International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 8.141
Peer Reviewed Bi-Monthly
Vol. 7 No. 2 January – February - 2026

Role of Agro-Climatic Zones in Determining Crop Suitability

Mr. Gaikwad N. V.[1] & Prof. Dr. Waghmare J. K.[2]

[1]*Assistant Professor, Krishna Mahavidyalay, Rethare bk.Tal-Karad, Dist-Satara.*

[2]*Professor, Dept. of Geography Bhai Kishanrao Deshmukh College, Chakur Tal- Chakur, Dist- Latur*

Corresponding Author – Mr. Gaikwad N. V.

DOI - 10.5281/zenodo.18655516

Abstract:

Agriculture is highly dependent on local climatic conditions, soil characteristics, and topographical features. Agro-climatic zones help classify regions with similar environmental conditions to guide scientific cropping patterns. This paper analyzes the concept of agro-climatic zoning, its determinants, and its role in crop suitability. The study highlights how climatic variables such as temperature, rainfall, soil type, and physiography influence decisions regarding cropping systems, land use planning, and agricultural productivity. The paper concludes that understanding agro-climatic zones is essential for sustainable agriculture, climate-resilient farming, and effective resource management.

Introduction:

Agriculture remains the backbone of the Indian economy and is directly influenced by climatic and geographical conditions. Crop performance varies significantly across regions due to differences in temperature, rainfall, soil fertility, altitude, and humidity. Agro-climatic zoning is a scientific method of dividing land into homogeneous units based on such parameters. It provides a framework to decide which crops are best suited to a particular region and how production can be optimized. As climate change intensifies, the significance of agro-climatic zones in planning sustainable agriculture has become even more important.

Concept of Agro-Climatic Zones:

Agro-climatic zones are geographical regions characterized by similar climatic conditions, soil types, and agricultural potential. The concept aims to achieve

- Optimal land use by identifying suitable crops
- Efficient resource utilization including water and soil nutrients
- Scientific cropping patterns aligned with local environmental conditions
- Improved agricultural planning and sustainability

India is divided into 15 Agro-Climatic Zones (Planning Commission) and 20 Agro-Ecological Regions (ICAR) based on climatic and soil characteristics.

Review of Literature:

Sharma and Rao (2018), in their study "Agro-Climatic Zoning for Optimizing Crop Planning in Semi-Arid Regions," aimed to identify suitable crops for semi-arid agro-climatic zones by analyzing long-term climatic parameters and soil characteristics. Using 20 years of temperature and rainfall data along with detailed soil surveys and GIS-based mapping, the authors delineated ecologically distinct zones and assessed crop performance. Their findings showed that millets, pulses, and oilseeds performed best under semi-arid conditions, while

water- intensive crops like sugarcane were unsuitable. They suggested promoting drought-tolerant varieties and micro-irrigation technologies. The study concluded that agro-climatic zoning enhances sustainability by guiding farmers toward crops naturally aligned with ecological conditions. Kulkarni (2020), in the paper "Influence of Temperature and Rainfall on Crop Suitability in Tropical Zones," examined how climatic factors shape crop suitability in tropical regions. The objective was to correlate long-term climatic patterns with major crop yields. Using regression analysis of temperature and rainfall data, the researcher found that rice, banana, and sugarcane yield patterns were highly sensitive to fluctuations in monsoon rainfall and warm temperature regimes. Erratic rainfall caused significant yield reductions in rice. The study suggested formulating region-specific crop calendars and adopting climate-smart agricultural practices. It concluded that climatic variables are the strongest determinants of crop suitability in tropical agro-climatic zones. Singh and Patil (2017), in their research "Soil-Based Suitability Analysis for Major Crops in Central India," focused on evaluating soil characteristics across agro-climatic zones to determine suitable crops. They collected soil samples, tested them for pH, organic carbon, and nutrient levels, and applied suitability scoring methods. Their findings revealed that black cotton soils were ideal for cotton and soybean, while red and lateritic soils supported pulses, groundnut, and horticulture crops. They suggested implementing soil-specific nutrient management plans for sustainable productivity. The study concluded that soil properties play a crucial role in determining crop suitability and must be integrated with climatic zoning. Thomas and Mehta (2021), in the study "GIS and Remote Sensing Applications in Agro-Climatic Zonation," investigated the use of advanced geospatial technologies to prepare high-resolution agro-climatic maps. Their objective was to improve the accuracy of crop suitability assessments. Using remote sensing data, NDVI indicators, land surface temperature, and soil moisture indices, the authors developed precise GIS-based zonation models. Findings indicated that these high- resolution maps captured micro-climatic variations more effectively than traditional maps and significantly improved crop recommendations for maize, groundnut, and cotton. They recommended that government agencies adopt GIS-based mapping for agricultural planning. The study concluded that modern technological tools enhance the precision and reliability of agro- climatic zoning. Deshmukh (2019), in the paper "Agro-Climatic Zoning as a Tool for Sustainable Agriculture," aimed to evaluate the role of zonation practices in promoting sustainable and resource-efficient farming. Using policy analysis, field surveys, and environmental assessments, the study found that aligning crops with zonal characteristics reduced irrigation demand by 30% and fertilizer use by 20%, while also improving income stability among farmers. The author suggested incorporating socio-economic variables, market accessibility, and climate change projections into future zoning models. The study concluded that agro-climatic zoning is vital for achieving sustainability, enhancing resource conservation, and strengthening climate-resilient agricultural strategies.

