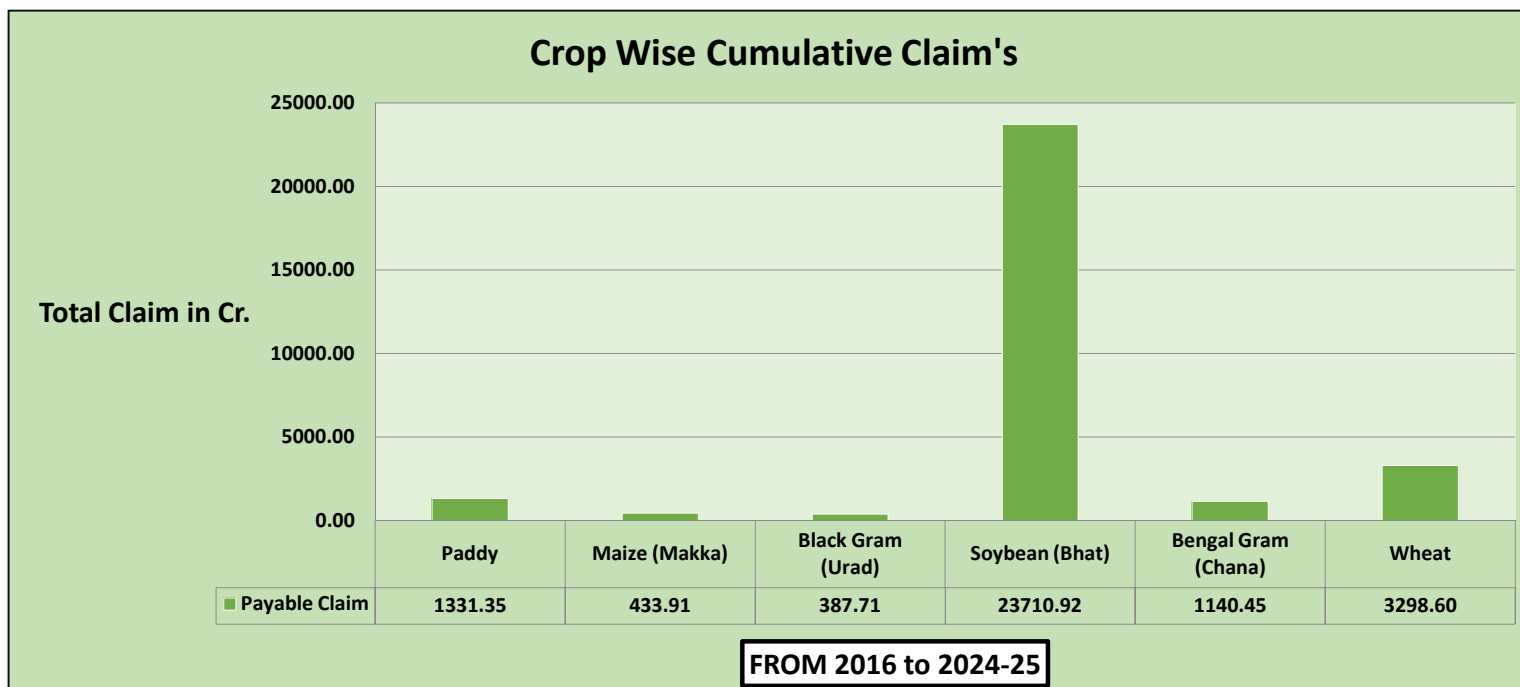


YES-TECH for crop loss estimation:

