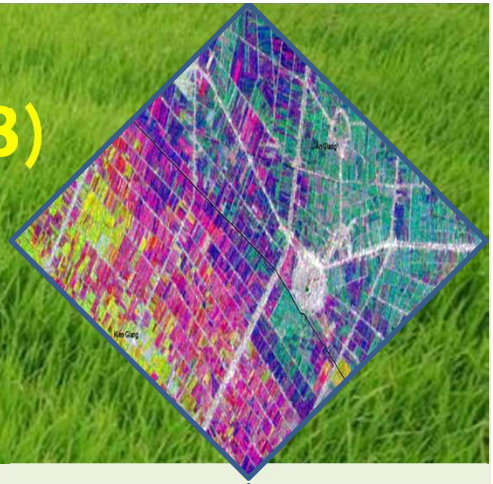
EOS-04 (RISAT-1A) & EOS-06 (Oceansat-3) Applications in Agriculture



EOS-04

- All-India *kharif* rice mapping
- *Kharif* sown area estimation (by August end)
- Rice mapping in Mekong River Delta, Vietnam
- Crop damage assessment

EOS-06

- All-India *kharif* sown area progress monitoring

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EOS-04 Data - Advantages

- Indian microwave mission with capability to image in multiple resolutions in single, dual, circular or full polarization
- New opportunities for various thematic applications with availability of multi-mode, multi-polarization data
- Wide range of incidence angles and swaths; full polarimetric data available at wider swath at MRS and CRS modes
- Seamless availability of data over Indian region throughout crop growth seasons
- Comparable with microwave data already available (in terms of spatial and temporal resolution)

EOS-04 Data for Agriculture

Mode/Data	Applications/ Advantages
Medium Resolution ScanSAR (MRS) systematic coverage dual pol. (HH, HV)	• *kharif* sown area at regional scale • Area under major crops • Deriving the crop phenolgy like sowing date, peak vegetative stage and harvesting for major crops • Assessing the affected crop area due to floods/cyclones/heavy rains • Time series data for cropping pattern/system analysis • Can supplement the optical data for analysis during *rabi* season (fog/cloud sometimes limits the optical data)
FRS-1/FRS-2 Full Polarimetry or Hybrid Polarimetry	• Improved discrimination of crops especially short duration *kharif* crops like maize, soybean, pearl millet etc. • Single or limited datasets instead of multi-temporal amplitude data for crop discrimination • Crop parameter retrieval
MRS/CRS Full Polarimetry or Hybrid Polarimetry	• Crop discrimination and parameter retrieval over large area due to wider swath and Full pol. information

Drought monitoring framework as per Manual 2016

nrsc

Mandatory Indicators

Triggar I

Rainfall Related Indices

- Actual Rainfall
- Normal Rainfall
- Rainfall Deviation /SPI
- Dry Spell

Filed verification

- Real time field visits
- Validation of drought assessment
- GT in 5 sites, each, of 10% of Villages

Impact Indicators

Triggar II

Satellite based Vegetation Indices

- NDVI (Normalized Difference Vegetation Index)
- NDWI/LSWI
- VCI of NDVI
- VCI of LSWI

Moisture based Indices

- MAI (Moisture Adequacy Index)
- PASM (Percent Available Soil Moisture)

Hydrological Indices

- RSI (Reservoir Storage Index)
- GWDI (Ground Water Drought Index)
- SFDI (Stream Flow Drought Index)

Crop planting/sowing status (manual collection)

- **Area under crops**

Criteria for declaration

3 to 4 of 6 impact indicators are to be satisfied

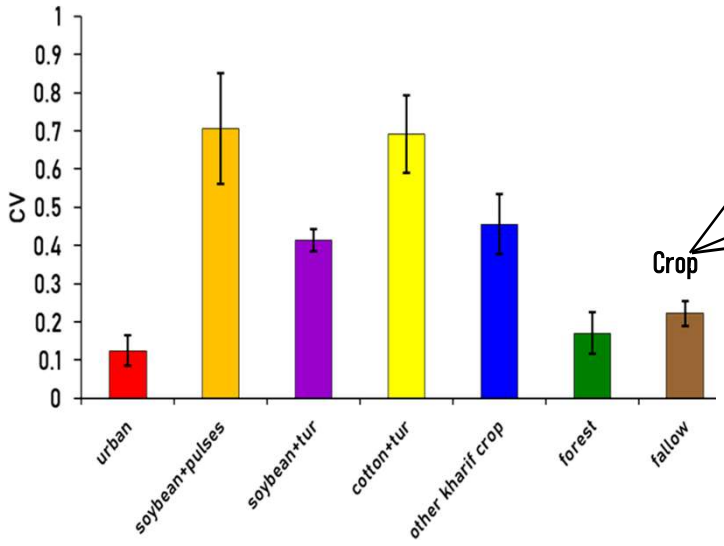
- ***Severe drought:*** *if two of the selected 3 impact indicators are in Severe category and 1 is in Moderate category*
- ***Moderate drought:*** *(i) if two of the selected 3 impact indicators are in 'Moderate' class. (ii) if two of the selected 3 impact indicators are in severe and 1 is in Normal category*

Kharif Sown Area Estimation by the end of August using EOS-04

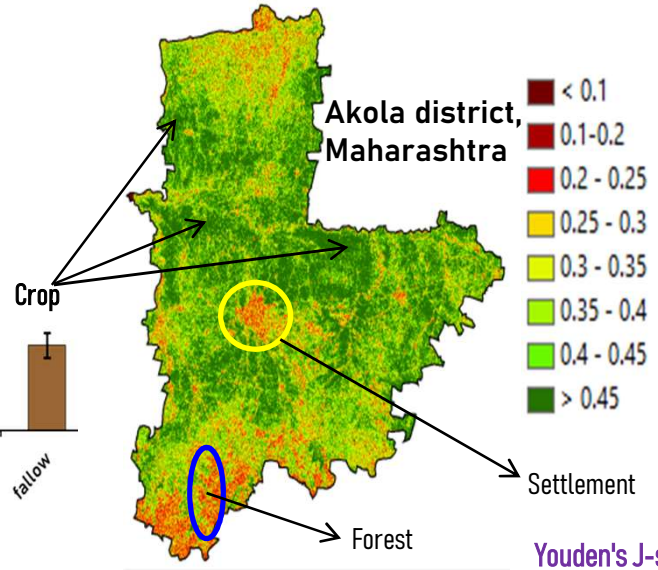
Objective - Early estimation of in-season *kharif* sown area *(MoA&FW requirement)*

Data used – EOS-04 MRS HV (Jun to Aug 2022), Max. NDVI composite of August month Optical data

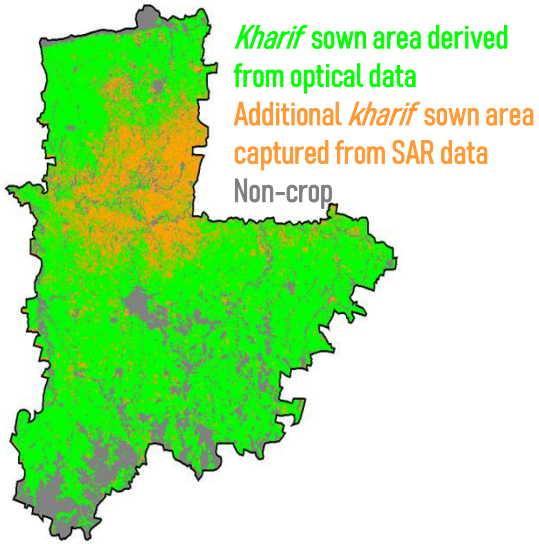
Crops exhibit higher CV than other land cover classes



Temporal CV of various land covers



End of August *kharif* sown area map of Akola district (SAR + Optical)

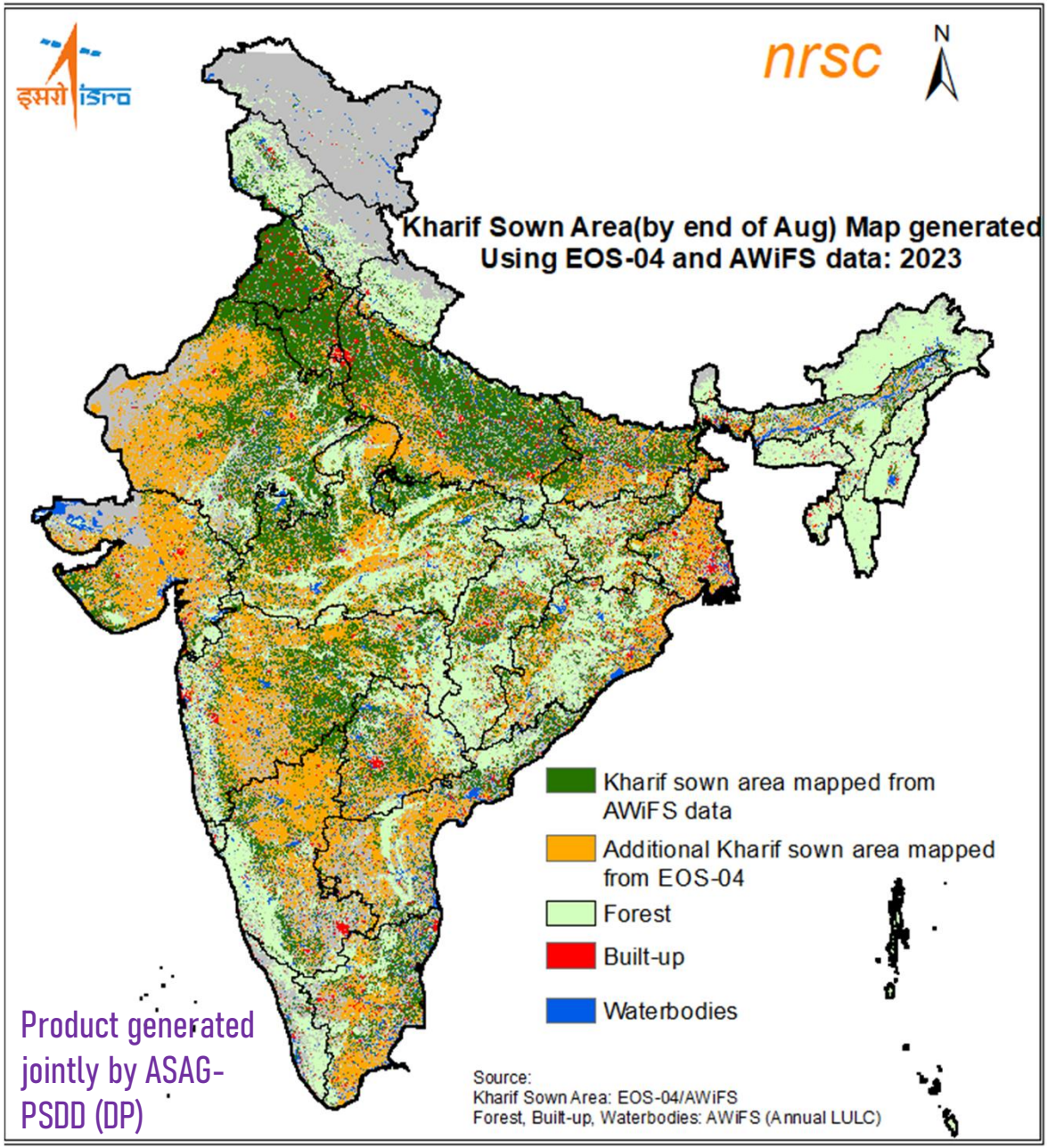


Youden's J-statistic (or Youden's index) indicates the threshold for which the difference between the true positive (Sensitivity) and false positive (1-Specificity) rate is the greatest

