JECAM Site-India/Vijayawada: Status

JECAM/GEOGLAM Science Meeting

Virtual Meeting

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Microwave Remote Sensing Lab

JECAM
Joint Experiment for Crop Assessment and Monitoring

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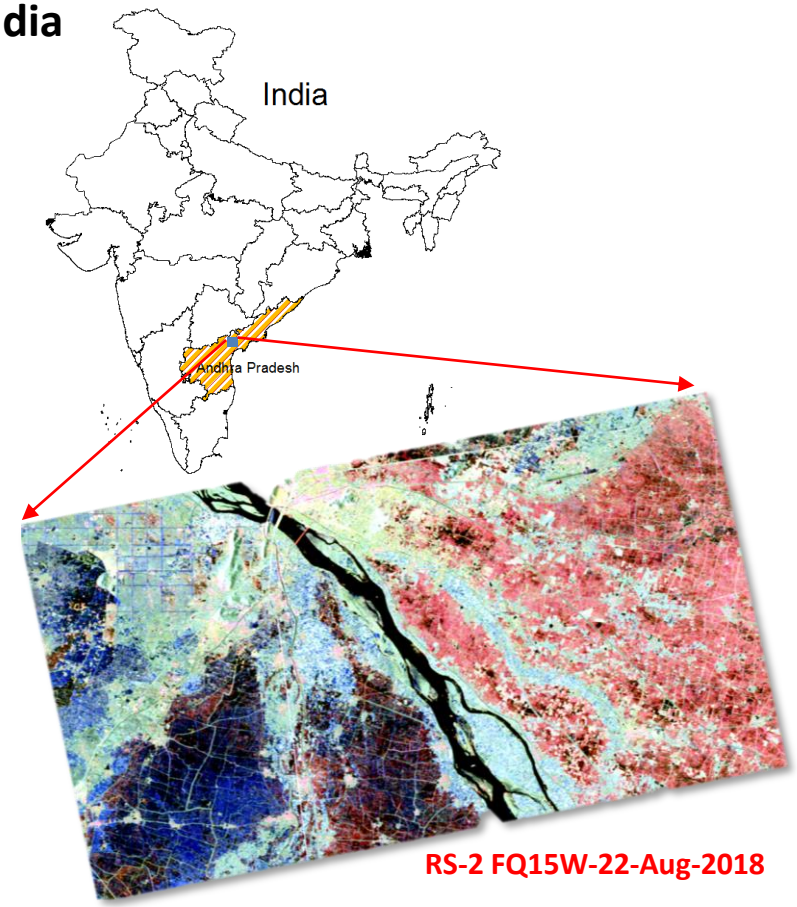
JECAM Site: Vijayawada, India

- Rice accounts > 40% of total grain production of India
- Cultivated and Consumed across the country



Why Andhra Pradesh state?

- Andhra Pradesh State: Rice bowl of India
- 11.6 million tonnes (2014-15): 11% of total India
- Yield: 3,036 kg/ha (2014-15)
- Cropping Area: 66% of total LULC
- Rice accounts: 28% of total cultivation area

Vijayawada, Andhra Pradesh site

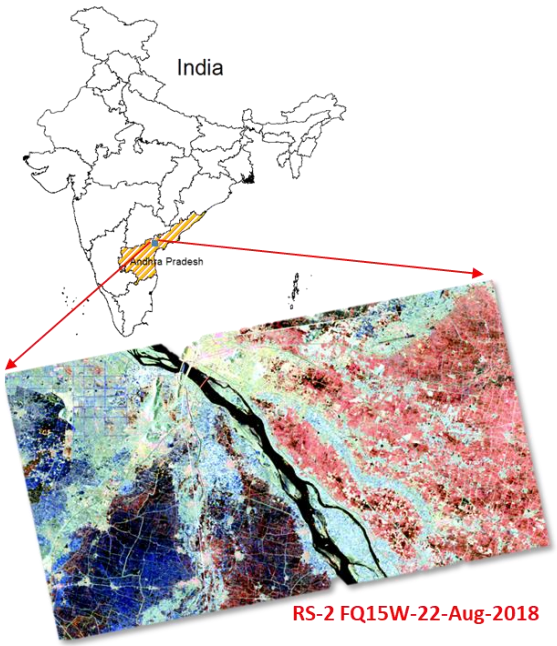
- Covers Krishna and Guntur districts
- Availability of previous information
- Field campaigns - 2014 and 2015
- Rice dominated region

http://jecam.org/studysite/india-vijayawada/

Site: Vijayawada, India

Purpose of project: **Crop characterization, mapping and Monitoring**

Duration: **2017-2019**



- **Location:** **Southern State of India** **(16^0 24'6.23"N and 80^0 41'2.41"E)**
  - Topography: Plain
  - Soils: Black cotton and Red Soils
  - Field size: 50 m X 50 m (approx.)
  - Irrigation dominated/Canal/Tanks

- **Crops: Rice dominated**
  - Others crops: Sugarcane, Corn, Turmeric
  - Crop calendar: Rice (July-November)

- **Climate and weather:** Tropical, 20^0-35^0 C temp. range
- **Agricultural methods used:** Rice Transplanting as well harvesting by hand as well as by machines

Objectives

Research Topics:

- Crop identification and Crop Area Estimation
- Crop Cover Mapping
- Crop Growth Monitoring
- Biophysical parameter/Phenology Retrieval

JECAM India group is also engaged in development of:

- Novel Biophysical parameter retrieval techniques,
- SAR derived vegetation indices
- Processing Chain for Differentiating Early and Late Transplanted Rice in Google Earth Engine
- Compact/Hybrid Polarimetric data potential for crops

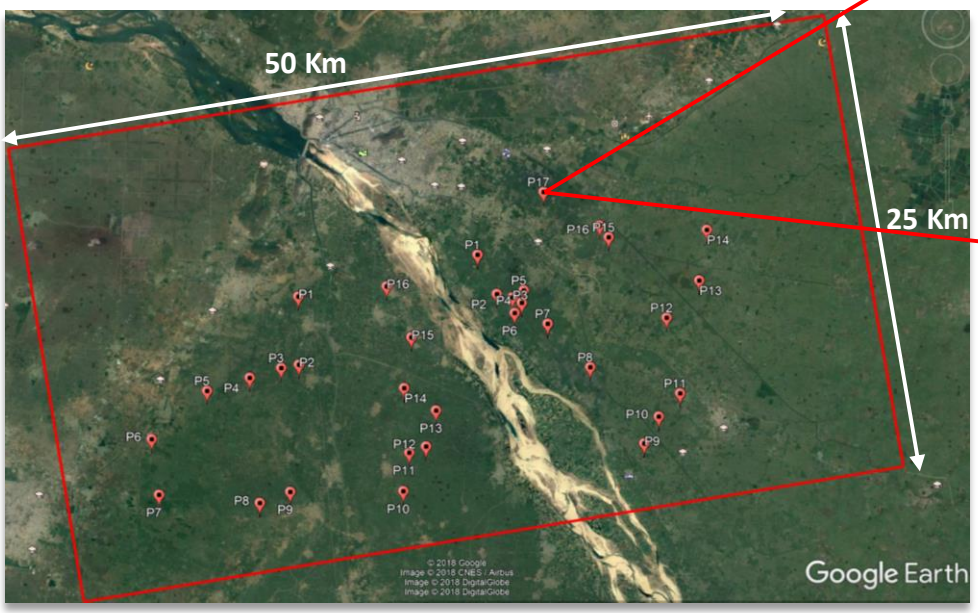
Earth Observation (EO) Data Received/Used

