Journal of Research and Development
A Multidisciplinary International Level Referred and Double Blind Peer Reviewed, Open Access
ISSN : 2230-9578 | Website: https://jrdrvb.org Volume-18, Issue-1| January - 2026

Original Article

Assessing Crop Suitability in a Semi-Arid Region Using a Composite Crop Suitability Index: Evidence from Shevgaon Tehsil, Maharashtra

Dr. Gokul S. Jadhav[1], Dr. Ravindra M. Shinde[2]
[1]Assistant Professor, Department of Geography, Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune (Affiliated to SPPU, Pune)
[2]Associate Professor, Department of Geography, Dr. D. Y. Patil Arts, Commerce and Science College, Pimpri, Pune(Affiliated to SPPU, Pune)
Email: jadhavgokul41@gmail.com

Manuscript ID:
JRD -2026-180102
ISSN: 2230-9578
Volume 18
Issue 1
Pp. 7-12
January - 2026
Submitted: 15 Dec. 2025
Revised: 25 Dec. 2025
Accepted: 10 Jan. 2026
Published: 31 Jan. 2026

Abstract

Agriculture in semi-arid regions is constrained by limited and uncertain rainfall, variable soil conditions, and increasing pressure on water resources, making scientific crop suitability assessment essential for sustainable land use planning. This study evaluates crop suitability in Shevgaon tehsil of Ahmednagar district, Maharashtra, using a Composite Crop Suitability Index (CSI). The assessment integrates three key agro-environmental parameters rainfall availability, soil characteristics, and soil pH through a weighted linear combination approach, assigning weights of 0.50, 0.30, and 0.20 respectively, based on their relative agronomic importance. Suitability scores were standardized following FAO guidelines and applied to major crops under both rainfed and irrigated scenarios. The results indicate that drought-tolerant crops such as jowar, bajra, and cotton are highly suitable under rainfed conditions, while wheat and maize remain marginally suitable and sugarcane is unsuitable without irrigation. Under irrigated conditions, the suitability of water-sensitive crops improves significantly, with sugarcane, wheat, maize, and onion shifting to moderately suitable classes, while drought-resilient crops maintain high suitability. The findings highlight the critical role of irrigation in expanding crop options and reducing production risks in semi-arid environments. The study provides a practical, location-specific framework to support informed crop selection, efficient water use, and sustainable agricultural planning in Shevgaon tehsil and similar semi-arid regions.

Keywords: *Crop suitability, Composite Suitability Index, semi-arid agriculture, irrigation impact, Weighted Linear Combination.*

Introduction

Agricultural production in semi-arid regions is strongly influenced by natural resource constraints, particularly limited and uncertain water availability, variable soil conditions, and climatic stress. These factors collectively shape cropping decisions, productivity levels, and farm income stability. In Maharashtra, a large proportion of agricultural land falls within semi-arid and drought-prone zones, where dependence on rainfall and heterogeneous soil conditions often results in uneven agricultural performance across regions. Scientific assessment of crop suitability is therefore essential for promoting efficient land use and reducing production risks in such environments. Shevgaon tehsil of Ahmednagar district represents a typical semi-arid agrarian setting, marked by low and erratic rainfall, spatial variability in soil characteristics, and predominance of rainfed agriculture. Although the agro-climatic conditions are broadly similar across the tehsil, variations in rainfall distribution and soil properties significantly influence crop performance and farmers' crop choices. In the absence of systematic suitability assessment, farmers often adopt cropping patterns that are not fully aligned with local resource potential, leading to yield instability and economic vulnerability. Crop suitability analysis offers a structured framework to evaluate the capacity of land to support different crops by integrating key agro-environmental parameters. Composite indices are particularly useful in this regard, as they allow multiple criteria to be combined into a single, interpretable measure.

Address for correspondence:
Dr. Gokul S. Jadhav, Assistant Professor, Department of Geography, Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune(Affiliated to SPPU, Pune)

How to cite this article:
Jadhav, G. S., & Shinde, R. M. (2026). Assessing Crop Suitability in a Semi-Arid Region Using a Composite Crop Suitability Index: Evidence from Shevgaon Tehsil, Maharashtra. Journal of Research & Development, 18(1), 7–12. https://doi.org/10.5281/zenodo.18541106

Quick Response Code:
Website: https://jrdrvb.org/
DOI: 10.5281/zenodo.18541106
OPEN ACCESS