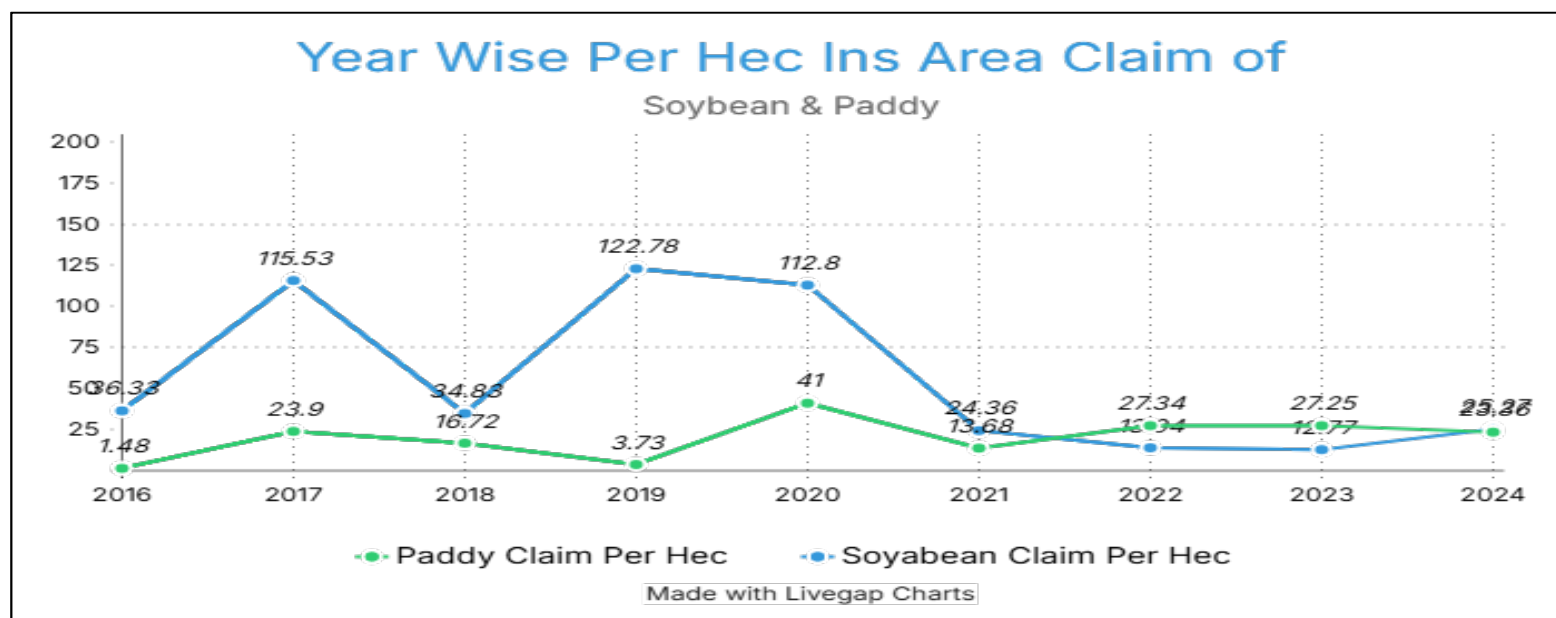
learnings from Madhya Pradesh

Crop wise claim pattern of MP



Paddy	Maize (Makka)	Black Gram (Urad)	Soybean (Bhat)	Bengal Gram (Chana)	Wheat
1331.35	433.91	387.71	23710.92	1140.45	3298.60

Comparison of Soybean and Paddy crop claim to per hectare insured area:



Year	2016	2017	2018	2019	2020	2021	2022	2023	2024
Soyabeen Claim Per Hec	36.33	115.53	34.83	122.78	112.80	24.36	13.94	12.77	25.27
Paddy Claim Per Hec	1.48	23.90	16.72	3.73	41.00	13.68	27.34	27.25	23.36

Agri GIS Project of MP

- Agri GIS project has been started in Madhya Pradesh since Kharif 2022 with collaboration with NRSC Hyderabad (ISRO), MPCST (Madhya Pradesh Council of Science and Technology) and MPSEDC (Madhya Pradesh State Electronics Development Corporation)
- Department of Agriculture signed a MoU with these organizations.
- GoI launched YES-TECH (yield estimation system through technology) program in 2023 for Paddy and Wheat crops with minimum 30 % weightage to technology based yield. In Agri GIS project we covered all major crops of the state with 100 % weightage.
- The Methodology and Technology was similar to YES-TECH guidelines.

Year	Selected Crops Kharif	Selected Crops Rabi	Additional Crop
2022-23	Soybean and Paddy	Wheat, Gram and Mustard	
2023-24	Soybean and Paddy	Wheat, Gram and Mustard	Maize, Pigeon pea, Cotton, Lentil and Linseed
2024-25	Soybean and Paddy	Wheat, Gram and Mustard	Maize, Pigeon pea, Cotton, Lentil and Linseed

Notified crops

KHARIF CROPS	Area Insured in Lakh Hec.	Cropped Area	Minimum Area in a IU	Loss Assessment
Major Crops				
Maize (Makka)	2.40	20.77	50 Hec.	RST
Paddy	6.82	38.30	50 Hec.	RST
Pearl Millet (Bajra)	0.19	2.87	50 Hec.	CCE
Pigeon Pea	0.06	1.51	50 Hec.	RST
Soybean (Bhat)	35.41	58.72	50 Hec.	RST
Minor Crops				
Black Gram (Urad)	1.14	4.24	500 Hec.	CCE
Cotton (Kapas)	0.48	5.37	500 Hec.	RST
Green Gram (Moong)	0.07	0.44	500 Hec.	CCE
Groundnut (Pea Nut)	0.30	7.00	500 Hec.	CCE
Kodo-Kutki	0.00	1.06	500 Hec.	CCE
Sesame	0.16	2.73	500 Hec.	CCE
Sorghum	0.08	0.90	500 Hec.	CCE
Grand Total	47.11	143.91	33%	
RABI CROPS				
Major Crops				
Bengal Gram (Chana)	1.75	13.54	50 Hec.	RST
Mustard	0.20	8.38	50 Hec.	RST
Wheat	38.71	101.09	50 Hec.	RST
Minor Crops				
Lentil (Masur)	0.22	6.30	500 Hec.	CCE
Linseed (Alsi)	0.01	0.48	500 Hec.	CCE
Grand Total	40.88	129.79	32.50%	

INTRODUCTION To Tech based yield estimation:

Training: The fortnightly indices derived from satellite and weather datasets are NDVI, LSWI, FAPAR, PAR, RF, RD, Tmax, Tmin and Backscatter of last five year have been used for yield modelling. The yield models AI/ML and SPM used for the training and validation as well as current year yield prediction for different notified crops.

This comprehensive approach not only contributes to a better understanding of crop yield prediction but also provides valuable insights for optimizing agricultural decision-making processes.

Validation: The resulting estimates from different models are first validated. Estimates from one of the models having higher accuracy will be used. Model parameterisation and implementation will be improved continuously year on year to achieve better accuracies. These estimates together with conventional estimates are used, to improve crop risk assessment.

Data correction: These estimates are also used to moderate the conventional estimates, by correcting the biased CCE data. For Kharif, backscatter data is used due to persistent cloud cover, and AI/ML models (RF,NN) are applied for crop yield estimation of Paddy, Soybean, Maize, and Arhar, while Cotton is estimated using a

Continued

Ensemble model : For Rabi, since optical data is available, both AI/ML models (RF, NN, and LSTM) and semi-physical models are utilized. Additionally, an ensemble modelling approach is applied to improve accuracy.

Approval of the yield: The modelled yield estimates data is being submitted to the Department of Farmer Welfare and Agriculture Development government of MP. The department open these results to Insurance companies and presented it in State Crop Insurance Technical Committee. After all approvals the yield data is proceed for claim calculation.