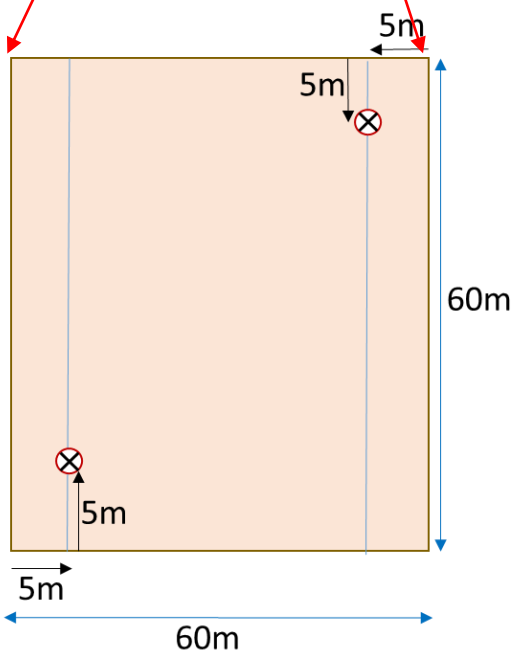
Data	Mission /Sensor	Space Agency /Supplier	Years of Acquisition	No. of Scenes	Polarization
SAR	Radarsat-2	MDA/(JECAM+SOAR) Canada	2014 2018 2019	20	Quad-Pol
	RISAT-1	NRSC, ISRO, India	2013-2016	13	Compact-Pol
	ALOS-2	JAXA, Japan	2019	25	Dual-pol
	TerraSAR-X	DLR, Germany	2019	19	Dual-pol
	Sentinel-1	ESA/ Openly available	2018 2019	11	Dual-pol
Optical	Landsat-8	NASA/USGS, USA	2018-2019	Cloud free data	
	Sentinel-2	ESA, Europe	2018-2019		

- As of now we did not face any major difficulty in data ordering and acquisition

In situ and Field survey Data

Parameters Collected: Plant Height, Soil Moisture, LAI (hemispherical photography), Phenology, management practices, water depth





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In situ and Field survey Data

Field Photographs of JECAM, Vijayawada site: Current Status

05 July 2018 | 27 July 2018 | 22 Aug 2018

Challenges?

1. Crop cutting experiment: Biomass measurements
2. Inconsistent field shapes and sizes;
3. Difficult to design a common sampling strategy

Results: Highlights from work completed

- **2014 Kharif season field data and satellite data shared with JECAM|AAFC**
- **2018 and 2019 In-situ measurements and shared with JECAM|AAFC**
- **Biophysical parameter estimation and classification**
- **JECAM India-Vijayawada webpage updated**

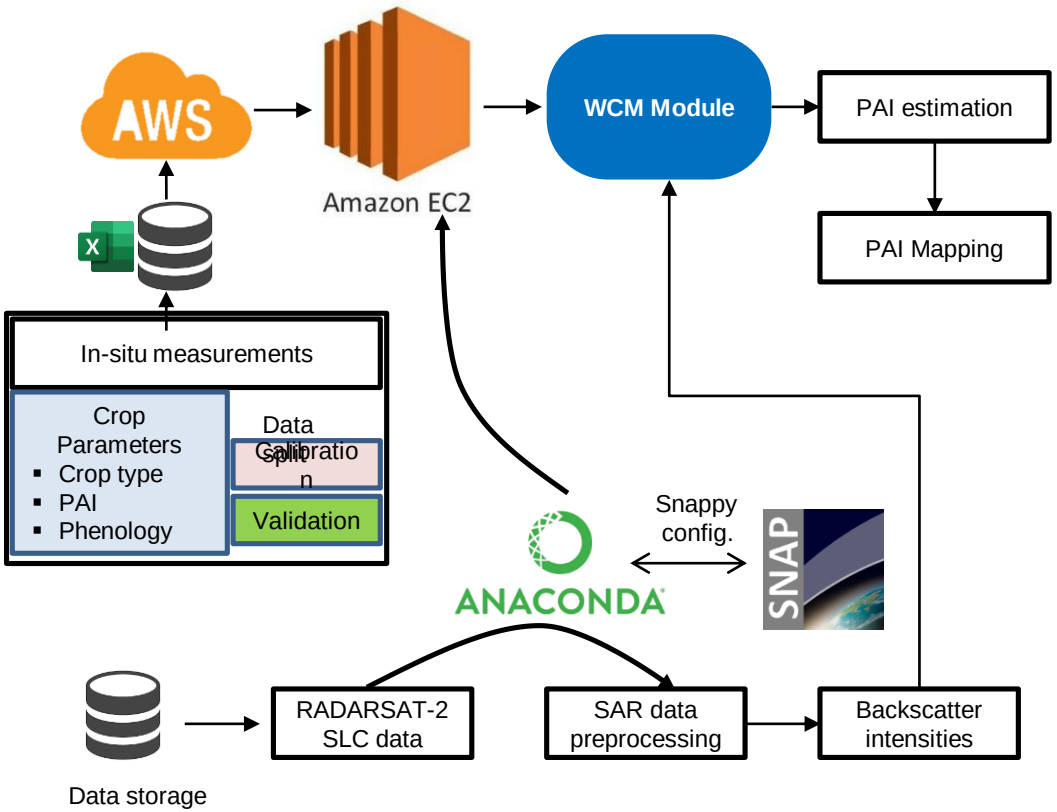
1

Crop biophysical parameter rettieval

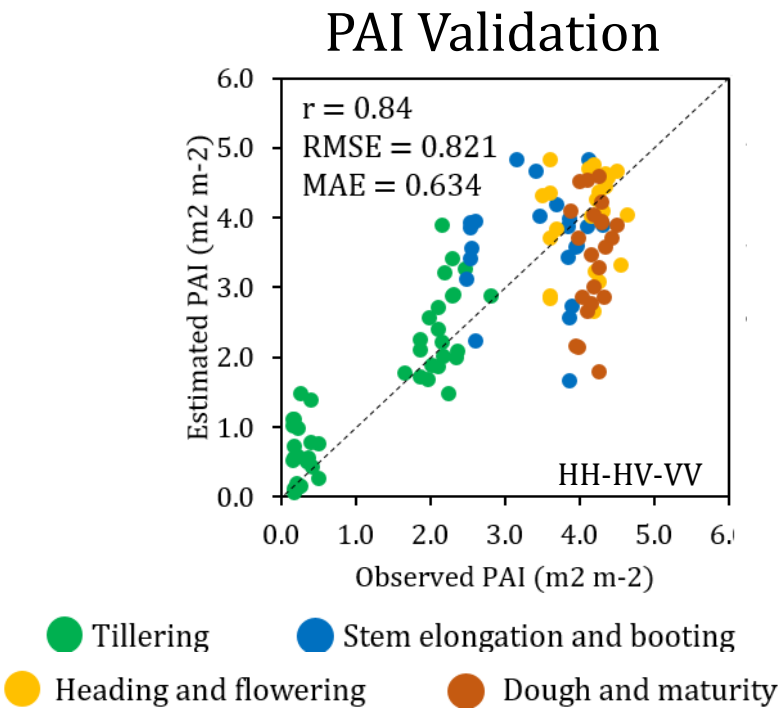
Rice– Plant Area Index (PAI)

