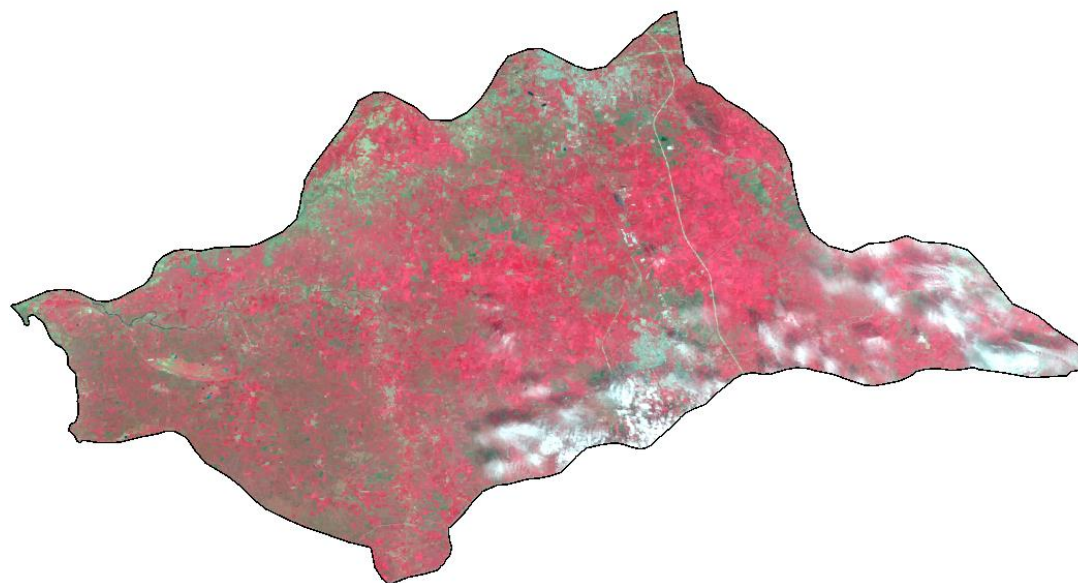


JECAM: India-Hoshangabad- Status



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¹Mahalanobis National Crop Forecast Centre, DAC&FW, New Delhi, India

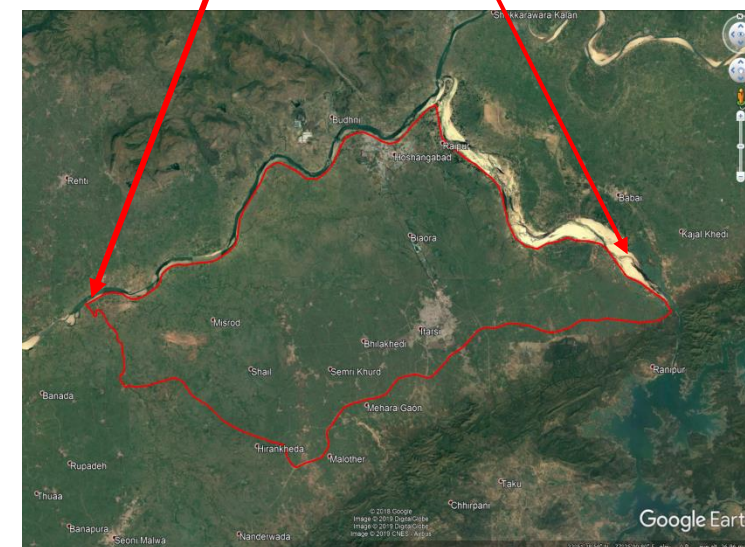
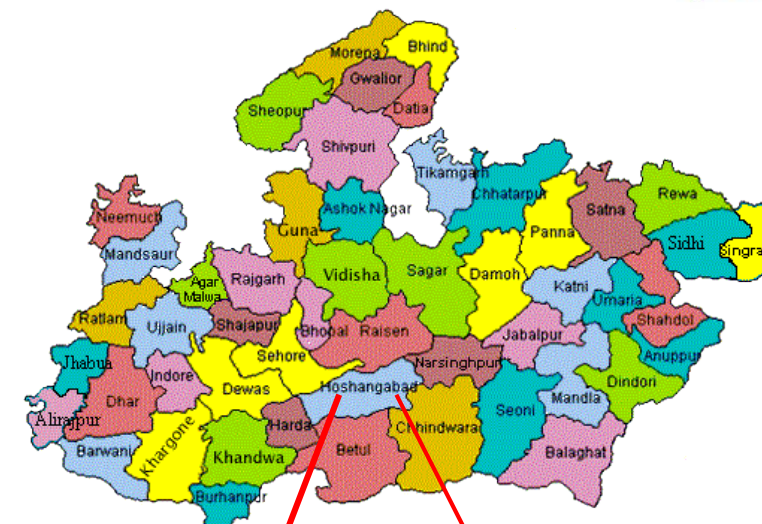
²Space Applications Centre, ISRO, Ahmedabad, India

³Madhya Pradesh Council of Science & Technology, Bhopal, India

December, 2020

Site Description

Site Description	
Area of Site	712 sq. km
Location	Part of Hoshangabad District (Madhya Pradesh, India)
Landscape Topography	Mostly flatlands
Typical Field Size	1.78 ha (Average of Madhya Pradesh)
Climatic and Weather	Hot summer and generally dry except during the south west monsoon season. About 92.8% of the annual rainfall received during monsoon seasons and only 7.2 % of the annual rainfalls take place during October to May period.
Major Crops and Calendars	Kharif (rainy): Soybean, Paddy, Maize Rabi (winter): Wheat, Gram(<i>Rabi</i>)
Soil Type and Texture	Deep medium Black soil, Sandy clay loam, sandy loam and clay loam
Irrigation Infrastructure	Approx. 89%.area irrigated



Project Objectives

- **Crop identification and Crop Area Estimation:**
 - Mapping of Soyabean Crop using Multi-Temporal SAR Data (Sentinel-1/ Radarsat).
 - Use of Optical data for Rabi season (winter) crop classification.
 - Use of Machine learning Algorithms
 - Data Fusion
- **Crop Condition/Stress monitoring**
 - Temporal NDVI/NDWI monitoring
- **Crop Phenology Parameter Extraction**
 - Deriving various phenology matrices using multi-temporal SAR & Optical Data