Journal of Research and Development
A Multidisciplinary International Level Referred and Double Blind Peer Reviewed, Open Access
ISSN : 2230-9578 | Website: https://jrdrvb.org Volume-18, Issue-1| January - 2026

The Composite Crop Suitability Index (CSI), based on a weighted linear combination method, enables objective assessment by assigning relative importance to rainfall, soil characteristics, and soil pH factors that are critical under semi-arid conditions.Against this backdrop, the present study applies a Composite Crop Suitability Index to assess crop suitability in Shevgaon tehsil. By integrating rainfall suitability, soil attributes, and soil pH, the study aims to identify suitability classes that can support informed crop planning, sustainable land management, and improved agricultural outcomes in the semi-arid regions of Maharashtra.

Study Area:

Shevgaon tehsil is located at the south of Ahmednagar district between $19^0$13'18'' North to $19^0$33'57'' North Latitude and from $75^0$01'48'' to $75^0$32'44" East Longitude. The total number of villages in the tehsil is 112. Total area of tehsil is 1031.85sq/km. The area under agriculture is 913.19 sq/km (88.5 %), under forest 11.57 sq/km (1.12 %), and remaining 107.09 sq/km (10.38 %) is used for other purpose. Average rainfall in Shevgaon tehsil is 501.7 mm.

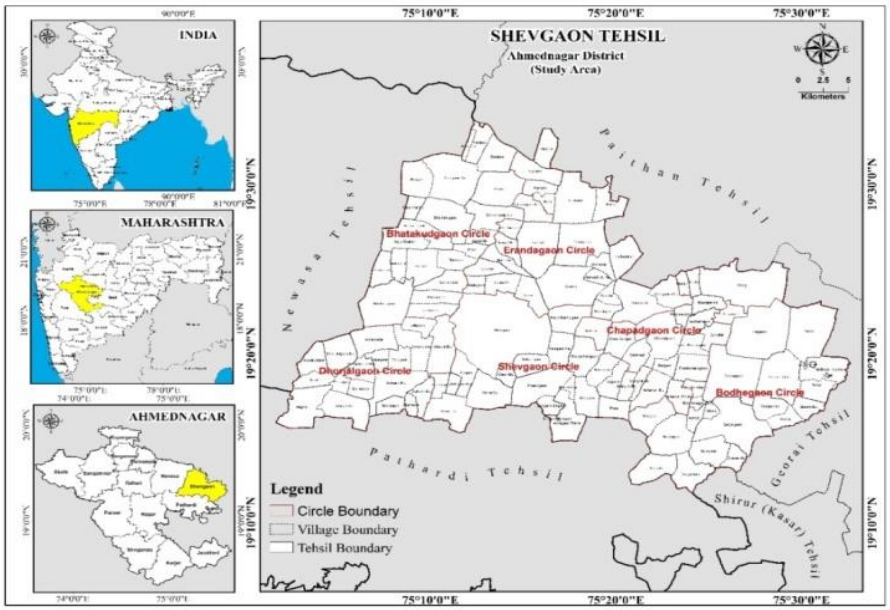

Fig. No. 1 Location map of Study Area

Objectives

1. To assess crop suitability in Shevgaon tehsil using rainfall, soil, and pH parameters through a Composite Crop Suitability Index.
2. To classify land into suitability categories for improved crop planning in the semi-arid region of Shevgaon tehsil of Maharashtra.

Methodology

Crop suitability in Shevgaon tehsil of Ahmednagar district, located in the semi-arid belt of Maharashtra, was assessed using a Composite Crop Suitability Index (CSI) derived through a weighted linear combination technique. The analysis incorporated three critical agro-environmental variables rainfall availability, soil properties, and soil reaction (pH) as these factors significantly influence crop performance under moisture-stress conditions. Each variable was converted into a standardized suitability score, namely rainfall suitability score (SRF), soil suitability score (SSoil), and soil pH suitability score (SpH), ensuring comparability across criteria. Based on their relative agronomic significance, weights of 0.50 for rainfall, 0.30 for soil, and 0.20 for pH were assigned, with the total weight summing to unity. The Composite Suitability Index was computed using the expression CSI = (0.50 × SRF) + (0.30 × SSoil) + (0.20 × SpH). The resulting index values were subsequently categorized into four suitability classes: highly suitable (CSI ≥ 4.0), moderately suitable (CSI 3.0–3.9), marginally suitable (CSI 2.0–2.9), and unsuitable (CSI < 2.0). This approach enables an integrated and location-specific evaluation of crop suitability in the semi-arid conditions of Shevgaon tehsil.