The following models of crop yield estimation are implemented in MP.

- (a) Semi-physical model
- (b) Machine Learning (AI) model
- (c) Ensemble model

Tasks to be completed

- Sown area estimation. (Sentinel 1 SAR Satellite data and Ground truth data : 1 lakh 30 Thousand 989 till 22 Aug. 2025)
- Preparation of database for weather and spectral indices
 - Current and historical 5 years.
 - Optical, SAR, biophysical parameters (NDVI, LSWI, FAPAR, backscatter Rainfall and Rainy days data.
- Crop maps (Soybean, Paddy, Maize, Arhar and Cotton)
 - Crop-specific feature matrix generation at halka level (fortnightly)
- ML /ensemble/ semi physical model based yield estimation and accuracy assessment
- In-season Crop damage assessment

Adopted models for crop yield estimation

S.No	Season & Crop	Models
1	Kharif (Soybean, Paddy, Maize and Arhar)	AI/ML models
2	Rabi (Wheat, Gram and Mustard)	Semi-physical model and AI/ML models
3	Rabi (Lentil, Linseed and Cotton)	Semi-physical model

Agri GIS Project of MP

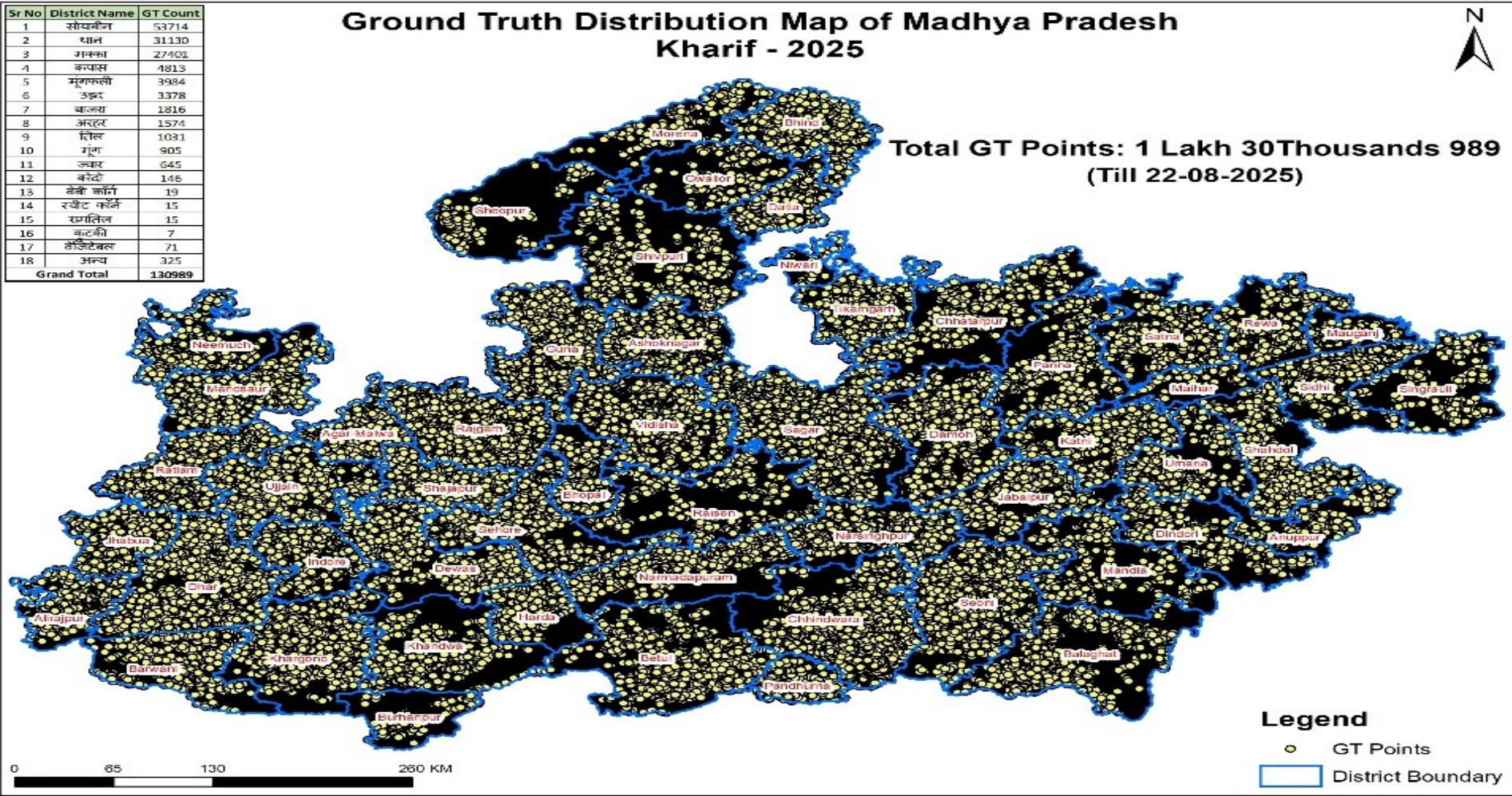
Field Data Collection and Processing

- Ground Truth (GT) points collected via Krishi Mapper GT Application.
- Enriched with attributes such as crop type Crop Name, Crop Condition, Crop Stage, Showing date, Crop Category, Harvesting date, Latitude, Longitude, Village, Tehsil and District Name etc.

Crop Mapping

- Sentinel-1/2 satellite data used to create temporal stacks and spectral graphs.
- AI/ML models (Random Forest, CNN) applied for crop classification → produces Level-1 crop map.
- Rule-based rectification using crop-specific backscatter ranges → refined into Level-2 crop map.
- Accuracy assessed through confusion matrices and Kappa statistics.