Earth Observation Data

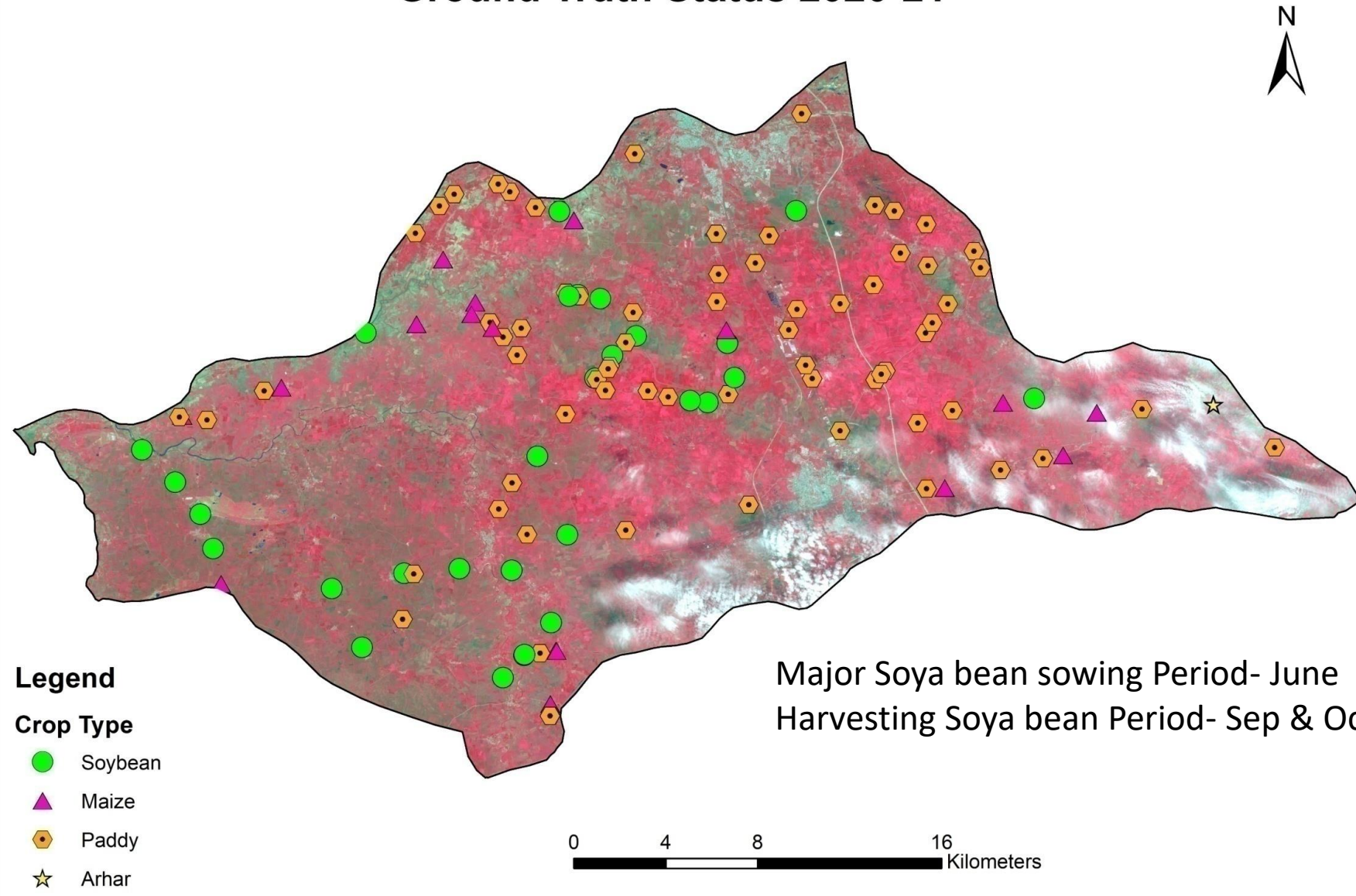
Optical Data

- *SENTINEL-2 -13 Sept. & 28 Sep.2020 (for reference)*

SAR Data

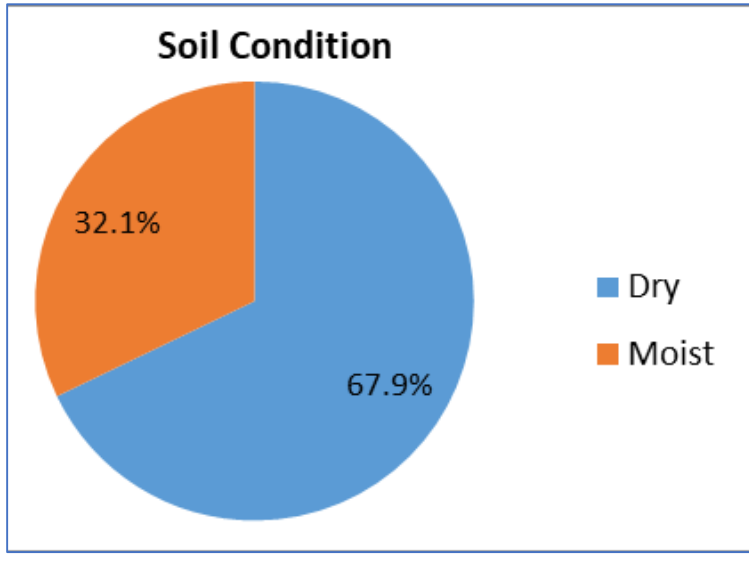
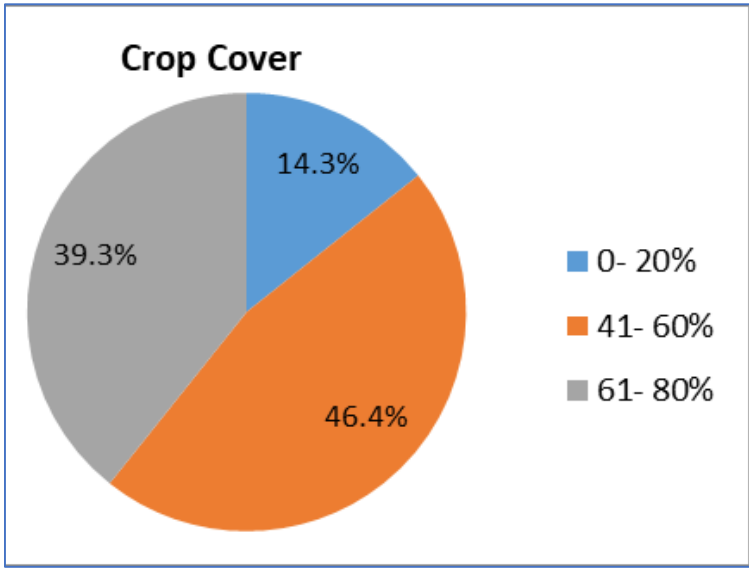
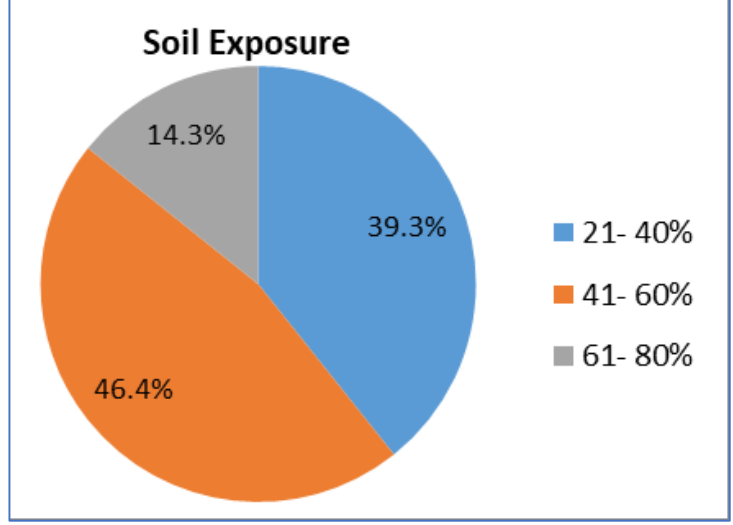
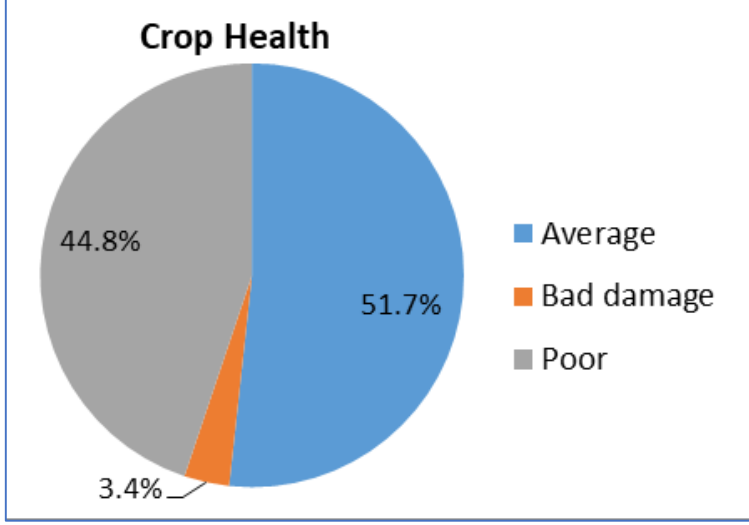
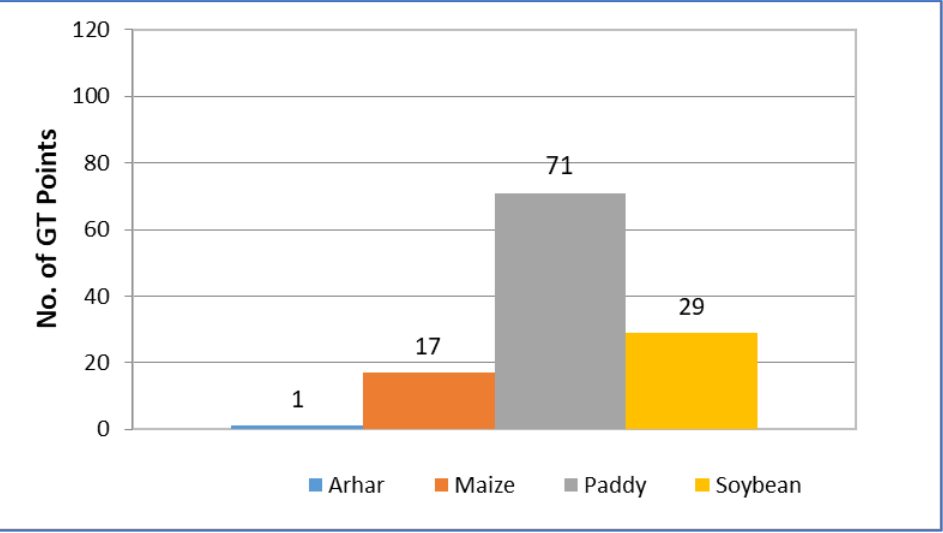
- *SENTINEL-1A – June to September/October (12 dates)*
 - *4-06-2020, 16-06-2020, 28-06-2020,10-07-2020,22-07-2020,03-08-2020, 27-08-2020, 08-09-2020, 20-09-2020,02-10-2020,14-10-2020 and 26-10-2020.*