Schematic workflow/ Rice PAI mapping

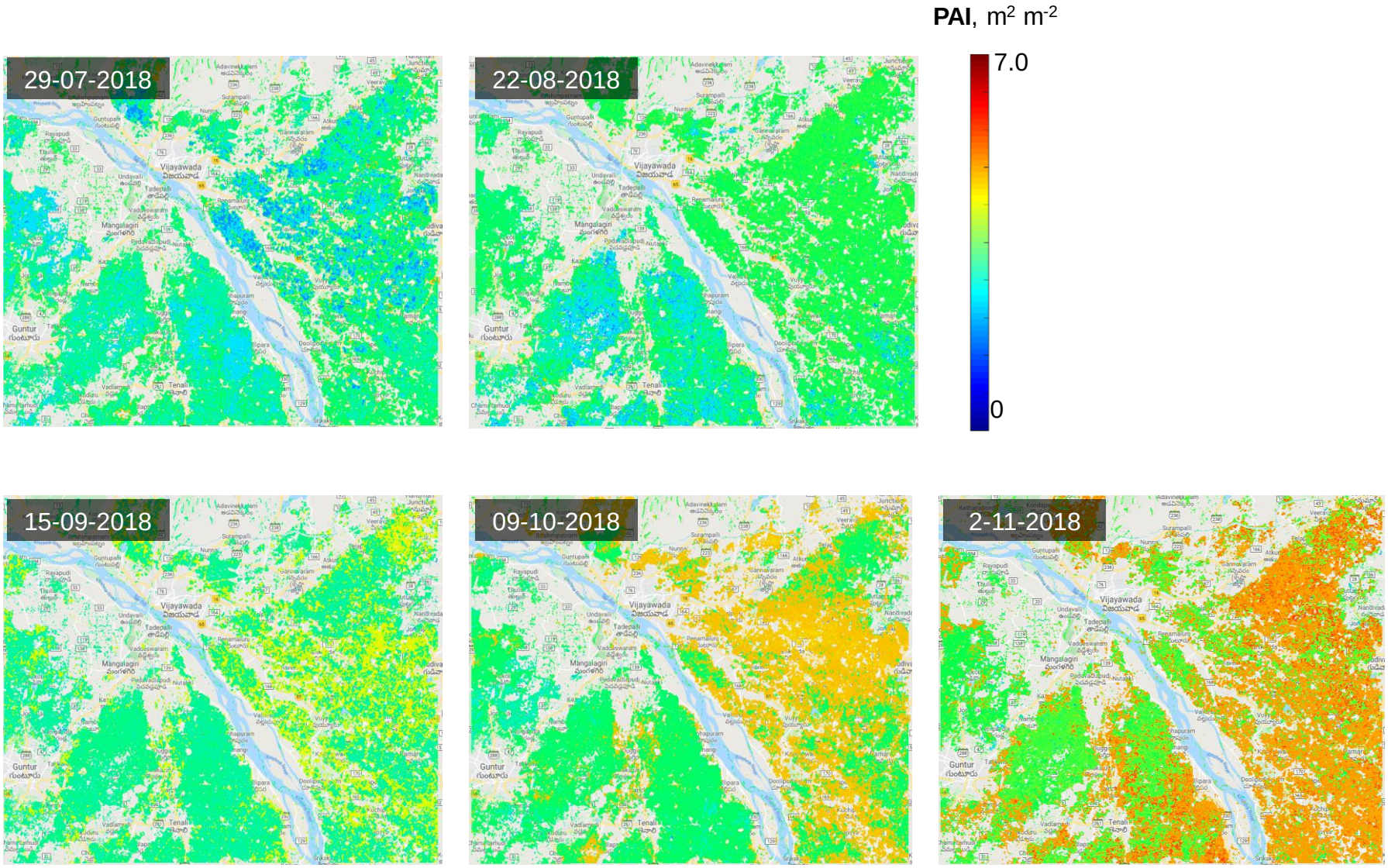
Water Cloud Model based inversion



2018 data



PAI mapping



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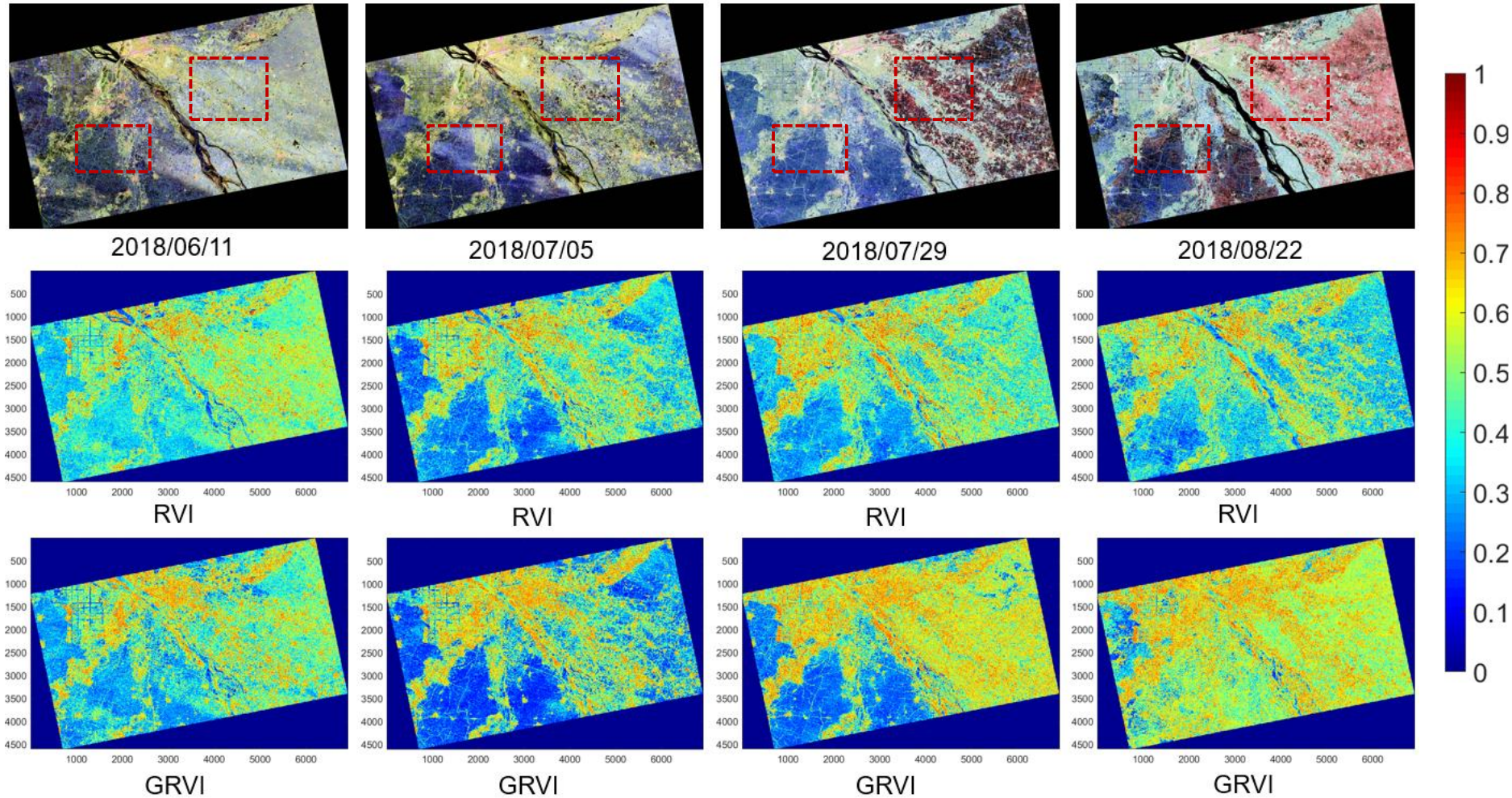
2

Vegetation growth condition monitoring

Generalized Radar Vegetation Index (GRVI)
vs.
Radar Vegetation Index (RVI)