Ground Truthing Kharif 2025



Yield Estimation

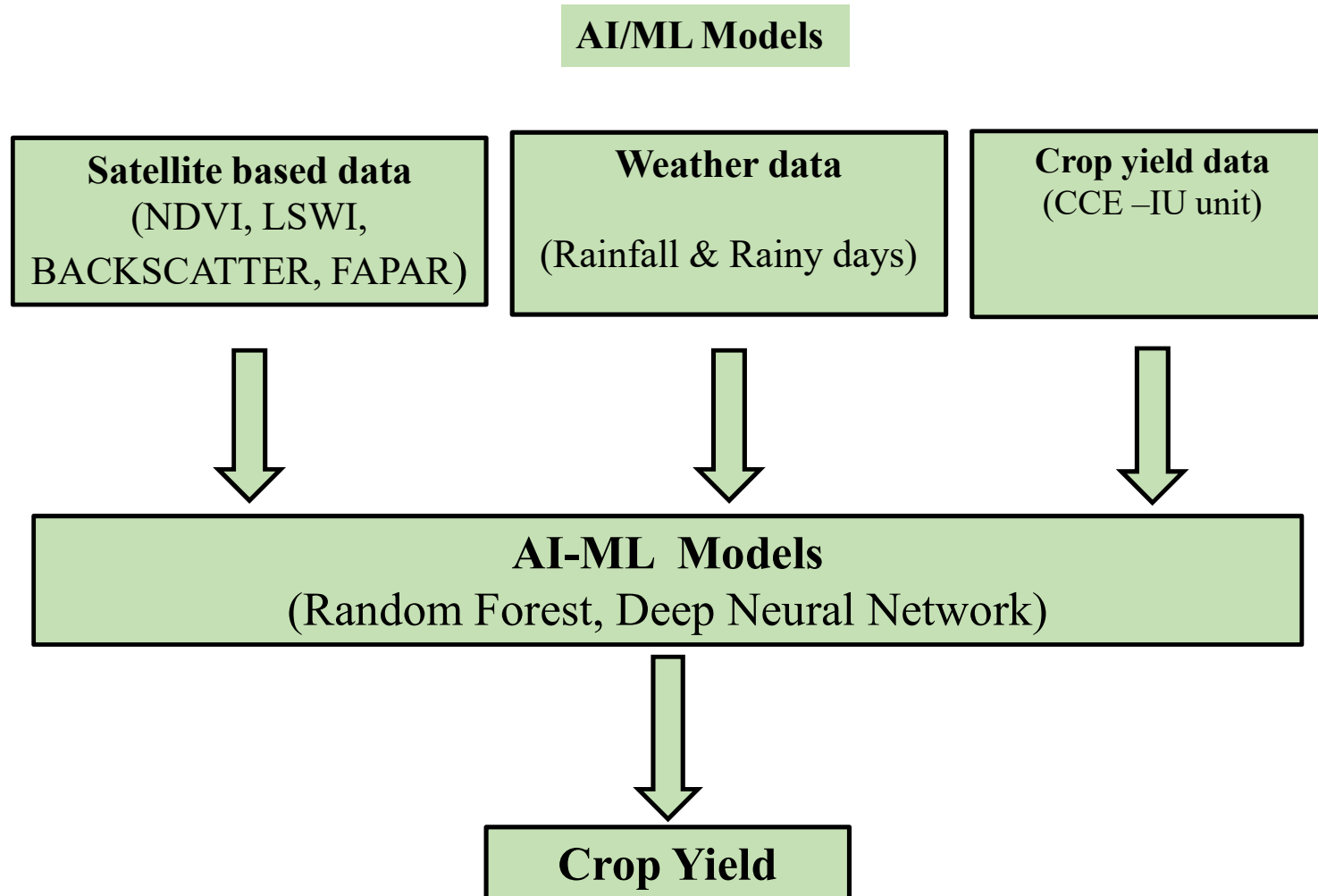
AIML Model

Machine Learning- Artificial Intelligence (AI) has become popular in solving the non-linear relationships between the variables particularly in the bio-physical framework involving crop yield estimation. AI includes Machine Learning (ML) and Deep Learning (DL) models. In recent years, AI models have gained momentum for crop yield estimation.

The broad list of input parameters for the above models include;

- Crop distribution maps and statistics
- Crop risk affected area maps and statistics— drought, floods, unseasonal rains, prevented-failed sowing
- Satellite derived crop condition indices – NDVI, LSWI, Backscatter and FAPAR
- Crop phenology metrics
- daily max & min temperature
- daily Rainfall, Rainy days

Yield Estimation



Yield Estimation

Semi-physical) Model

Semi-physical methods are based on bio-chemical process of plant

– light absorption for:

photosynthesis,

radiation use efficiency,

stress factors,

accumulated biomass

grain yield.

Availability of precise information on crop variety, planting and harvest date and derivation of water stress and temperature stress factors would lead to better performance of these models.

Special activities done

1. Correction factors used details.

A Crop Damage Assessment using Microwave Backscatter Analysis: Crop damage assessment is carried out by analyzing the change in microwave backscatter values obtained from pre- and post-event satellite images. A significant reduction in backscatter values in the post-event image, as compared to the pre-event image, indicates possible crop damage or loss of vegetation due to external factors such as heavy rainfall or flooding. This technique helps in identifying the extent and severity of damage over large areas. The analysis will revealed a noticeable decrease in backscatter values, signifying substantial crop damage in the affected agricultural areas.

B Special Ground Truthing for localized events like hailstorm, water stagnation etc. has been done and Incorporated in tech based yield estimation.