Ground Truth Status 2020-21



Crop	No of GT
Arhar	1
Maize	17
Paddy	71
Soya bean	29
Grand Total	118

Ground Truth Description



Ground Truth Photographs

Soybean (09.09.2020)



Soybean (08.09.2020)



Maize (08.09.2020)



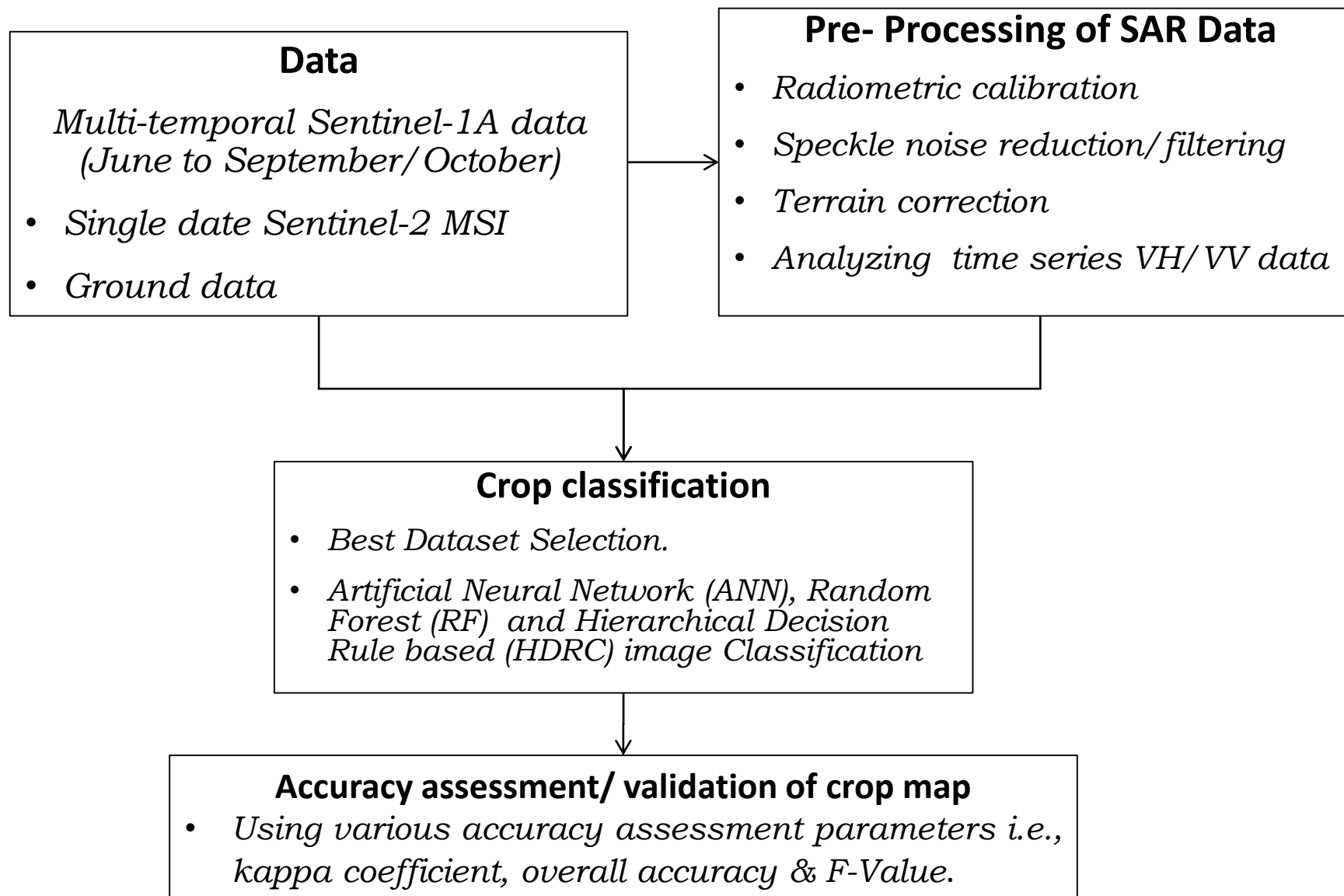
Rice (08.09.2020)



Maize (08.09.2020)

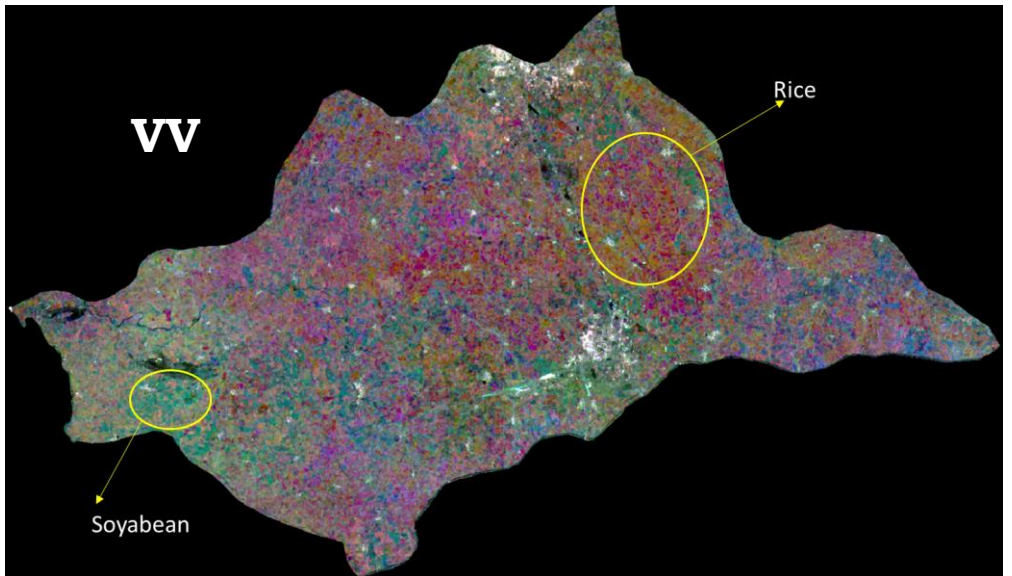
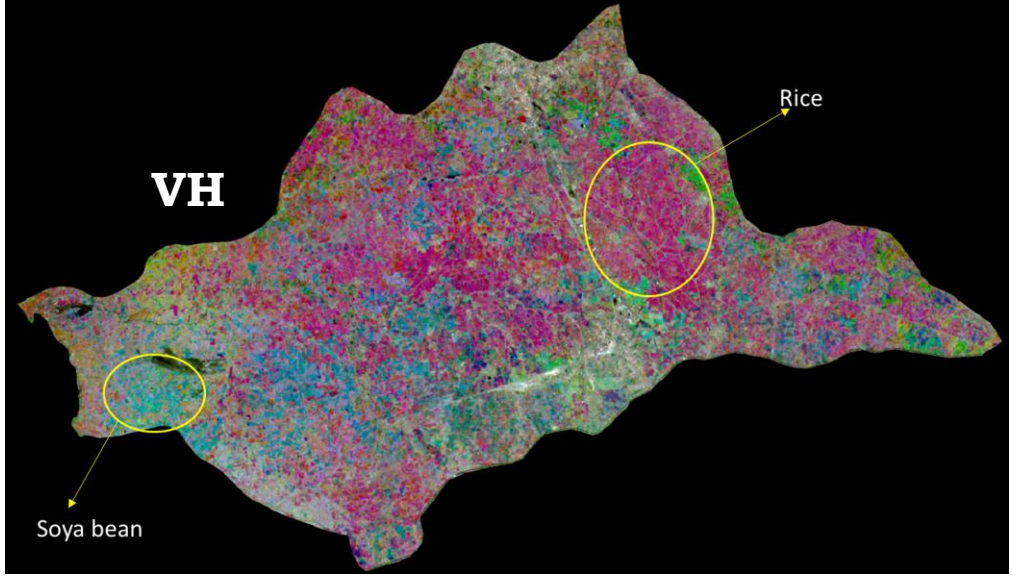


