9th India International Water Week-2026

PF4: Smart Irrigation Management

Crop Water Estimation using Remote Sensing

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Objectives

- Crop classification using satellite data for 2025-2026.
- Estimation of crop acreages using survey and satellite image for 2025-2026.
- Estimation of stage-wise crop-wise water requirements for 2025-26.

Study Area

Study Area & Extent

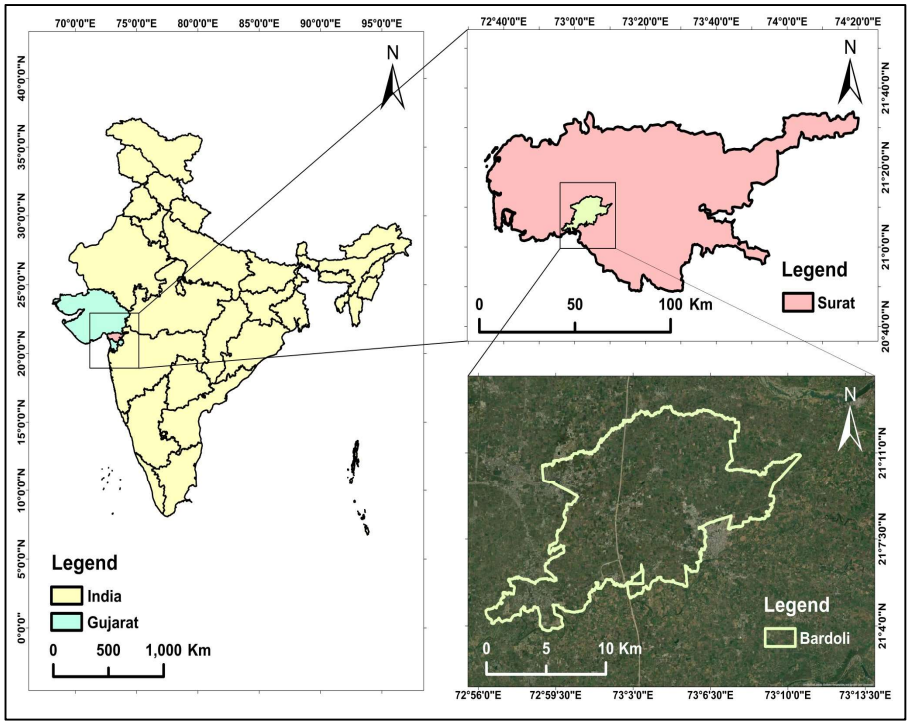
Located between 21°04'N to 21°14'N and 72°56'E to 73°12'E. The study assesses Bardoli Sub-Division in Surat District. Covers an extent of upto 18150.5 ha which includes Bardoli, Palsana, and Mota regions.

Water Sources

The Tapi River and the Ukai Reservoir (Vallabh Sagar) serve as the principal sources of water for this region.

Ukai Dam System

Constructed in 1972, the Ukai Dam system plays a crucial role in supporting irrigation, power generation, and flood control.