Research Problems:

Although agriculture in India (or any region) is strongly shaped by its agro-climatic diversity, there remains a significant gap in understanding the precise relationship between agro- climatic parameters and crop suitability. Farmers often select crops based on traditional practices rather than scientific zone-specific recommendations, which results in low

productivity and increased vulnerability to climate change. The existing agro-climatic zone classifications are not always updated with recent climatic variability, leading to mismatches between recommended and actual crop performance. Furthermore, there is inadequate integration of soil data, micro- climatic factors, and modern GIS-based assessments in crop planning. Limited awareness among farmers about climatic suitability also creates challenges in adopting climate-resilient cropping systems. These issues indicate the need for a systematic study that identifies the role of agro- climatic zones in determining crop suitability and provides scientifically grounded zoning-based crop planning strategies.

Objectives of the Study:

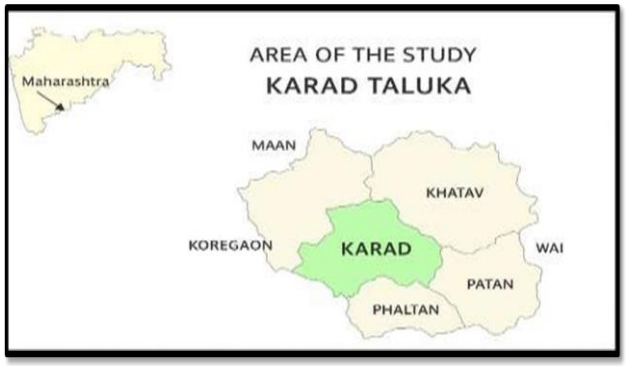
1. To analyse the key agro-climatic characteristics such as temperature, rainfall, soil type, and growing period of different agro-climatic zones and understand their impact on crop suitability.
2. To identify and recommend the most suitable crops for each agro-climatic zone based on scientific assessment of climatic and soil requirements.

Research Methodology:

The present study adopts a descriptive and analytical research methodology to examine how agro-climatic zones influence crop suitability. The research is based on both primary and secondary data. Secondary data is collected from ICAR reports, IMD climate records, government statistical handbooks, agro-climatic zone classifications, soil survey reports, and published research articles. The study analyzes major climatic and soil variables against crop requirements using agro-ecological zoning techniques, GIS mapping, and comparative climatic assessment. Statistical tools such as descriptive analysis, correlation analysis, and trend evaluation are used to interpret climate–crop relationships. The methodology enables a systematic identification of the crops best suited for each agro-climatic zone and helps assess the extent to which climatic characteristics influence cropping patterns. Through this integrated approach, the research aims to develop a scientific and zone-specific crop suitability framework for sustainable and climate-resilient agriculture.

Area of the Study:

The study is conducted in Karad Taluka, located in Satara district of Maharashtra, India. Karad is known for its agriculture-based economy, with fertile soils and varied agro-climatic conditions suitable for crops like sugarcane, wheat, and horticultural produce. The region experiences a semi-arid to moderate climate, making it ideal for studying the relationship between agroclimatic zones and crop suitability. The map of study area is as shown below.



Data Analysis and Interpretation:

The data collected for the study was systematically analyzed to understand how variations in agro-climatic conditions influence crop suitability across different zones. Climatic data such as temperature range, annual and seasonal rainfall distribution, humidity levels, and length of growing period (LGP) were compared

zone-wise to identify patterns that support or restrict crop growth. Soil parameters including soil type, texture, fertility status, and pH were examined to determine their compatibility with specific crop requirements. GIS-based maps were used to visualize spatial differences in climate and soil characteristics, allowing clearer interpretation of regional suitability patterns. Crop performance data and existing cropping systems were evaluated to check whether the crops currently grown align with scientific suitability indicators. Correlation analysis helped identify the strength of relationships between agro-climatic variables and crop yields. The interpretation revealed that temperature-sensitive crops perform better in zones with moderate thermal regimes, while water-intensive crops show higher suitability in high-rainfall zones. In contrast, drought-prone areas are more suitable for hardy, low-water-demand crops. The analysis also highlighted mismatches where farmers grow crops unsuitable for their climatic conditions, often resulting in low productivity. Overall, the interpreted data confirms that agro-climatic zones have a direct and decisive role in determining crop suitability, and zone-specific planning can significantly enhance agricultural sustainability and productivity.