Special CCE

In major crop-growing districts, around 300 to 400 special CCEs are conducted. CCEs are categorized into two types: primary and secondary. If the crop at a primary CCE

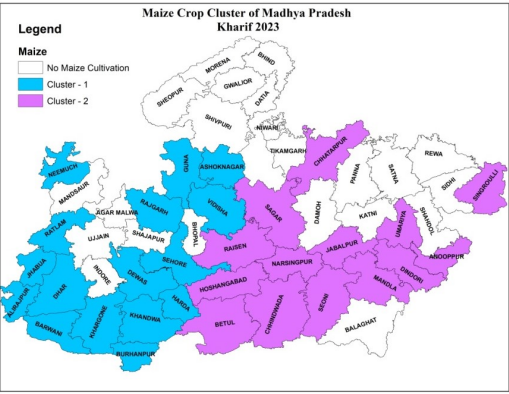
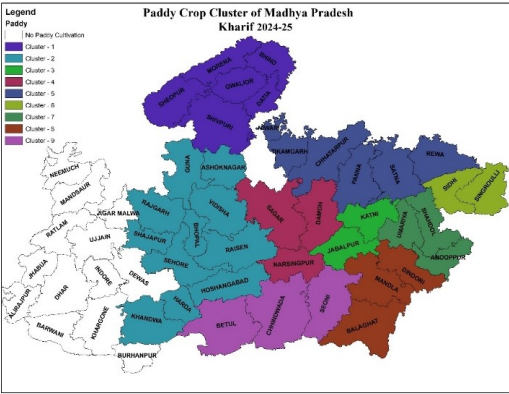
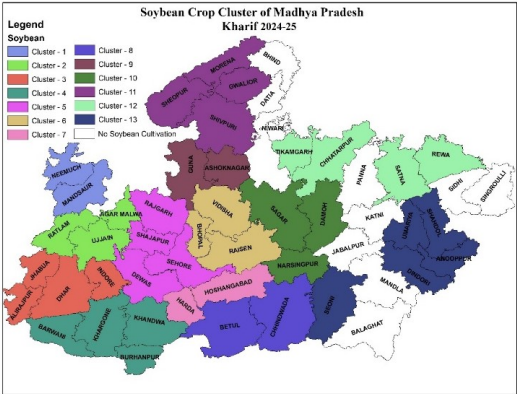
Details of Satellite Data

Season	Satellite data	Duration
Rabi	Sentinel -2 (Optical satellite data)	October to April
Kharif	Sentinel -1 and EOS-4 (Microwave satellite data)	June to October

Parameters	Source	Temporal Resolution	Spatial Resolution
Season max. FAPAR	Sentinel-3	10 Days	300 m.
Season max. NDVI	Sentinel-2	15 Days	10 m.
Season max. LSWI	Sentinel-2	15 Days	10 m.
Daily Integrated insolation PAR (INSAT 3D)	MOSDAC	Daily	4 km
Root Zone Soil Moisture (Rabi Season)	SMAP	Daily	10 Km.
Temperature (Rabi Season)	NASA Power	Daily	0.5*0.5 Degree
Rainfall and rainy days(June to September) (Kharif Season)	CHIRPS IMD	Daily	5 Km 25 Km.
Yield data	Dept. of Agriculture	Yearly	-
crop layer	Sentinel-1 Sentinel-2	12 Days 05 Days	20m 10m

Crop Clustering for Yield Estimation

The Clustering based upon Agro-ecological zone, crop area and historical yield patterns.

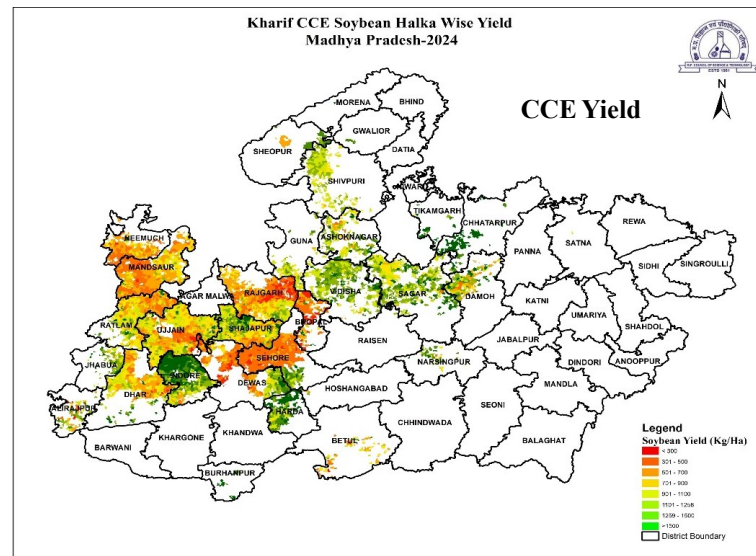
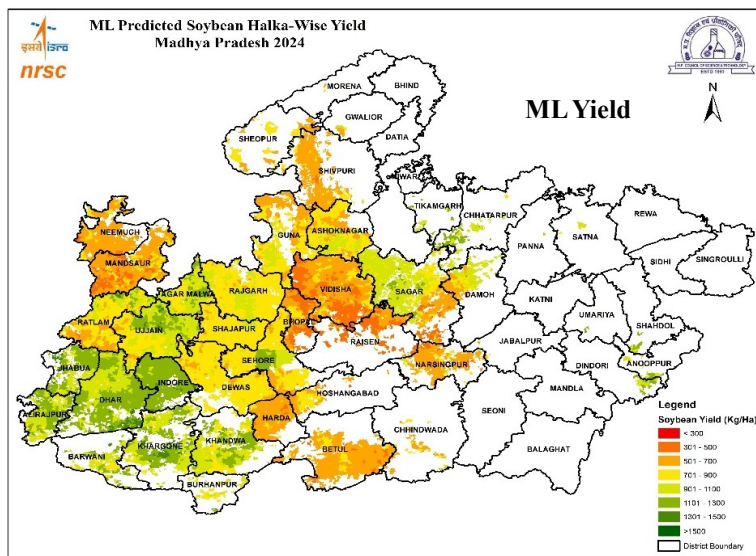


