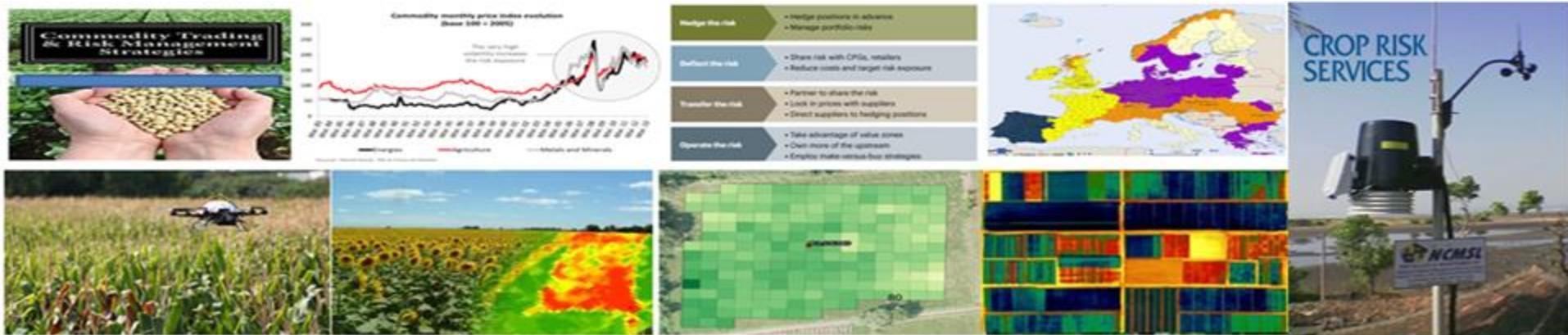


Technology Based Crop Yield Estimation

Jodhpur District, Rajasthan

Kharif'2021

Presented to
Future Generali India Insurance Company Limited

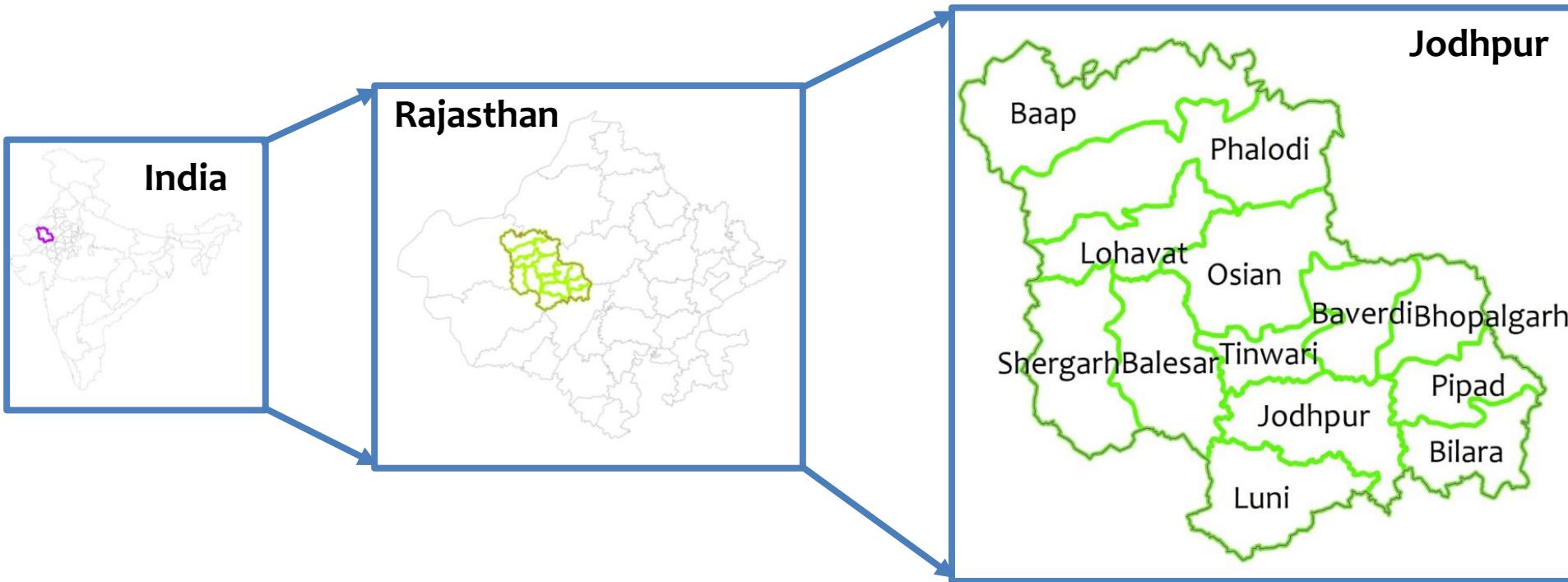


Presented by
National Commodities Management Services Limited
[Formerly National Collateral Management Services Limited]

