Remote Sensing for Agricultural Applications

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GeoSmart India, 2016: Geomatics for Digital India, March 2, 2016
Indian Agriculture

- **Net Area Sown**: 141.6 Mha (43%)
- **Foodgrain production**: 252 Mt
  - (Kharif: 128 Mt, Rabi: 124 Mt)
- **Horticulture Production**: 281 Mt
- **Net Irrigated Area**: 65.3 Mha (46.4%)
- **Agrl. Share of GDP(%)**: 13.9
- **Employment Opportunity**: 54.6%
- **Average Field size**: 1.15 ha
Diversity of Physical Parameters controlling Indian Agriculture

120 cm rainfall
75% during southwest monsoon season
Western coastal plain and NE region >400 cm
Western Rajasthan, Gujarat, Haryana & Punjab < 60 cm

• NAI/NAS is >90% for Punjab and <15% for Maharashtra
• Irrigation coverage high (>80%) for Wheat, Sugarcane and low (<15%) for millets, pulses

4 Major Soil types
- Alluvial soils (77.7 Mha, Fertile)
- Black soils (51.8 Mha, Fairly fertile)
- Red soils (51.8 Mha, Differ in fertility)
- Laterite soils (12.7 Mha, Low Fertility)

4 Physiographical divisions
- Northern mountain region
- Great plains of the north
- The Peninsular plateau
- The Coastal plains and Islands
Altitude ranges from >1000 m to <250 m
Agriculture: the Major Driver for Indian Space Programme

- Birth of Remote Sensing in India with Coconut Wilt Experiment of 1970
- A Major Role in Defining Indian Remote Sensing Satellites
- Significant Role in Growth of Digital Image Processing in India; Development of In-house Software
- One of the Themes with Largest Number of Professionals (Inside & Outside ISRO) Involved
- Crop Forecasting Activity is the Biggest Single User of Remote Sensing Data (especially, Resourcesat-2, Radarsat/RISAT) in India
- Institutionalization: Establishment of MNCFC under MoA&FR
- Acceptance in National and International Level
47 Years of Use of Remote Sensing in Crop Assessment

1969 NASA-ISRO-MoA
1978 JEP
1988 CAPE
1997 FASAL Pilot
2007 FASAL
2012 NCFC

Coconut Root Wilt study in Kerala
Experimental Studies on Crop Discrimination
Area & production Estimates of major crops at State level.
National Wheat, FASAL-Odisha
District-State-National forecasts using multiple approaches for multiple forecasts
Institutionalisation of Space Technologies developed by ISRO
Major National level Programmes

**FASAL** (Forecasting Agricultural output using Space, Agrometeorology & Land based observations)

**NADAMS** (National Agricultural Drought Assessment & Monitoring System)

**CHAMAN** (Coordinated Horticulture Assessment and Management using geoinformatics)

**KISAN** (Crop Insurance using Space technology and geoinformatics)
Aims at providing multiple pre-harvest production forecasts of crops at National/State/District level

National/State/District forecasts:
• Kharif Rice (Kharif + Rabi)
• Cotton
• Sugarcane
• Wheat
• Rapeseed & Mustard
• Sorghum (Rabi)
• Pulses (Rabi)
• Jute

53.2% of total cropped area; 78.3% of Foodgrain production

Partners: MoA, ISRO, IMD, ICAR, IEG, 19 State Agri. Depts., 17 State Remote Sensing Centres, 46 Agro-Met Field Units (SAUs)
Geospatial Technology for Field Data Collection

- Sampling plan based on RS data
- Smartphones/Tablets
- Android based App. by NRSC
- Bhuvan Geoportal
- State Agrl. Dept. Officials

- >18000 GT points, >2400 CCEs

Groundtruth

Crop Cutting Expt
Yield forecasting: Methods

I. District/Met-Subdivision level Agro-meteorological models

II. Rice Biomass Modeling using SAR data

III. Semi-Physical Model for Wheat

IV. Crop Cutting Experiments using RS based Sampling Plan
Remote Sensing driven Crop Cutting Experiments
<table>
<thead>
<tr>
<th>Estimates</th>
<th>Remote Sensing</th>
<th>DES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^{st})</td>
<td>31(^{st}) Aug</td>
<td>2 date data, State level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mainly guided by visual observations</td>
</tr>
<tr>
<td>2(^{nd})</td>
<td>30(^{th}) Sep</td>
<td>3 date data, District Level</td>
</tr>
<tr>
<td>3(^{rd})</td>
<td>31(^{st}) Jan (Final)</td>
<td>Using Remote sensing based yield models &amp; Tamil Nadu Samba Rice</td>
</tr>
<tr>
<td>4(^{th})</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Final</td>
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</tbody>
</table>
Comparison with DES

**Correlation (Area)**

**RMSE { Area (M. Ha) }**
Comparison with DES

**Correlation (Production)**

- Khanirice
- Rapeseed & Mustard
- Rabi-rice
- Wheat
- Jute

**RMSE (Production) M. Tonn / Bales**

- Khanirice
- Rapeseed & Mustard
- Rabi-rice
- Wheat
- Jute
Map of Rabi Emergence Area in 6 States

2015-16

(3rd Dekad of December) (1st Dekad of January) (2nd Dekad of January) (3rd Dekad of January) (1st Dekad of February)

2013-14

(3rd Dekad of December) (1st Dekad of January) (2nd Dekad of January) (3rd Dekad of January) (1st Dekad of February)
Operational Drought assessment during Kharif using Remote Sensing (Methodology developed by ISRO)

Periodic District/Sub-District level drought assessment for 14 Agriculturally Dominant states of India (5 at Sub District level)

Satellite based indices, Rainfall data, Ground information on Sowing progression and Irrigation Statistics are used for drought assessment

Drought Warning (Normal, Watch & Alert) is given in June July & August, while Drought Declaration (Mild, Moderate & Severe) in September & October
Drought Assessment: Inputs

1. Remote Sensing based indices:
   - Normalized Difference Vegetation Index (NDVI)
   - Normalized Difference Water Index (NDWI)
   - Vegetation Condition Index (VCI)

2. Area Favourable for Crop Sowing (using Satellite based Index and Soil Moisture Index)

3. District level Rainfall Deviation

4. Irrigation percentage

District level Irrigation%  Rainfall Data from IMD

NDVI from NOAA Data (1 km)  NDWI from MODIS Data (500 m)
NDVI from AWiFS Data (56 m)  Soil Moisture Index
28 August 2015
Drought Assessment: October, 2015
II (d) NORMALIZED DIFFERENTIAL VEGETATION INDEX (NDVI)

Normalized Differential Vegetation Index (NDVI), which is one of the 4 key Indices to be examined for Declaration of Mandals as Drought affected in the “Manual for Drought Management ” Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi, published in November-2009. The NDVI data has been provided by Mahalanobis National Crop Forecast Centre (MNCFC), Department of Agriculture & Cooperation
Vegetation & Temperature Condition Index

- Vegetation Condition Index (NDVI) = \(100 \times \frac{(\text{NDVI} - \text{NDVI}_{\text{min}})}{\left(\text{NDVI}_{\text{max}} - \text{NDVI}_{\text{min}}\right)}\)
- Vegetation Condition Index (NDWI) = \(100 \times \frac{(\text{NDVI} - \text{NDVI}_{\text{min}})}{\left(\text{NDVI}_{\text{max}} - \text{NDVI}_{\text{min}}\right)}\)
- Temperature Condition Index = \(100 \times \frac{(\text{LST}_{\text{max}} - \text{LST})}{\left(\text{LST}_{\text{max}} - \text{LST}_{\text{min}}\right)}\)

Agricultural Condition (January 2016)
CHAMAN: Horticulture Assessment

- Area assessment and production estimation of major horticultural crops
- Geospatial Applications for Horticultural Development
- R&D Studies: Precision Farming, Signature Study, Yield Modeling.

Area and Production (7 Crops, 12 states, 180 Districts)
- Fruits: Banana, Mango and Citrus
- Vegetables: Potato, Onion and Tomato
- Spices: Chili

Horticultural Development Studies
i) Site Suitability
ii) Post-Harvest Infrastructure
iii) Crop Intensification
iv) GIS database creation
v) Orchard Rejuvenation
vi) Aqua-horticulture.
KISAN: Remote Sensing for Crop Insurance

Objectives

- High Resolution Remote sensing for Crop Cutting Experiment planning
- To develop better models for crop yield assessment
- To provide yield estimates at block level
- To develop/evaluate an approach/index for index-based insurance

Partners

- Mahalanobis National Crop Forecast Centre
- ISRO Centres (SAC & NRSC)
- India Meteorological Department
- State Remote Sensing Centers
- State Agriculture Departments
- Climate Change, Agriculture and Food Security (CCAFS)
Impact of Disaster on Agriculture

- Rice-Flooded Area Assessment, post-Phailin Cyclone in Odisha State, October, 2013

- Impact Assessment of Heavy Rainfall and Hailstorm in Northern India during Feb-Mar, 2015
Whitefly Attack

18 Aug, 2014
19 Sept, 2014
5 Oct, 2014

21 Aug, 2015
6 Sept, 2015
8 Oct, 2015
Issues & Requirements

Minor and Scattered Crops

Non-Rice Kharif Crops

Accurate Yield Forecasts

Impact of Extreme Weathers

Higher Frequency of RS Data

Better Models for Yield

Satellite Derived Product

Geospatial Platforms
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