Formula:

1. **Composite Crop Suitability Index (CSI)** = (WRF×SRF)+(WSoil×SSoil)+(WpH×SpH)
2. **CSI Weighted Method** = (0.50×SRF) + (0.30×SSoil) + (0.20×SpH)
3. **Weighted Linear Combination =** CSI = $(W_1 \times S_1) + (W_2 \times S_2) + (W_3 \times S_3)$

Journal of Research and Development
A Multidisciplinary International Level Referred and Double Blind Peer Reviewed, Open Access
ISSN : 2230-9578 | Website: https://jrdrvb.org Volume-18, Issue-1| January - 2026

Weights Used: Rainfall (RF) = **0.50** Soil = **0.30** pH = **0.20**	**Composite Crop Suitability Index** **CSI** = Composite Suitability Index **SRF** = Rainfall suitability score **SSoil** = Soil suitability score **SpH** = Soil pH suitability score **0.50, 0.30, 0.20** = weights assigned based on relative importance **Σ Weights = 1.00**	**Suitability Classification Criteria (Suggested)** **S1 (Highly Suitable):** CSI ≥ 4.0 **S2 (Moderately Suitable):** 3.0 – 3.9 **S3 (Marginally Suitable):** 2.0 – 2.9 **N (Unsuitable):** < 2.0

Analysis and Discussions:

1. Rainfall, Soil, and pH Suitability Scores of Major Crops

Table No. 1 Rainfall, Soil, and pH Suitability Scores of Major Crops

Crops	Typical Rainfall Need (mm)	RF Score S_1)	Soil Type Requirement	Soil Texture Score S_2)	Ideal pH Range	pH Score (S_3)
Sugarcane	750–1200+ (High)	1 (Needs irrigation)	Deep, well-drained soil	2 (Drainage issues in black soil)	6.5–7.5 (Tolerates 5.8–8.5)	3 (Tolerates alkalinity)
Cotton	500–1000 (Moderate)	4 (Ideal range)	Black cotton soil (Regur)	5 (Ideal soil)	6.5–7.5	3 (Tolerates alkalinity)
Onion	650–1000 (Moderate)	2 (Sensitive to extremes)	Sandy loam	2 (Heavy soil not ideal)	5.8–6.5	1 (Not suitable for high pH)
Wheat	500–750 (Moderate/Cool)	2(Low Rabi rainfall)	Loam, clay loam (Neutral pH)	4 (Good water retention)	6.0–7.0	2 (Prefers neutral)
Jowar	450–900 (Drought resistant)	5(Highly adapted)	Sandy/Black soil	4 (Adapted)	6.0–8.5	4 (Tolerant)
Bajra	300–600 (Arid resistant)	5(Highly adapted)	Sandy/Light soil	3 (Adapted)	6.5–8.0	4 (Tolerant)
Maize(Corn)	500–1000 (Moderate)	2(Needs fertile soil & timely rain)	Deep alluvial loam	3 (Adapted)	5.5–8.0	3 (Tolerant)

Source: Compiled by Author Based on FAO Guideline from Tehsil Agriculture Record – 2025

The table illustrates the approach for assessing crop suitability in Shevgaon tehsil using three critical agro-environmental parameters based on FAO guidelines. For each crop, the typical rainfall requirement (e.g., sugarcane: 750–1200 mm, cotton: 500–1000 mm, bajra: 300–600 mm) is compared with local rainfall data to assign a **rainfall** suitability score (S_1)**.** The soil type and texture requirement of each crop (e.g., sugarcane: deep, well-drained soil; cotton: black cotton soil; onion: sandy loam) is evaluated to determine the soil suitability score **(S_2)**, considering factors such as drainage, fertility, and water retention. Likewise, the ideal pH range for each crop (e.g., sugarcane: 6.5–7.5; wheat: 6.0–7.0; bajra: 6.5–8.0) is used to calculate a pH suitability score **(S_3)**, indicating tolerance to soil acidity or alkalinity.

These standardized scores for rainfall, soil, and pH are then used as inputs for the Composite Crop Suitability Index (CSI)**,** where each parameter is weighted according to its relative importance. This framework provides a systematic and replicable method to evaluate land suitability for different crops under the semi-arid conditions of Shevgaon tehsil, ensuring that all critical agro-environmental needs of crops are explicitly considered in the analysis.