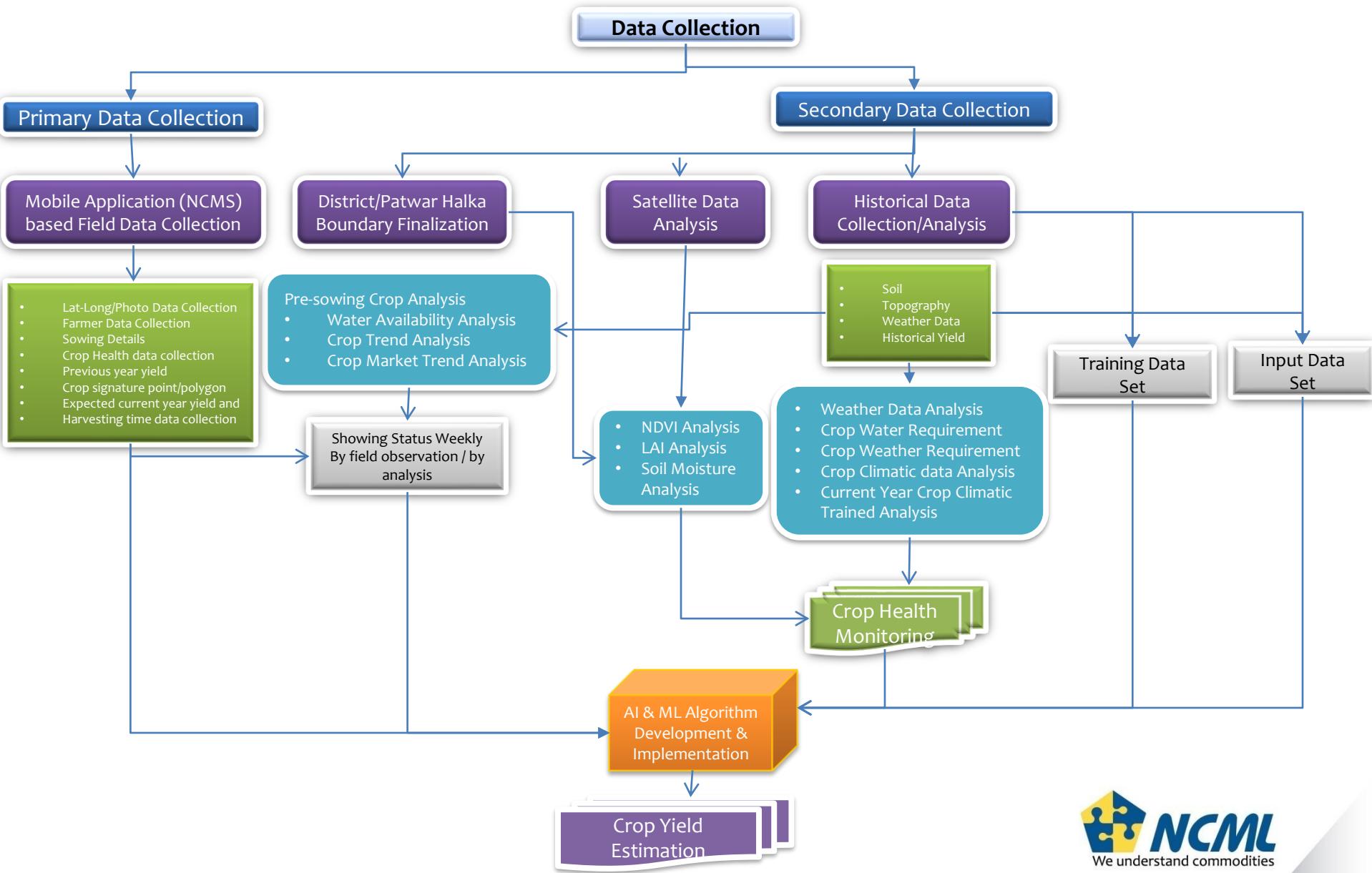
Study Area – Kharif'21

Study Area: Jodhpur (Rajasthan)