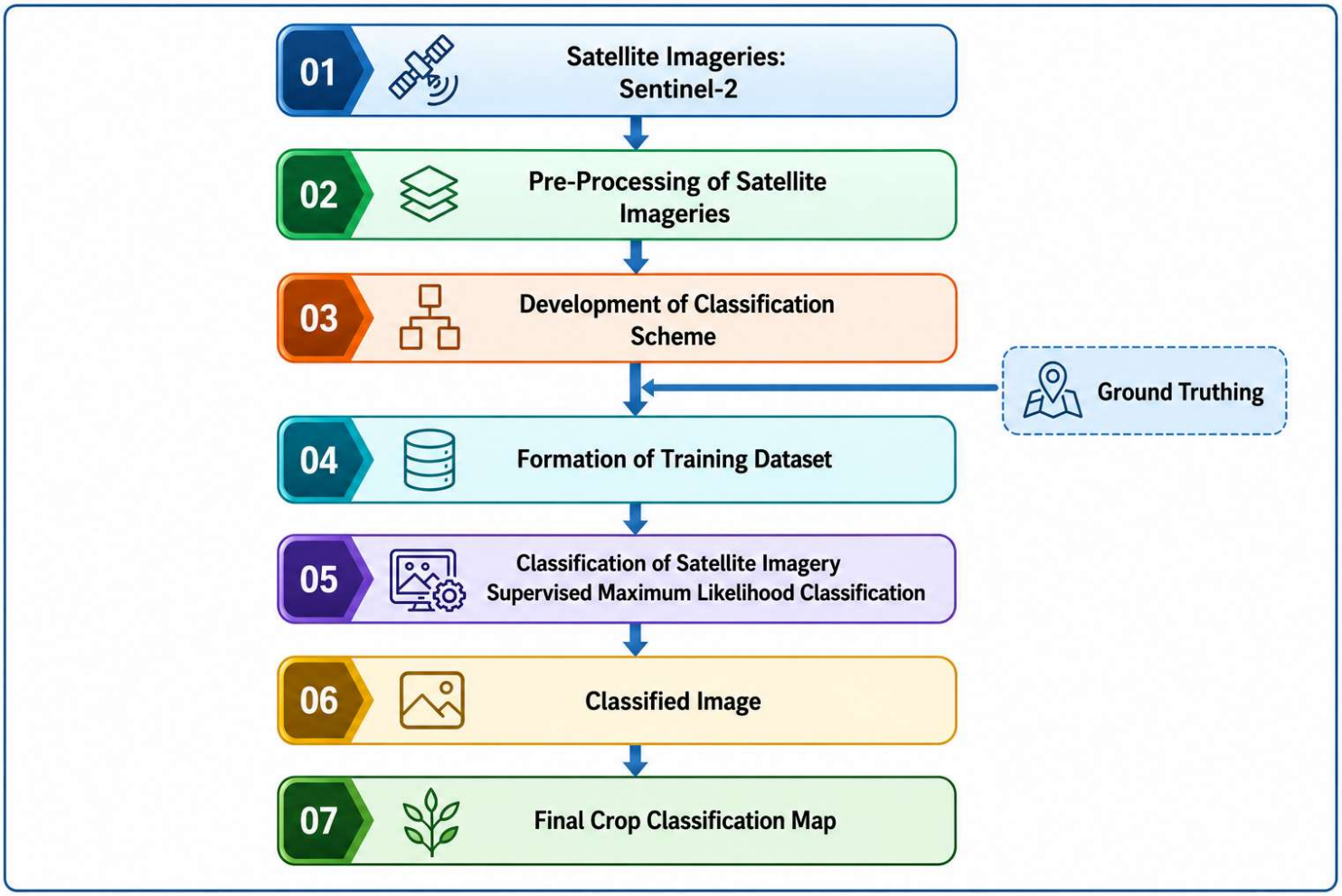
Bardoli Sub-Division, Surat District — Study Area Map

Datasets

Satellite Sensor	Band Name	Spatial Resolution (m)
Sentinel 2 (MSI)	Blue	10
	Green	
	Red	
	NIR	
	SWIR	20

Daily meteorological (Temp, Radiation, Wind, Humidity) data required for the estimation of reference Evapotranspiration (ET_0) were obtained from the NASA Prediction of Worldwide Energy Resources (POWER) & Open Weather Map.

Methodology



Estimation of Crop Water Requirement

$$ET_0 = \frac{0.408\Delta(R_n - G) + (\frac{900\gamma}{T_{mean}+273})u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

Where,

ET_0 = reference evapotranspiration (mm day^{-1});

Δ = slope of saturation vapor pressure versus air temperature curve [kPa $^0C^{-1}$];

R_n = net radiation at the crop surface [$MJm^{-2}d^{-1}$];

G = soil heat flux density at the soil surface [MJ m^{-2} d^{-1}];

T_{mean} = mean daily air temperature [^0C];

u_2 = mean daily wind speed at 2 m height [m s^{-1}];

e_s = saturation vapor pressure [kPa];

e_a = actual vapor pressure at [kPa];

$(e_s - e_a)$ = vapor pressure deficit [kPa];

γ = psychrometric constant [kPa $^0C^{-1}$];