Journal of Research and Development
A Multidisciplinary International Level Referred and Double Blind Peer Reviewed, Open Access
ISSN : 2230-9578 | Website: https://jrdrvb.org Volume-18, Issue-1| January - 2026

2. Impact of Rainfed and Irrigated Conditions:

Table No. 2 Impact of Rainfed and Irrigated Conditions

Crop	Rain Score (SRain)	Soil Score (SSoil)	pH Score (SpH)	Rainfed CSI	Irrigation Score SIrrigation)	Irrigated CSI
Sugarcane	1	2	3	**1.7**	3	**3.7**
Cotton	4	5	3	**4.1**	4	**4.1**
Onion	2	2	1	**1.8**	3	**3.3**
Wheat	2	4	2	**2.6**	3	**3.6**
Jowar	5	4	4	**4.9**	4	**4.9**
Bajra	5	3	4	**4.2**	4	**4.2**
Corn (Maize)	2	3	3	**2.5**	3	**3.5**

Source: Compiled by Author Based on applied method from Tehsil Agriculture Record – 2025

The table no.2 demonstrates the impact of rainfed versus irrigated conditions on crop suitability in Shevgaon tehsil using the Composite Crop Suitability Index (CSI). Under the **rainfed scenario**, crops heavily dependent on water, such as **sugarcane**, show low rainfall suitability (SRain = 1) and a relatively low Rainfed CSI of 1.7, despite moderate soil (SSoil = 2) and pH (SpH = 3) scores. Under irrigation, its Rainfall constraint is alleviated (SIrrigation = 3), resulting in a higher Irrigated CSI of 3.7**,** indicating significant improvement in adaptability. Similarly, onion has low rainfed suitability (SRain = 2, Rainfed CSI = 1.8), but irrigation improves its CSI to 3.3.

Crops like cotton are less affected by rainfall limitations due to their moderate water requirement; its rainfed CSI is already high at 4.1 (SRain = 4, SSoil = 5, SpH = 3), and irrigation does not change the CSI significantly (Irrigated CSI = 4.1), reflecting inherent suitability under existing conditions. Wheat**,** with moderate rainfall sensitivity (SRain = 2, SSoil = 4, SpH = 2), improves from a Rainfed CSI of 2.6 to an Irrigated CSI of 3.6, showing notable benefit from supplemental water.

Drought-tolerant crops like **jowar** (Rainfed CSI = 4.9) and bajra (Rainfed CSI = 4.2) show minimal change under irrigation (Irrigated CSI = 4.9 and 4.2, respectively), reflecting their ability to perform well under limited rainfall. Maize (corn) improves moderately from a Rainfed CSI of 2.5 (SRain = 2, SSoil = 3, SpH = 3) to an Irrigated CSI of 3.5 (SIrrigation = 3), demonstrating that irrigation can enhance yields but is not as critical as for highly water-demanding crops.

3. Composite Crop Suitability for Rainfed :

Table No. 3 CSI for Rainfed region of Shevgaon Tehsil

Crop	Rainfed CSI	Rainfed Suitability Class
Jowar	4.9	S1 (Highly Suitable)
Cotton	4.1	S1 (Highly Suitable)
Bajra	4.2	S1 (Highly Suitable)
Wheat	2.6	S3 (Marginally Suitable)
Corn (Maize)	2.5	S3 (Marginally Suitable)
Sugarcane	1.7	N (Unsuitable)
Onion	1.8	N (Unsuitable)

Source: Compiled by Author Based on applied method from Tehsil Agriculture Record – 2025

Under rainfed conditions in Shevgaon tehsil, drought-tolerant crops such as jowar (CSI = 4.9, S1 – Highly Suitable)**,** bajra (CSI = 4.2, S1 – Highly Suitable)**,** and cotton (CSI = 4.1, S1 – Highly Suitable) **are** highly suited to the semi-arid environment, reflecting their ability to perform well under limited and erratic rainfall. Crops like wheat (CSI = 2.6, S3 – Marginally Suitable) and maize (CSI = 2.5, S3 – Marginally Suitable) show moderate adaptability, indicating potential risk of yield loss during dry spells. Water-intensive crops such as sugarcane (CSI = 1.7, N – Unsuitable) are poorly suited under rainfed conditions due to high water requirements that cannot be met by natural rainfall alone. These results emphasize the need for careful crop selection in rainfed areas to ensure stable production, reduce crop failure risks, and optimize land use in the semi-arid conditions of Shevgaon tehsil.

The suitability analysis under rainfed conditions is important for planning sustainable agriculture, as it identifies crops that are inherently resilient to rainfall variability and those that require intervention, such as supplemental irrigation or soil moisture conservation. By focusing on crops with higher Rainfed CSI, farmers can maximize productivity while minimizing economic losses and resource wastage. This targeted approach to crop planning also informs policymakers and extension services about priority crops for rainfed farming, enabling the design of strategies that enhance food security and livelihood stability in semi-arid regions.

Journal of Research and Development
A Multidisciplinary International Level Referred and Double Blind Peer Reviewed, Open Access
ISSN : 2230-9578 | Website: https://jrdrvb.org Volume-18, Issue-1| January - 2026

4. Composite Crop Suitability for Rainfed :

Table No. 4 CSI for Irrigated region of Shevgaon Tehsil

Crop	Irrigated CSI	Irrigated Suitability Class
Jowar	4.9	S1 (Highly Suitable)
Cotton	4.1	S1 (Highly Suitable)
Bajra	4.2	S1 (Highly Suitable)
Wheat	3.6	S2 (Moderately Suitable)
Corn (Maize)	3.5	S2 (Moderately Suitable)
Sugarcane	3.7	S2 (Moderately Suitable)
Onion	3.3	S2 (Moderately Suitable)

Source: Compiled by Author Based on applied method from Tehsil Agriculture Record – 2025

When irrigation is applied in Shevgaon tehsil, the suitability of water-sensitive crops improves markedly. Sugarcane**,** which was previously unsuitable under rainfed conditions (CSI = 1.7, N), increases to CSI = 3.7 (S2 – Moderately Suitable)**,** demonstrating the substantial benefit of supplemental water. Similarly, wheat (CSI = 3.6, S2 – Moderately Suitable) and maize (CSI = 3.5, S2 – Moderately Suitable) shift to higher suitability classes, reflecting reduced production risks and enhanced yield potential. Drought-tolerant crops such as jowar, bajra, and cotton retain their S1 (Highly Suitable) status, showing that irrigation does not significantly alter their already favorable adaptation. These results highlight the role of irrigation in transforming marginally suitable and unsuitable crops into productive options under semi-arid conditions.

The suitability analysis under irrigated conditions is crucial for optimizing land and water resources in Shevgaon tehsil. It demonstrates how targeted irrigation can expand the range of viable crops, increase resilience to rainfall variability, and improve economic returns for farmers. By identifying crops whose CSI improves significantly with irrigation, policymakers and extension agencies can prioritize irrigation planning, water allocation, and crop support programs. This approach ensures sustainable agricultural development, enhances food security, and maximizes productivity in semi-arid regions where rainfall alone is insufficient to meet crop water requirements.

5. Major Outcomes

1. **Highly suitable under rainfed conditions:** Drought-tolerant crops such as **jowar (CSI = 4.9, S1)**, **bajra (CSI = 4.2, S1)**, and **cotton (CSI = 4.1, S1)** perform well without irrigation, reflecting their adaptability to semi-arid rainfall conditions.
2. **Marginally suitable under rainfed conditions:** Crops like **wheat (CSI = 2.6, S3)** and **maize (CSI = 2.5, S3)** are moderately adapted but face production risk due to limited rainfall.
3. **Unsuitable under rainfed conditions:** Water-intensive crops, particularly **sugarcane (CSI = 1.7, N)**, cannot thrive without supplemental water.
4. **Improved suitability with irrigation:** Sugarcane improves to **CSI = 3.7 (S2)**, wheat to **CSI = 3.6 (S2)**, and maize to **CSI = 3.5 (S2)**, showing that irrigation mitigates rainfall limitations and enhances crop performance.
5. **Stable suitability of drought-tolerant crops:** Jowar, bajra, and cotton maintain their **S1 (Highly Suitable)** classification under irrigation, indicating minimal dependence on additional water.
6. **Implication for crop planning:** The analysis identifies crops suitable for rainfed farming and those that benefit significantly from irrigation, enabling **informed crop selection, efficient land use, and sustainable agricultural development** in semi-arid Shevgaon tehsil.

