate (CGR)

$$CGR = \left(\frac{Y_t}{Y_0}\right)^{\frac{1}{n}} - 1$$

Where:

Where:

- Y_t = Final value
- Y_0 = Initial value
- n = Number of years

Herfindahl Index (Crop Diversification Index)

$$HI = \sum (P_i)^2$$

Where:

P_i = Proportion of area under the i-th crop.

Percentage Change

$$\text{Percentage Change} = \frac{(\text{New Value} - \text{Old Value})}{\text{Old Value}} \times 100$$

V. RESULT

Sr. No.	Crops	2011-12		2015-16		2020-21		2024-25	
		Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
1	Rice	15.44	28.49	15.03	25.93	1560.5	3291.2	1692.54	4048.96
2	wheat	8.78	14.99	9.11	9.81	1126.2	2071.4	1313.55	2635.26
3	Jowar	32.29	26.27	32.17	12.05	2320.4	2186.3	1690.32	1871.42
4	Bajri	8.38	8.23	8.01	3.33	687.5	905.6	443.36	564.92
5	Maize	8.77	24.57	0.92	0.93	81.6	93.9	68.67	96.24
6	Ragi	1.3	1.38	10.67	16.6	1203.1	3588	1696.53	5481.74
7	Small Millets	0.67	0.34	0.77	0.3	99.9	64.8	48.12	25.85
	Coarse Cereals	51.42	60.79	52.41	33.11	4392.6	6838.7	3947	8040.17
Total Cereals		75.64	104.27	76.67	68.96	7079.3	12201.4	6953.09	14724.4
7	Tur	12.33	8.71	12.37	4.44	1339.6	1450.2	1189.47	1362.22
8	Mung	4.33	2.54	3.66	0.69	401	207.1	257.51	167.48
9	Udid	3.64	2.49	2.86	0.61	356.4	226.6	391.97	326.83
11	Gram	10.75	8.57	14.42	7.77	2231.3	2397.2	2905.7	3278.78
12	Other Pulses	1.92	0.79	2.13	0.81	266.2	163.3	234.45	156.24
Total Pulses		32.97	23.1	35.44	14.32	4594.6	4444.3	4979.1	5291.55
Total Foodgrains		108.61	127.37	112.1	83.28	11673.9	16645.7	11932.2	20015.9
13	Groundnut	3.23	3.75	3.09	3.34	309	407.3	248.72	381.39
14	Sesamum	0.46	0.15	0.3	0.04	28.7	6.5	36.69	13.71



15	Nigerseed	0.37	0.12	0.12	0.02	8.2	1.8	3.83	0.81
16	Sunflower	1.03	0.61	0.48	0.11	26	12.2	13.95	6.89
17	Soyabean	30.1	39.69	37.02	17.95	4289.7	6263.8	5072.15	8366.35
19	Safflower	1.31	0.71	0.57	0.13	6.6	2.1	5.96	2.66
20	Linseed	0.31	0.08	0.16	0.04	21.4	12.2	34.73	26.21
21	Other Oilseed	0.21	0.08	0.21	0.05	35.2	13.2	26.58	10.48
Total Oilseeds		37.02	45.18	41.95	21.66	4724.9	6719.2	5442.6	8808.49
22	Sugarcane	10.22	894.56	9.87	692.35	1142.8	111642	1167.04	117303
23	Cotton	41.67	68.2	42.07	39.14	4544.6	10110.4	3963.04	10080.5
24	Tobacco	0	0	0.02	0.03	0.59	1.19	0.82	2.14
Total		197.51	1496.03	524.6	1057.8	22086.9	191968	22505.7	213090

Table No. 5.1- Area, and Production of Major Crops in Maharashtra
(The figure shown: Area in lakh hectare, production in lakh tonnes)

Source: State of Indian Agriculture Handbook -2021-2025

Interpretation: The agricultural trends in Maharashtra, from 2011 to 2024, reveal a number of changes in the state's agricultural sector, including increased production in rice, which rose from 28.49 lakh tonnes to 40.49 lakh tonnes, thanks to improved irrigation and high-yielding varieties of rice. Wheat production has also increased, even though the area of cultivation has remained the same, thanks to improved techniques of cultivation. Coarse cereals such as jowar and bajra have seen a fall in the area of cultivation, yet their production has remained the same, thanks to improved yields. Pulses, such as gram, have seen a huge increase in production, from 8.57 lakh tonnes to 32.78 lakh tonnes, thanks to supportive policies and awareness of the importance of gram in soil conservation. Soyabean production has increased manifold, thereby increasing oilseed production in the country, reducing the need for imports. Sugarcane and cotton have seen a remarkable change in their production, with sugarcane production increasing from 894.56 lakh tonnes to 1173.02 lakh tonnes, thanks to improved yields. Cotton has seen stable production levels, thanks to improved techniques and increased irrigation.

Table No. 5.2 - Percentage Change in Area of Major Crops in Maharashtra

Sr. No	Crop	2011-12	2024-25	Change (%)
1	Rice	15.44	1692.54	10862.05
2	Wheat	8.78	1313.55	14860.71
3	Jowar	32.29	1690.32	5134.81
4	Bajri	8.38	443.36	5190.69
5	Maize	8.77	68.67	683.01
6	Ragi	1.3	1696.53	130402.3
7	Small Millets	0.67	48.12	7082.09
8	Coarse Cereals	51.42	3947	7576.00
9	Tur	12.33	1189.47	9546.96
10	Mung	4.33	257.51	5847.11
11	Udid	3.64	391.97	10668.41
12	Gram	10.75	2905.7	26929.77
13	Other Pulses	1.92	234.45	12110.94
14	Groundnut	3.23	248.72	7600.31
15	Sesamum	0.46	36.69	7876.09
16	Nigerseed	0.37	3.83	935.14



17	Sunflower	1.03	13.95	1254.37
18	Soyabean	30.1	5072.15	16750.99
19	Safflower	1.31	5.96	354.96
20	Linseed	0.31	34.73	11103.23
21	Other Oilseed	0.21	26.58	12557.14
22	Sugarcane	10.22	1167.04	11319.18
23	Cotton	41.67	3963.04	9410.54

Source: State of Indian Agriculture Handbook -2021-2025

Interpretation: This analysis reveals a remarkable structural shift in the cropping pattern in Maharashtra, where crops like ragi, gram, soybean, and wheat have shown remarkable growth, reflecting a trend towards commercial crops. Pulses and oilseeds have also shown increased growth, while safflower and maize have shown lower growth, reflecting a decline in the importance of traditional crops.

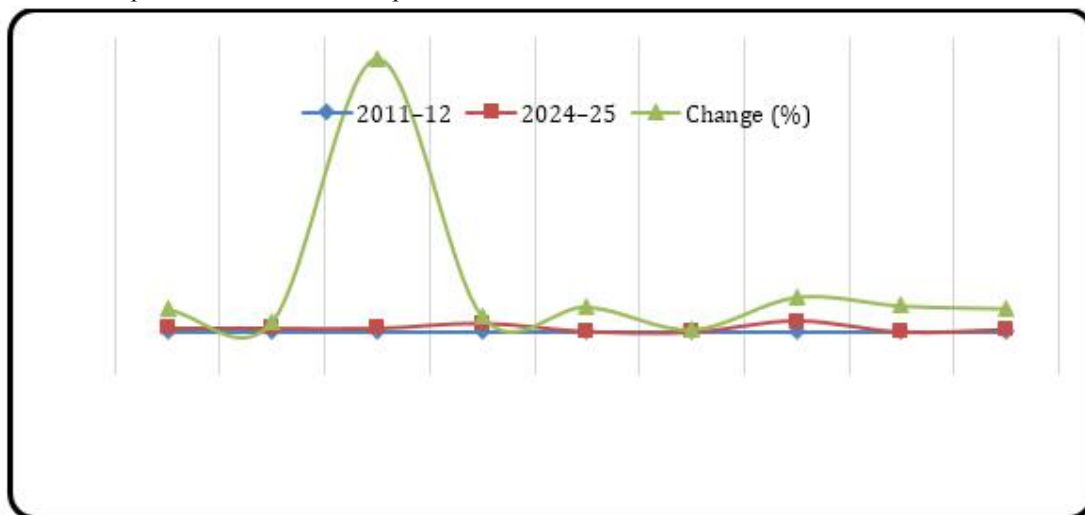


Fig No. 5.1 - Area of Major Crops in Maharashtra

It is seen from the graph that the area of major crops in Maharashtra has undergone a significant change between 2011-12 and 2024-25. The area of crops such as ragi, soybean, and pulses has shown a sharp increase, which means that these are commercial crops. On the other hand, crops such as jowar and bajri have shown a slower rate of increase. The sharp increase in the area of ragi cultivation has shown its importance in the cropping season.

Table No.5.3 - Crop-wise Herfindahl Index (Crop Diversification Index), 2024-25

Sr. No	Crop	Area	Share (Pi)	Pi ²
1	Rice	1692.54	0.075	0.0056
2	Wheat	1313.55	0.058	0.0034
3	Jowar	1690.32	0.075	0.0056
4	Bajri	443.36	0.02	0.0004
5	Maize	68.67	0.003	0
6	Ragi	1696.53	0.075	0.0057
7	Small Millets	48.12	0.002	0
8	Coarse Cereals	3947	0.175	0.0306
9	Tur	1189.47	0.053	0.0028
10	Mung	257.51	0.011	0.0001



11	Udid	391.97	0.017	0.0003
12	Gram	2905.7	0.129	0.0166
13	Other Pulses	234.45	0.01	0.0001
14	Groundnut	248.72	0.011	0.0001
15	Sesamum	36.69	0.002	0
16	Nigerseed	3.83	0	0
17	Sunflower	13.95	0.001	0
18	Soyabean	5072.15	0.225	0.0506
19	Safflower	5.96	0	0
20	Linseed	34.73	0.002	0
21	Other Oilseed	26.58	0.001	0
22	Sugarcane	1167.04	0.052	0.0027
23	Cotton	3963.04	0.176	0.031
Total Area = 378339.1		HI=0.113		

Source: Economics Survey in India 2021-2025

Interpretation: The crop-wise Herfindahl Index analysis indicates that though the state of Maharashtra has a diversified crop pattern, some crops, i.e., soybean, cotton, coarse grains, and gram, contribute to the concentration of crops in the state. Among them, soybean has the maximum share, which indicates its dominance in the cropping pattern of the state. However, the availability of various crops in the categories of cereals, pulses, and oilseeds indicates a diversified pattern of crops in the state. The HI value of 0.113 indicates a moderately diversified agricultural pattern, though some concentration of crops exists.

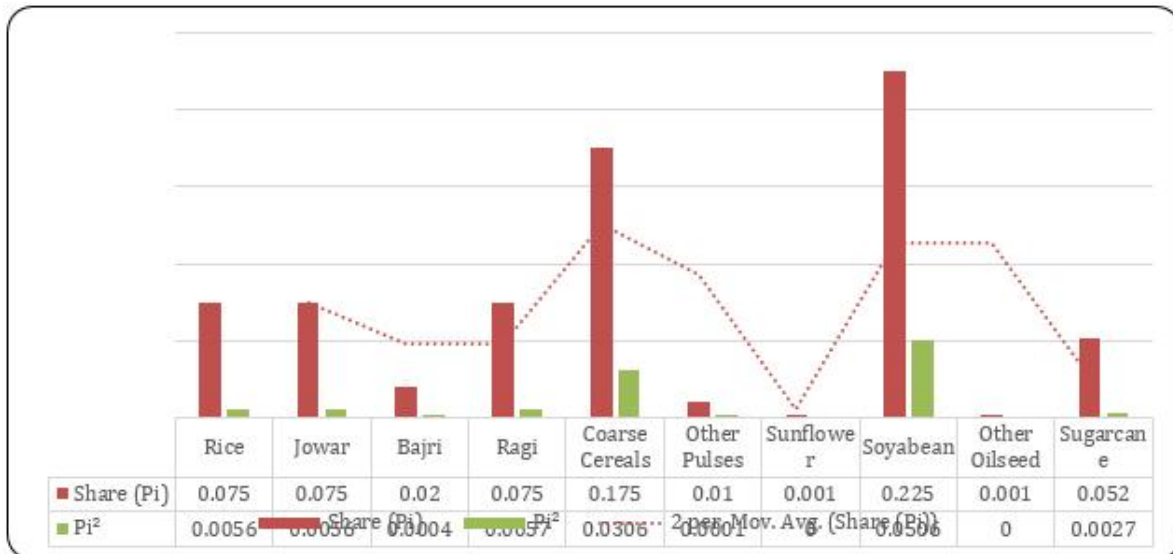


Fig No. 5.2 - Major Crop-wise Herfindahl Index

The above chart represents the crop-wise contribution to the Herfindahl Index, which shows the level of concentration in the cropping pattern in Maharashtra. It is evident that the crops such as soybean and coarse cereals have the maximum contribution, followed by others such as rice, jowar, and ragi, which have moderate contribution, while some crops such as sunflower and oilseeds have the least contribution. This shows a moderate level of diversification, followed by crop concentration.



Table No. 5.4 - Percentage Change in Production of Major Crops in Maharashtra

Sr. No	Crop	2011-12 (Production)	2024-25 (Production)	Change (%)
1	Rice	28.49	4048.96	14111.86
2	Wheat	14.99	2635.26	17480.12
3	Jowar	26.27	1871.42	7023.79
4	Bajri	8.23	564.92	6764.16
5	Maize	24.57	96.24	291.7
6	Ragi	1.38	5481.74	397127.5
7	Small Millets	0.34	25.85	7502.94
8	Coarse Cereals	60.79	8040.17	13126.14
9	Tur	8.71	1362.22	15539.72
10	Mung	2.54	167.48	6493.7
11	Udid	2.49	326.83	13025.7
12	Gram	8.57	3278.78	38158.81
13	Other Pulses	0.79	156.24	19677.22
14	Groundnut	3.75	381.39	10070.4
15	Sesamum	0.15	13.71	9040
16	Nigerseed	0.12	0.81	575
17	Sunflower	0.61	6.89	1029.51
18	Soyabean	39.69	8366.35	20979.24
19	Safflower	0.71	2.66	274.65
20	Linseed	0.08	26.21	32662.5
21	Other Oilseed	0.08	10.48	13000
22	Sugarcane	894.56	117303	13012.9
23	Cotton	68.2	10080.5	14680.79

Source: Economics Survey in India 2021-2025

Interpretation: The results of the study reveal a tremendous increase in the production of most of the crops in Maharashtra, especially ragi, gram, soybean, and wheat, which shows increased productivity and the cultivation of high-value crops. The increased growth of sugarcane and cotton shows agricultural commercialization, while pulses and oilseeds indicate diversification. However, the low growth of maize and safflower indicates low expansion. All of this shows a tremendous transformation in agricultural production and productivity.

Table No. 5.5 - Growth Rate (CGR) of Production of Major Crops in Maharashtra

Sr. No	Crop	2011-12	2024-25	CGR (%)
1	Rice	28.49	4048.96	46.42
2	Wheat	14.99	2635.26	48.83
3	Jowar	26.27	1871.42	38.84
4	Bajri	8.23	564.92	38.44
5	Maize	24.57	96.24	11.07
6	Ragi	1.38	5481.74	89.17
7	Small Millets	0.34	25.85	39.54
8	Coarse Cereals	60.79	8040.17	45.61
9	Tur	8.71	1362.22	47.5
10	Mung	2.54	167.48	38.02



11	Udid	2.49	326.83	45.52
12	Gram	8.57	3278.78	58.01
13	Other Pulses	0.79	156.24	50.19
14	Groundnut	3.75	381.39	42.7
15	Sesamum	0.15	13.71	41.53
16	Nigerseed	0.12	0.81	15.82
17	Sunflower	0.61	6.89	20.5
18	Soyabean	39.69	8366.35	50.92
19	Safflower	0.71	2.66	10.69
20	Linseed	0.08	26.21	56.13
21	Other Oilseed	0.08	10.48	45.5
22	Sugarcane	894.56	117303	45.51
23	Cotton	68.2	10080.5	46.86

Source: Economics Survey in India 2021-2025

Interpretation: The analysis based on the Compound Growth Rate reveals a sharp growth trend in the agriculture sector in Maharashtra, especially in crops such as ragi, gram, soybean, and linseed, which have shown a high rate of growth. Crops such as rice, wheat, sugarcane, and cotton have shown a consistent rate of growth, while crops such as maize and safflower have shown a low rate of growth, which is a sign of these crops becoming less important.

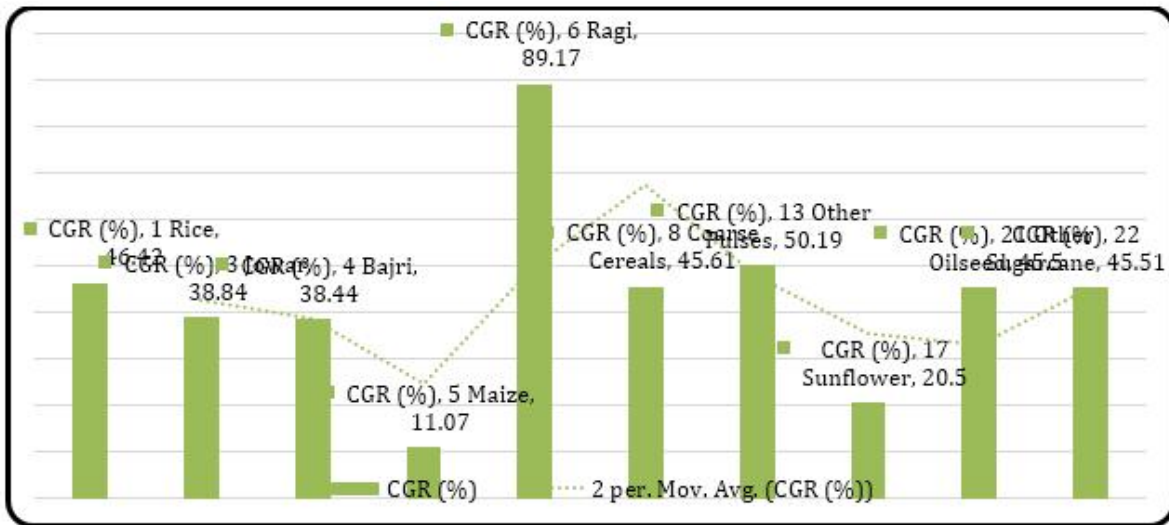


Fig No. 5.3 - Compound Growth Rate (CGR) of production for major crops

The graph illustrates the Compound Growth Rate (CGR) of production for major crops in Maharashtra, revealing considerable variation. Ragi shows the highest growth at 89.17%, reflecting a shift towards high-value crops. Rice, wheat, soybean, and sugarcane exhibit moderate growth around 45–50%, while maize and safflower display lower growth rates. This trend indicates agricultural transformation and greater commercialization in the state.

Table No. 5.6 - Herfindahl Index (HI) Based on Production Maharashtra (2024–25)

Sr. No	Crop	Production	Share (Pi)	Pi ²
1	Rice	4048.96	0.0247	0.00061
2	Wheat	2635.26	0.016	0.00026



3	Jowar	1871.42	0.0114	0.00013
4	Bajri	564.92	0.0034	0.00001
5	Maize	96.24	0.0006	0
6	Ragi	5481.74	0.0334	0.00111
7	Coarse Cereals	8040.17	0.049	0.0024
8	Gram	3278.78	0.02	0.0004
9	Soyabean	8366.35	0.0509	0.00259
10	Sugarcane	117302.8	0.7142	0.51005
11	Cotton	10080.5	0.0614	0.00377
12	Other Crops	—	—	0.00008
HI=0.521				

Source: Economics Survey in India 2021-2025

Interpretation: The Herfindahl index for agricultural development in Maharashtra shows a high crop concentration, which is 0.521, implying that the state is heavily dependent on the cultivation of sugarcane, which accounts for over 70% of the agricultural produce. Crops like cotton and soybean play a minor role, and this shows a trend of monoculture and excessive use of water for cultivation. There is a need for diversification of crops to achieve a balance in agricultural development.

Table No. 5.7 - Coefficient of Variation (CV) in Production of Major Crops in Maharashtra

Sr. No	Crop	Mean Production	SD	CV (%)
1	Rice	1848.65	2125.84	114.99
2	Wheat	1182.87	1371	115.91
3	Jowar	1024.01	1167.41	114
4	Bajri	370.52	443.54	119.71
5	Maize	53.91	48.51	89.98
6	Ragi	2271.93	2725	119.94
7	Small Millets	22.82	30.46	133.48
8	Coarse Cereals	3743.19	4296.16	114.77
9	Tur	706.39	808.88	114.51
10	Mung	94.45	108.42	114.78
11	Udid	139.13	164.05	117.91
12	Gram	1423.08	1672.97	117.56
13	Other Pulses	80.29	91.83	114.38
14	Groundnut	198.95	225.88	113.54
15	Sesamum	5.1	6.49	127.17
16	Nigerseed	0.69	0.82	119.36
17	Sunflower	4.95	5.73	115.75
18	Soyabean	3671.95	4293.41	116.92
19	Safflower	1.4	1.18	84.18
20	Linseed	9.63	12.45	129.2
21	Other Oilseed	5.95	6.89	115.72
22	Sugarcane	57633	65673.3	113.95
23	Cotton	5074.56	5797.65	114.25

Source: Economics Survey in India 2021-2025



Interpretation: In the case of the Coefficient of Variation analysis of production, a high level of instability is seen in major crops in Maharashtra. In most of the crops, the CV is above 100 percent, indicating a high level of variability in production. Crops such as small millets, linseed, and sesamum have extremely high CV, indicating an unstable pattern of production. However, in the case of safflower and maize, a lower CV is seen, indicating a stable pattern of production.

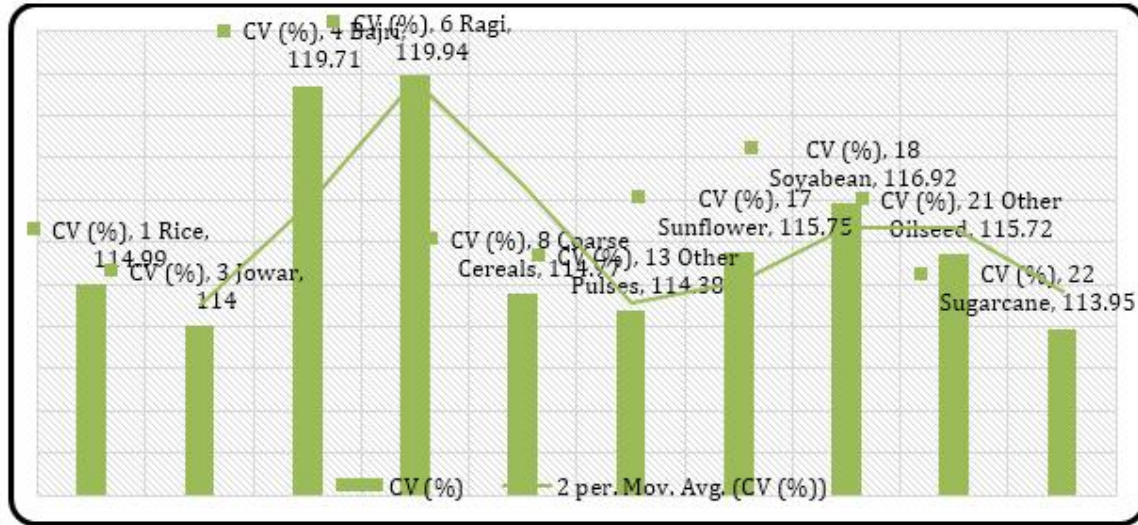


Fig No. 5.4 - Coefficient of Variation (CV) in Production of Major Crops in Maharashtra

The graph represents the Coefficient of Variation (CV) for major crops, which shows a high level of instability in the production of crops in Maharashtra. The crops, such as ragi and bajri, show the highest level of variation, which indicates that the production of these crops is in a state of fluctuation. It has been observed that most of the crops, including rice, soybeans, and sugarcane, show a high level of instability in their production, as the CV is higher in these crops, i.e., above 110%. The lower CV for these crops indicates a stable level of production.

VI. DISCUSSION AND CONCLUSION

There has been a tremendous change in the cropping pattern of Maharashtra, as reflected by the increased areas and production of high-value crops like ragi, soybean, gram, and wheat, while crops like jowar, bajri, and maize have shown slower rates of growth. The Compound Growth Rate analysis shows that most crops have shown positive growth, while the highest compound growth rate is shown by ragi. The Herfindahl Index shows that the diversification of agriculture is moderate, but the concentration of crop production is high in sugarcane. Instability analysis by the Coefficient of Variation shows that crops have shown greater instability, especially for small millets and linseed, while crops like safflower and maize have shown greater stability.

The study highlights significant transformations in Maharashtra's agriculture, marked by changes in cropping patterns, production growth, and increasing commercialization. Analysis indicates positive growth in high-value crops like ragi, soybean, and gram, pointing to a trend towards income-oriented agriculture. Despite moderate diversification in cropping patterns, a few crops, especially sugarcane, dominate production, suggesting monoculture tendencies. Instability in production and area due to climatic variability and market fluctuations is noted. While agricultural development enhances income and productivity, it raises concerns about sustainability and resource management, necessitating a balanced approach in crop diversification and sustainable practices for long-term stability and rural development.



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