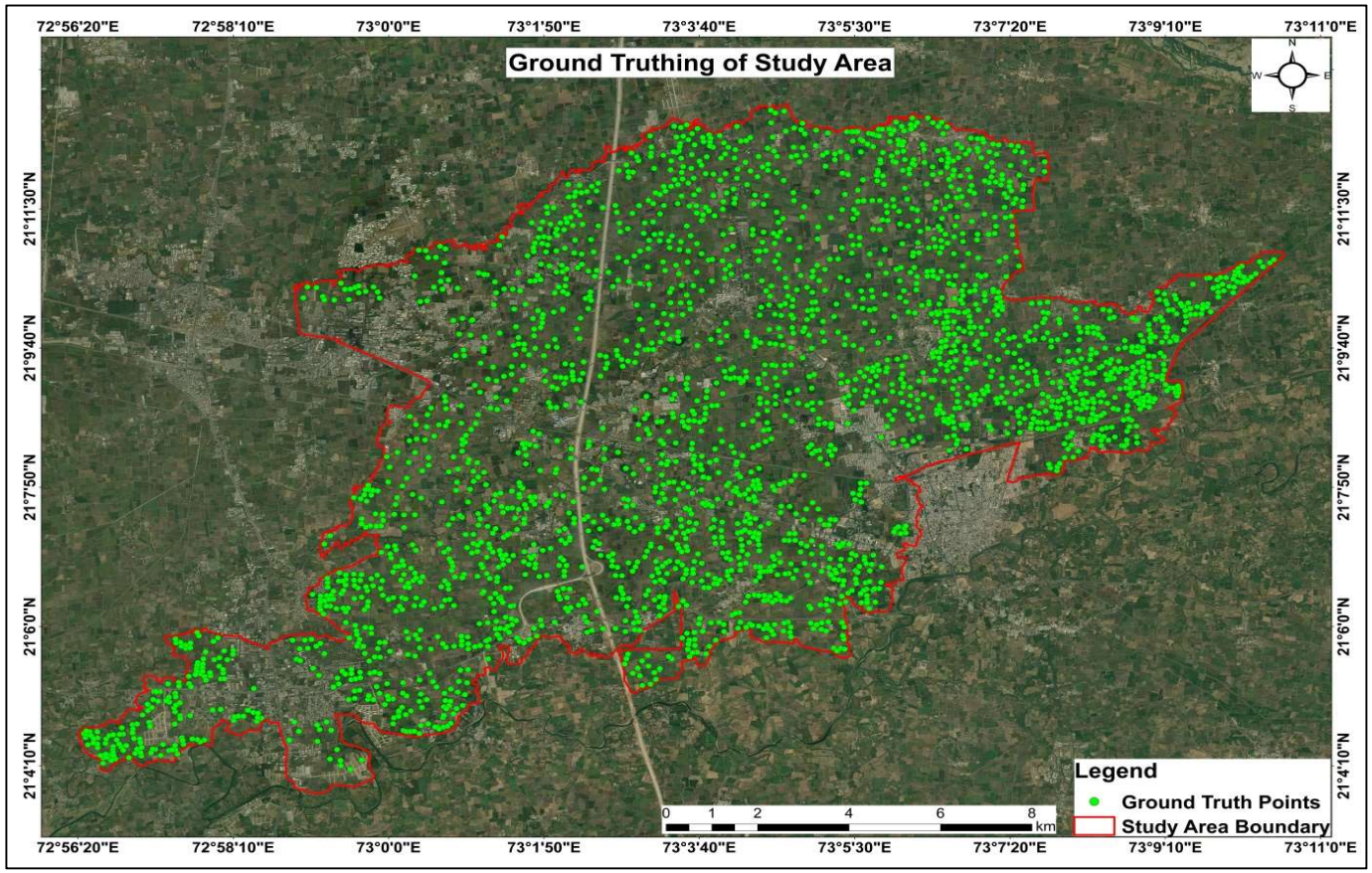
λ = latent heat of vaporization ≈ 2.45 MJ kg^{-1}.

Components	Source/Method
Reference ET (ET_0)	FAO-56 Penman-Monteith Equation
Climate Data	NASA POWER (Temp, Radiation, Wind, Humidity)
Crop Specificity	Crop Coefficients (K_c) for Sugarcane & Banana
Final Output	Total Crop Water Requirement (ET_c)