GRVI based rice growth condition monitoring



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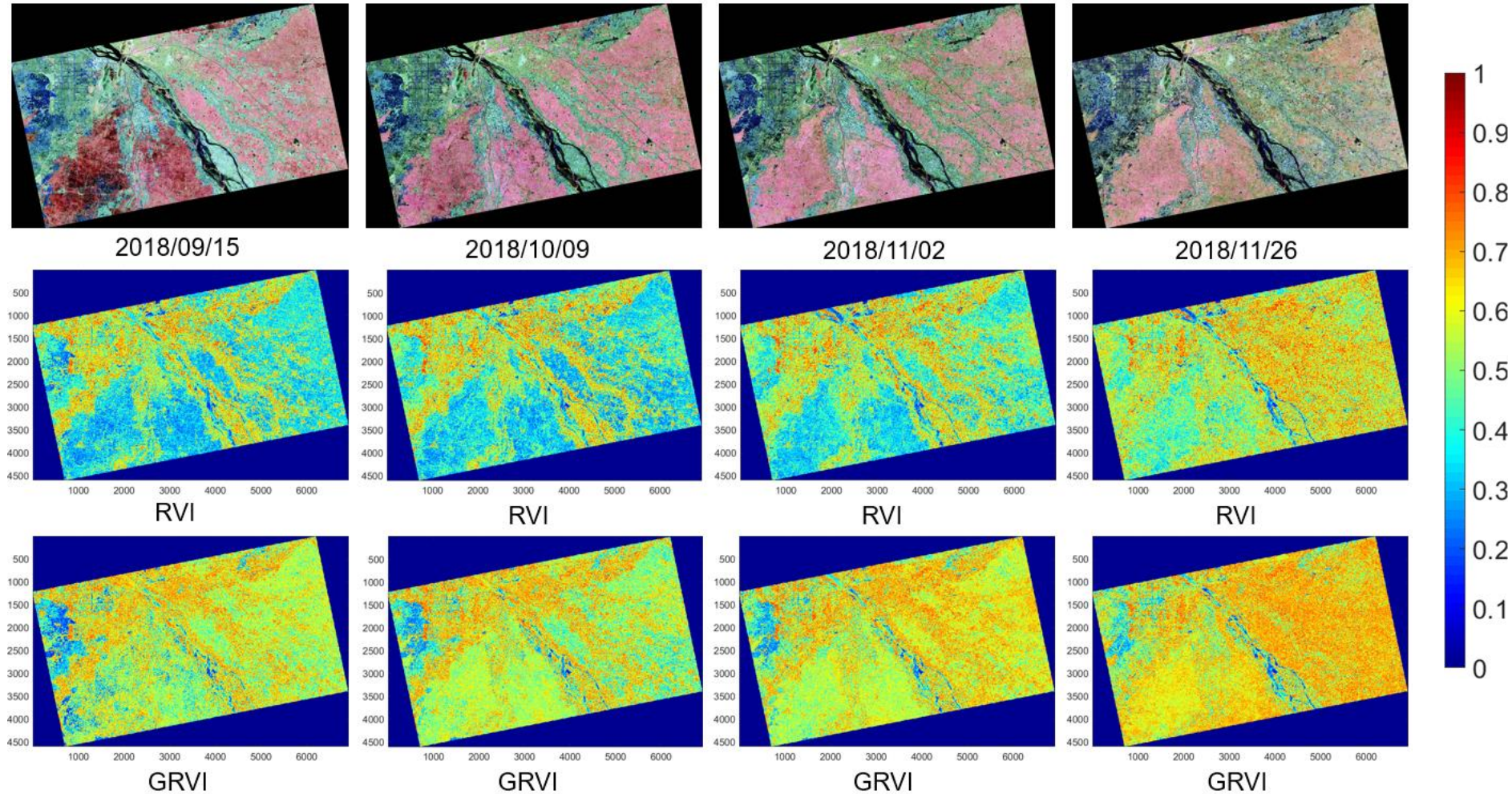
GRVI based rice growth condition monitoring