6. Recommendations for Crop Selection:

1. **Prioritize drought-tolerant crops for rainfed farming:** Cultivate crops like **jowar, bajra, and cotton** under natural rainfall conditions, as they are highly suitable (S1) and ensure stable yields in semi-arid areas.
2. **Use irrigation for water-sensitive crops:** Consider **sugarcane, wheat, and maize** in irrigated fields to improve their suitability from marginal or unsuitable to moderately suitable (S2), enhancing productivity and reducing crop failure risks.
3. **Match crops to soil and pH conditions:** Select crops that align with local soil texture and pH levels to maximize growth, such as cotton on black cotton soils and wheat on loam soils with neutral pH.
4. **Plan crop rotation based on adaptability:** Alternate highly suitable drought-resistant crops with moderately adaptable crops under irrigation to optimize land use, maintain soil fertility, and reduce economic risk.
5. **Focus on resource-efficient farming:** Avoid cultivating high water-demand crops in strictly rainfed areas, and invest in water-saving techniques (e.g., drip irrigation, mulching) to support moderately suitable crops and ensure sustainable yields.

Conclusion

The study of crop suitability in Shevgaon tehsil using the Composite Crop Suitability Index (CSI) highlights the differential adaptability of crops under rainfed and irrigated conditions in a semi-arid environment. Under rainfed conditions, drought-tolerant crops such as jowar, bajra, and cotton are highly suitable (S1), whereas water-sensitive

crops like sugarcane are unsuitable, and moderately sensitive crops such as wheat and maize are marginally suitable (S3). These results underscore the importance of selecting crops based on local agro-environmental conditions, particularly rainfall, soil type, and soil pH, to optimize production and minimize risks associated with rainfall variability.The analysis further demonstrates the positive impact of irrigation, which significantly improves the suitability of water-demanding crops: sugarcane moves from unsuitable (N) to moderately suitable (S2), while wheat and maize shift from marginally suitable (S3) to moderately suitable (S2). Drought-resilient crops maintain their highly suitable status under irrigation, reflecting their inherent adaptability. Overall, the study provides practical insights for farmers and policymakers, emphasizing the need for strategic crop selection, efficient water management, and sustainable land use practices. Implementing these recommendations can enhance productivity, reduce economic vulnerability, and support resilient agriculture in the semi-arid conditions of Shevgaon tehsil.

References

1. Abdel Rahman, M. A. E., Saleh, A. M., & Arafat, S. M. A. (2022). Assessment of land suitability using soil indicators in a geomatics environment. *Scientific Reports, 12*(1), 1–15.
2. Chaudhari, R., & Gaikwad, S. (2021). GIS-based site suitability analysis for sustainable agriculture. *Applied Ecology and Environmental Sciences, 9*(3), 241–248.
3. Food and Agriculture Organization of the United Nations. (1976). *A framework for land evaluation* (FAO Soils Bulletin No. 32, pp. 1–72). FAO.
4. Food and Agriculture Organization of the United Nations. (1985). *Guidelines: Land evaluation for irrigated agriculture* (FAO Soils Bulletin No. 55, pp. 1–231). FAO.
5. Indian Council of Agricultural Research. (2014). Estimation of soil erosion and crop suitability using remote sensing and GIS. *Indian Journal of Agricultural Sciences, 84*(1), 18–23.
6. Indian Council of Agricultural Research. (2022). Cropland suitability assessment using multi-criteria evaluation techniques: A review. *Indian Journal of Agricultural Sciences, 92*(5), 554–562.
7. Indian Council of Agricultural Research. (2022). Crop suitability assessment using soil and environmental parameters. *Indian Journal of Agricultural Research, 56*(2), 208–213.
8. Mostafiz, R. B., Noguchi, R., & Ahamed, T. (2021). Agricultural land suitability assessment using satellite-derived indices. *Land, 10*(2), 223–235.
9. National Bureau of Soil Survey and Land Use Planning. (2019). *Soil resource atlas of Maharashtra* (pp. 1–180). ICAR-NBSS&LUP.
10. Pan, G., Li, L., & Zhang, X. (2023). Crop suitability assessment under varying irrigation regimes in arid regions. *Agronomy, 14*(11), 2601–2618.
11. Singh, A. K., Rahman, B., & Thakur, R. (2019). Land suitability and irrigation potential for improving cropping intensity. *Journal of the Indian Society of Soil Science, 67*(3), 345–354.
12. Sys, C., Van Ranst, E., & Debaveye, J. (1991). *Land evaluation, Part I: Principles in land evaluation and crop production calculations* (pp. 1–274). General Administration for Development Cooperation.
13. Zolekar, R. B., & Bhagat, V. S. (2015). Multi-criteria land suitability analysis for agriculture in semi-arid regions. *Arabian Journal of Geosciences, 8*(6), 3773–3790.