$$ET_c = ET_0 \times K_c$$

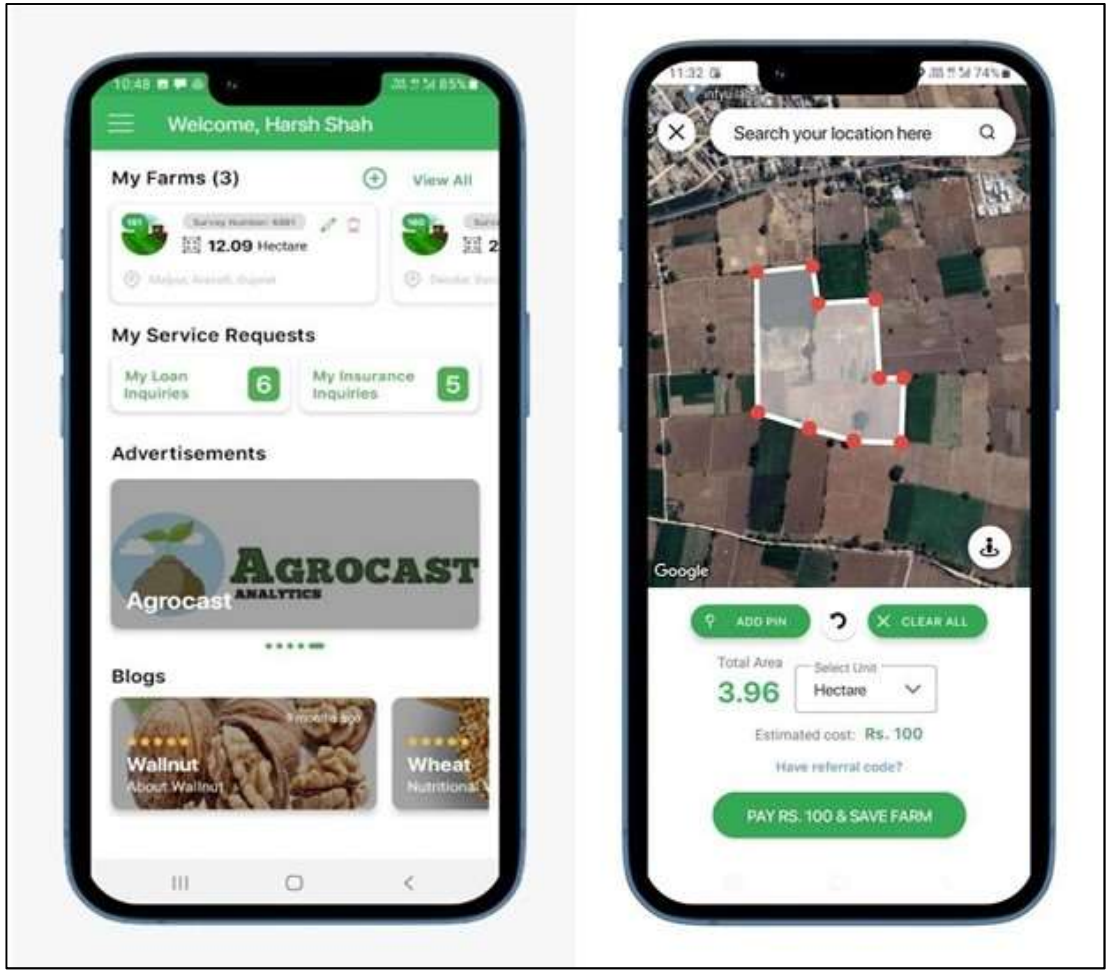
The FAO-56 Penman-Monteith method was employed to estimate Reference Evapotranspiration (ET_0) using meteorological parameters from NASA POWER & Open Weather data. Total crop water requirements (ET_c) were then determined by applying specific crop coefficient (K_c) values for sugarcane and banana.