Crops under Study: Green Gram, Groundnut, Guar and Bajra



Project Framework



Data Collection

S. No	Data Set	Source	Frequency of Data
1	Historical yields at Patwar Halka	State Government	2009 to 2019
2	Weather (Rainfall, Relative Humidity)	AWS (NCML)	2014 to 2021 (Daily)
3	NDVI/LAI	MODIS	2014 to 2021 (Fortnightly)
4	Soil Moisture	AMSR-E/Aqua surface soil moisture (LPRM) L3	2014 to 2021 (Daily)
5	Current year Field Data	NCML	18-Aug to 28-Aug, 12-Sep to 22-Sep & 08-Oct to going on

Approach

Step-1

Agri Infrastructure Mapping Block Level
(Irrigated, Unirrigated, Source, Soil etc.)

Step-2

Historical Weather Analysis
(Temp, RH, Rainfall etc.)

Step-3

Crop Feature & Cycle
(Crop lifecycle & important epochs, Crop behavior etc.)

Step-4

Field Identification & Geotagging & Regular Physical crop monitoring

Step-5

Crop Monitoring for Biotic & Abiotic Stress through Remote Sensing & other Technology

Step-6

Crop Monitoring using technology

Step-7

Technology/Modeling based Patwar Halka level Crop Yield prediction

Dataset Description

- **Objective:** To predict yield for year 2021 in Jodhpur at PatwarHalk level (Total of 380) for 4 major crops in the region i.e. Bajra, Guar, Groundnut & Greengram.
- **Input Data:** For each PatwarHalk, input data used is NDVI (Avg.), Soil Moisture (Avg.) & Rainfall (Cumulative) at fortnightly level from June till September i.e. total of 8 Fortnights starting from year 2014 till 2019.
- **Target Data:** For each PatwarHalk, actual observed yield has been considered for all four crops (Bajra, Guar, Groundnut & Greengram) starting from year 2014 till 2019.
- **Prediction Data:** For each PatwarHalk, input data like NDVI (Avg.), Soil Moisture (Avg.) & Rainfall (Cumulative) has been taken at fortnightly level from June till September i.e. total of 8 Fortnights for year 2021.
- **Output Data from statistical model:** As per objective, predicted yield for year 2021 for all four crops at PatwarHalk level.

REMOTE SENSING BASED CROP HEALTH MONITORING

(OPTICAL AND MICROWAVE SATELLITE)