Role of Agro-Climatic Zones in Determining Crop Suitability (Comprehensive Frequency Distribution of Farmer (N=40))

S.N	Question & Options	Frequency	Percent	Valid Percent	Cumulative Percent
1	Do you think your local climate affects the type of crops you can grow?				
	a) Yes, very much	30	75.0	75.0	75.0
	b) Yes, to some extent	8	20.0	20.0	95.0
	c) No	1	2.5	2.5	97.5
	d) Not sure	1	2.5	2.5	100.0
	Total	40	100.0	100.0	
	How well do you understand the agro-climatic zone of your area?				
	a) Very well	18	45.0	45.0	45.0
	b) Moderately	16	40.0	40.0	85.0
	c) A little	5	12.5	12.5	97.5
	d) Not at all	1	2.5	2.5	100.0
	Total	40	100.0	100.0	
3	What is the main factor that decides your crop selection?				
	a) Rainfall	10	25.0	25.0	25.0
	b) Soil type	9	22.5	22.5	47.5
	c) Market demand	11	27.5	27.5	75.0
	d) Availability of irrigation	10	25.0	25.0	100.0
	Total	40	100.0	100.0	
4	How suitable is your soil for the crops you currently grow?				
	a) Highly suitable	18	45.0	45.0	45.0
	b) Moderately suitable	17	42.5	42.5	87.5
	c) Less suitable	4	10.0	10.0	97.5
	d) Not suitable	1	2.5	2.5	100.0
	Total	40	100.0	100.0	
5	How often do you face climate-related problems?				
	a) Very often	19	47.5	47.5	47.5
	b) Sometimes	16	40.0	40.0	87.5
	c) Rarely	4	10.0	10.0	97.5

	d) Never	1	2.5	2.5	100.0
	Total	40	100.0	100.0	
6	Do you receive any guidance from agricultural officers?				
	a) Regularly	8	20.0	20.0	20.0
	b) Occasionally	10	25.0	25.0	45.0
	c) Rarely	11	27.5	27.5	72.5
	d) Never	11	27.5	27.5	100.0
	Total	40	100.0	100.0	
7	How satisfied are you with the crop productivity?				
	a) Highly satisfied	16	40.0	40.0	40.0
	b) Satisfied	14	35.0	35.0	75.0
	c) Neutral	6	15.0	15.0	90.0
	d) Dissatisfied	4	10.0	10.0	100.0
	Total	40	100.0	100.0	
8	Have you adopted climate-resilient or zone-specific crop varieties?				
	a) Yes, many	13	32.5	32.5	32.5
	b) Yes, a few	15	37.5	37.5	70.0
	c) No, but planning	7	17.5	17.5	87.5
	d) No, not aware	5	12.5	12.5	100.0
	Total	40	100.0	100.0	
9	What is the major challenge you face?				
	a) Irregular rainfall	16	40.0	40.0	40.0
	b) Soil fertility issues	5	12.5	12.5	52.5
	c) Water shortage	10	25.0	25.0	77.5
	d) Pests & diseases	9	22.5	22.5	100.0
	Total	40	100.0	100.0	
10	Do you think identifying crop suitability can improve your income?				
	a) Yes, definitely	26	65.0	65.0	65.0
	b) Yes, to some extent	11	27.5	27.5	92.5
	c) No change	1	2.5	2.5	95.0
	d) Not sure	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

The analysis of the responses from 40 farmers reveals that agro-climatic factors play a decisive role in shaping crop suitability perceptions and practices. A large majority (75%) strongly acknowledged that local climate highly influences the crops they can grow, while another 20% agreed to some extent, indicating that climatic awareness is widespread among farmers. Understanding of their agro-climatic zone is also reasonably strong, with 45% claiming very good knowledge and 40% having moderate awareness, showing that most farmers are familiar with their agro-ecological conditions. When asked about the main factor influencing crop selection, market demand (27.5%) slightly surpassed rainfall (25%) and irrigation availability (25%), suggesting that economic considerations guide decisions alongside climatic factors. Soil suitability emerged as another positive aspect, with 45% rating their soil as highly suitable and 42.5% as moderately suitable, reflecting relatively favorable soil conditions in the region. However, climate-related stress remains a major challenge, as 47.5% reported facing such problems very often and 40% sometimes, highlighting the vulnerability of agriculture to climatic fluctuations. Support from agricultural officers is limited, as only 20% receive regular guidance while 55% report rare or no guidance, indicating a gap in extension services. In terms of productivity