Field Survey

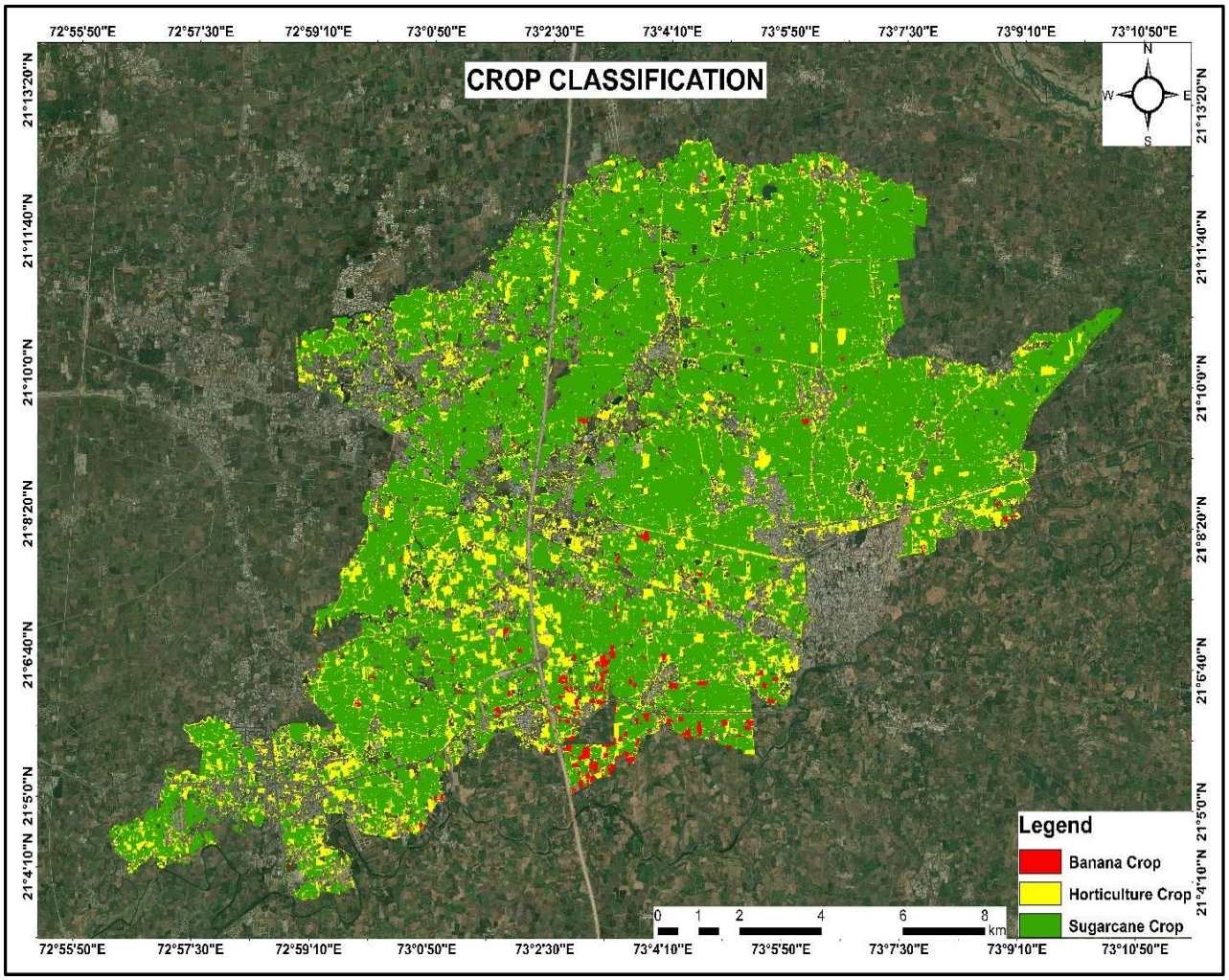


The field survey was conducted and **2,656** distinct ground truth points were collected and surveyed an area of **3,468.42 ha** to ensure enhanced accuracy.