Kharif Sown Area Estimation by the end of August using EOS-04

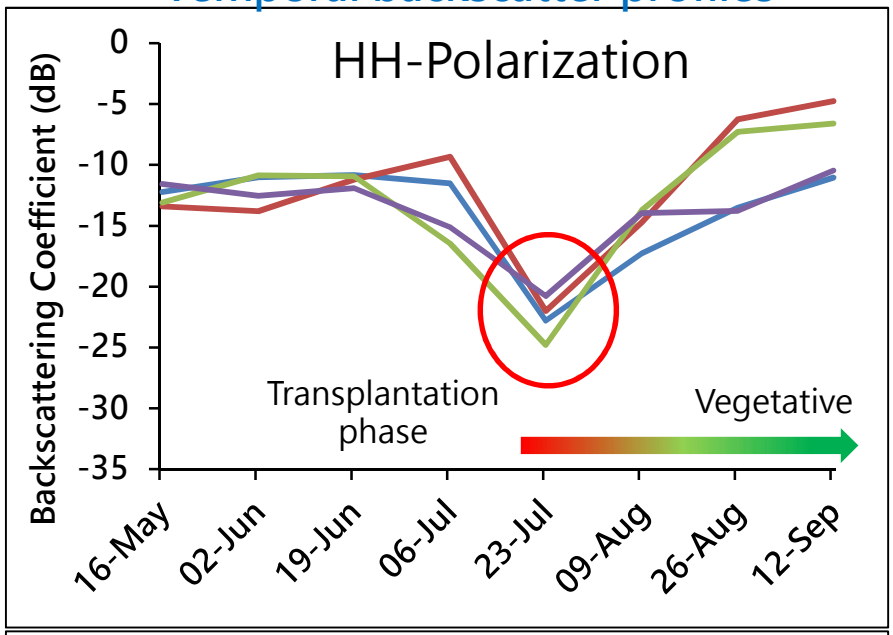
Achivement

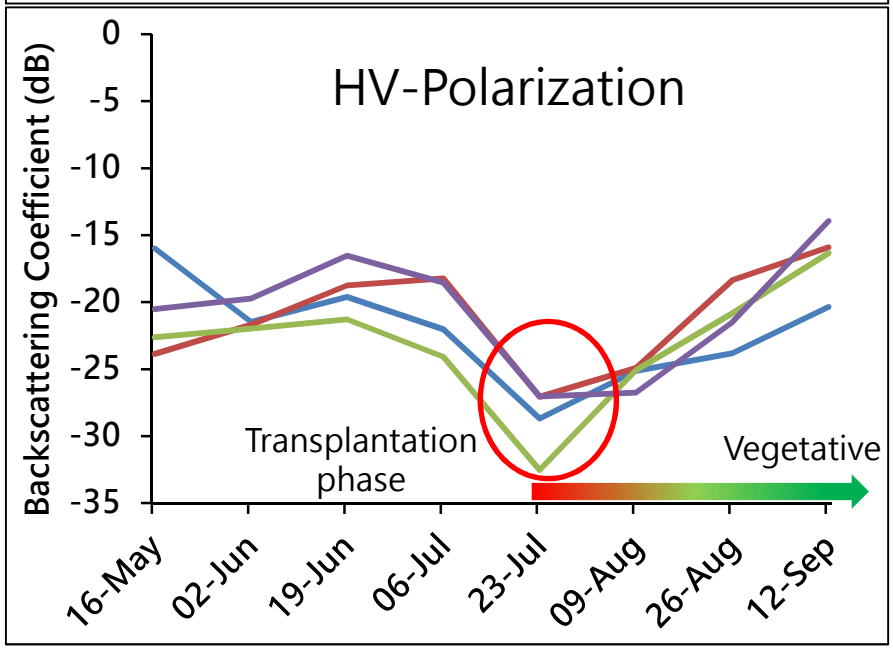
- Synergy of optical & SAR enhanced the accuracy of *kharif* sown area at national level
- Process automated in DP chain for upscaling to national level



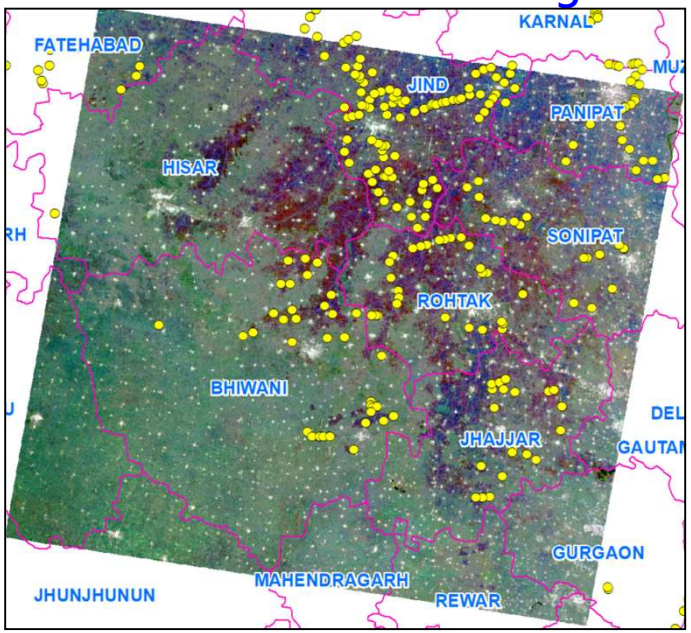
Temporal backscatter (MRS) for Crop Mapping

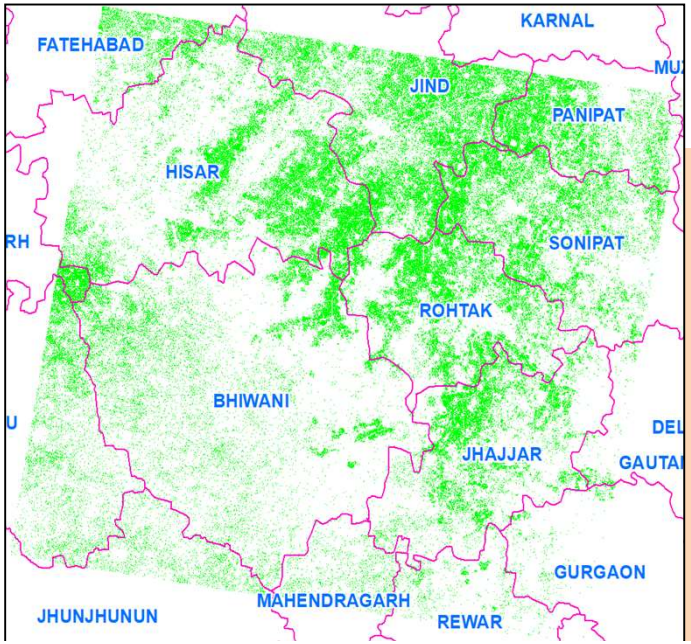
Temporal backscatter profiles





RGB: 06Jul23Jul09Aug





Mapping of Rice crop

Part of Haryana

Rice crop

- Both HH & HV showed good sensitivity to rice crop growth
- MRS data can be readily used for operational estimation of rice crop area

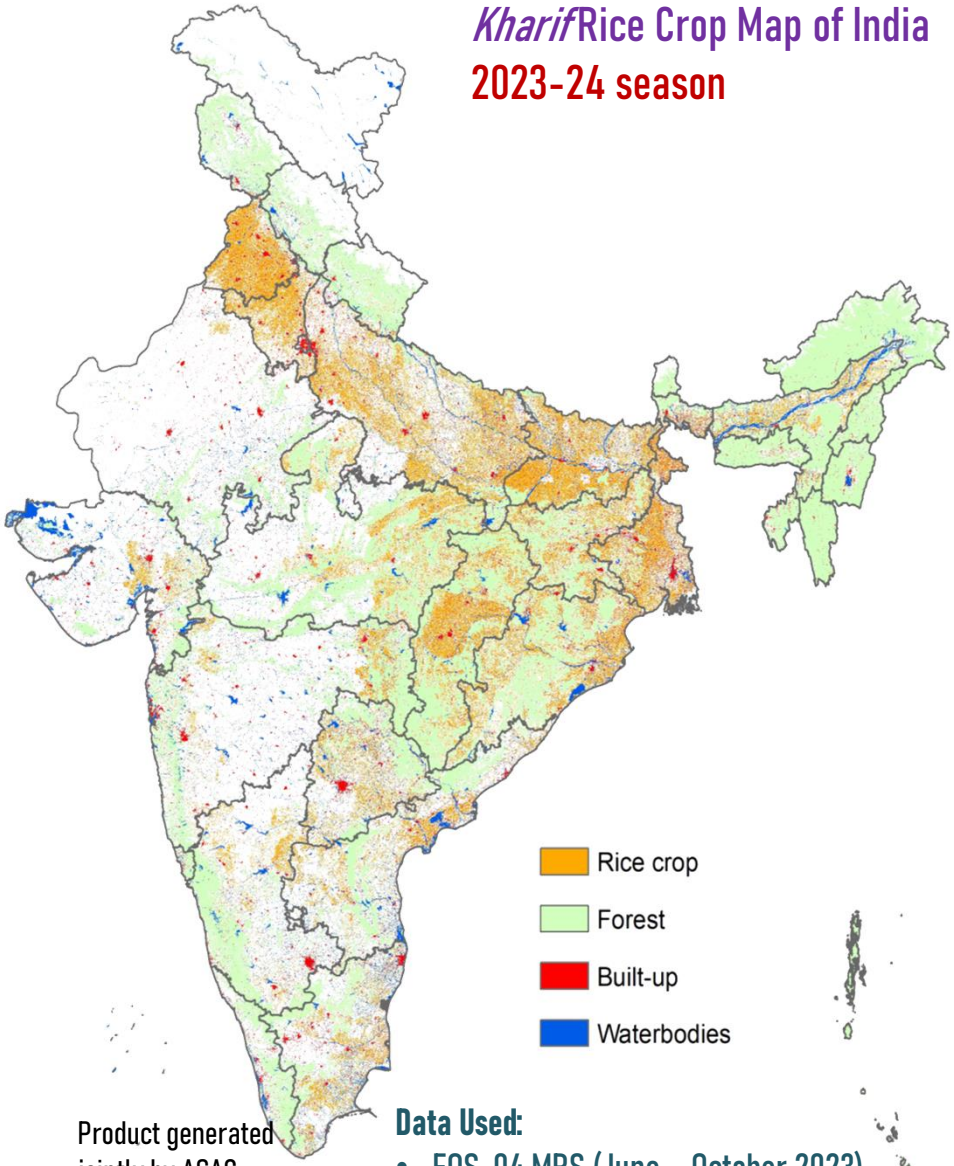
Rice crop mapping using EOS-04 MRS data-National scale

Achievement:

Pre-harvest acreage estimation of rice crop in *kharif* season through DP chain

- Addresses staggered transplantations

Kharif Rice Crop Map of India
2023-24 season



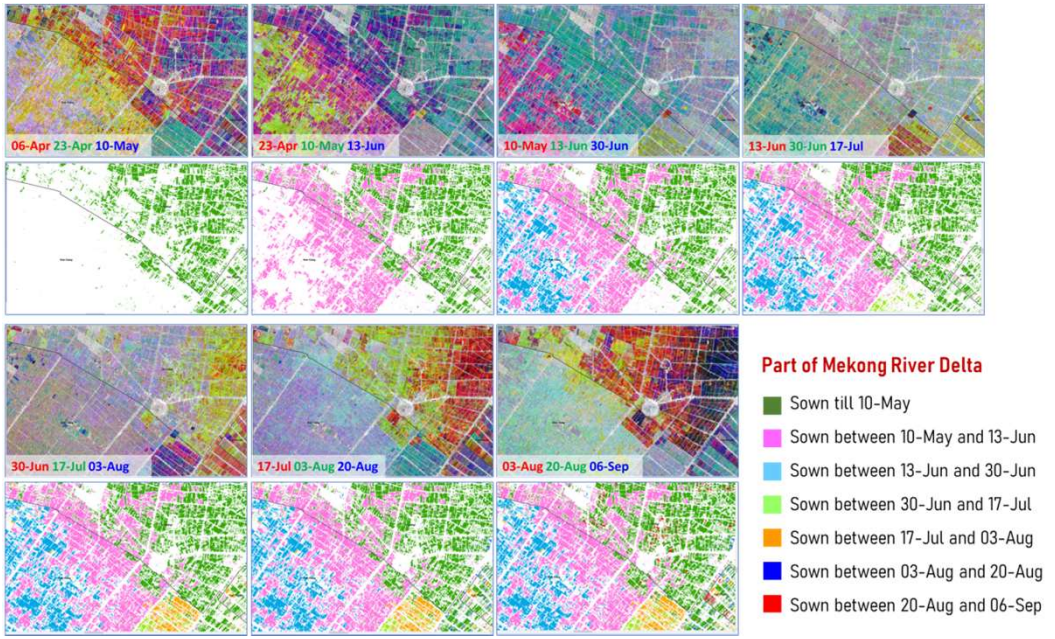
Product generated jointly by ASAG-PSDD (DP)

Data Used:

- EOS-04 MRS (June – October 2023)
- AWiFS 1:250K LU/LC

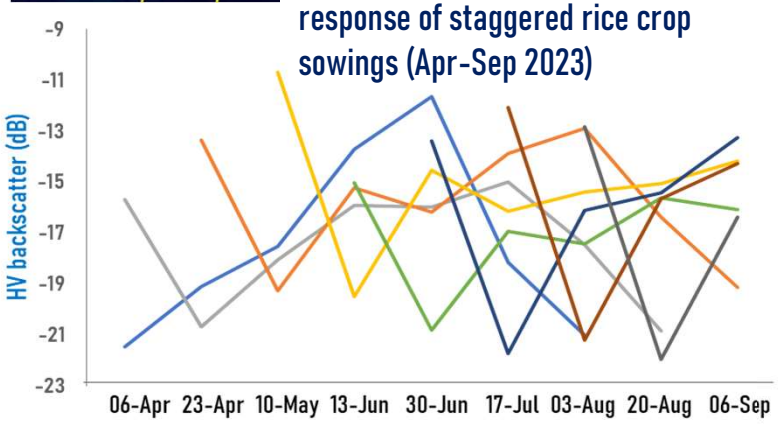
EOS-04 Data for Rice Crop Mapping in Mekong River Delta, Vietnam

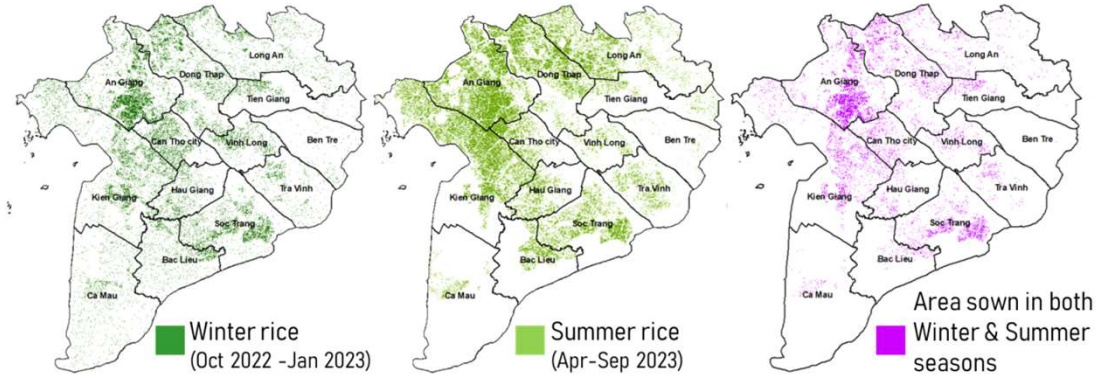
- Programmed systematic coverage of EOS-04 MRS HV data over Mekong river delta for Summer season rice crop mapping (Apr-Sep '23)
- **Study can be extended to rice-growing SAARC/South-East Asian countries**

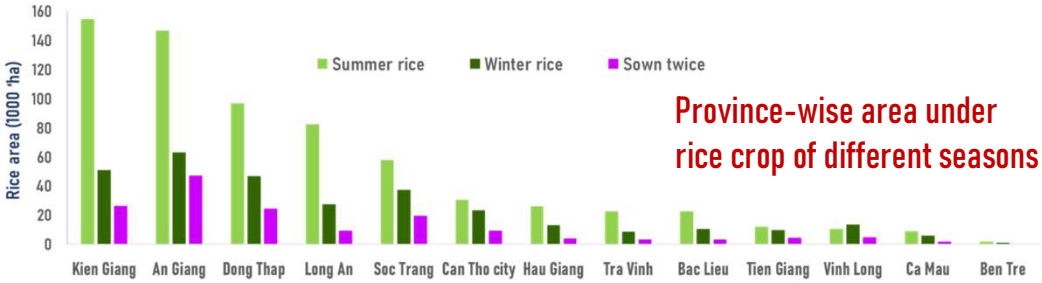


EOS-04 coverage of Mekong River Delta region

EOS-04 HV temporal backscatter response of staggered rice crop sowings (Apr-Sep 2023)



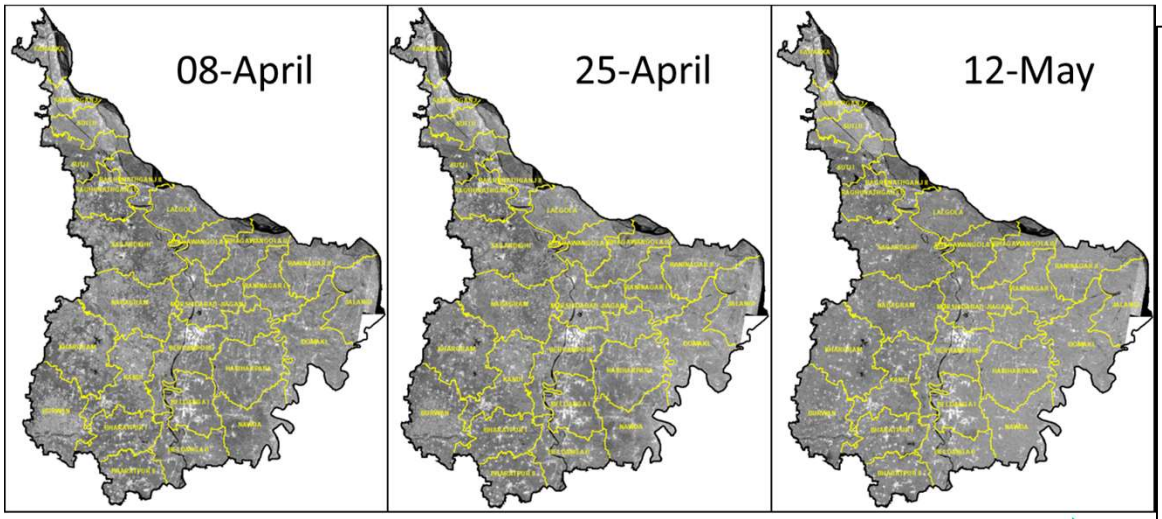




Province-wise area under rice crop of different seasons

Temporal backscatter (MRS) for Crop Mapping

Mapping of Jute crop

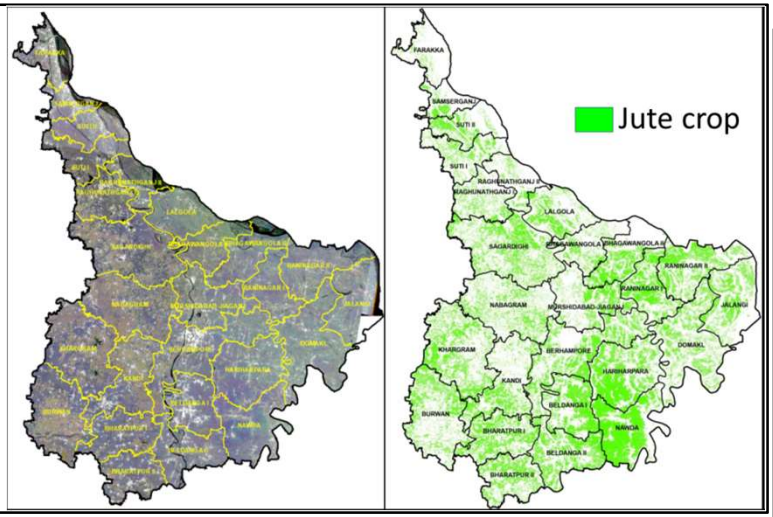


Sowing/germination (-12 to -10 dB) → Early vegetative (-10 to -7 dB) → Vegetative (-6 to -5 dB)

Murshidabad district, West Bengal

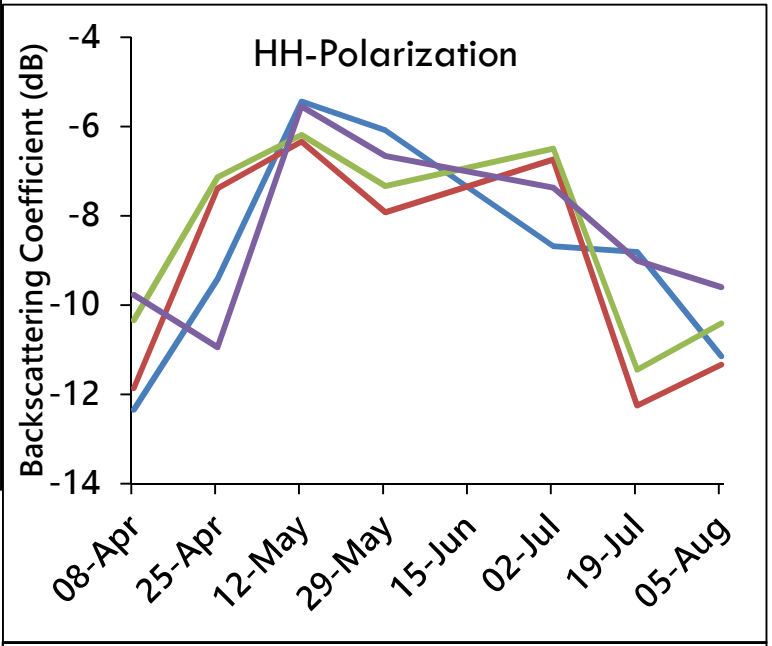
RGB
08Apr
25Apr
12May
(18 m pixel)

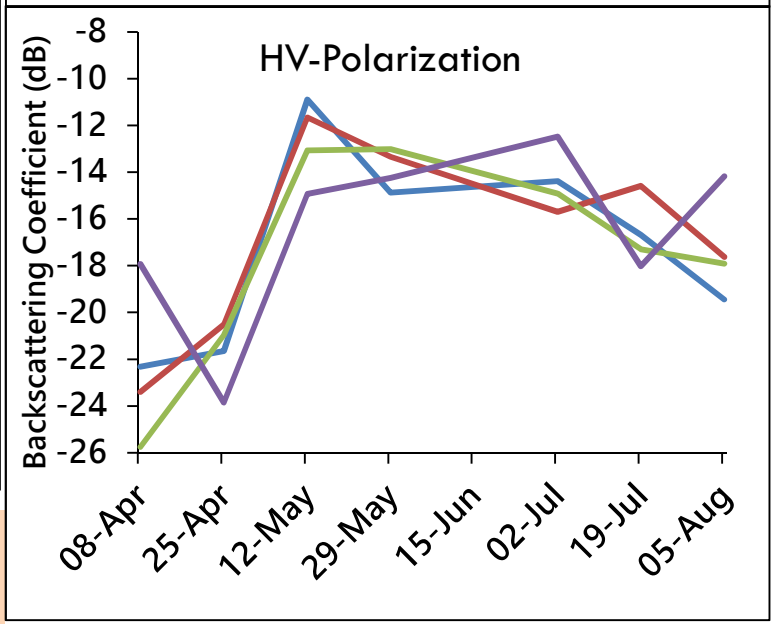
(HH-Pol.)



- Both HH & HV showed good sensitivity to Jute crop growth
- MRS data can be readily used for operational mapping of jute crop

Temporal backscatter profiles

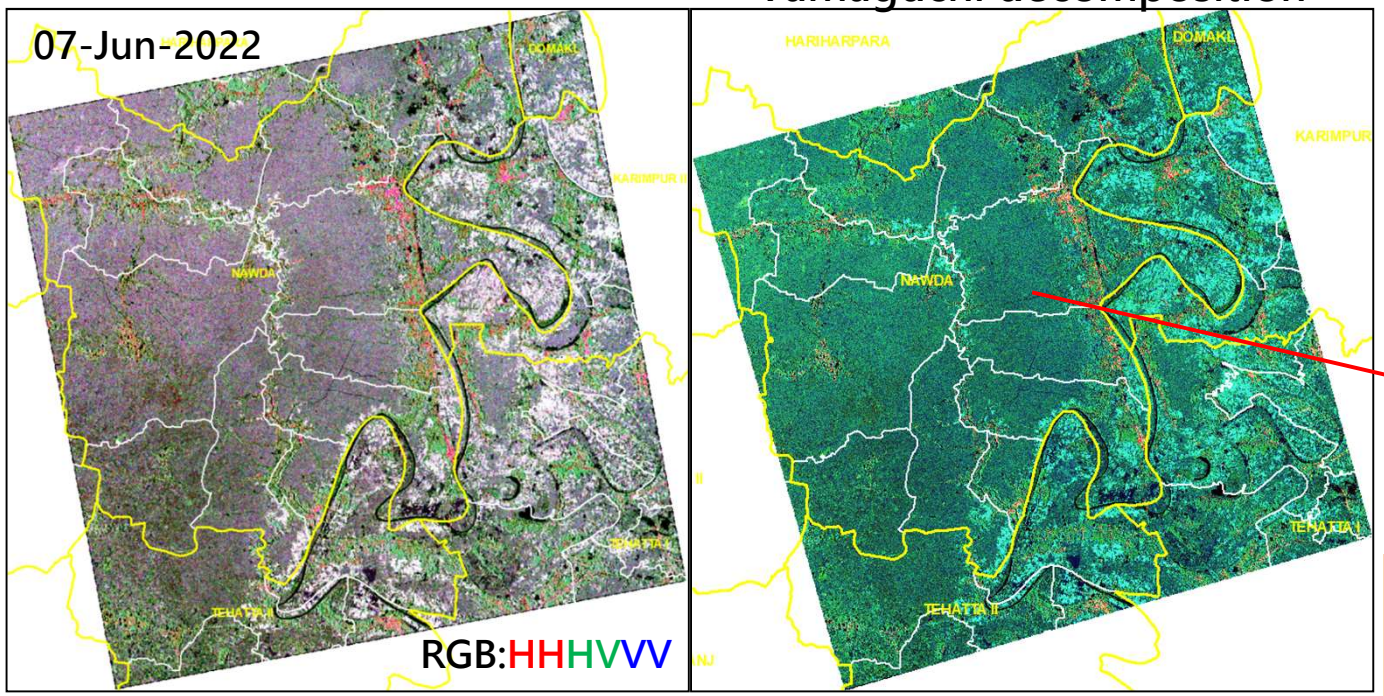




Full Polarimetry for Improved Crop Classification

FCC of Full Pol. data

Yamaguchi decomposition

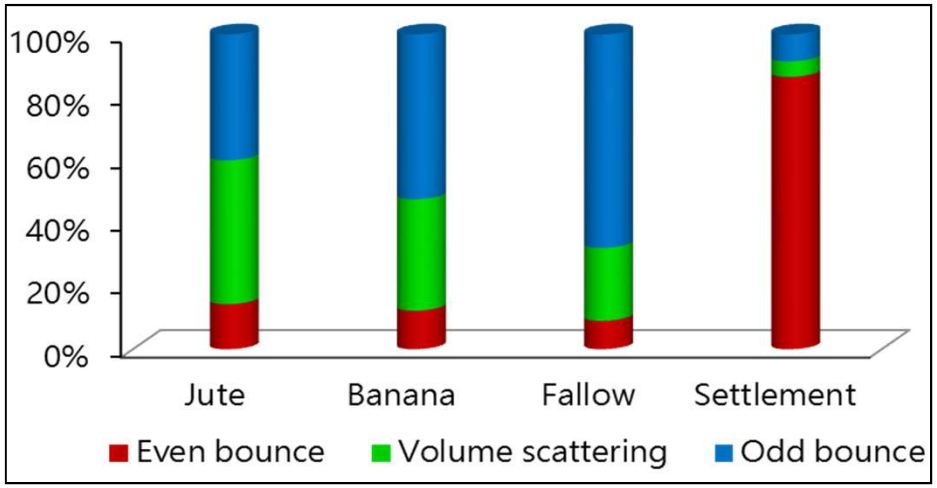


Scattering mechanisms of crops at various growth stages

RGB
Even bounce
Volume
Odd bounce

At **Vegetative stage** of jute crop, **Volume scattering** is the dominant scattering mechanism

07-June-2022

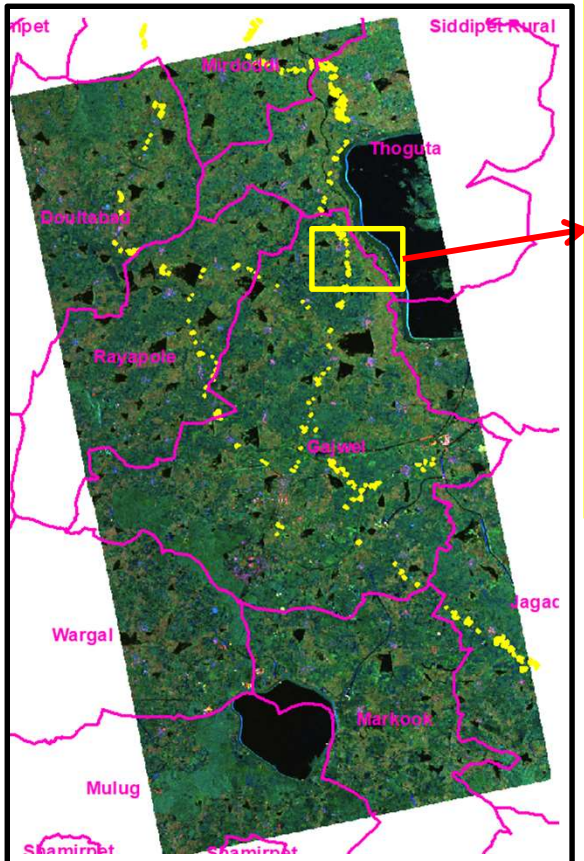


Scattering contributions from crops

Cover/Crop	Dominant scattering mechanism (s)
Jute	Volume (multiple scattering) & Odd bounce
Banana	Odd bounce and Vol.
Fallow	Odd bounce
Settlement	Even bounce

Single-date Full Polarimetry Application – Multi-Crop Scenario

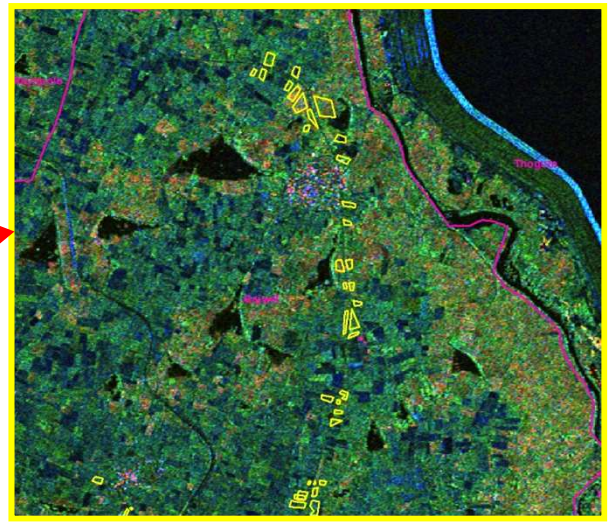
Fully Polarimetric data for crop classification



RGB
Even bounce
Volume
Odd bounce

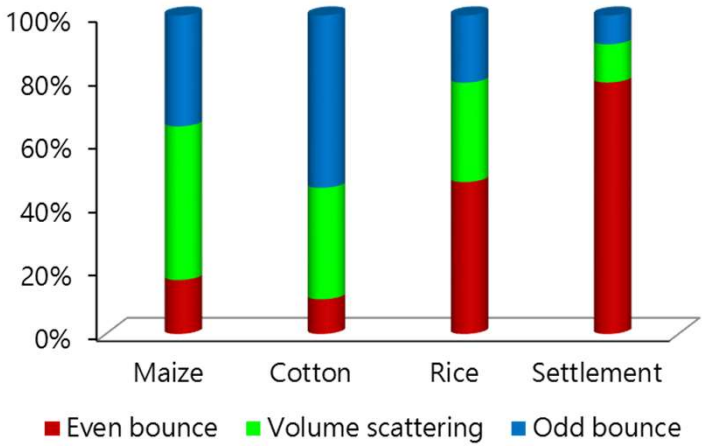
Yamaguchi decomposition

Parts of Telangana



Ground Truth data overlaid on image

Scattering contributions from different crops



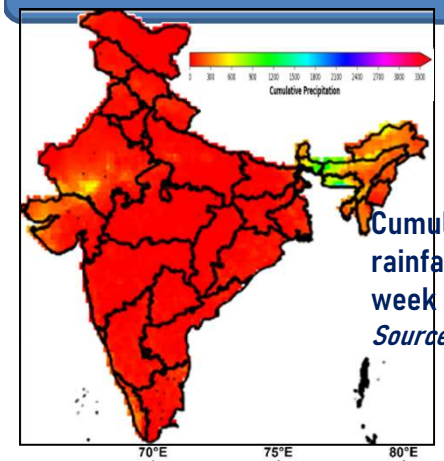
Cover/ Crop	Dominant scattering mechanism(s)
Maize	Volume (multiple scattering) & Odd bounce
Cotton	Odd bounce and Vol.
Rice	Even bounce & Vol.
Settlement	Even bounce

Maize crop at maturity

Cotton crop at flowering to squaring stage

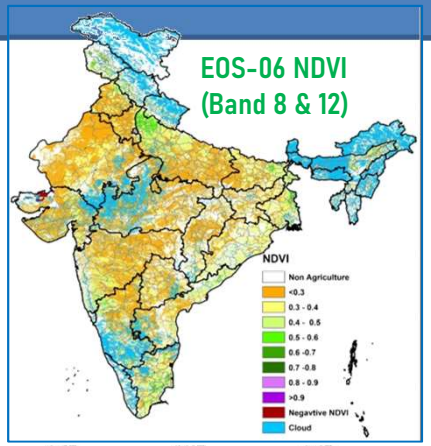
Rice crop at max tillering to grain filing stage

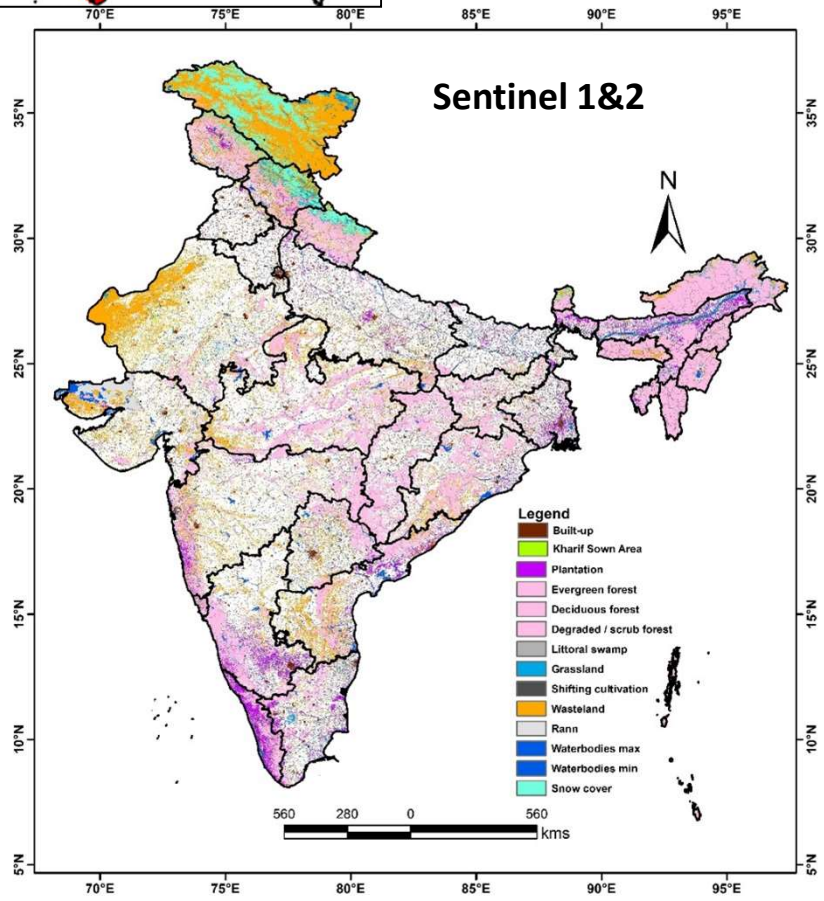
Oceansat (EOS-06) Data for *Kharif* Sown Area Monitoring

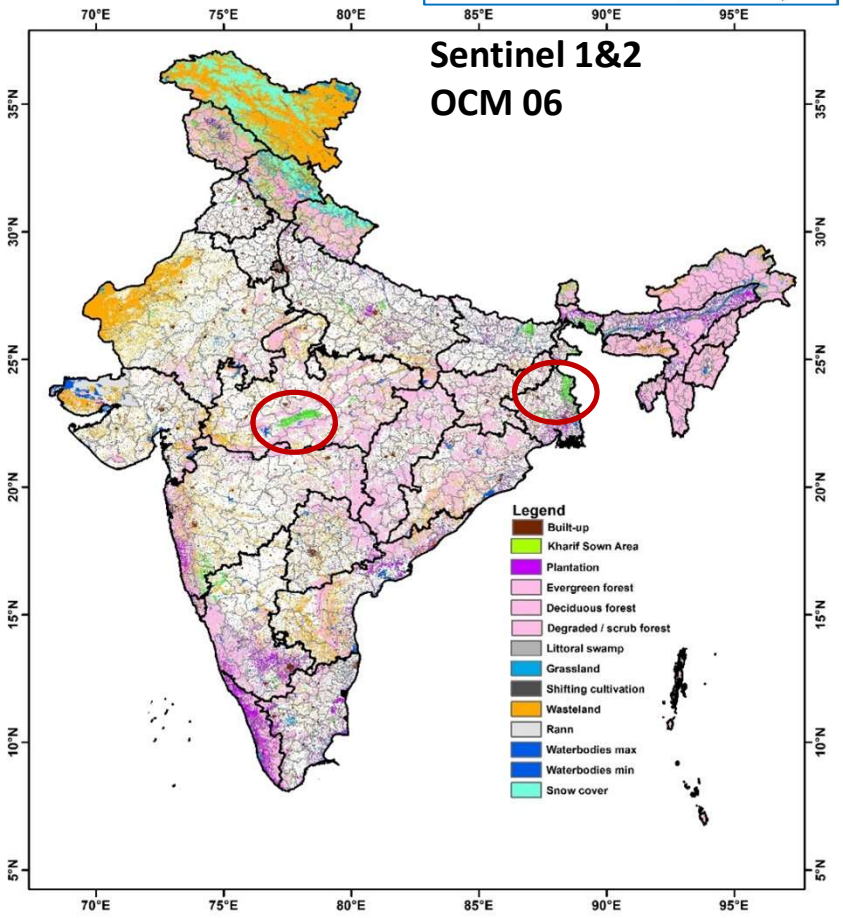


Cumulative rainfall (till 3rd week of Jun '23)
Source: IMD

KHARIF SOWING PROGRESS DURING JUNE 1ST WEEK 2023

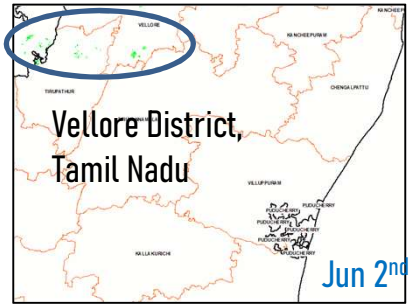




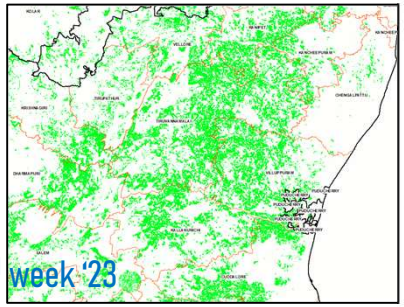


Oceansat (EOS-06) Data for *Kharif* Sown Area Monitoring

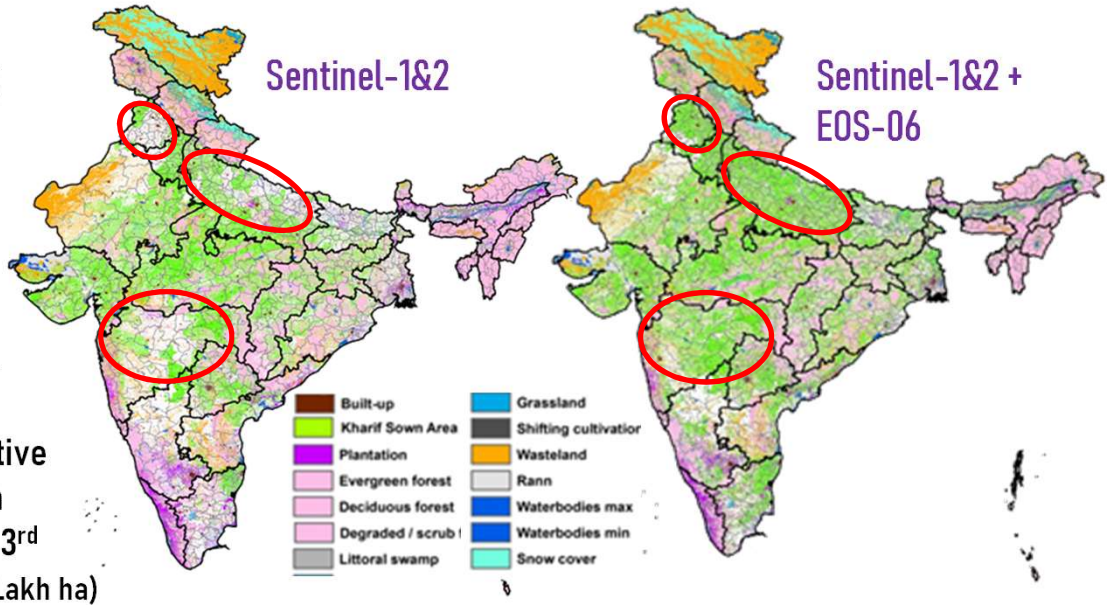
Kharif sown area detected using only Sentinel-1&2 data



Kharif sown area detected using Sentinel-1&2 along with EOS-06



Kharif sowing progress during June 4th week 2023



All-India Cumulative *Kharif* Sown Area Progress till Sep 3rd week '23 (Area in Lakh ha)

Time period	Sentinel-1 &2	Sentinel-1&2 + EOS-06
JUNE 1ST WK	2.4	44.7
JUNE 2nd WK	18.8	86.9
JUNE 3rd WK	115.1	172.2
JUNE 4th WK	562.0	593.8
JULY 1st WK	712.8	778.1
JULY 2nd WK	785.6	861.6
JULY 3rd WK	853.4	983.5
JULY 4th WK	940.2	1086.8
AUG 1ST WK	971.5	1135.7
AUG 2nd WK	995.8	1218.6
AUG 3rd WK	1015.1	1228.8
AUG 4th WK	1059.3	1276.6
SEPT 1st WK	1102.6	1363.5
SEPT 2nd WK	1107.2	1383.9
SEP 3rd WK	1113.2	1399.4
Total	**11355.0**	**13614.1**

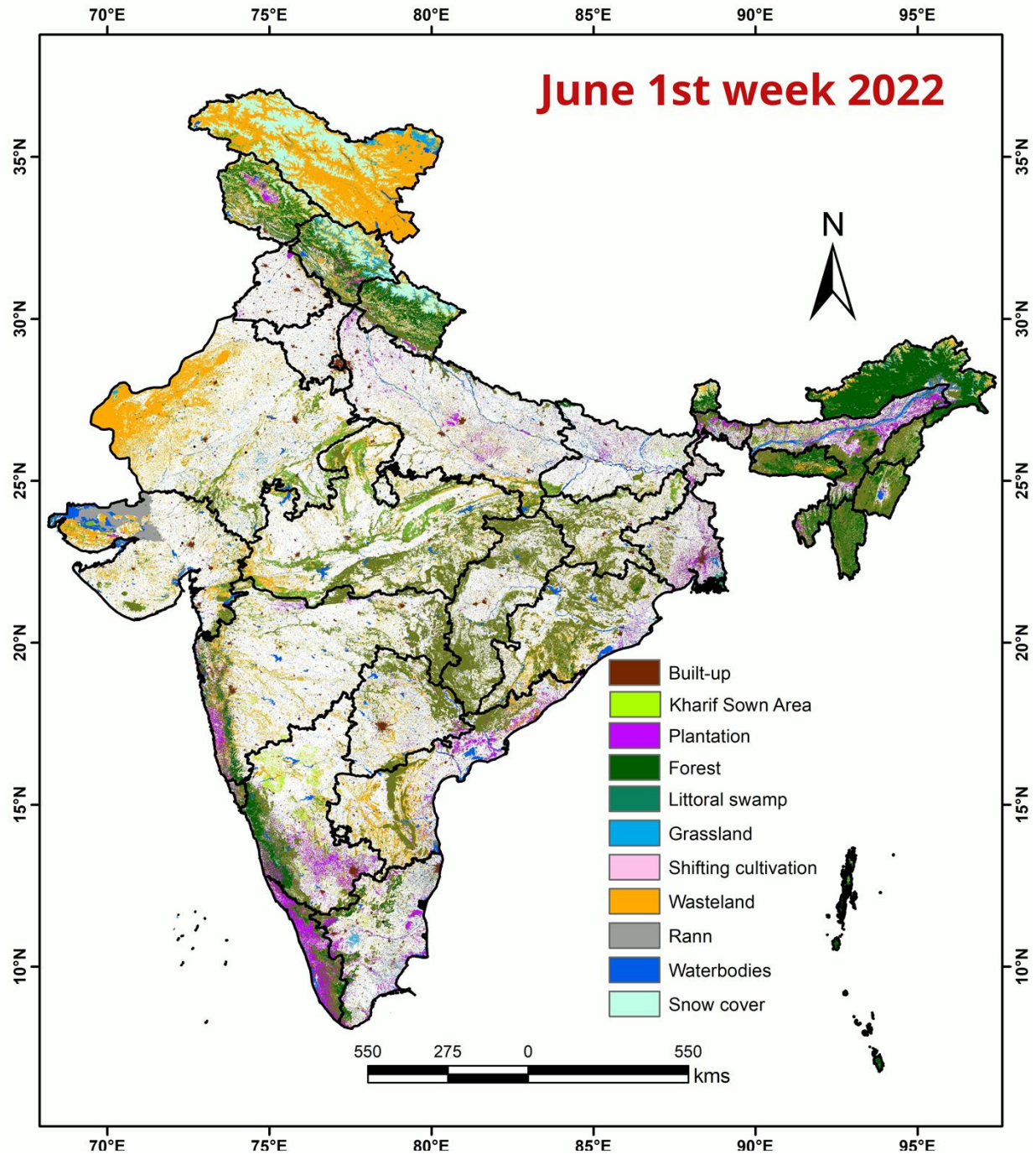
Observations

- Use is more significant in the initial period of *kharif* season (June to mid-July)
- Reduced dependency on IMD gridded data

Future Plan

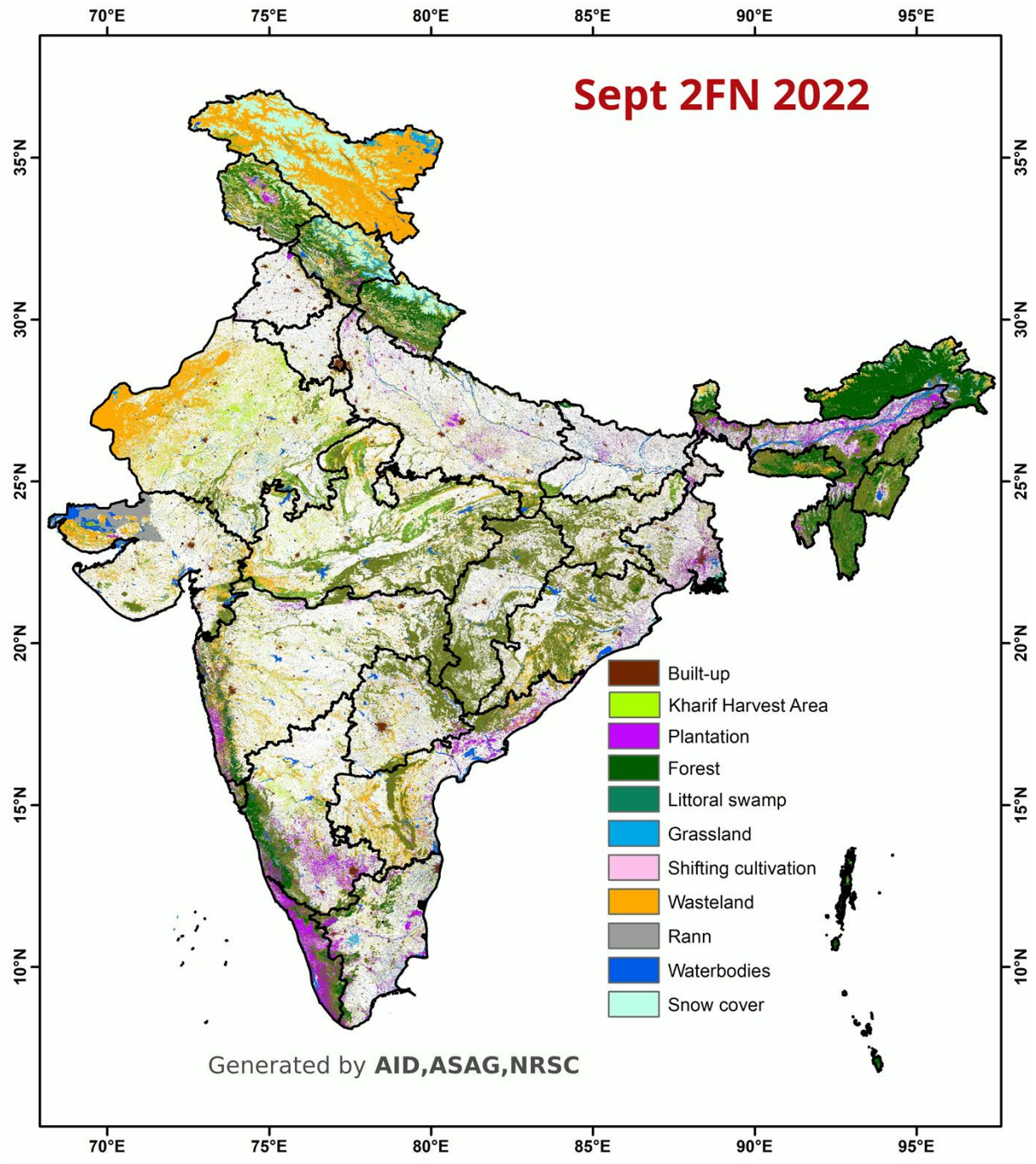
- Integration of AWiFS and EOS-04 with EOS-06 is planned for better crop surveillance activities

Kharif Sowing Progress- 2022



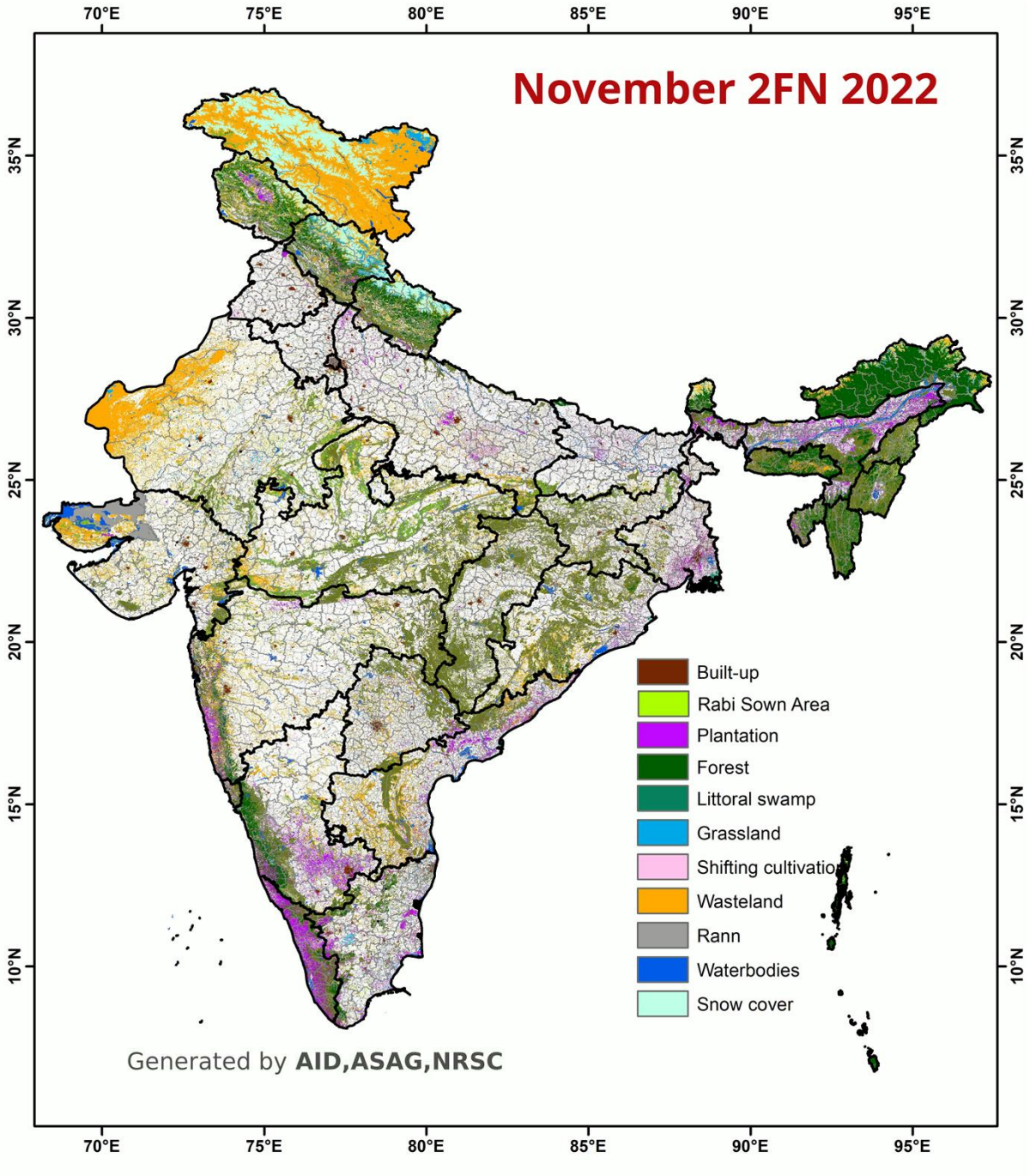
Generated by **AID,ASAG,NRSC**

Kharif Harvest Progress- 2022

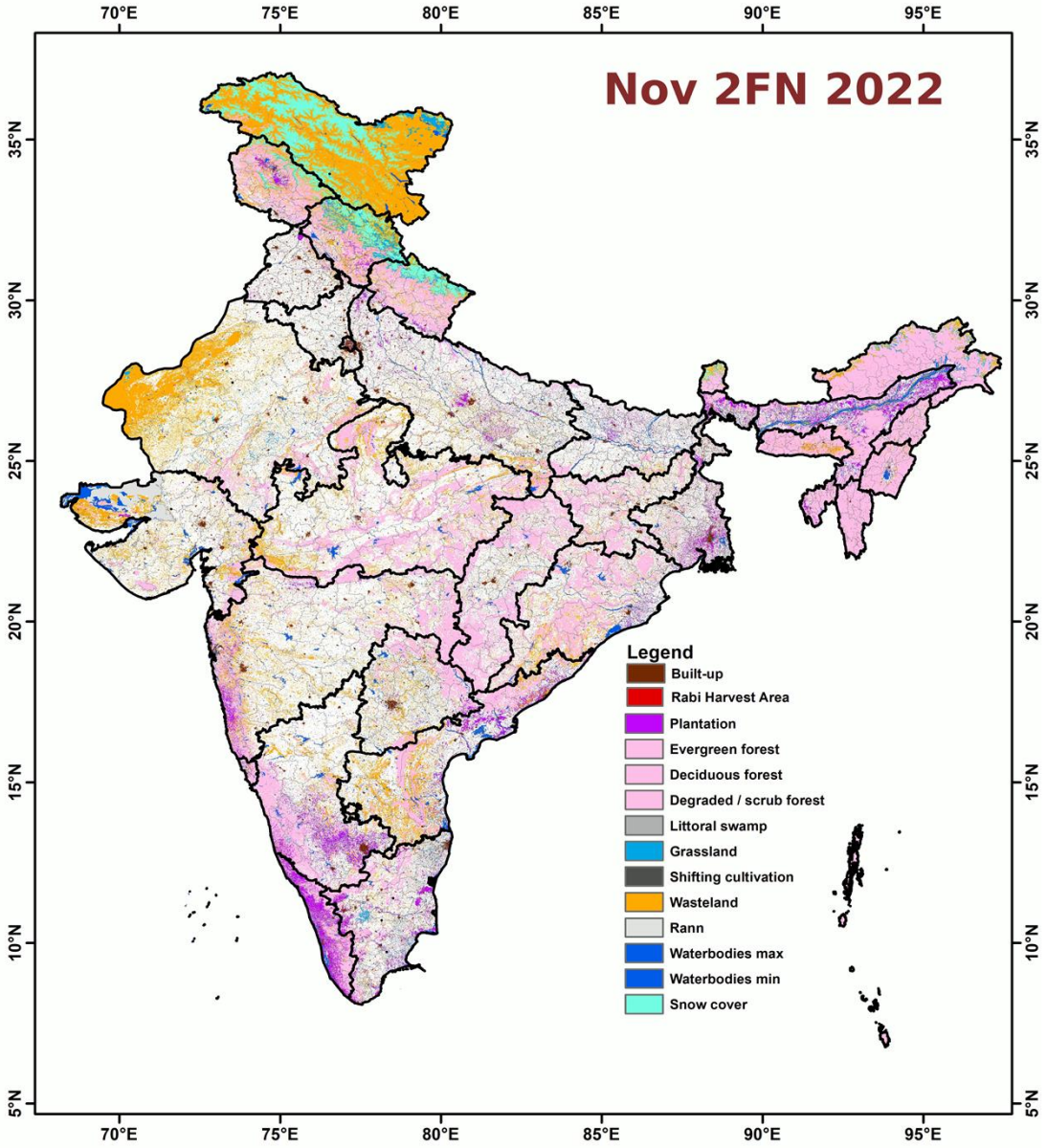


Generated by **AID,ASAG,NRSC**

Rabi Sowing Progress- 2022



Rabi Harvest Progress- 2022 -23



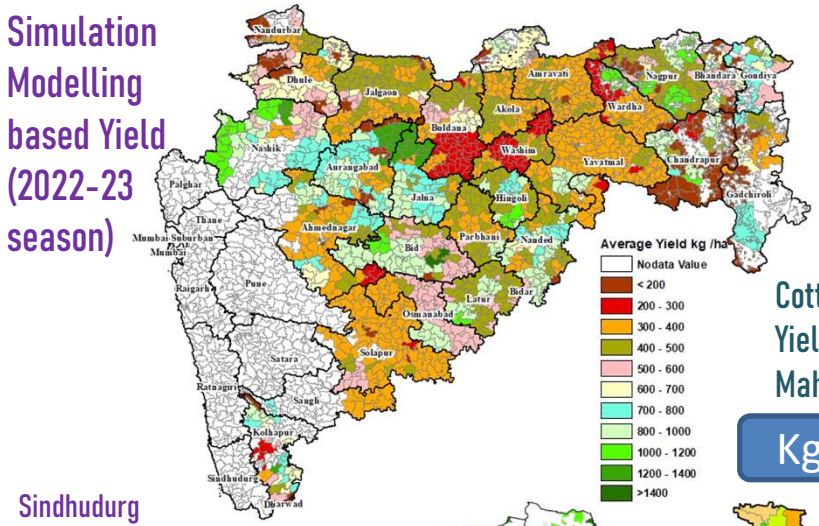
RABI HARVEST PROGRESS AT PIXEL

Generated by **AID,ASAG,NRSC**

Digital Agriculture Initiatives in Maharashtra

- **Crop surveillance** – Sowing & harvest progression, crop maps, weather extremes
- **Yield estimation** Soybean, paddy and cotton crops

Simulation Modelling based Yield (2022-23 season)

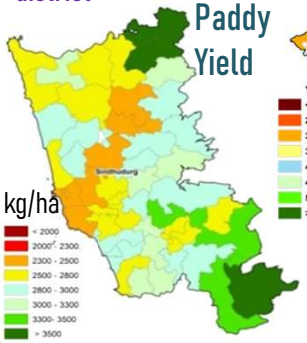


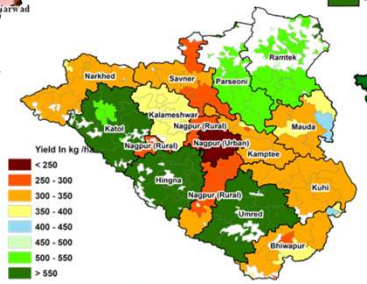
Cotton Crop Yield in Maharashtra

Kg/ha

Sindhudurg district

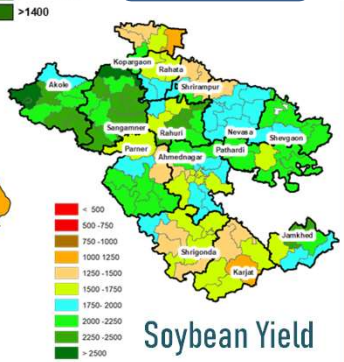
Paddy Yield





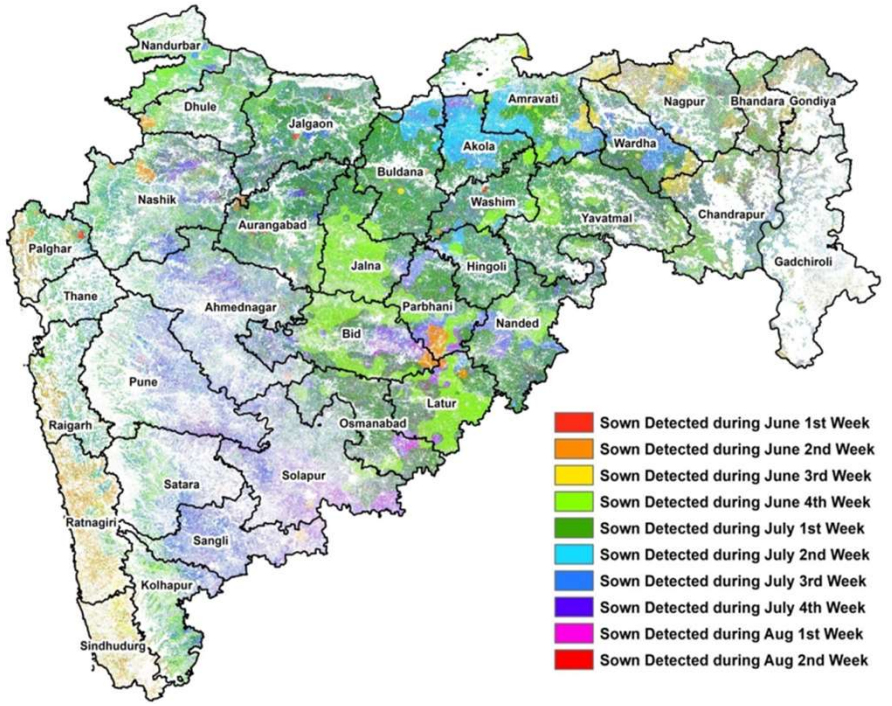
Cotton Yield

Nagpur district



Soybean Yield

Ahmednagar district



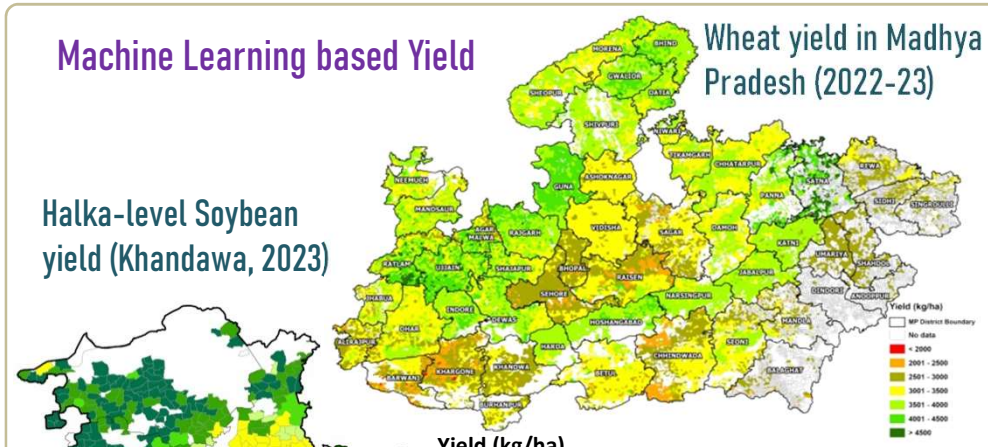
In-season *kharif* sown area progression (2023-24 season)

Digital Agriculture Initiatives in Madhya Pradesh

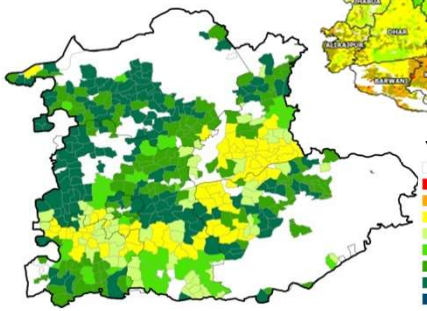
Major crops: Soybean, Paddy, Wheat, Gram, Mustard

Machine Learning based Yield

Wheat yield in Madhya Pradesh (2022-23)

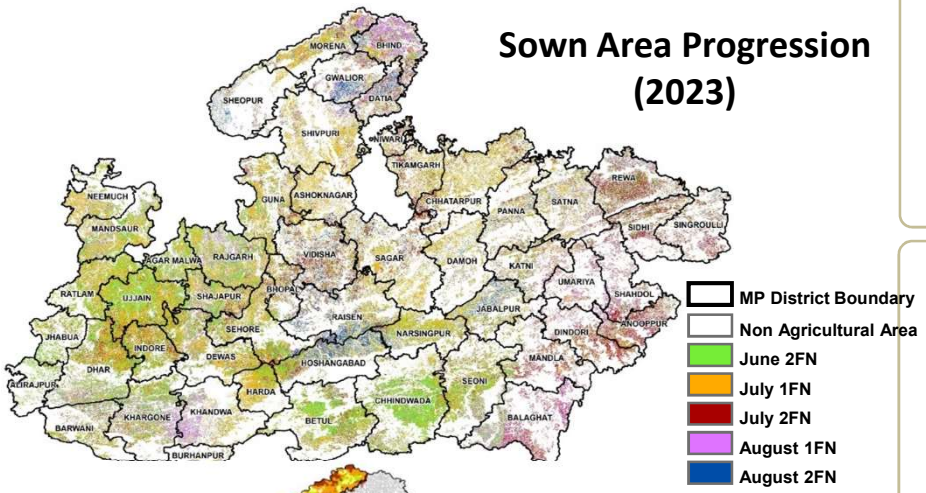


Halka-level Soybean yield (Khandawa, 2023)

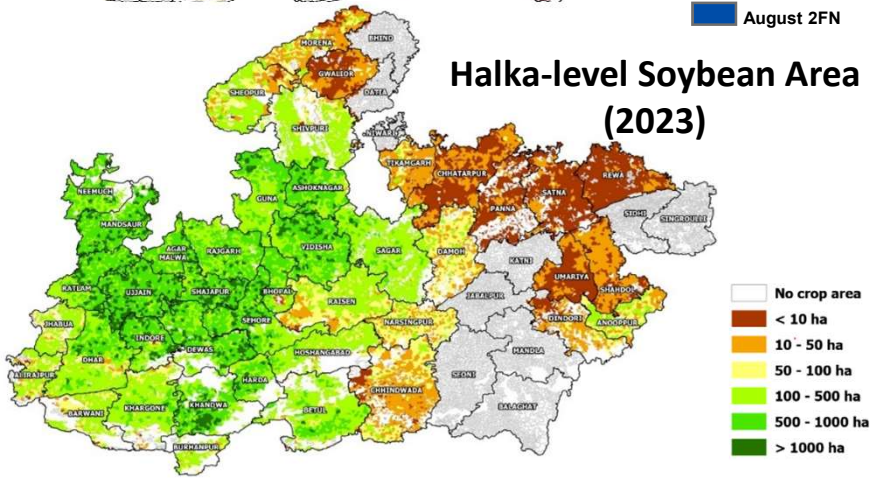


ML models (RF & DNN) trained using historical years yield and features derived from satellite and weather datasets

Sown Area Progression (2023)

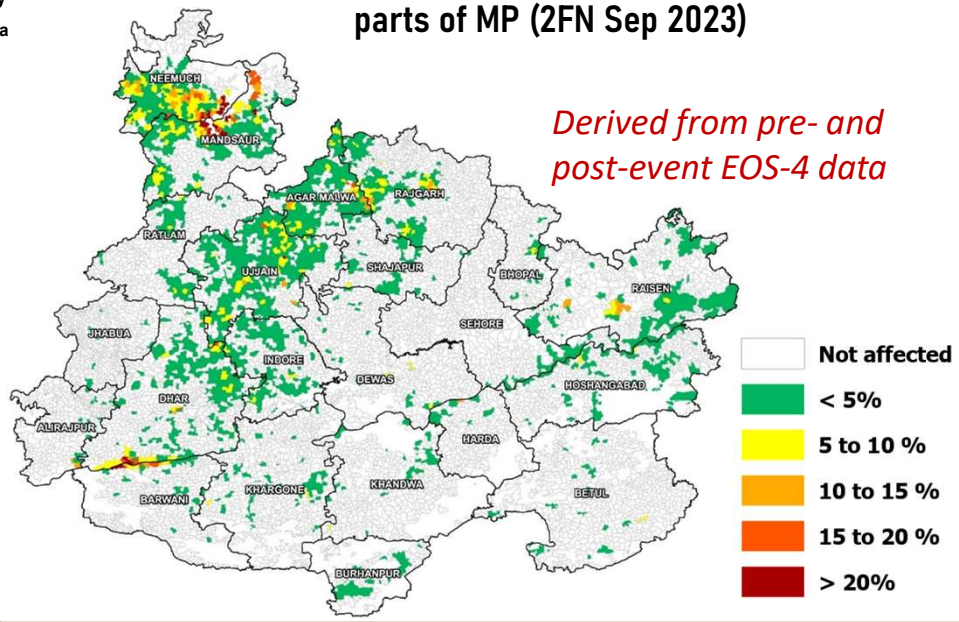


Halka-level Soybean Area (2023)



Affected Soybean area due to extreme rainfall event in parts of MP (2FN Sep 2023)

Derived from pre- and post-event EOS-4 data



Observations from Use Cases

- Temporal MRS dual-pol EOS-04 data can be used in **operational mapping of *kharif* crops namely rice and jute** at national level
- **Single-date full polarimetric** data can be utilized to discriminate multiple crops like **cotton, paddy, maize, jute, banana, etc.**
- **Multi-temporal full polarimetric** data can improve the classification accuracies in **multi-cropped scenario**
- Better crop discrimination owing to distinct scattering mechanisms of different crops due to their geometry (vertical orientation or horizontally spread)

Current and Potential Applications

- EOS-04 data is being utilized for ongoing operational projects for meeting the requirements of state agriculture departments
  - MahaAgritech (Maharashtra state)
    - Monitoring *kharif* sown area and its progression
    - Mapping of *kharif* crops (rice, soybean)
  - MP AgriGIS (Madhya Pradesh state)
    - *Kharif* sown area
    - Mapping of *kharif* crops (rice, soybean)
- Potential studies
  - Area estimation of short-duration *kharif* crops
  - Monitoring the progression of stubble burnt areas under cloud/smoke
  - Estimation of cropped area affected due to extreme weather events
  - Texture analysis with high resolution FRS for planation crops
  - Retrieval of crop biophysical parameters
  - Soil moisture estimation


Thank You