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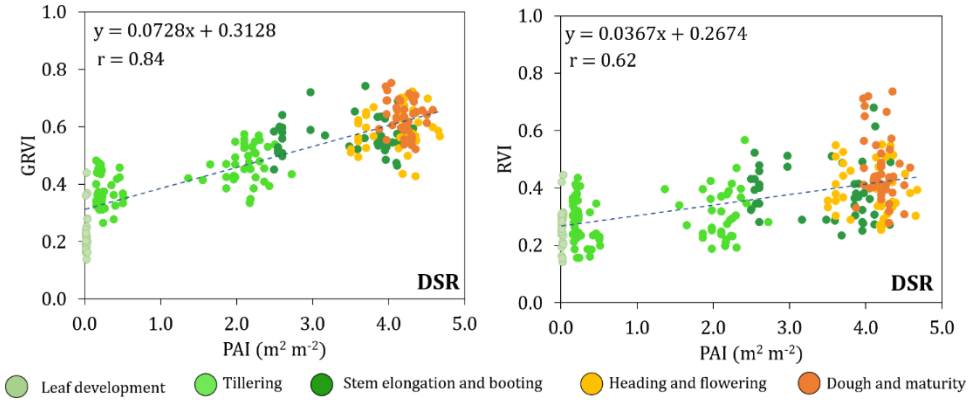
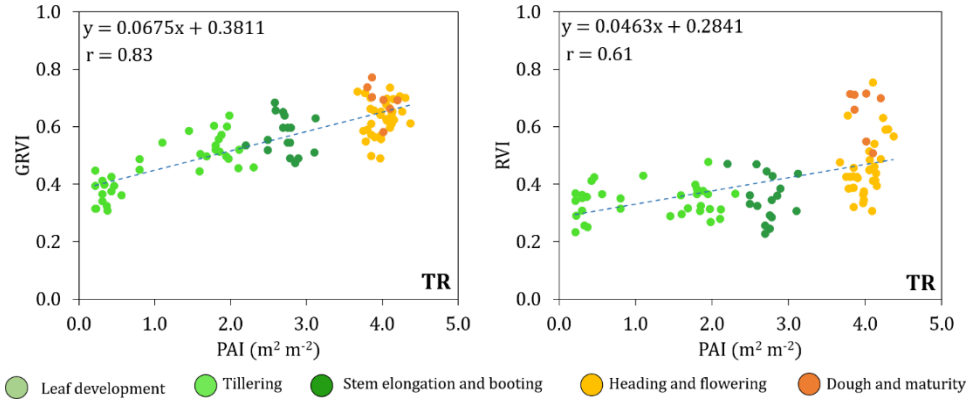
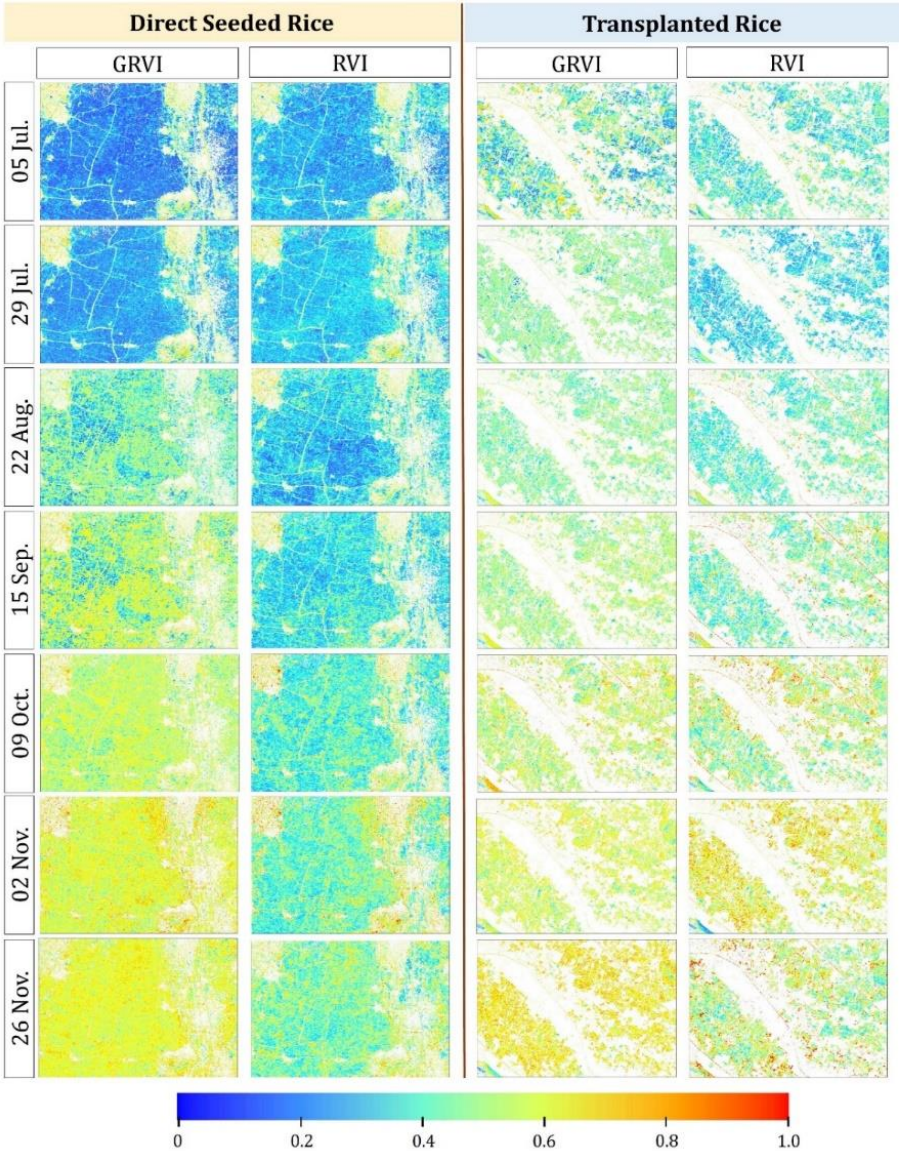
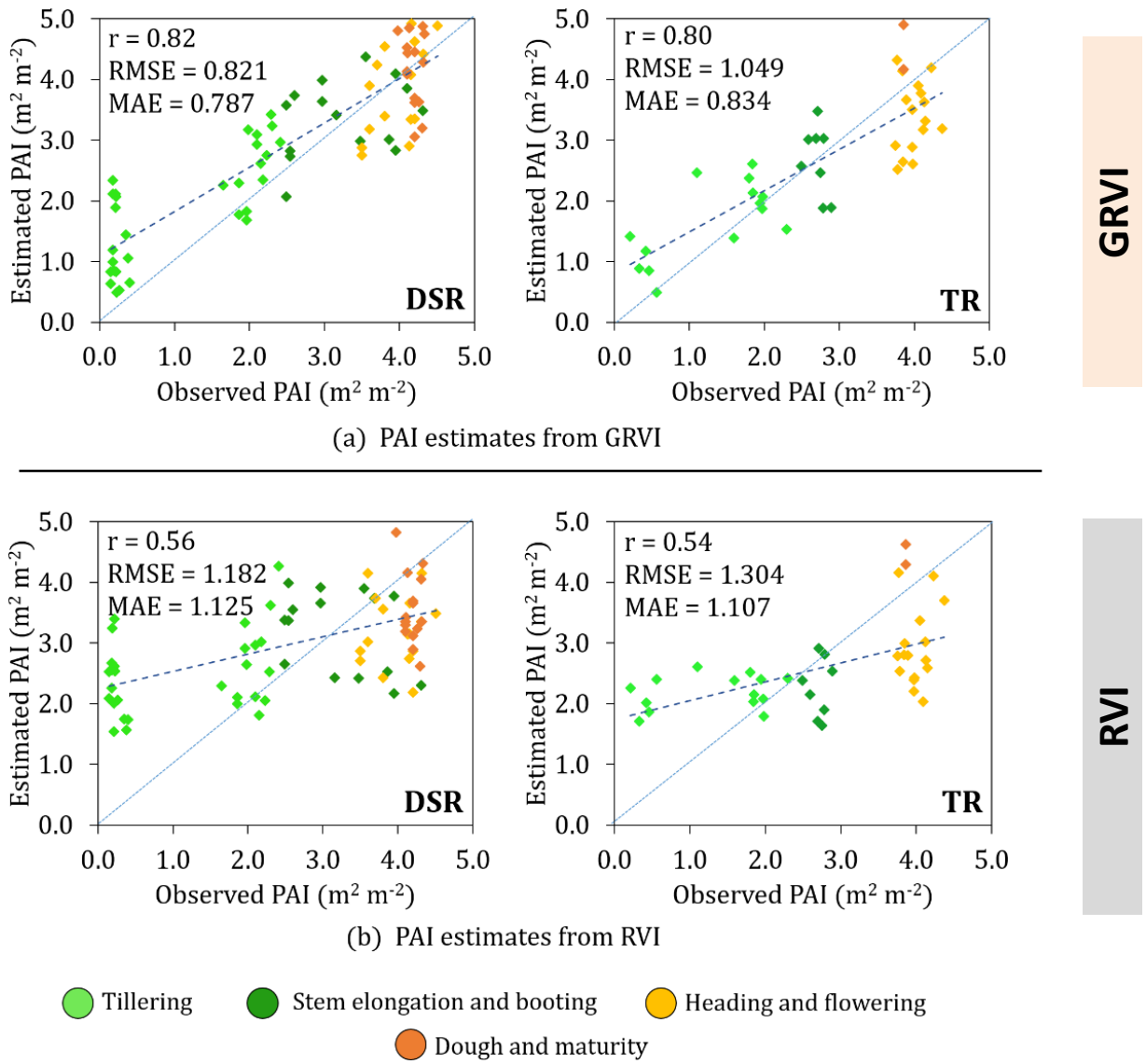
Results: Correlation analysis







PAI estimation from GRVI and RVI



2

Crop classification using RADARSAT-2 quad-pol SAR data

--from elements of Kennaugh matrix

--Classifier: XGB and RF

Cross-site validation– Canada (Carman) and India (Vijayawada)

Indian test site

Best user's (UA), producer's (PA) and overall (OA) accuracy for day-wise and time-series data for different crops for the Indian test site.

		XGB				RF			
		UA	PA	OA	κ	UA	PA	OA	κ
Day-wise	Banana	84.89	65.60			94.95	33.97		
	Cotton	70.73	70.73	81.45	0.66	68.02	70.19	79.76	0.61
	Rice	80.10	66.60			81.56	53.38		
	Sugarcane	84.92	89.65			82.81	92.95		
Time-series	Banana	87.46	84.39			100.00	53.50		
	Cotton	82.31	88.31	87.75	0.78	75.68	88.31	84.34	0.71
	Rice	84.18	66.28			79.87	47.89		
	Sugarcane	90.29	91.85			87.26	93.00		

Separability analysis
Time-series vs. day-wise data

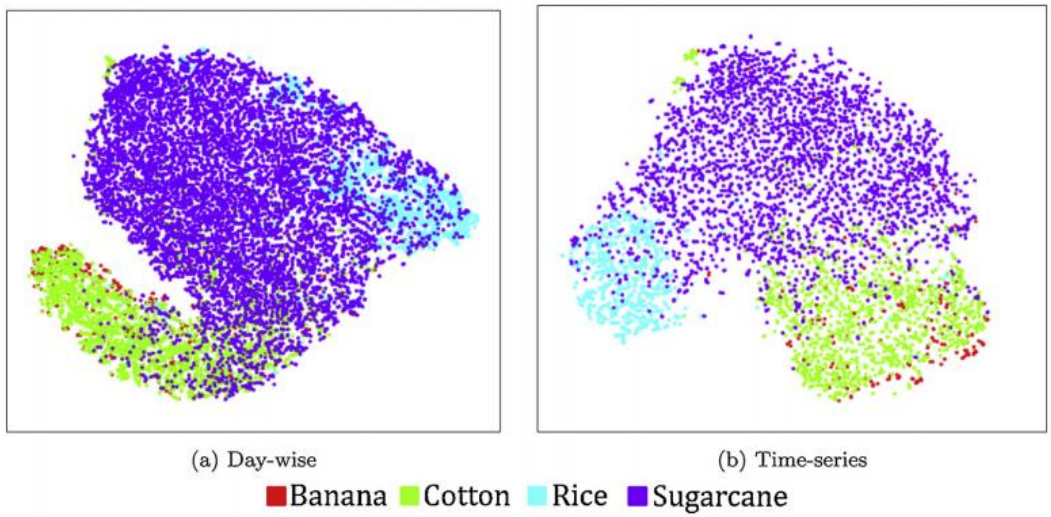


Fig. 6. TSNE plots of the (a) day-wise and (b) time-series data stack over the Indian test site.