Methodology for Data Analysis

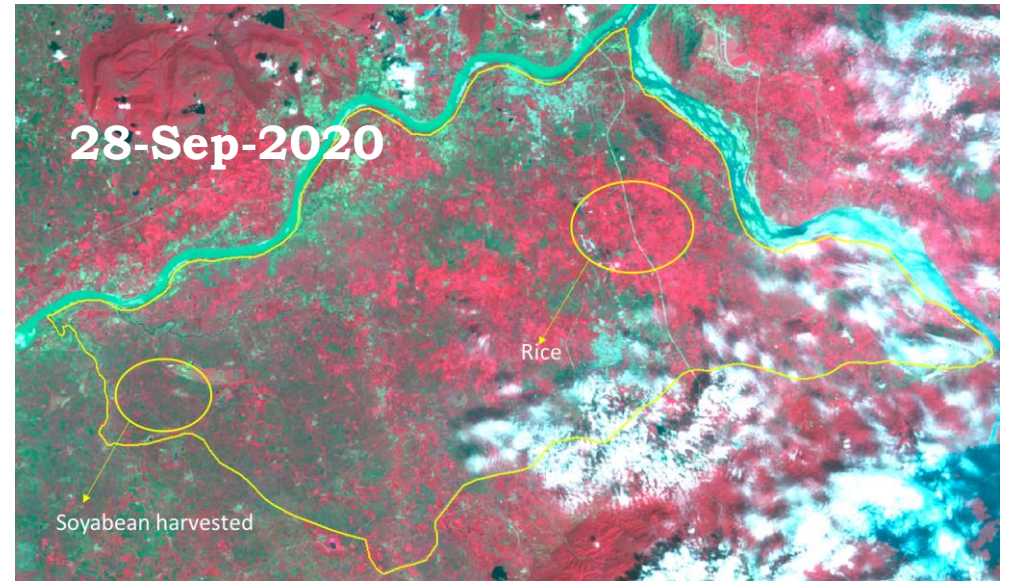
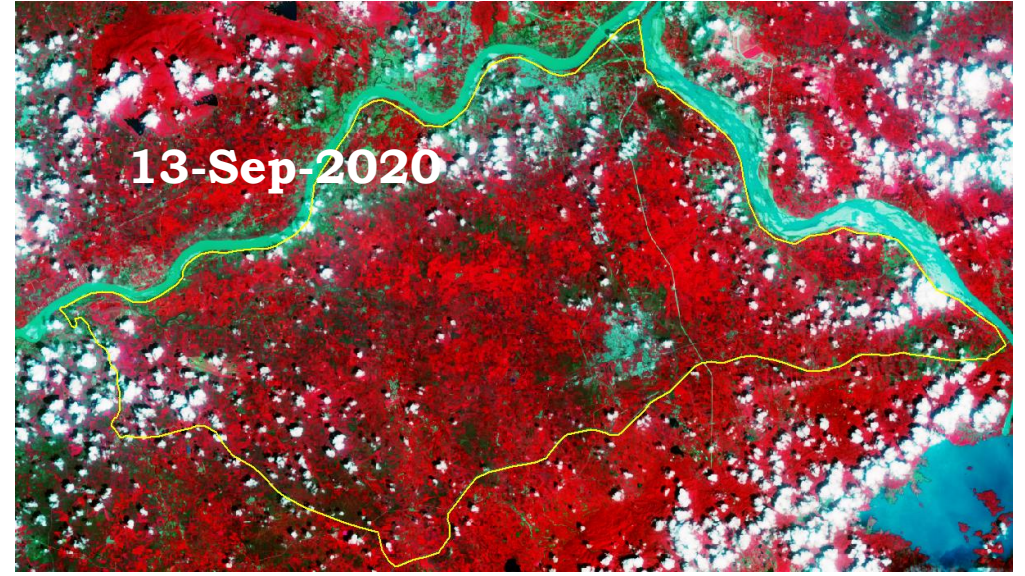


Sentinel-1& 2 Data Showing Crop Signatures

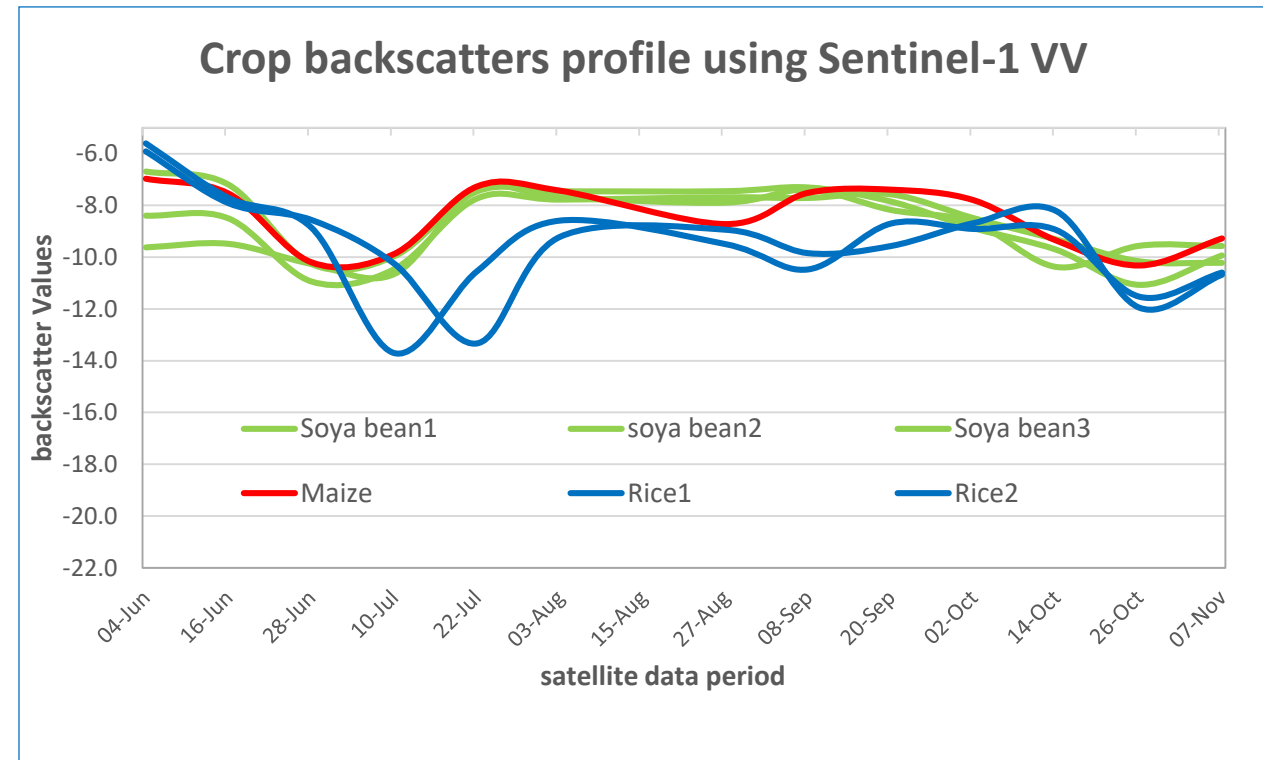
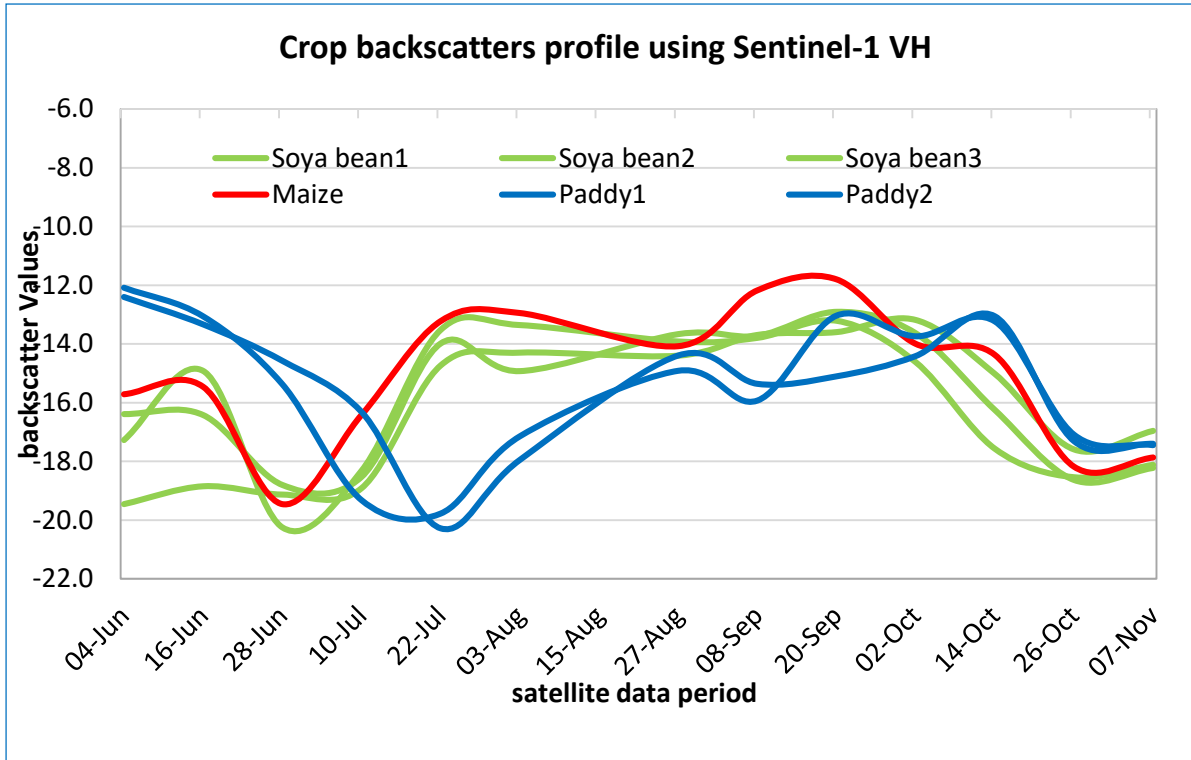
Sentinel 1 SAR 3- Date Composite