CLUSTER ID	(SOYABEAN)
Cluster 1	Neemuch, Mandsaur
Cluster 2	Ratlam, Ujjain, Agar Malwa
Cluster 3	Alirajpur, Jhabua, Dhar, Indore
Cluster 4	Barwani, Khargone, Khandwa, Burhanpur
Cluster 5	Rajgarh, Dewas, Shajapur, Sehore
Cluster 6	Vidisha, Bhopal, Raisen
Cluster 7	Harda, Hoshangabad
Cluster 8	Betul, Chhindwada
Cluster 9	Guna, Ashoknagar
Cluster 10	Sagar, Damoh, Narsinghpur
Cluster 11	Sheopur, Gwalior, Morena, Shivpuri
Cluster 12	Tikamgarh, Chhatarpur, Satna, Rewa
Cluster 13	Seoni, Dindori, Umaria, Shahdool, Anoopur

CLUSTER ID	(PADDY)
Cluster 1	Sheopur, Gwalior, Morena, Shivpuri, Bhind, Datia
Cluster 2	Guna, Ashoknagar, Vidisha, Bhopal, Raisen, Rajgarh, Shajapur, Sehore, Harda, Khandwa, Hoshangabad
Cluster 3	Katni, Jabalpur
Cluster 4	Sagar, Damoh, Narsinghpur
Cluster 5	Tikamgarh, Chhatarpur, Satna, Rewa, Panna, Niwari
Cluster 6	Sidhi, Singroulli
Cluster 7	Umaria, Shahdool, Anooppur
Cluster 8	Mandla, Balaghat, Dindori
Cluster 9	Betul, Chhindwada, Seoni

CLUSTER ID	(MAIZE)
Cluster 1	Neemuch, Ratlam, Alirajpur, Jhabua, Dhar, Barwani, Khargone, Burhanpur, Dewas, khandwa, Sehore, Guna, Ashoknagar, Vidisha, Rajgarh, Harda
Cluster 2	Betul, Chhindwada, Seoni, Mandla, Dindori, Umaria, Anooppur, Jabalpur, Narsinghpur, Raisen, Sagar, Chhatarpur, Hoshangabad, Singroulli

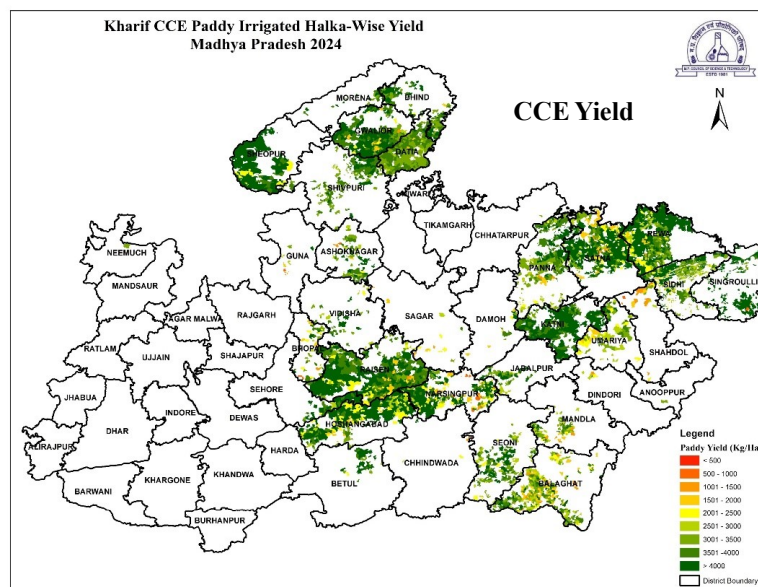
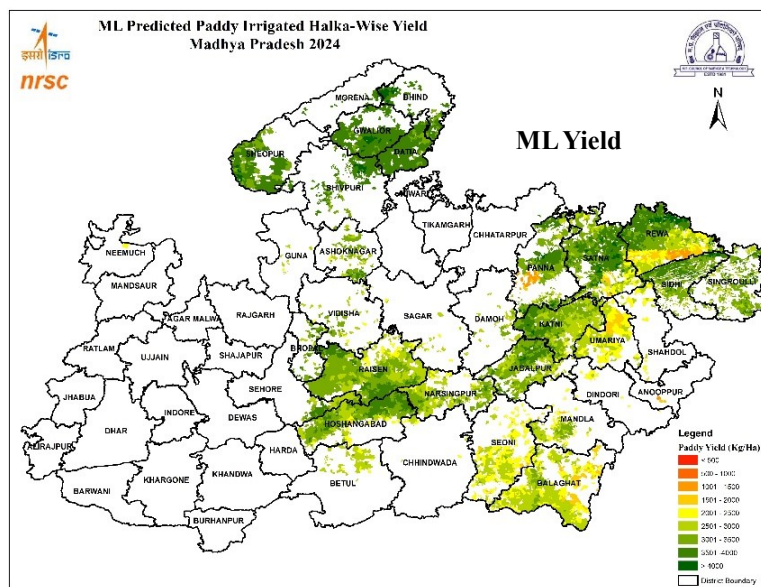
Soybean crop AI/ML model estimated Yield vs CCE yield (Kharif 2024)



