JECAM: India-Bargarh- Status

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Rice accounts > 40% of total grain production of India.
It is cultivated and consumed across the country.
Odisha is a major Rice growing state, where paddy crop is grown, in both the seasons (Kharif & Rabi).
The site was selected for Yield estimation study.
Bargarh site was selected because it is major Rice growing site and also irrigated.
This site can also be used for AsiaRiCE programme.

<table>
<thead>
<tr>
<th>Site Description</th>
<th>Odisha, India</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area of Site</strong></td>
<td>791 sq. km</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Attabira, Part of Bargarh District (Odisha), India</td>
</tr>
<tr>
<td><strong>Landscape Topography</strong></td>
<td>Mostly flatlands surrounded by eastern ghats.</td>
</tr>
<tr>
<td><strong>Climatic And Weather</strong></td>
<td>Climate is classified as tropical. Major rainfall during southwest monsoon period. 1527 mm of average annual rainfall. Average temperature 27.2°C</td>
</tr>
<tr>
<td><strong>Major Crops And Calendars</strong></td>
<td>Kharif (Rainy): Paddy Rabi (Winter): Paddy</td>
</tr>
<tr>
<td><strong>Soil Type &amp; Texture</strong></td>
<td>Major soil is Lateritic soil with patches of mixed red and yellow soils.</td>
</tr>
<tr>
<td><strong>Irrigation Infrastructure</strong></td>
<td>Approx. 76% area is irrigated</td>
</tr>
<tr>
<td><strong>Average Field Size</strong></td>
<td>1 ha</td>
</tr>
</tbody>
</table>

Village Panchayats, Attabira

Attabira, Bargarh
Project Objectives

❖ To evaluate the various approaches and data for crop area, condition monitoring and yield estimation, with the aim of establishing ‘best practices’ for Rice-Rice agricultural systems.

❖ Development of advance protocol for yield estimation, loss assessment and smart sampling, at lower administrative unit, for crop insurance.
1. **Ground Truth:** 30 GTs collected covering the study area with multiple crops.

2. **AWS based weather information:** Past 5 years weather data from AWS installed at Bheeden, Padampur and Paikmal. Gridded 0.25° daily weather data collected from IMD.

3. **Crop parameters:** Various crop parameters like Sowing time, Variety, Crop health status, etc. collected.

4. **Crop Cutting Experiments:** Around 50 Crop Cutting Experiments (CCEs) conducted through Smart sampling (remote sensing based CCE planning). Crop information such as Crop yield, Crop Biomass, Harvesting time etc. were collected during CCE.
## Satellite Data Used

<table>
<thead>
<tr>
<th>Data /Product</th>
<th>Satellite</th>
<th>Sensor</th>
<th>Resolution (m)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Insolation</td>
<td>INSAT 3D</td>
<td>Imager</td>
<td>1000</td>
<td>MOSDAC</td>
</tr>
<tr>
<td>8-days FAPAR</td>
<td>Terra</td>
<td>MODIS</td>
<td>500</td>
<td>NASA-RIVERB</td>
</tr>
<tr>
<td></td>
<td>Resourcesat 2</td>
<td>AWiFS</td>
<td>56</td>
<td>NRSC-NDC</td>
</tr>
<tr>
<td>8-days Surface reflectance</td>
<td>Terra</td>
<td>MODIS</td>
<td>500</td>
<td>NASA-RIVERB</td>
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<tr>
<td></td>
<td>Resourcesat 2</td>
<td>AWiFS</td>
<td>56</td>
<td>NRSC-NDC</td>
</tr>
<tr>
<td>NDVI &amp; LSWSI during Stage</td>
<td>Resourcesat 2</td>
<td>LISS III</td>
<td>23.5</td>
<td>NRSC-NDC</td>
</tr>
<tr>
<td>Maximum Vegetative Stage</td>
<td>Sentinel 2</td>
<td>MSI</td>
<td>10</td>
<td>ESA</td>
</tr>
<tr>
<td>Crop (Rice) mask</td>
<td>Landsat 8</td>
<td>OLI</td>
<td>30</td>
<td>NASA</td>
</tr>
<tr>
<td>Crop Sowing Period</td>
<td>Sentinel 1</td>
<td>SAR</td>
<td>20</td>
<td>FASAL Project</td>
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<td>SAR</td>
<td>20</td>
<td>FASAL Project</td>
</tr>
</tbody>
</table>
Paddy Ground truth in Attabira Block
Information collected during Ground truth