Sentinel-2 MSI



Crop Backscatter Profile using Sentinel-1 VH & VV

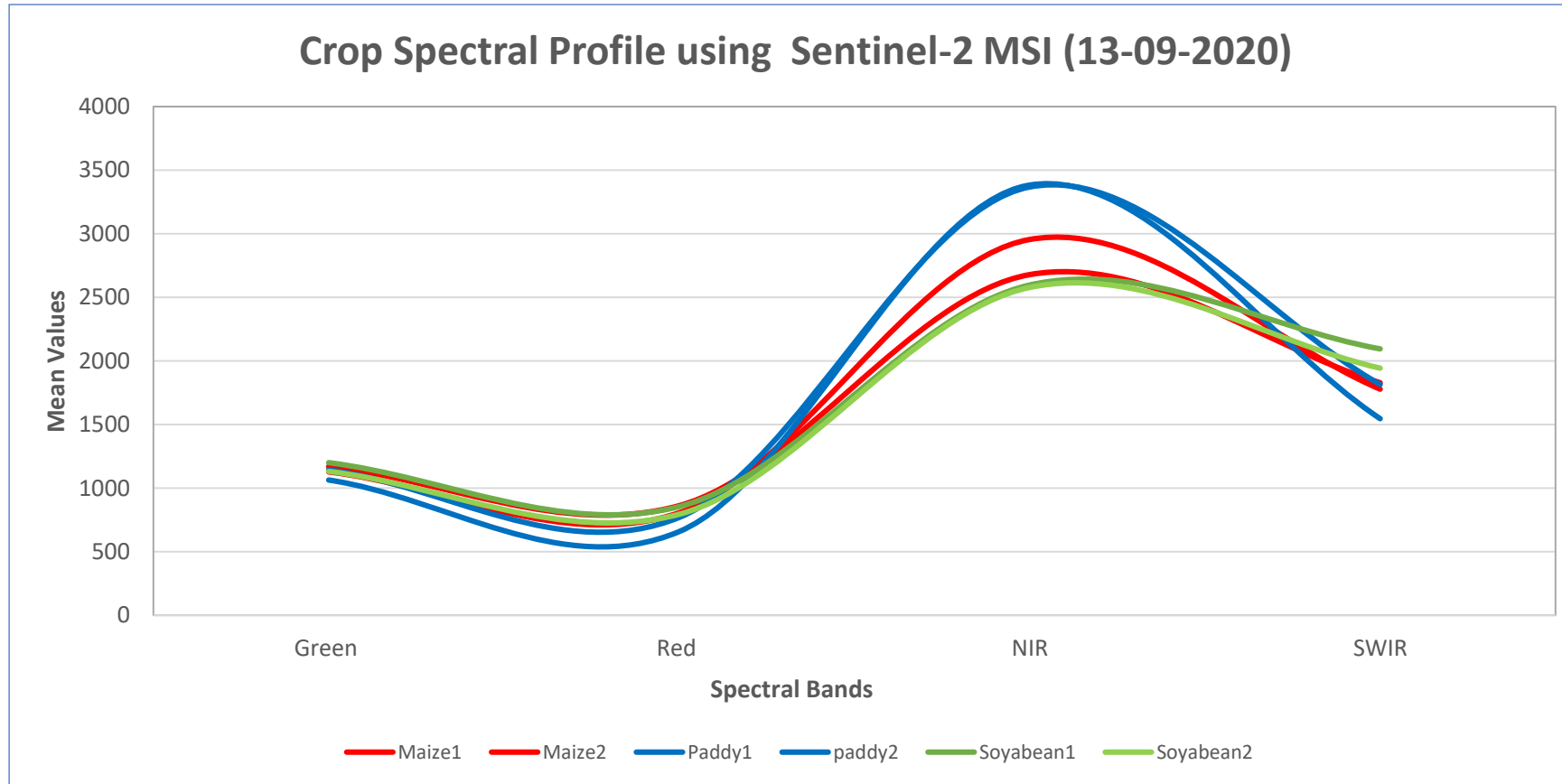


Best Date Selection using Separability (Transformed Divergence)

VH: 28 Jun, 22 Jul, 08 Sep

VV: 04 Jun, 22 Jul, 08 Sep

Crop Profile using Sentinel-2 MSI

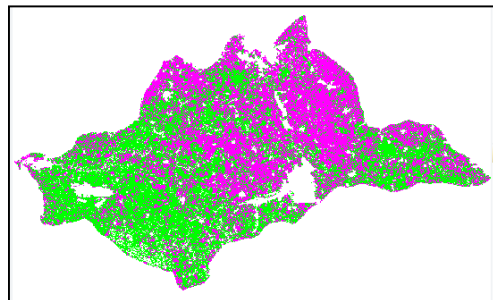
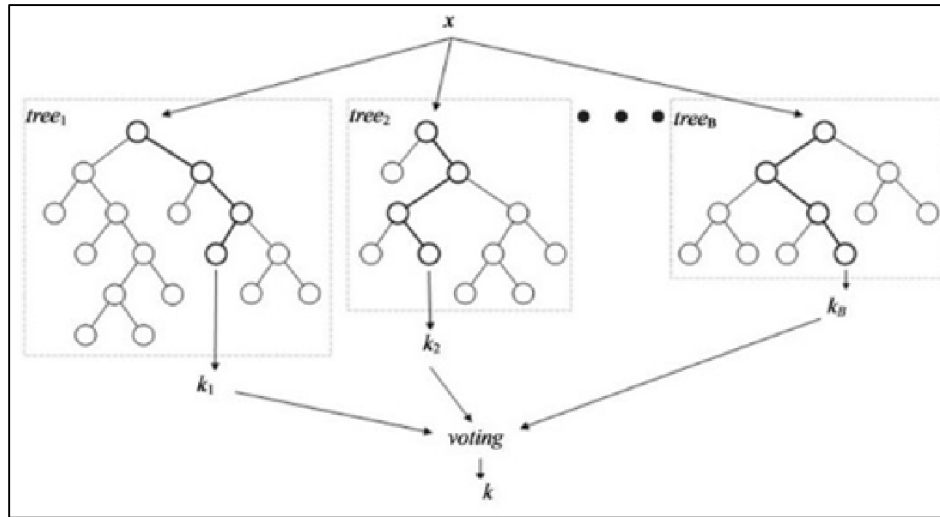
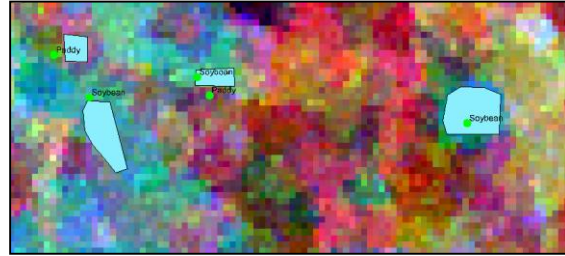
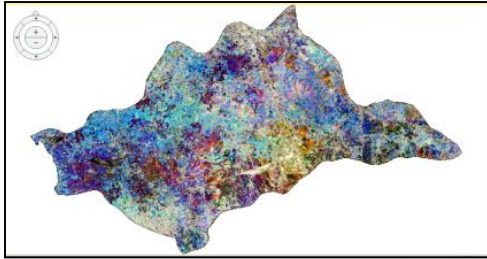