Cluster wise agreement of CCE estimates vs modelled estimates (AI/ML average) for Soybean Crop									
Cluster	<-40	-40 to -30	-30 to -20	-20 to 20	20 to 30	30 to 40	>40	Total	Halkas with -20% to 20% deviation
1	27	43	62	299	49	37	73	590	50.68
2	32	37	67	306	67	52	339	900	34.00
3	27	64	87	289	42	34	203	746	38.74
4	7	2	0	2	0	0	0	11	18.18
5	109	111	88	284	63	64	679	1398	20.31
6	239	36	10	28	2	4	72	391	7.16
7	115	8	4	4	0	0	0	131	3.05
8	7	9	12	21	3	1	12	65	32.31
9	28	36	45	78	7	1	12	207	37.68
10	136	61	82	230	19	16	27	571	40.28
11	84	63	18	15	0	0	2	182	8.24
12	34	23	11	5	1	0	0	74	6.76
Total	845	493	486	1561	253	209	1419	5266	29.64

- In about 29.64 % halka, model derived Soybean yield estimates are within the range of (-+20%) w.r.t CCE estimates
- In about 43.67 % halka, model derived Soybean yield estimates are within the range of (+- 30%) w.r.t CCE estimates

Paddy (irrigated) AI/ML model estimated Yield vs CCE yield (Kharif 2024)

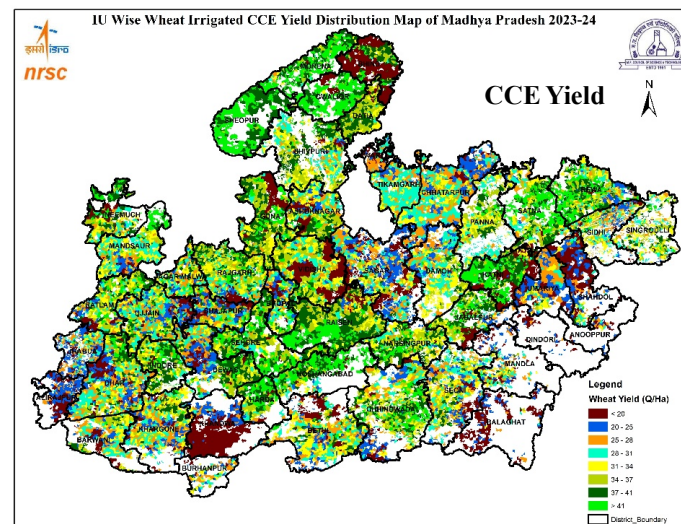
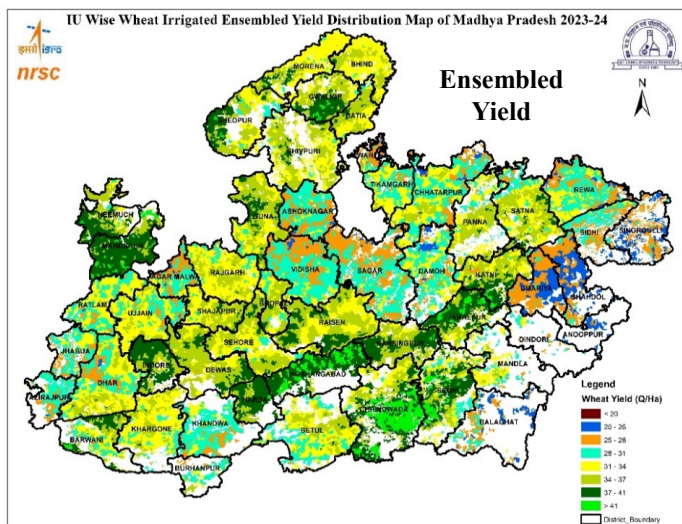


Cluster wise agreement of CCE estimates vs modelled estimates (AI/ML average) for Paddy IR Crop

Cluster	<-40	-40 to -30	-30 to -20	-20 to 20	20 to 30	30 to 40	>40	Total	Halkas with -20% to 20% deviation
1	0	4	58	753	15	1	39	870	86.55
2	36	130	269	362	25	22	106	950	38.11
3	11	69	94	162	8	1		345	46.96
4	28	72	58	53	13	14	48	286	18.53
5	169	159	239	491	35	16	107	1216	40.38
6	23	76	77	218	21	10	12	437	49.89
7	5	16	22	46	8	4	18	119	38.66
8	20	54	103	205	17	8	74	481	42.62
9	55	62	62	54	1	0	2	236	22.88
10	0	1	0	0	0	0		1	0.00
Total	347	643	982	2344	143	76	406	4941	47.44

- In about 47.44 % halka, model derived Paddy IR yield estimates are within the range of (-+20%) w.r.t CCE estimates
- In about 70.20 % halka, model derived Paddy IR yield estimates are within the range of (+- 30%) w.r.t CCE estimates

