Analysis of NAVYAKOSH Fields Using Satellite

1. Satellite Analysis of Fields – By Agri Matrix India (AMI) Pvt Ltd

AMI is a Technology Partner to LCB Fertiliser Pvt Ltd for impact assessment of crop growth through satellite-based analytics.

About the Company

- Registered in Raipur; incubated at IIT (Ropar); main advisory center at Indore
- *Winner*, HDFC Parivartan – **WATER Challenge 2024**
- Working with GoI / PSA on **RuTAGe SMART VILLAGE CENTER program (RSVC)**
- Areas of work: **Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Maharashtra, Haryana**

2. Technology Work

AMI provides an **Integrated Technology Solution** covering the complete crop lifecycle from pre-sowing to post-harvest.

Stage	Technology Services Included
Pre-Sowing	Satellite-based Soil Organic Carbon (OC) and soil nutrient analysis, calculation of Basel Dose, and Crop rotation planning.
Crop Cycle	Satellite-based Crop Monitoring, Drones utilization, and MIDAS Advisory services.
Harvest/Post Harvest	Yield estimation, implementation of Block Chain technology, and services related to Carbon Credits.

3. Satellite Sources Used for Analysis

- **Primary Sources:**

    - Sentinel-2 (10 m resolution)
    - PlanetScope (3 m resolution)

- **Reserve Source:**

    - Sentinel-1 (Radar) for cloudy days (Source: EOS)

For both systems, thresholds for cloud and shadow coverage are adjusted.

4. Analysis Method

4.1 Mapping of Fields

- Field polygons were plotted based on locations of farms where Navyakosh was applied and adjacent farms where Navyakosh was not applied
- Field sizes ranged from **0.14 ha to 1.4 ha**; fields with and without Navyakosh were of comparable sizes
- Crop type configured as multiple crops with updated sowing dates
- Irrigation and tillage configured as **surface irrigation** and **conventional tillage**, common to the region
- Weather forecasts from **WWS (9.2 km grid)** around each field were used
- Weather analytics using the **last 5 years of data** were activated for mapped fields

4.2 Baselining Historical Data (Productivity – Sowing – Sampling)

Historical field data was assessed for:

- **Productivity Maps:**
  Generated by combining indices such as **MSAVI, NDVI, RECI, NDRE, NDMI** over a selected data range for Variable Rate Application (VRA)
- **Sowing Maps:**
  Based on NDVI measured over selected time periods
- **Nitrogen, Phosphorus, Potassium (NPK) Maps:**
  Created using NDVI and NDRE indices to determine nutrient distribution and support VRA
- Historical data range considered: **2017–2024**

5. Assessment of Crop Performance Through Indices

5.1 Vegetation Monitoring – MSAVI & NDVI

NDVI and MSAVI measure vegetation greenness and vigor. Higher values indicate healthy vegetation, while lower values suggest stress or bare soil.

Index Interpretation

- **0.60–1.00:** Dense, lush vegetation; vigorous growth
- **0.40–0.59:** Moderate healthy vegetation; good canopy
- **0.20–0.39:** Sparse vegetation; possible stress
- **0.10–0.19:** Very sparse vegetation; early growth or degradation
- **0.00–0.09:** Bare soil, water bodies, or dry land

Additional Observations

- MSAVI reduces soil background influence, improving accuracy in early crop stages
- Temporal index trends track crop stages from germination to harvest
- Color-coded spatial maps highlight vegetation variability
- Fields treated with Navyakosh showed improved vegetation compared to untreated fields on sample dates

5.1.1 Crop Health Monitoring – RECI & NDRE

Chlorophyll Sensitivity (RECI)

RECI detects chlorophyll concentration and nutrient stress, especially nitrogen deficiency.

Value Interpretation

- **0.45–1.00:** Very good crop health
- **0.35–0.44:** Good health
- **0.25–0.34:** Moderate stress
- **0.15–0.24:** Poor health
- **<0.15:** Bare soil or dead crop

Key Insights

- NDRE enables early stress detection before visual symptoms
- Both indices penetrate dense canopies effectively during later growth stages
- Zonal health classification supports improved yield prediction
- Navyakosh-applied fields showed higher chlorophyll content than control fields

5.2 Moisture Index – NDMI

NDMI identifies moisture stress and supports irrigation decisions.

NDMI Interpretation

- **0.40–1.00:** Very high moisture; healthy crop
- **0.30–0.39:** Adequate moisture
- **0.20–0.29:** Moderate stress
- **0.10–0.19:** Low moisture; stress likely
- **<0.10:** Severe moisture stress or barren land

Higher NDMI values generally align with higher NDVI/MSAVI, indicating healthy crops. Low NDMI zones indicate yield risk due to water stress and enable early mitigation.

5.3 Moisture Correlation with Slope & Elevation

- Steep slopes showed faster runoff; flatter areas retained moisture
- Elevation influenced microclimate and crop suitability
- Combining NDMI, slope, and elevation improved yield risk assessment accuracy

5.4 Yield Assessment

Yield estimation used a **commercial hybrid model**:

- **WOFOST model** for physiological crop growth simulation
- **LAI assimilation** using Sentinel-2 imagery
- Outputs included biomass, storage organ weight, soil moisture, and total water use
- Additional inputs:
    - Historical yield data (3–5 years)
    - Weather parameters (rainfall, temperature, humidity)
    - Soil properties and vegetation indices (NDVI, EVI, NDRE)
- Machine learning models (e.g., **Random Forest**) fused outputs

Yield accuracy achieved: 80–90%, with forecasts up to **2 months in advance**

6. Recommendations

The LCB Fertiliser + Agri Matrix agronomy and satellite technology model can be scaled as follows:

(a) Satellite-Based INM/IPM Scheduling

- Use NDVI, NDRE, NDMI, and soil moisture indices for real-time advisories
- Potential outcomes:
    - Up to **25% reduction** in fertilizer misuse
    - **30% improvement** in pest control timing in the first cycle

(b) Baseline Crop Resilience Tracking

- Standardized pre- and post-application baselines
- Target improvements:

    - **15–20% yield increase**
    - **10–15% improvement** in soil C/N ratio

(c) Soil Health & Microbial Monitoring

- Combine remote sensing with IoT-based microbial analysis
- Expected results within 1–2 seasons:

    - **20% increase** in soil organic carbon
    - **25% growth** in beneficial microbial populations

(d) Reduced Input Dependency

- INM/IPM driven by satellite data may enable:

    - **20–35% reduction** in chemical pesticide and urea use
    - **15–25% reduction** in irrigation demand

(e) Open-Source Impact Data Assets

- Develop national geospatial layers of crop and soil performance
- Use cases include:

    - Government incentive schemes (e.g., PKVY)
    - Carbon credit programs and sustainability certifications