Random Forest (RF) based Classification

Input Layers

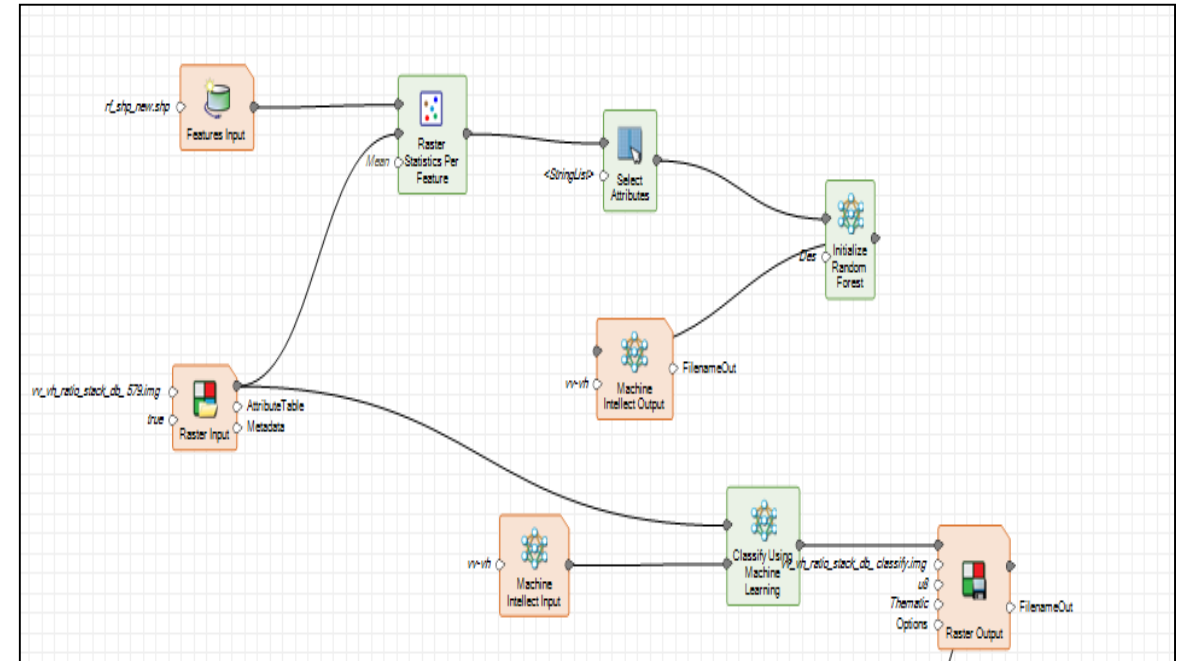
Sentinel -1 Multidate image

Training sets



Output
classified
image

Spatial Model

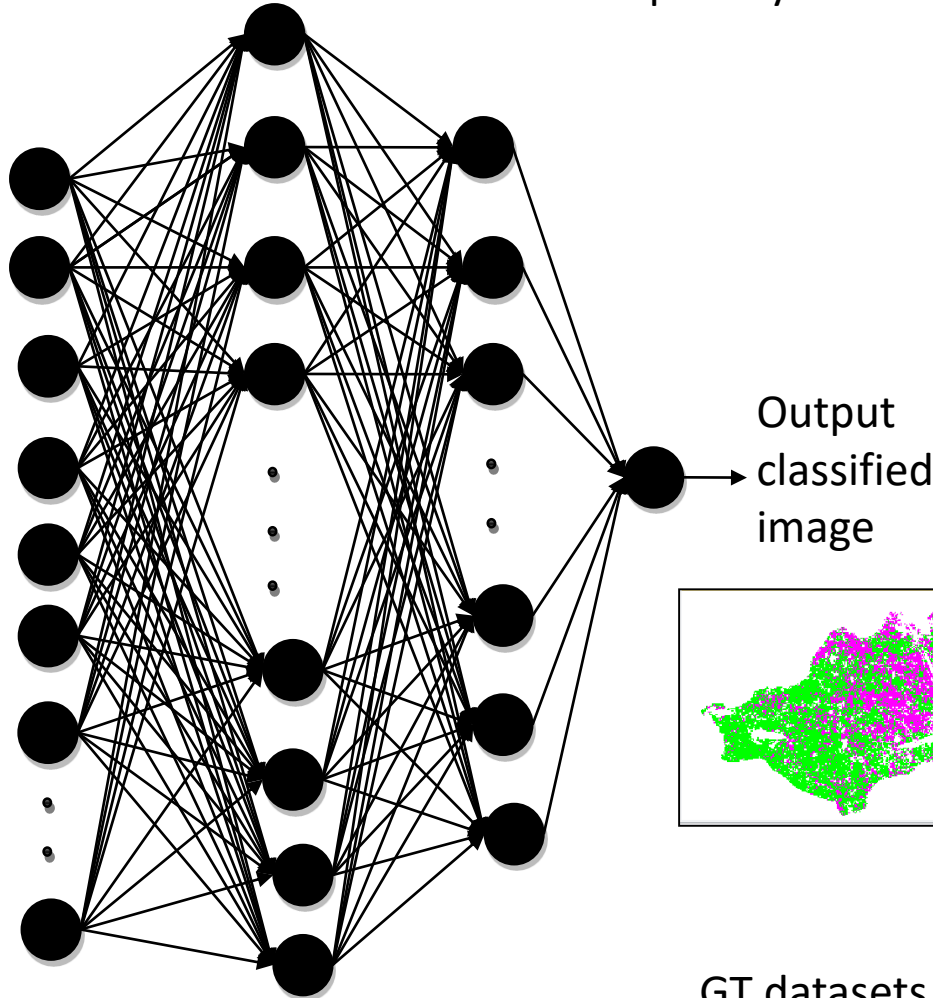


ANN based Classification

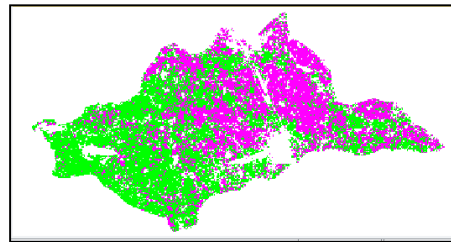
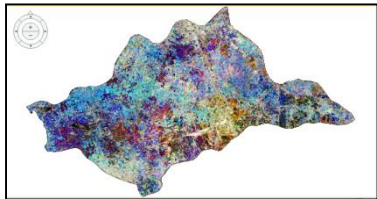
Input Layers