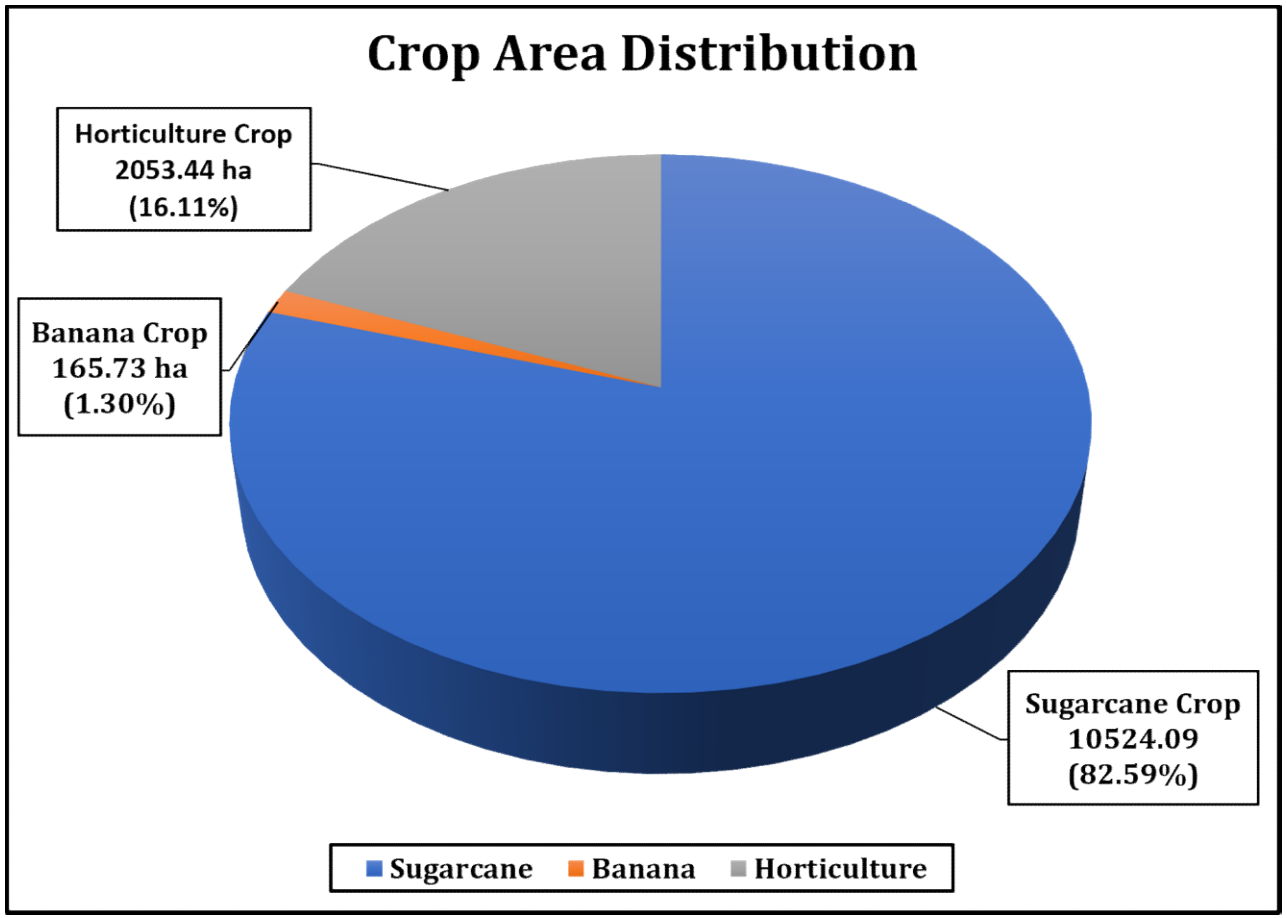
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Wheat
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CLEAR ALL
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Hectare
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Crop Classification



Crop Acreages



Total crop area is **12743.24 ha**

Accuracy Assessment for Crop Classification

Class Value	Sugarcane	Banana	Horticulture	Total	U_Accuracy	Kappa
Sugarcane	824	15	31	870	0.95	0
Banana	1	151	0	152	0.99	0
Horticulture	12	5	92	109	0.84	0
Total	837	171	123	1131	0	0
P_Accuracy	0.98	0.88	0.75	0	0.94	0
Kappa	0	0	0	0	0	0.86

- The Confusion Matrix table also known as an error matrix, which is a standard tool used in Remote Sensing and GIS to evaluate the accuracy.
- The table indicates that **94%** of the total area was classified correctly.

Crop Water Requirement

Crops	Crop Area (ha)	Water Requirement (MCM)			Annual Total (MCM)
		Rabi Season	Zaid Season	Kharif Season	
Sugarcane	10524.09	34.64	99.00	40.04	**173.68**
Banana	165.73	0.84	1.13	0.33	**2.30**
Horticulture (Mango & Sapota)	2053.44	10.84	10.84	10.84	**32.52**
Grand Total	**12743.24**	**46.32**	**110.97**	**51.21**	**208.5**

Crop Water Requirement Comparison

Government Data (2024-25)

Season	Water (MCM)
Rabi	89.22
Zaid (Hot Weather)	146.64
Kharif	24.92
Total	**260.78**

Present Study

Season	Water (MCM)
Rabi	46.32
Zaid (Hot Weather)	110.97
Kharif	51.21
Total	**208.5**

Conclusions

- **Agricultural area declined ~ 22.33%** from 2010 to 2025 due to continuously urban expansion.