Variety
- Hybrid
- MTU 1156
- Jamuna
- Others

Crop Covered
- Paddy
- Cotton
- Moong
- Groundnut

Field condition
- Dry
- Flood
- Moist

Crop condition
- Average
- Good

Sowing time
- June 1 FN
- June 2 FN
- July 1 FN
- July 2 FN

Legend
- Other crop
- Paddy

Ground truth points over Attabira Block of Odisha
Satellite data- Sentinel-2 MSI (27 Oct 2020)
UAV Imaging

UAV used: Fixed wings
Endurance: 1-1.5 hr.
Resolution: 15cm
Camera used: RGB and Multispectral
Location: Attabira Block-Bargarh
Temporal Sentinel-1 Images
Backscatter (VH)

01-JUN-2020
13-JUN-2020
25-JUN-2020
07-JUL-2020
31-JUL-2020
12-AUG-2020
24-AUG-2020
05-SEP-2020

Early transplanted
Late transplanted
Temporal Sentinel-1 Images
Backscatter (VH)

17-SEP-2020

29-SEP-2020

10-OCT-2020

23-OCT-2020

04-NOV-2020

16-NOV-2020

Peak vegetative growth
Rice mapping and Yield estimation
(Schema of work)

- Ground data:
  - Crop
  - Transplanting date

- Cadastral parcel map

- Rice Mapping:
  - Pixel wise
  - Parcel wise

- Transplanting dates

- Decision rules

- Temporal Sentinel-1 VV & VH

- Temporal Sentinel-2

- Season Max $\sigma^{0}_{VH}$

- NDVI, LSWI

- Crop condition

- DSSAT crop Model

- Ancillary Data:
  - Weather
  - Soil
  - Management
  - Crop parameters

- Parcel wise rice yield
**Rice Mapping & Transplanting Dates**

- **RGB**
  - 07Jul (VH)
  - 12Aug (VH)
  - 05Sep (VH)

- **Transplanting dates**
  - 07Jul
  - 31Jul
  - 12Aug
  - Water
Area Statistics

Total Rice area

Early transplanted

Late transplanted

Area in ha
- < 250
- 250-500
- 500-750
- 750-1000
- 1000-1250
- > 1250

< 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 60%
- > 60%
Rice Yield Simulation

Kharif rice crop growth and yield simulated using crop growth simulation model (DSSAT) with following inputs:

✓ Soil map (NBSSLUP)
✓ Daily weather data like maximum, minimum temperature, rainfall and solar radiation
✓ Rice map (NRSC)
✓ Sowing map/start of the season (NRSC)
✓ Temporal NDVI & LSWI (Sentinel 2A)

Results:
✓ Simulated yield is highly dependent on start of the season and late sown pixels have higher values of yield
Crop Yield Estimation using Production Efficiency Model (PEM)

RUE: Maximum radiation use efficiency (g/MJ/day); HI: harvest Index (economic yield/Total dry matter); NPP: Net Primary Product; LSWI: Land Surface Water Index; PAR: Photosynthetically Active Radiation (0.4-0.7μm); fAPAR: Fraction of PAR absorbed by the plant; T: Daily average temperature; Tmax: higher thresh hold for crop growth; Tmin: Lower thresh hold for crop growth and Topt: Optimum temp. for crop growth

\[
T_{stress} = \frac{(T - T_{min})(T - T_{max})}{(T - T_{min})(T - T_{max}) - (T - T_{opt})^2}
\]

Yield = \sum_{Sowing}^{Harvesting} NPP * HI
Remote Sensing based Plans for Crop Cutting Experiments (CCE)

Paddy Crop Map

Paddy Yield map using PEM

Proposed CCE location
Crop Cuts conducted in selected sites
Proposed analysis

- Derivation of crop phenological matrices.
- Integration of optical and SAR data for better mapping and monitoring of rice crop.
- Evaluation of advanced classifiers for rice crop classifications.
- Validation of estimated crop yield using CCE data.
- Exploring other methods (AI/ML) for crop yield estimation.

Thank you.