Hidden Layers

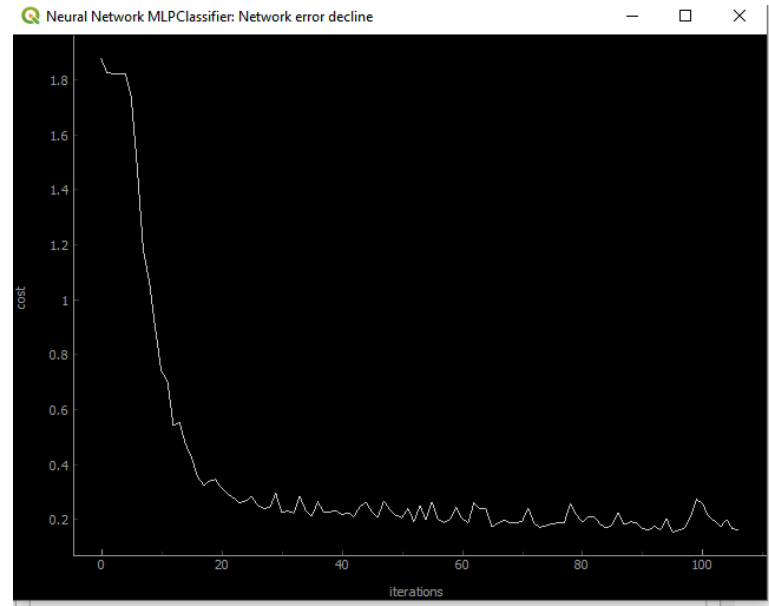
Output Layer



Inputs are Different dates SAR images



Output classified image



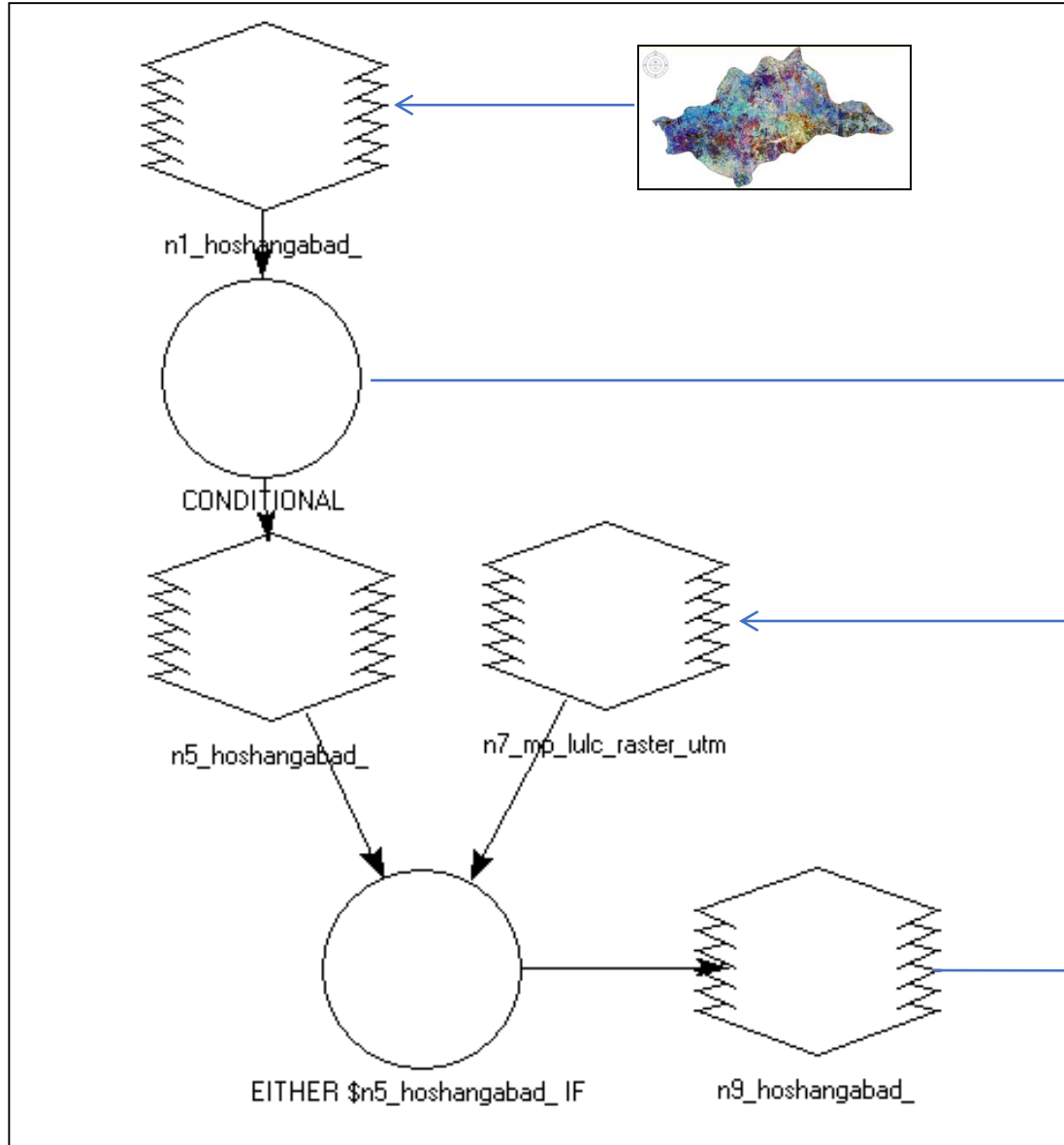
Training error curve

Neural Network MLPClassifier	
Parameters	Log
Average accuracy: 0.9651535992663915	
Kappa class 1: 0.9386463373466861	
Kappa class 2: 0.9342922053645891	
Kappa class 3: 0.968700272417458	

Accuracy of testing data

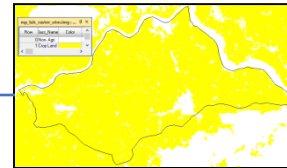
GT datasets were divided into Training (67%) and Testing (33%)

Hierarchical Decision Rule Classification (HDRC)