- Crop classification for 2025–2026:
  - Mapped a **total crop area** of **12,743.24 ha**.
  - **Sugarcane: 10,524.09 ha (82.59%)**
  - **Horticulture: 2,053.44 ha (16.11%)**
  - **Banana: 165.73 ha (1.30%)**

- Estimation of stage-wise crop-wise water requirements for 2025-2026:
  - Analyzed using the FAO-56 Penman–Monteith method.
  - **Sugarcane: ~173.68 MCM (83.3%)**
  - **Horticulture: ~ 32.52 MCM (15.6%)**
  - **Banana: ~2.30 MCM (1.1%)**

Thank you for your attention

Q&A

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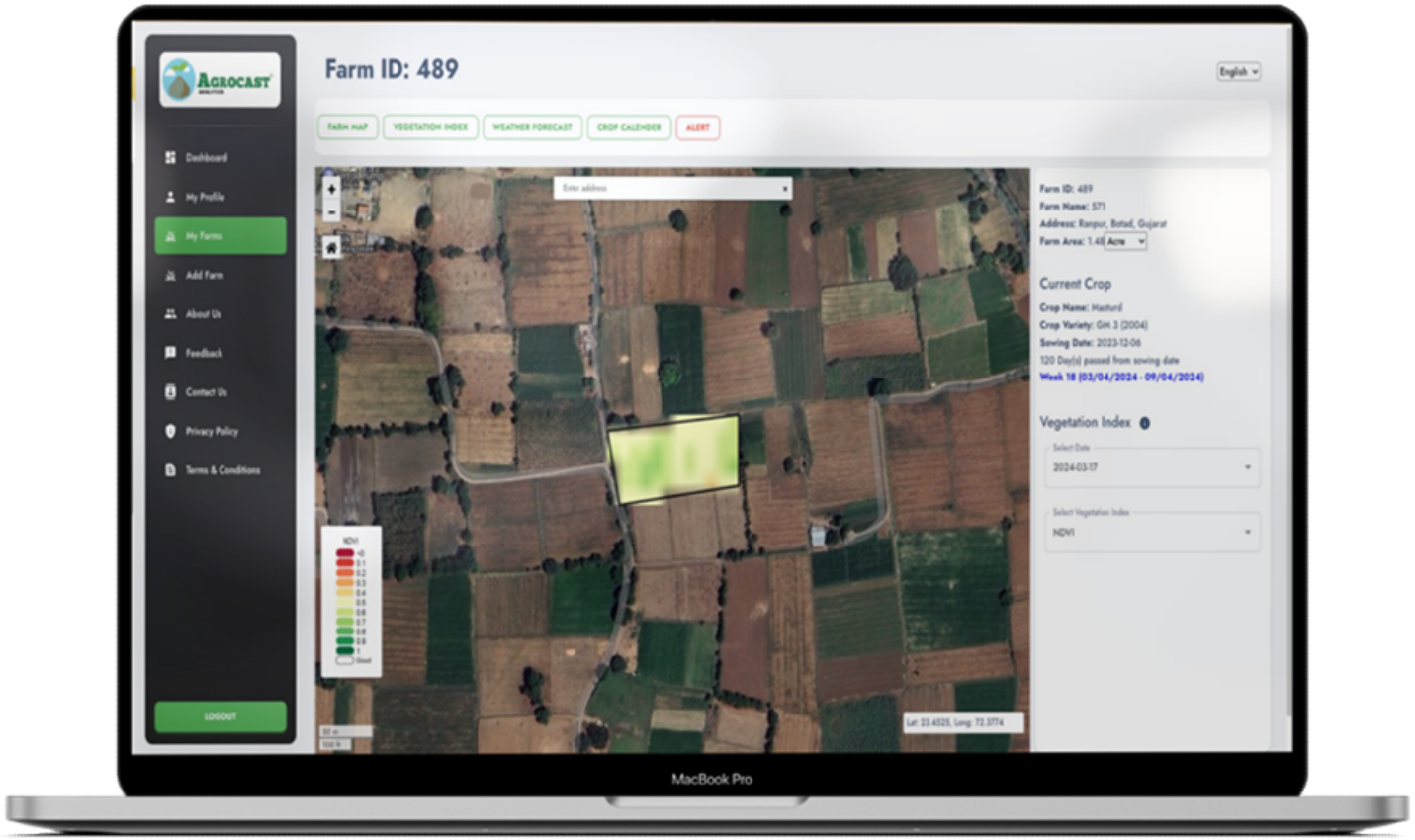
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