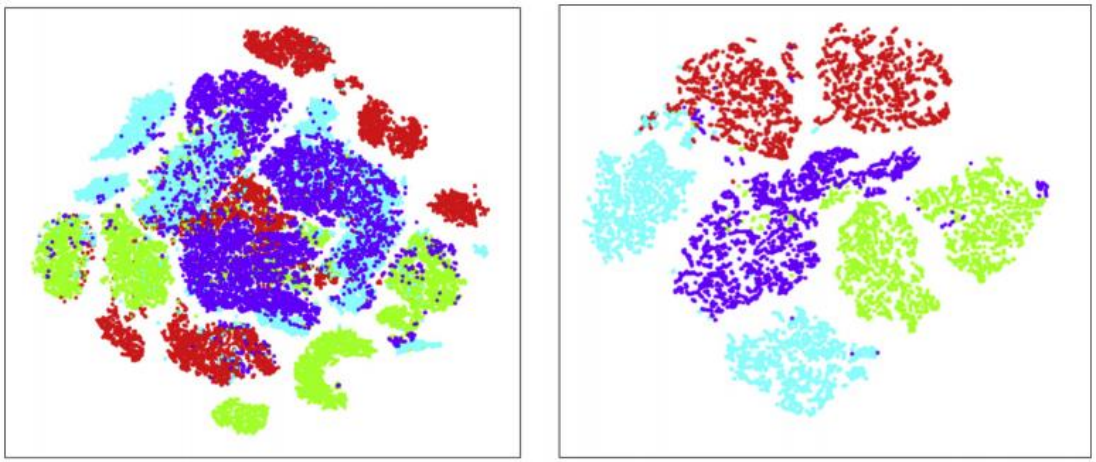
Cross-site validation– Canada (Carman) and India (Vijayawada)

Canadian test site

Best user's (UA), producer's (PA) and overall (OA) accuracy for day-wise and time-series data for different crops in Canadian test site.

		XGB				RF			
		UA	PA	OA	k	UA	PA	OA	k
Day-wise	Wheat	86.59	79.34			86.78	78.74		
	Canola	82.95	77.68	74.97	0.66	79.18	76.81	72.99	0.64
	Soybean	74.12	71.95			72.17	67.24		
	Corn	53.33	67.98			51.3	65.8		
Time-series	Wheat	70.97	96.85			82.65	86.46		
	Canola	85.34	91.85	80.41	0.73	89.29	66.14	76.89	0.69
	Soybean	86.73	81.49			71.57	85.99		
	Corn	84.59	48.53			67.28	67.83		