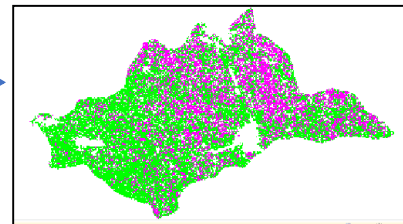


Model values for paddy & soybean

Agri Mask



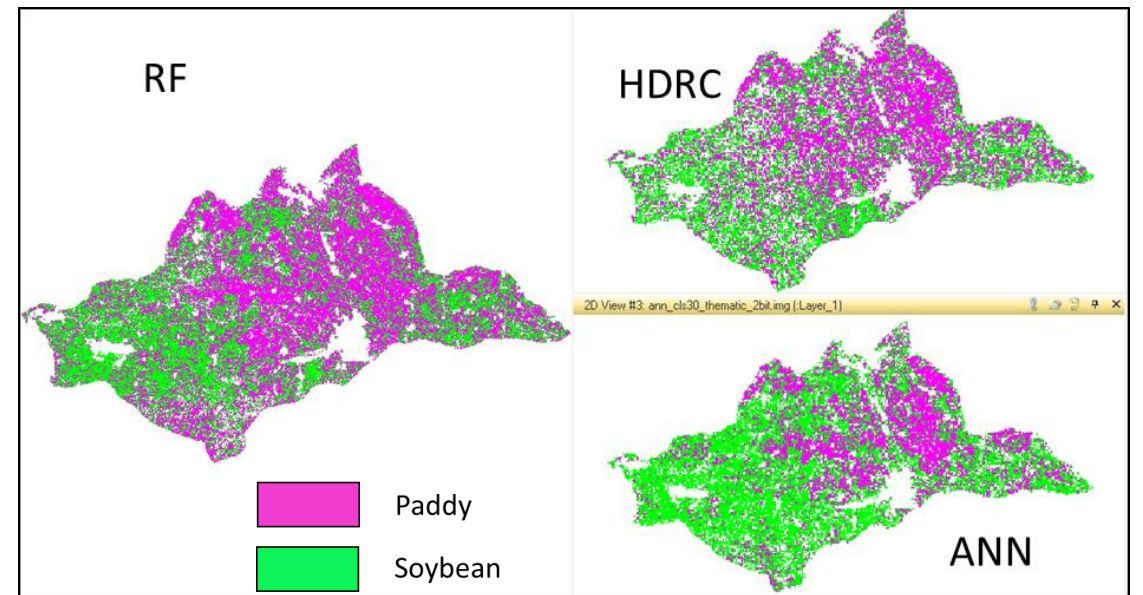
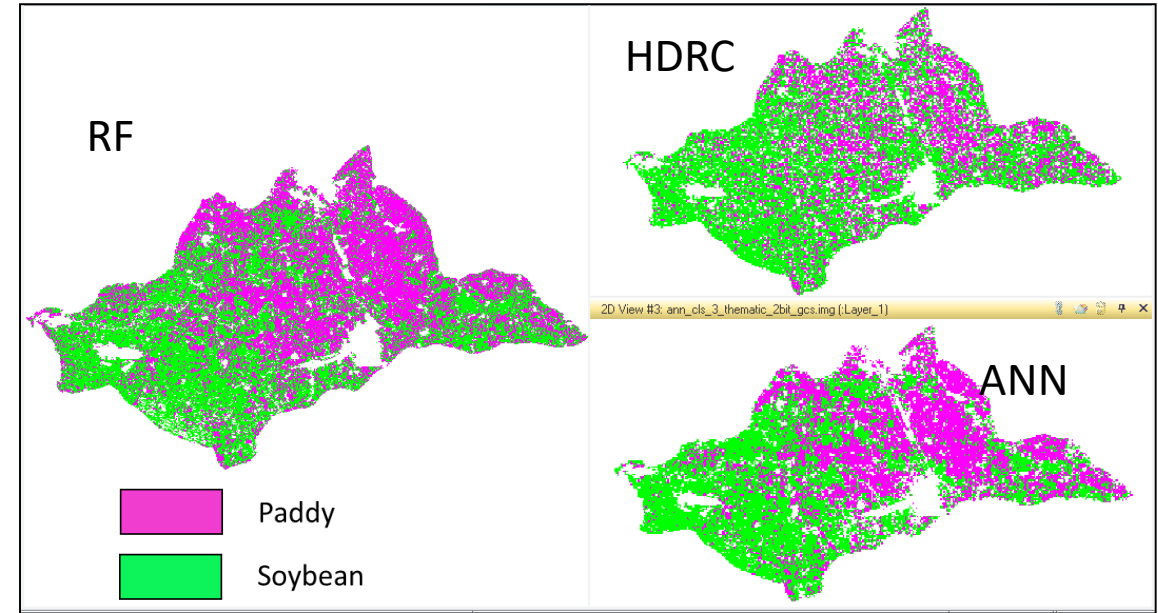
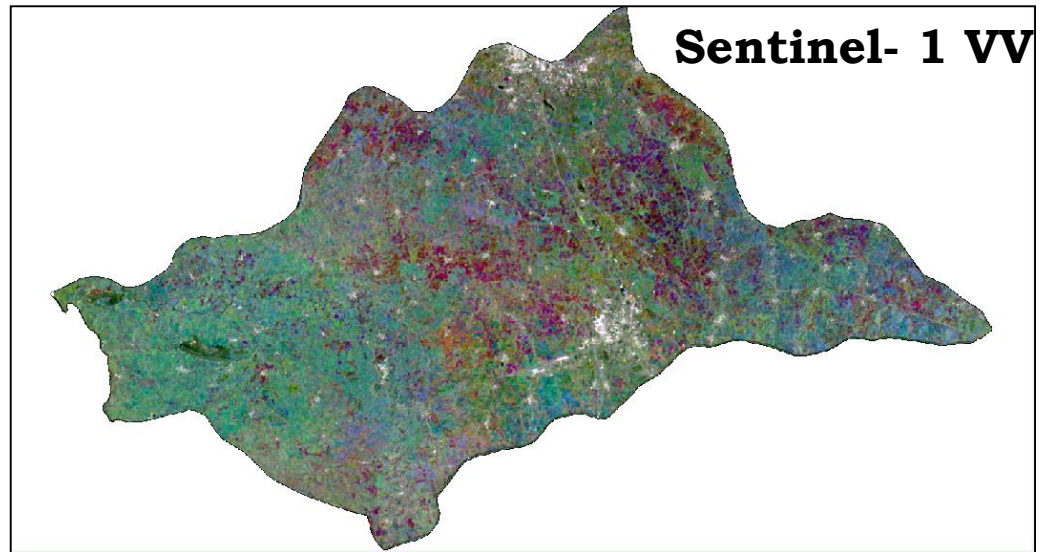
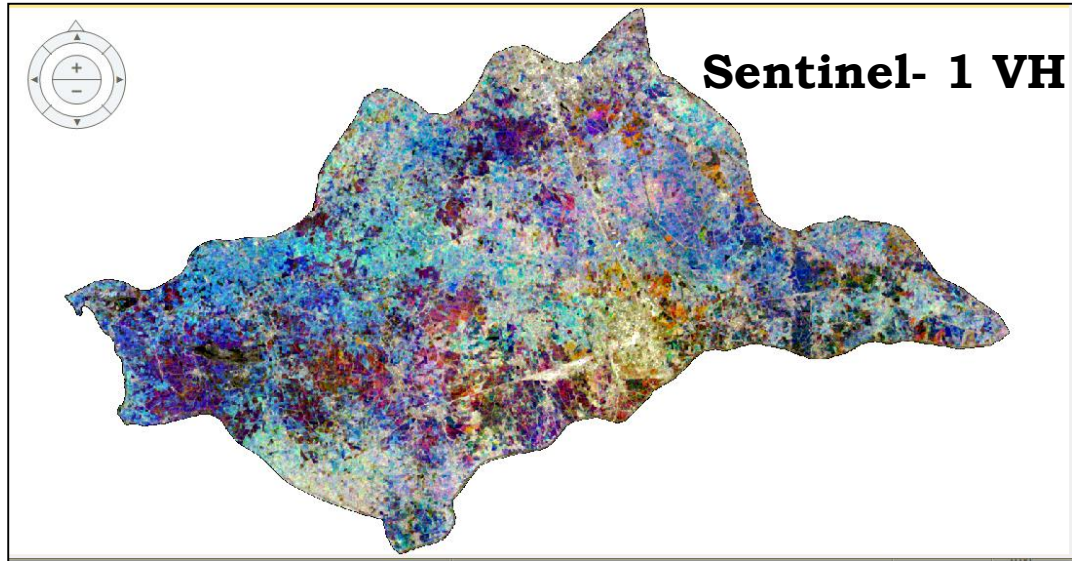
Output classified image



```

CONDITIONAL {
(
$n1_hoshangabad_(5) ge 30
and $n1_hoshangabad_(5) le 100
and $n1_hoshangabad_(6) ge 40
and $n1_hoshangabad_(6) le 120
and $n1_hoshangabad_(7) ge 80
and $n1_hoshangabad_(7) le 180
and (($n1_hoshangabad_(6) - $n1_hoshangabad_(5))>0)
and (($n1_hoshangabad_(7) - $n1_hoshangabad_(6))>0)
)1,
(
$n1_hoshangabad_(5) ge 30
and $n1_hoshangabad_(5) le 100
and $n1_hoshangabad_(6) ge 40
and $n1_hoshangabad_(6) le 120
and $n1_hoshangabad_(7) ge 70
and $n1_hoshangabad_(7) le 140
and (($n1_hoshangabad_(5) - $n1_hoshangabad_(6))>0)
and (($n1_hoshangabad_(7) - $n1_hoshangabad_(6))>5)
and (($n1_hoshangabad_(8) - $n1_hoshangabad_(7))>0)
)2,
(
$n1_hoshangabad_(6) ge 100
and $n1_hoshangabad_(6) le 150
and $n1_hoshangabad_(7) ge 120
and $n1_hoshangabad_(7) le 170
and $n1_hoshangabad_(8) ge 130
and $n1_hoshangabad_(8) le 180
and (($n1_hoshangabad_(7) - $n1_hoshangabad_(6))>5)
and (($n1_hoshangabad_(8) - $n1_hoshangabad_(7))>5)
)8,
(
$n1_hoshangabad_(5) ge 100
and $n1_hoshangabad_(5) le 160
and $n1_hoshangabad_(7) ge 100
and $n1_hoshangabad_(7) le 180
and $n1_hoshangabad_(9) ge 80
and $n1_hoshangabad_(9) le 140
and (($n1_hoshangabad_(7) - $n1_hoshangabad_(9))>0)
)9
}
    
```

Classified images



Accuracy Comparison using different classification techniques

	RF (Dates 3,5,9)*									HDRC (All dates)						ANN (All dates) (3 Hidden Layers -10,30,30 neurons), (300 iterations)					
	VH			VV			VV/VH			VH			VV			VH			VV		
	PA	UA	F-value	PA	UA	F-value	PA	UA	F-value	PA	UA	F-value	PA	UA	F-value	PA	UA	F-value	PA	UA	F-value
Paddy	90.14	86.49	88.28	78.87	83.58	81.16	71.83	79.69	75.56	69.01	85.96	76.56	80.28	78.08	79.16	85.92	91.04	88.41	66.2	92.16	77.05
Soybean	72.41	55.26	62.68	79.31	53.27	63.73	62.07	52.94	57.14	68.97	42.55	52.63	34.48	35.71	35.08	82.76	58.54	68.57	86.21	44.64	58.82
Overall Accuracy	73.95%			68.91%			60.50%			60.50%			60.50%			73.11%			63.87%		
Kappa	0.5192			0.4480			32.06%			0.3394			0.2851			0.5244			0.4110		
	Dates (5,7,9)*																				
Paddy	88.73	91.3	90.00	88.73	82.89	85.71	88.73	75.90	81.82												
Soybean	79.31	53.49	63.89	62.07	54.55	58.07	55.17	55.17	55.17												
Overall Accuracy	75.63%			71.43%			68.07%														
Kappa	0.5622			0.4689			38.00%														

*D3: 28th June, 2020; D5: 10th July, 2020; D7: 3rd August, 2020 & D9: 8th September, 2020

PA: Producer's Accuracy

UA: User's Accuracy

Conclusions

- ✓ *Temporal soybean and Paddy backscatter signature from Sentinel-1 (VV, VH) SAR Data were analyzed, best dataset selected and crop classification was carried out using different ML algorithms.*
- ✓ *Paddy had higher classification accuracy than soybean.*
- ✓ *Random Forest performed better than other classifiers (HDRC, ANN).*

Future Work

- ✓ *Rabi season crop classification using Sentinel/ Resourcesat 2 LISS III/ Landsat data.*
- ✓ *Crop Condition and Phenology Monitoring.*
- ✓ *Exploring other SAR data for Soybean and Rice Classification.*
- ✓ *Optical & SAR data fusion*

Thank you.