satisfaction, 40% were highly satisfied and 35% satisfied, yet 25% expressed neutral or poor satisfaction, suggesting scope for improvement. Adoption of climate-resilient or zone- specific varieties is partial, with 32.5% adopting many such varieties and 37.5% adopting a few, while 30% remain unaware or only planning, reflecting moderate but uneven adoption levels. The major challenges identified were irregular rainfall (40%), water shortage (25%), pests and diseases (22.5%), and soil fertility issues (12.5%), all pointing toward multi-dimensional constraints affecting crop performance. Finally, an overwhelming 65% of farmers felt that identifying crop suitability would definitely improve their income, while 27.5% believed it would help to some extent, confirming that farmers recognize the economic benefits of aligning crops with agro-climatic conditions. Overall, the interpretation suggests that while farmers have good awareness of climate and soil conditions, they face significant climatic challenges and require stronger extension support and scientific guidance to fully adopt zone-specific and climate- resilient crop planning.

Findings of the Study:

Farmers' Awareness and Influence of Agro-Climatic Factors on Crop Selection:

The study reveals that a significant majority of farmers (75%) believe that their local climate strongly affects the type of crops they grow, while 85% of respondents have at least a moderate understanding of their agro-climatic zone. Rainfall, soil type, market demand, and irrigation availability were all cited as key factors influencing crop selection, indicating that agro-climatic conditions, along with resource availability, play a crucial role in determining cropping patterns.

Impact on Crop Productivity and Adoption of Zone-Specific Practices:

About 45% of farmers reported their soil as highly suitable for the crops they grow, and nearly 87.5% faced climate-related problems sometimes or very often. Only 32.5% had adopted many climate-resilient or zone-specific crop varieties, though 65% believed that identifying crop suitability could improve their income. These findings highlight that while farmers recognize the importance of agro-climatic suitability, actual adoption of climate-resilient practices is moderate, and there is substantial scope to enhance productivity through scientific, zone-specific crop planning.

Suggestions:

- Promote Zone-Specific Crop Planning: Farmers should be guided to select crops based on the climatic, soil, and water conditions of their agro-climatic zone to ensure higher productivity and sustainability.
- Encourage Adoption of Climate-Resilient Varieties: Introduction and adoption of drought- tolerant, flood-resistant, or short-duration crop varieties suitable for specific zones can help reduce crop losses due to climate variability.
- Strengthen Farmer Awareness and Training: Regular workshops, training programs, and awareness campaigns by agricultural officers can improve farmers' understanding of agro- climatic zones and crop suitability, enabling informed decision-making.

Conclusion:

The study on the role of agro-climatic zones in determining crop suitability highlights that climatic conditions, soil characteristics, and length of growing period are critical factors

influencing crop selection and productivity. The findings indicate that farmers are aware of the impact of climate on their crops, yet the adoption of zone-specific and climate-resilient varieties remains moderate. Proper understanding and utilization of agro-climatic zoning can guide farmers in selecting suitable crops, optimizing resource use, and improving overall yield and income. Moreover, scientific planning based on zone-specific characteristics can reduce risks associated with climate variability, soil degradation, and water scarcity. The study concludes that integrating agro-climatic knowledge with modern technologies, farmer training, and policy support is essential to promote sustainable, productive, and climate-resilient agriculture across different regions.

References:

1. FAO. (2012). Agro-ecological zoning: Guidelines for crop suitability and land evaluation. Food and Agriculture Organization of the United Nations. Rome: FAO.
2. ICAR. (2017). Agro-climatic zones of India: Classification and crop planning. Indian Council of Agricultural Research, New Delhi.
3. Kulkarni, S. (2020). Influence of temperature and rainfall on crop suitability in tropical regions. Journal of Agricultural Science, 12(3), 45–54.
4. Sharma, R., & Rao, P. (2018). Agro-climatic zoning for optimizing crop planning in semi-arid regions. Indian Journal of Agronomy, 63(2), 120–128.
5. Singh, A., & Patil, V. (2017). Soil-based suitability analysis for major crops in Central India. International Journal of Soil Science, 12(1), 33–42.
6. Thomas, R., & Mehta, K. (2021). GIS and remote sensing applications in agro-climatic zonation. Journal of Geospatial Science, 14(4), 201–210.
7. Deshmukh, P. (2019). Agro-climatic zoning as a tool for sustainable agriculture. Indian Journal of Environmental Science, 9(2), 67–74.
8. Government of India, Ministry of Agriculture. (2019). Agricultural statistics at a glance. New Delhi: Directorate of Economics and Statistics.