Separability analysis
Time-series vs. day-wise data



(a) Day-wise (b) Time-series

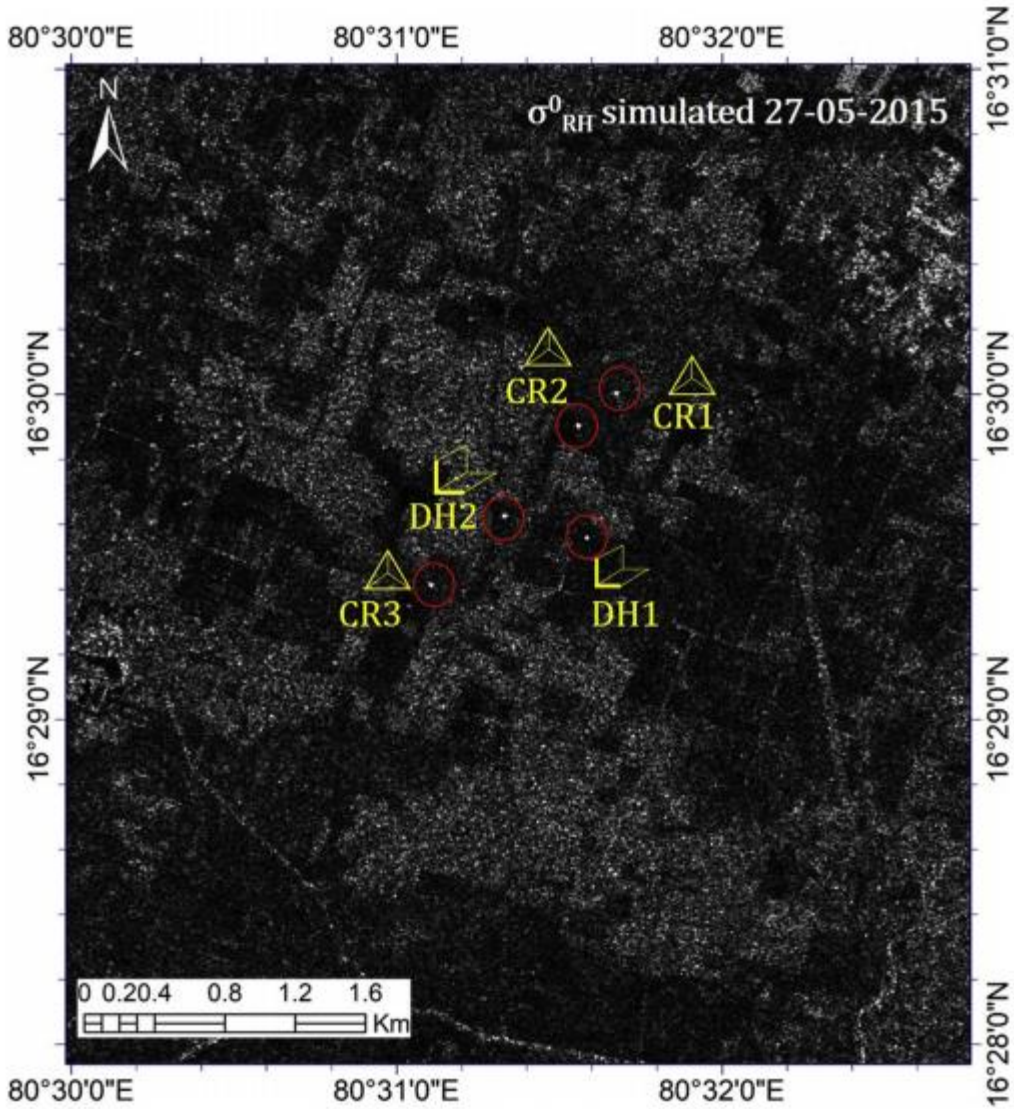
Wheat Canola Soybean Corn

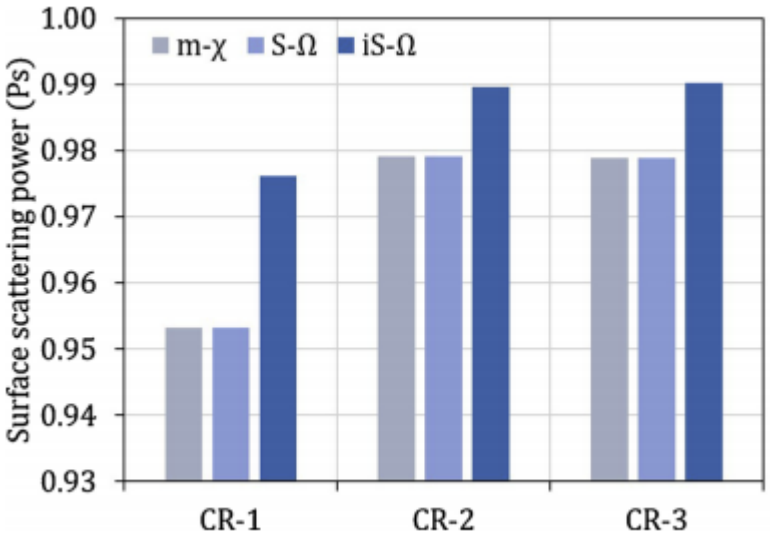
2

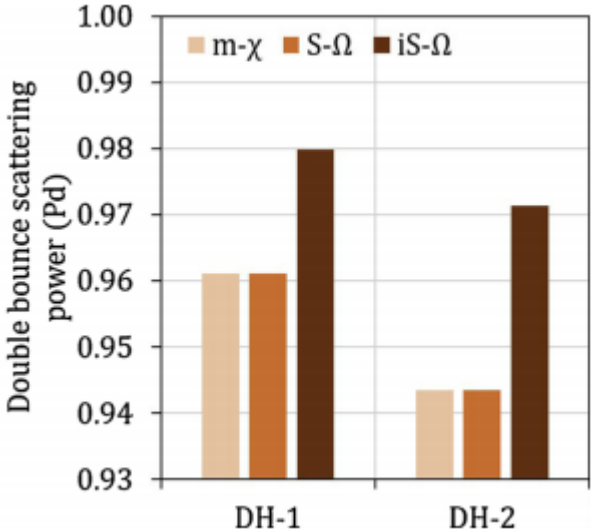
Crop characterization using iS-Ω decomposition for compact polarimetric SAR data

- iS- Ω
- S- Ω
- m-χ

Comparison of scattering powers







iS- Ω powers: Rice

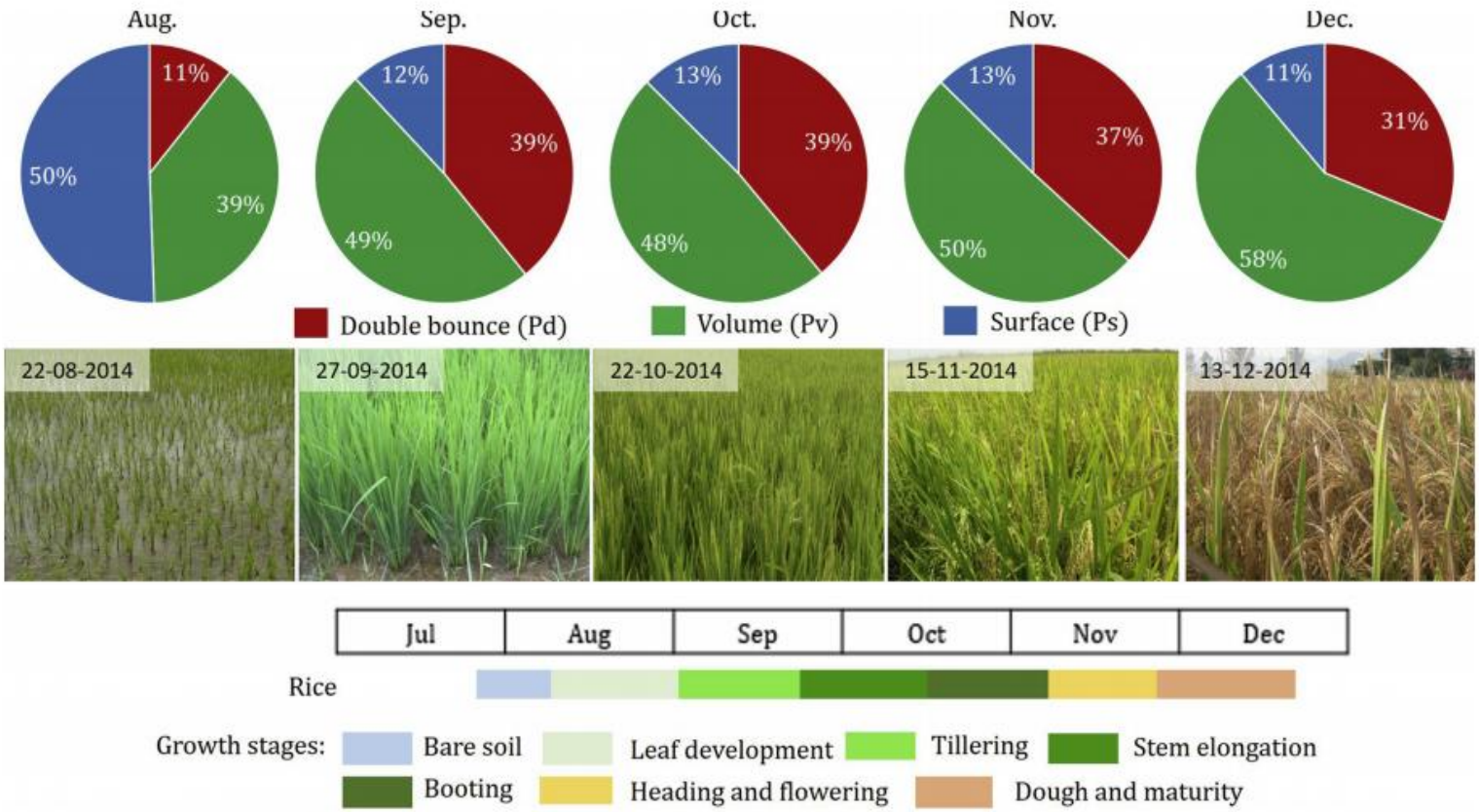


Fig. 6. Scattering powers of $iS - \Omega$ decomposition at different growth stages of rice.

iS- Ω powers: Cotton

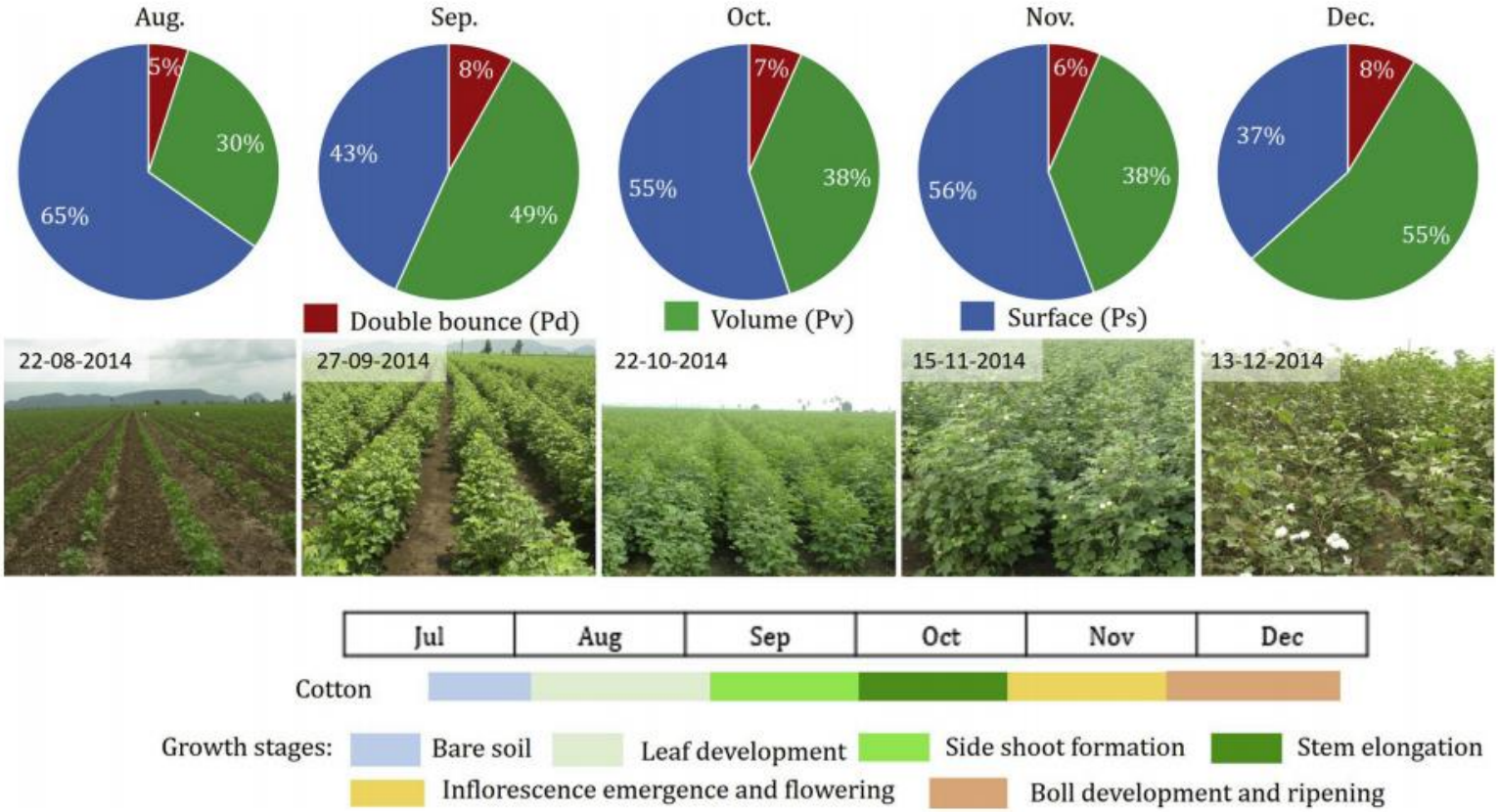


Fig. 7. Scattering powers of $iS - \Omega$ decomposition at different growth stages of cotton.

iS- Ω powers: Sugarcane

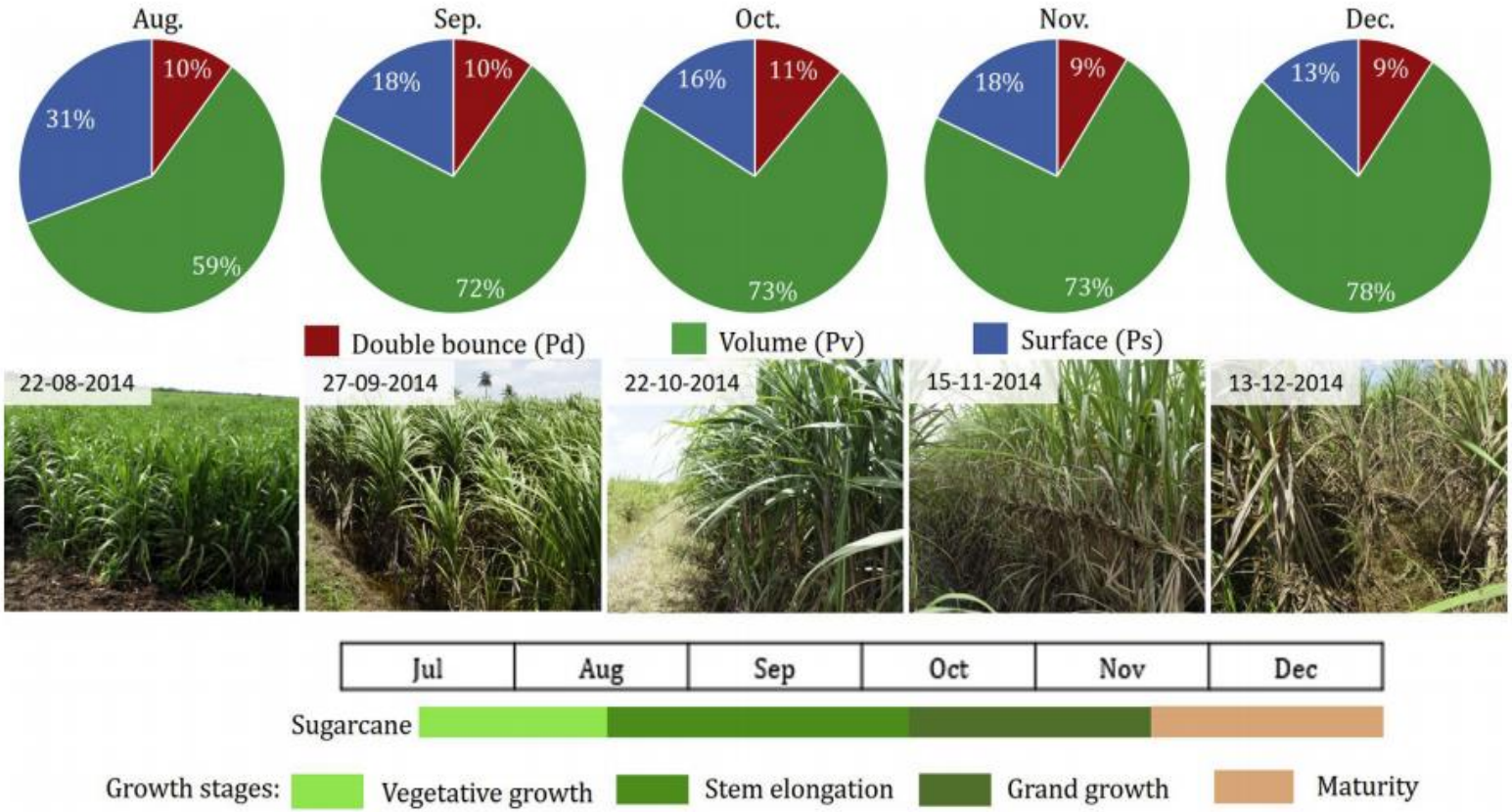


Fig. 8. Scattering powers of $iS - \Omega$ decomposition at different growth stages of sugarcane.

Publications:

- D. Mandal, V. Kumar, D. Ratha, J. M. Lopez-Sanchez, A. Bhattacharya, H. McNairn, Y. S. Rao, and K.V. Ramana, "Assessment of rice growth conditions in a semi-arid region of India using the Generalized Radar Vegetation Index derived from RADARSAT-2 polarimetric SAR data. " *Remote Sensing of Environment*, Vol 237, 2020, 111561, DOI: 10.1016/j.rse.2019.111561.

- S. Dey, D. Mandal, L. Dingle Robertson, B. Banerjee, V. Kumar, H. McNairn, A. Bhattacharya, Y.S. Rao, "In-Season Crop Classification Using Elements of the Kennaugh Matrix Derived from Polarimetric RADARSAT-2 SAR Data," *International Journal of Applied Earth Observations and Geoinformation*, Vol 88, 2020, 102059.

- V. Kumar, D. Mandal, A. Bhattacharya, Y. S. Rao, "Crop characterization using an improved scattering power decomposition technique for compact polarimetric SAR data," *International Journal of Applied Earth Observation and Geoinformation*, Vol.88, 2020, 102052, DOI: 10.1016/j.jag.2020.102052.

- D. Mandal, V. Kumar, Y. S. Rao, A. Bhattacharya, K. V. Ramana, "Experimental Field Campaigns at Vijayawada Test Site," Microwave Remote Sensing Lab, Indian Institute of Technology Bombay, India, Tech. Rep. MRS2019TR02, 2019. doi: 10.17605/OSF.IO/DN3E8

Collaborations

- Describe the nature of any collaboration with other JECAM / Asia-RiCE sites or other relevant partners (i.e. who, objective, brief status).

Partners made:

- Andhra Pradesh State Remote Sensing Center (APSAC)
- Agri-Universities (Bidhan Chandra Krishi Vishwavidyalaya)

- Supports in field data collection, local knowledge, weather information

Plans for Next Growing Season

- Will you hold the course, or modify the approach?
  - Will follow the same course
  - JECAM India developed algorithms and methodology can be tested for other JECAM test sites also
  - A multi-year cross-validation framework is under process

- Do you anticipate using the same type/quantity of EO data next year?
  - Yes, we anticipate same type of EO data next year

Thank you for your attention!

Send your queries to:

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Associate Professor
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