Ensembled model yield vs CCE Yield for Wheat IR crop Rabi – 2023-24



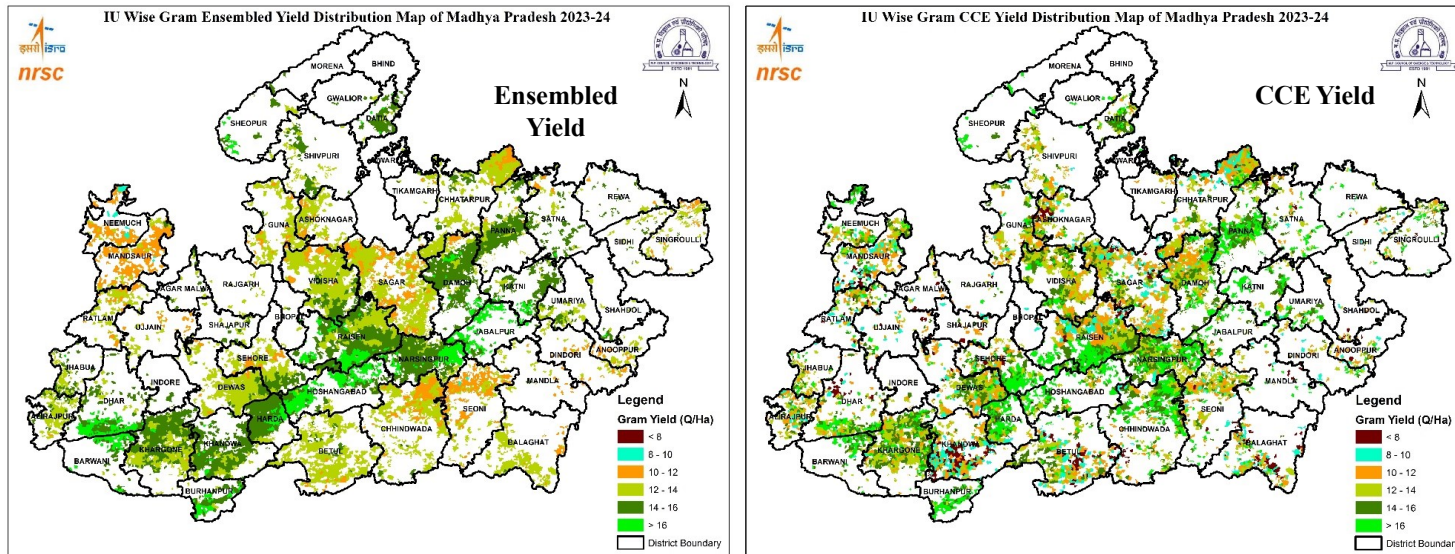
Deviation of CCE estimates w.r.t. Model average estimates (ML and LUE) Wheat IR

Cluster	<-40	-40to-30	-30to-20	-20to20	20to30	30to40	>40	Total	Halkas with -20 to 20 deviation
1	1	5	23	330	148	68	93	668	49.40
2	0	8	30	716	173	118	214	1259	56.87
3	12	64	113	869	111	90	132	1391	62.47
4	0	1	17	488	65	45	130	746	65.42
5	0	0	6	686	110	53	118	973	70.50
6	0	0	3	120	33	31	283	470	25.53
7	0	10	84	955	77	45	159	1330	71.80
8	3	26	143	1007	41	17	70	1307	77.05
9	6	35	177	1208	77	50	64	1617	74.71
10	1	4	45	897	73	28	43	1091	82.22
11	0	1	14	380	61	37	33	526	72.24
12	3	21	105	1873	154	97	124	2377	78.80
13	6	69	226	789	33	11	18	1152	68.49
14	53	225	413	1021	84	50	134	1980	51.57
15	1	4	15	975	264	176	518	1953	49.92
16	9	36	311	1809	40	16	25	2246	80.54
Total	95	509	1725	14123	1544	932	2158	21086	66.98

Cluster wise agreement of CCE estimates vs modelled estimates (AI/ML & SPM) average for Wheat IR

- In about 66.98 % halka, model derived Wheat irrigated yield estimates are within the range of (-+20%) w.r.t CCE estimates
- In about 82.48 halka, model derived Wheat irrigated yield estimates are within the range of (+- 30%) w.r.t CCE estimates

Ensembled model yield vs CCE Yield for Gram crop Rabi – 2023-24



Cluster wise agreement of CCE estimates vs modelled estimates (AI/ML & SPM) average for Gram

Deviation of CCE estimates w.r.t. Model average estimates (ML and LUE) Gram									
Cluster	<-40	-40to-30	-30to-20	-20to20	20to30	30to40	>40	Total	Halkas with -20 to 20 deviation
1	25	29	65	282	25	28	49	503	56.06
2	14	18	66	933	123	77	228	1459	63.95
3	0	4	7	174	29	8	13	235	74.04
4	3	2	12	160	12	6	21	216	74.07
5	25	92	179	942	78	55	83	1454	64.79
6	5	9	50	785	67	40	63	1019	77.04
7	40	85	139	652	80	60	170	1226	53.18
8	28	45	102	615	47	45	68	950	64.74
9	20	22	42	378	47	34	42	585	64.62
10	0	3	14	174	21	10	4	226	76.99
Total	160	309	676	5095	529	363	741	7873	64.71

- In about 64.71 % halka, model derived Gram yield estimates are within the range of (-+20%) w.r.t CCE estimates.....
- In about 80.02 % halka, model derived Gram yield estimates are within the range of (+- 30%) w.r.t CCE estimates

Importance of specific satellite data and weather data in tech based yield estimation:

Weather, Meteorological instrument (AWS and ARG) will be additionally required to improve the accuracy of crop classification and crop yield estimation. Weather data at the **Halka level** will be essential to capture local variations in temperature, rainfall, and humidity. the impact of climatic conditions on crop growth and productivity.

Monitoring Crop Growth Conditions: Temperature, rainfall, humidity, and solar radiation data are used to assess crop development stages and stress conditions.

Identifying Crop Stress: Abnormal weather patterns such as drought, excess rainfall, or heat stress can be detected and linked to yield variations.

Developing Yield Models: Weather parameters are integrated with remote sensing data and crop models (e.g., DSSAT, WOFOST) to simulate and predict yield.

Temporal Yield Forecasting: Continuous weather data throughout the season helps in updating and refining yield forecasts at different growth stages.

Spatial Yield Variability Analysis: Panchayat- or district-level weather data improves spatial accuracy in yield estimation by capturing local climatic variations

Similarly, satellite data such as cloud free Optical data in rabi season **EOS-4 (RISAT-1A)** and **Sentinel-1** will be required for better data availability, temporal coverage, and detailed crop monitoring throughout the Kharif growing season.

Thanks: