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SPATIO – TEMPORAL PERSPECTIVE OF CROPPING PATTERN CHANGES IN SOLAPUR DISTRICT

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ABSTRACT

Agriculture plays a vital role in rural livelihoods, food security and economic development. The agricultural pattern reflects the spatio-temporal distribution of crops and Crop Combination. It denotes the crop combination of increase and decrease trend in cerels, pulses, oilseeds and Cash Crops. For the crop combination of major crops are denoted by using weaver's crop combination method. This method is used to measure the dominance and diversity of cropping Patterns. The research paper attempted to examine temporal changes in cropping patterns from 2009 to 2021. This study is based on secondary data received from the Agriculture and Irrigation Department of Solapur District (2009-2021), which is analyzed using growth rate calculation, trend analysis and Weaver classification method. The results show a sharp decline in cereals, which fell from 68.4 percent of the total crop area in 2009 to only 10.0 percent in 2021, representing a total decline of 88 percent. In contrast, the production of pulses increased steadily from 5.3 percent in 2009 to 19.0 percent in 2021, leading to strong and consistent growth. Oilseeds showed fluctuations but increased from 3.2 percent in 2009 to 8.3 percent in 2021, indicating a long-term growth. The most significant change was in cash crops, which increased from 23.1 percent in 2009 to 62.7 percent in 2021, indicating a remarkable growth due to irrigation development, market demand and agro-industrial support. The crop mix analysis further shows that while cereals dominated in 2009 and 2011, in 2016 there was a dual dominance of cereals and cash crops, by 2021, only cash crops emerged as the dominant category. Overall, Solapur's agricultural sector has shifted from cereal-based subsistence farming to commercial, irrigation-driven cash cropping systems. This transformation has increased farmer incomes and strengthened agro-industrial linkages, but it has also reduced crop diversity and increased dependence on water-intensive crops, raising concerns about sustainability and food security.

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INTRODUCTION

Agriculture has been the bedrock of India's economy and society, shaping the livelihoods, culture and food security of millions of people. It not only provides employment to a large segment of the rural population but also supports agro-based industries and contributes significantly to the national income. Within this broader framework, the concept of agricultural system plays a key role. For the socio-economic development of any region. It refers to the arrangement and distribution of different crops in a given region over time, which is influenced by natural conditions such as soil, rainfall, temperature and irrigation as well as socio-economic factors such as market demand, government policies and technological developments. Over the past few decades, Indian agriculture has undergone a major transformation. In earlier days which regions were only depended on subsistence agriculture and depended on rain-fed agriculture, are now moving towards irrigated, commercial and high-value crop production. This change has brought new opportunities such as higher productivity, increased income and better integration with agro-industry. At the same time, it has also brought new challenges including water scarcity, soil degradation and decline of traditional food crops. Solapur district in Maharashtra presents a striking example of these transformations. Traditionally known for its drought-prone conditions and the dominance of food grains such as jowar and bajra, the district has undergone significant agricultural transformations in recent years. With the development of irrigation facilities has given the emergence of sugar mills, the cotton ginning industry, oil mills and the growing market for horticultural crops such as grapes, pomegranates, and vegetables have all contributed to a restructured agricultural system. Most of the farmers are shifting from single-crop subsistence farming to multi-crop and commercial farming practices. This transformation is not only economic but also geographical in nature. Changes in land use, crop choices, and cropping intensities reflect a profound process of adaptation to environmental constraints and new opportunities. Therefore, the study of agricultural practices and crop combinations in Solapur district provides valuable insights into how rural areas evolve under the combined influence of irrigation, technology, market forces, and policy interventions.

IMPORTANCE OF THE STUDY

Solapur district's agriculture is undergoing structural transformation due to irrigation expansion, changing market demands, climate change, and government intervention. Once traditionally dependent on food grains, the district is now shifting to market-driven and high-value crops such as sugarcane, cotton, grapes, chillies, and horticultural produce. This shift has important implications for food security, water sustainability, and rural livelihoods. Analyzing the temporal changes in farming practices from 2009 to 2021 is essential to understand how farmers are adapting to new opportunities and risks. The sharp decline in cereals highlights challenges in food availability, while the expansion of cash crops suchas sugarcane, oil seeds, vegitables and fruits. It reflects on economic growth but also raises sustainability concerns due to their high

water demands. At the same time, pulses and oilseeds are gaining importance due to their resilience, soil-enriching qualities, and strong market demand. Additionally, innovative multi-cropping models are encouraging diversification, ensuring stable income and ecological balance. Thus, such a study is important for the understanding the economic geography of agriculture in Solapur, as it reveals how farmers balance profitability, resource management and sustainability.

STUDY AREA

Solapur district is located in the state of Maharashtra. It lies between 17°10' North and 18°32' North latitude and 74°42' East and 76°15' East longitude. It covers an area of about 14,895 sq km. The district has 11 talukas: Solapur North, Solapur South, Akkalkot, Barshi, Karmala, Madha, Malshiras, Mohol, Pandharpur, Sangola and Mangalwedha. The land of Solapur is mainly part of the Deccan Plateau. The surface is mostly flat or gently sloping plains, with some low hills and elevations. The Bhima River is the main river and its tributaries such as the Sina, Maan and Bhogwati also flow through the district. The construction of the Ujani on Bhima river dam has brought about a major change in agriculture. Its left and right canal systems (about 120 km each) provide irrigation to a large area. In addition, seepage ponds, dams and catchment projects helps in storing water and increasing groundwater level. The climate of Solapur is semi-arid, meaning hot and dry with low and irregular rainfall (550-750 mm) per year. The soil here is predominantly black cotton soil (regur), which holds water well and is good for crops such as cotton, sugarcane and cereals. In some places, there is also red soil, which supports pulses and oilseeds. Traditionally, Rabi Jowar was the main crop of Solapur. But after irrigation became available, farmers started cultivating many other crops such as sugarcane, cotton, grapes, chillies and vegetables. Today, Solapur has become a region of multi-crop and commercial farming, where both traditional crops and modern cash crops are grown.

OBJECTIVES:

The main objective are to analyze the temporal changes in agricultural land use in Solapur district between 2009 and 2021 and to assess changes in cropping patterns using the crop combination method.

DATA SOURCES AND RESEARCH METHODOLOGY:

To achieve the main objective of analyzing the temporal changes in agricultural land use in Solapur district (2009-2021) and assessing the changes in cropping patterns using Weaver's cropping pattern method, this study is mainly based on secondary data. The required information has been collected from the Agricultural Census Report, District Statistical Summary, Irrigation Department records and collected research data (2009-2021). These sources provide consistent data on land use and crop distribution. The analysis is based on different techniques. Statistical methods such as growth rate, percentage change and annual average growth were used to study the expansion and decline of crops. Weaver's cropping pattern was used to identify effective cropping patterns. It uses the formula:

$$D = \sqrt{\left(X - \frac{100}{N}\right)^2}$$

Where, D is Deviation, X is Percentage of individual crop area, n is Number of crops considered. The region with the lowest deviation represents the dominant crop combination. In addition, a comparative temporal analysis was conducted to examine the changes between 2009, 2011, 2016 and 2021. The results were presented through tables, charts and maps for clear understanding.

CHANGE IN AGRICULTURAL PATTERN

The agricultural practices of Solapur district show a clear change in land use and crop preferences between 2009 and 2021. The total area under cultivation has decreased from 11,74,221 hectares in 2009 to 9,97,889 hectares in 2021, reflecting the combined effects of soil fertility, migration, water scarcity, and changing farmer choices. The most notable change is shown the sharp decline in the production of cereals, which once dominated but have now lost their importance due to low yields, high risk, and low market returns. In contrast, pulses have gained steady importance, as they are more resilient to dry conditions, improve soil fertility, and command better market prices. Oilseeds show a mixed trend, with occasional setbacks but also a revival with supportive policies and demand. Most important things happens during this period, cash crops have expanded strongly due to irrigation through the canals of the Ujani Dam, better price guarantees, and the growth of agro-industries in the district.

Table No. 1

AGRICULTURAL PATTERN CHANGE : SOLAPUR DISTRICT (In %)

(2009, 2011, 2016, 2021 YEAR)

Sr. No.	Land Use Category	2009	2011	2009-2011 Growth Rate	2016	2021	2016-2021 Growth Rate	Total Average Annual Growth Rate
1	Cereals	68.4	73.88	-3.55	48.32	-79.62	10.05	-15.9
2	Pulses	5.27	6.69	13.45	7.87	136.73	19.02	9.8
3	Oilseeds	3.23	5.36	48.28	0.8	911.66	8.29	6.7
4	Cash Crops	23.1	14.06	-45.64	43.01	42.74	62.65	7.2
Total in Ha.		1174221	1048596	-10.7	1018324	-2.89	997889	-1.6

Source: Compiled by researcher, 2025 using District Socio-Economic Data, 2009, 2011, 2016, 2021

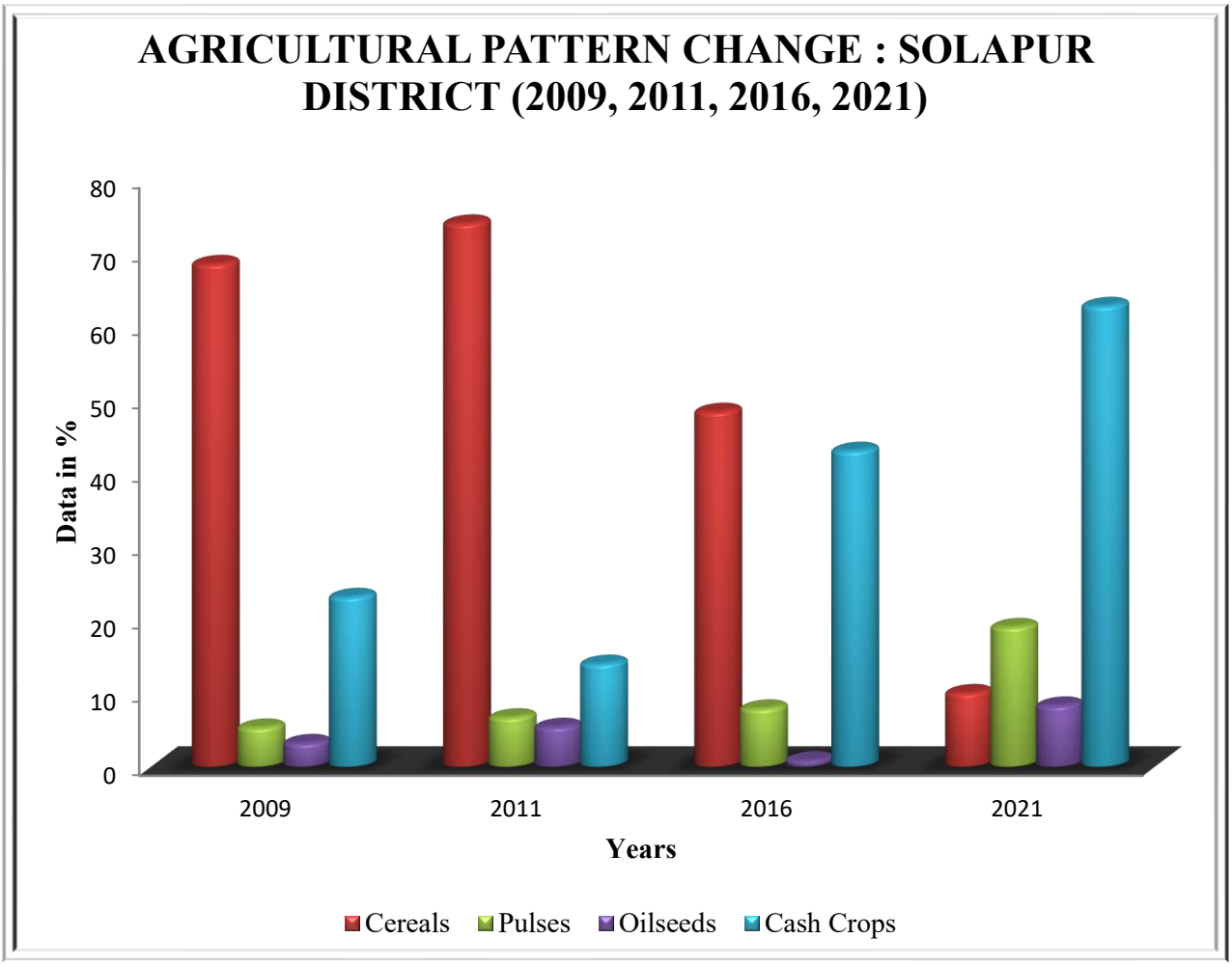

Fig. No. 2

The overall analysis of Table No. 1 and fig.no.2 shows that agricultural pattern change in Solapur district during 2009, 2011, 2016, 2021 year.

In case of the High Growth, The area under pulses increased from 5.27 percent (61,857 ha) in 2009 to 6.69 percent (70,174 ha) in 2011, a further 7.87 percent (80,158 ha) in 2016 and finally to 19.02 percent (1,89,755 ha) in 2021. Pulses recorded the highest average annual growth rate of +9.8 percent indicating a consistent and strong growth trend. Several reasons explain this growth: Pulses require less water and are well-suited to the semi-arid conditions of Solapur; they improve soil fertility through nitrogen fixation, reducing fertilizer costs; increasing demand for protein-rich food ensures better market prices; government support through schemes like the National Food Security Mission (NFSM) has boosted adoption; And their short cropping cycles help farmers mitigate both weather and market risks.

In case of the Moderate growth, Cash crops accounted for 23.1 percent of the total area (2,71,232 ha) in 2009, declined to 14.06 percent in 2011 (1,47,451 ha), then increased rapidly to 43.01 percent (4,37,977 ha) in 2016 and a further 62.65 percent (6,25,181 ha) in 2021. With an average annual growth rate of +7.2 percent, cash crops show a strong structural shift towards commercialization. This growth has been driven by the expansion of Ujani dam irrigation canals,

which enabled the cultivation of water-demanding crops like sugarcane; strong agro-industrial linkages such as sugar mills and cotton ginning units, which ensured market security; Higher net income compared to cereals which encouraged farmers to switch; easy availability of inputs like seeds, fertilizers and credit; and policy support like minimum support price for cotton and assured price for sugarcane.

On the other hand, oilseeds covered 3.23 percent in 2009 (37,933 hectares), increased to 5.36 percent in 2011 (56,248 hectares), then declined to 0.80 percent in 2016 (8,173 hectares), but recovered strongly to 8.29 percent in 2021 (82,683 hectares). Despite the fluctuations, oilseeds maintained a median annual growth rate of +6.7 percent. The reasons for this trend are strong demand for self-sufficiency in edible oil, which encouraged farmers; adoption of improved seed varieties and good agricultural practices supporting recovery; a major decline in 2016 due to rain failure and market volatility; and later a revival due to price support and government procurement policies, which boosted farmers' confidence.

In case of the Low growth, Cereals dominated with 68.4 percent (8,03,199 ha) in 2009, reached 73.88 percent (7,74,723 ha) in 2011, then declined to 48.32 percent (4,92,016 ha) in 2016 and finally declined to just 10.05 percent (1,00,270 ha) in 2021. This represents an average annual decline of -15.9 percent, making cereals the most severely affected crop category in Solapur district. The reasons for this decline are multiple: Cereal farming is heavily dependent on rainfall, making it highly risky compared to irrigated alternatives; low market returns discouraged farmers from continuing traditional cereal cultivation; increasing input costs and pest/disease stress reduced profitability; Land was reallocated to more profitable crops such as sugarcane, cotton, and horticulture; and urbanisation and land conversion further reduced the area under grain cultivation.

CROP COMBINATION

Crop combination is a vital concept in agricultural geography as it explains the distribution, dominance, and diversification of crops within a region, reflecting the interplay of natural factors like rainfall, soil, and irrigation with socio-economic forces such as market demand, subsidies, and cultural practices. In Solapur district, a drought-prone semi-arid zone of Maharashtra, the period from 2009 to 2021 shows a remarkable agricultural transformation. Using J. C. Weaver's Standard Deviation Method (1954)—where crop areas (cereals, pulses, oilseeds, cash crops) were first converted into percentages, their deviations from the mean calculated, squared, and summed, and the least deviation used to identify the dominant type—the district's crop combination was systematically analyzed. In 2009 and 2011, the district was cereal-dominated, reflecting subsistence-oriented farming. By 2016, the pattern shifted to a dual combination of cereals and cash crops, indicating the growing role of commercial farming. Finally,

in 2021, cash crops became the dominant type, with cereals reduced to a minor share. This progression highlights Solapur's movement from traditional cereal-based agriculture towards a more commercialized cash crop economy influenced by irrigation development and market pressures..

Table No. 2

SOLAPUR DISTRICT : CROP COMBINATION (2009–2021) (in percent)

Year	Cereals (%)	Pulses (%)	Oilseeds (%)	Cash Crops (%)	Deviation Sum	Crop Combination Type
2009	68.4	5.3	3.2	23.1	2750.68	Single Crop Dominated (Cereals)
2011	73.9	6.7	5.4	14.0	3229.83	Single Crop Dominated (Cereals)
2016	48.3	7.9	0.8	43.0	1746.89	Dual Crop Dominated (Cereals + Cash Crops)
2021	10.0	19.0	8.3	62.7	1956.28	Single Crop Dominated (Cash Crops)

Source: Compiled by researcher, 2025

In 2009, cereals accounted for 68.4% of the total crop area, while pulses accounted for 5.3 percent, oilseeds for 3.2 percent, and cash crops for 23.1percent. This pattern reflects a strong reliance on food grain cultivation, which is mainly due to the dependence on rainfed agriculture and the subsistence needs of farming households. The dominance of cereals reflects traditional agricultural practices, where irrigation facilities were limited and farmers preferred risk-reducing alternatives. Although cash crops covered almost a quarter of the crop area, their share was not sufficient to replace the combination type. The overall crop composition of this year reflects the monoculture trend, ensuring food security but exposing the system to soil nutrient depletion and stagnation in farm income.

By 2011, cereals had further consolidated their dominance with a share of 73.9 percent of the crop area. Pulses (6.7%) and oilseeds (5.4%) showed a slight improvement, while cash crops declined to 14.0 percent. The crop mix remained cereal-dominated, confirming the persistence of subsistence farming. Farmers' choices were influenced by the familiarity of cereal production, consumption needs and relatively stable markets. However, this lack of diversity presents vulnerabilities: the high concentration in cereals limited opportunities for crop rotation, weakened soil fertility management and created less resilience against climate stresses.

A major structural shift occurred in 2016. Cereals declined sharply to 48.3 percent of the total crop area, while cash crops increased to 43.0 percent. Cereals improved to 7.9 percent, but oilseeds declined only to 0.8 percent. With the lowest deviation of 1746.89, this year saw a dual

crop dominance of cereals and cash crops. The expansion of irrigation through wells, canals and micro-irrigation systems, along with growing market demand for commercial crops such as sugarcane and cotton, were the major drivers of this change. The move towards commercial farming significantly improved farm incomes, yet it also led to increased water requirements and volatile markets.

By 2021, there had been a decisive transition towards cash crop dominance in Solapur district. Cash crops increased to 62.7 percent of the crop area, while cereals declined to just 10.0 percent. Pulses increased significantly to 19.0 percent, reflecting their role in government incentives and crop rotation, while oilseeds increased modestly to 8.3 percent. This pattern represents a complete reversal of the earlier cereal-dominated structure, which reflected the influence of profit, procurement systems, subsidies and drought-resistant crop preferences. While cash crops now serve as the backbone of the district's agriculture, the dominance of a single business group creates sustainability concerns such as soil exhaustion, water scarcity, and vulnerability to market price fluctuations.

CONCLUSION

The temporal analysis of agricultural practices and crop combinations in Solapur district (2009–2021) clearly shows that the district has shifted from a traditional cereal-dominated subsistence farming system to a cash crop-based commercial economy. Once occupying nearly 70% of the area, cereals have declined to only 10%, while pulses have steadily increased due to their drought resistance, soil-enriching capacity, and government support schemes. Oilseeds showed fluctuations but eventually revived, increasing their market importance. The most significant change is the rapid expansion of cash crops, which covered 23 percent of the area in 2009 and reached about 63 percent in 2021, made possible by irrigation from the Ujani Dam, agro-industrial linkages, and profitability. According to Weaver's method, in 2009 and 2011 the district showed a cereal-dominated single crop combination, in 2016 a dual crop combination of cereals + cash crops, and in 2021 a complete cash crop-dominated combination. These changes increased farmer incomes and strengthened rural–industrial linkages, but also raised serious challenges such as declining soil fertility, water scarcity, reduction in food grains, and market instability. Therefore, the future of agriculture in Solapur requires balanced diversification, where cereals, pulses, oilseeds, and cash crops are integrated in a sustainable manner so that both livelihoods and food security can be preserved.

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