Crop Health Monitoring

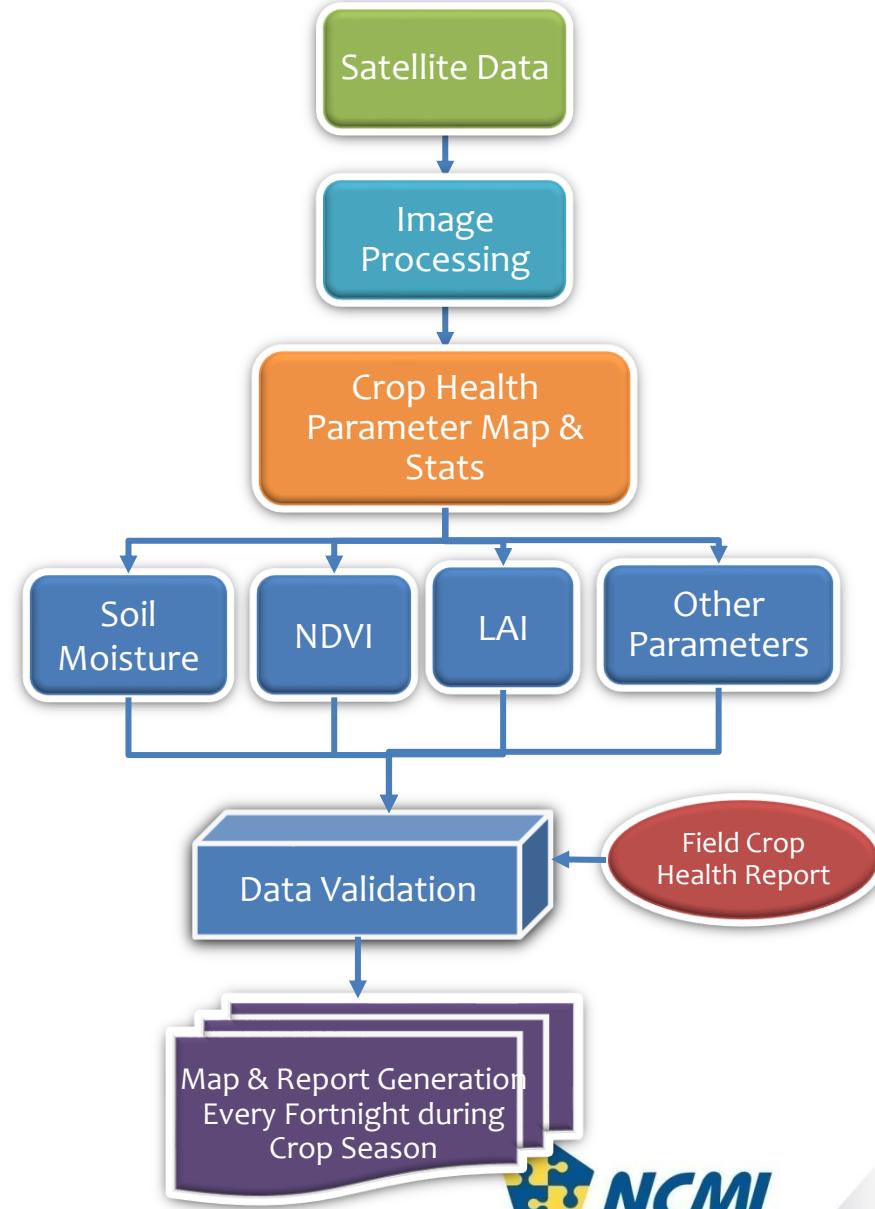
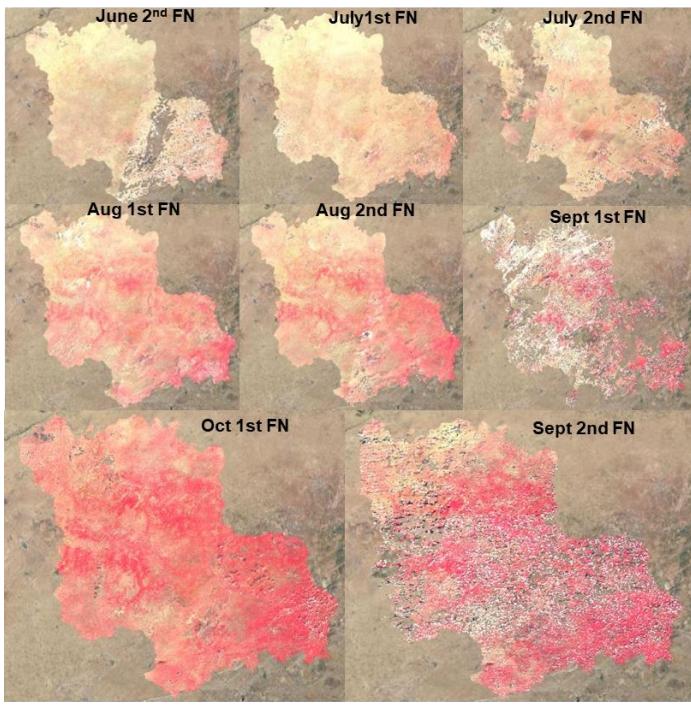
Data Used for Crop health Monitoring

Optical Satellite data

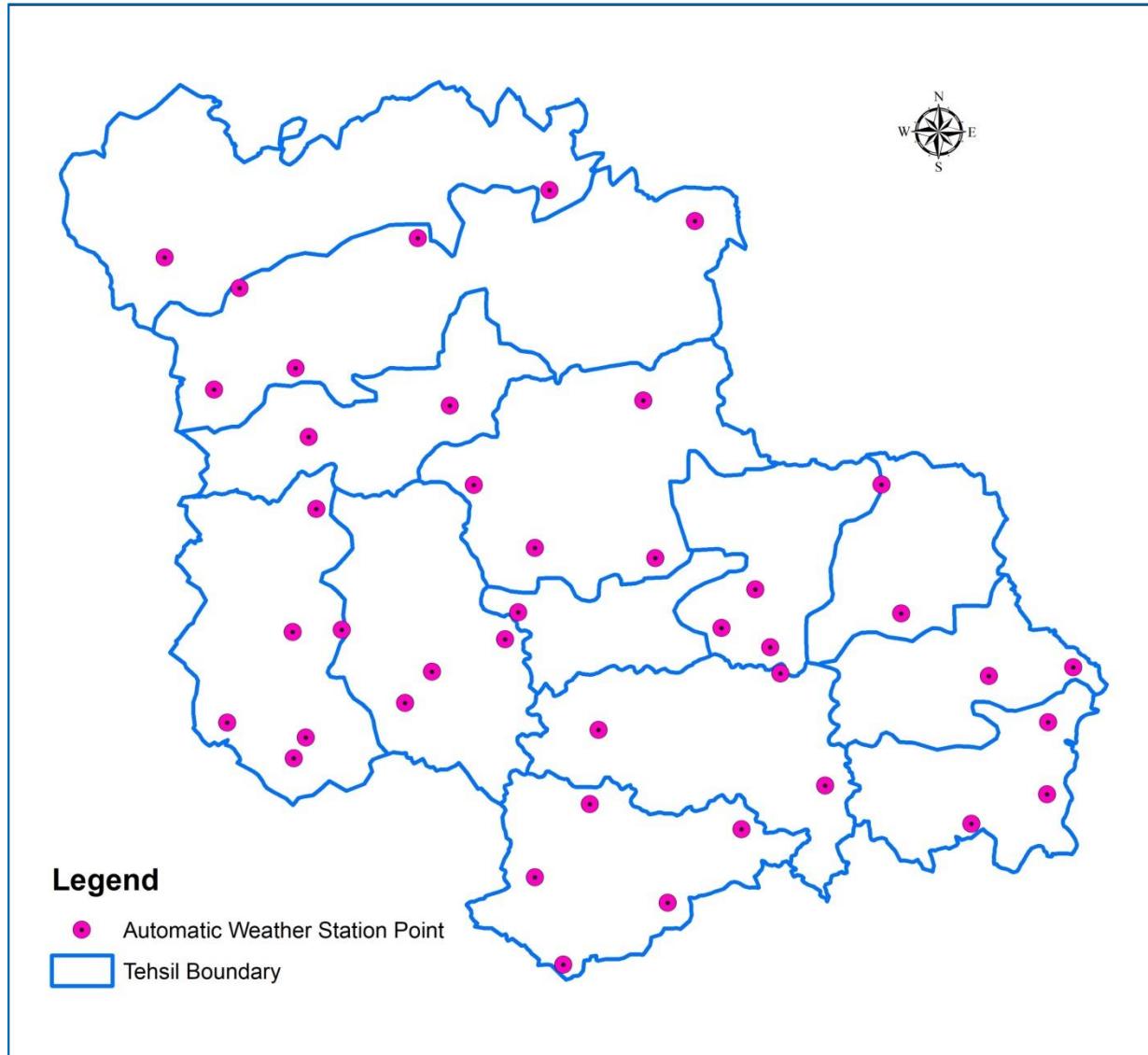
MODIS (250m)
Sentinel 2 (10 & 20m)

Microwave Satellite Data

Sentinel1(10 &20m)



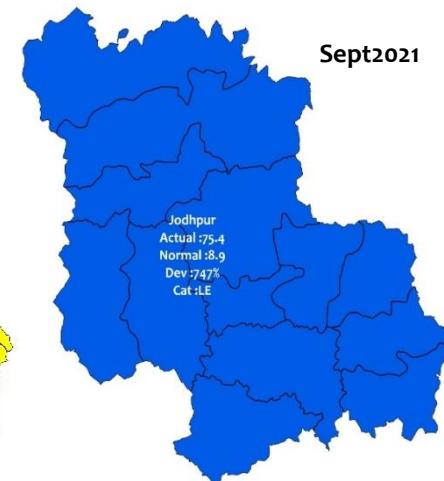
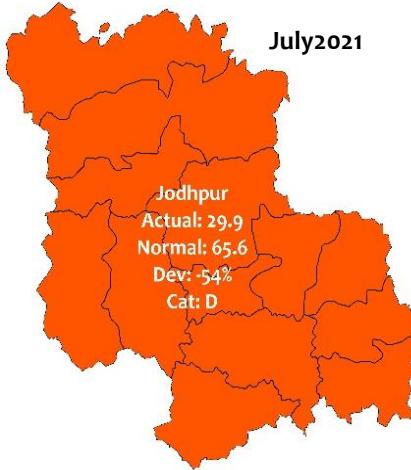
Automatic Weather Station Location Map



Crop Health Monitoring- Rainfall Status

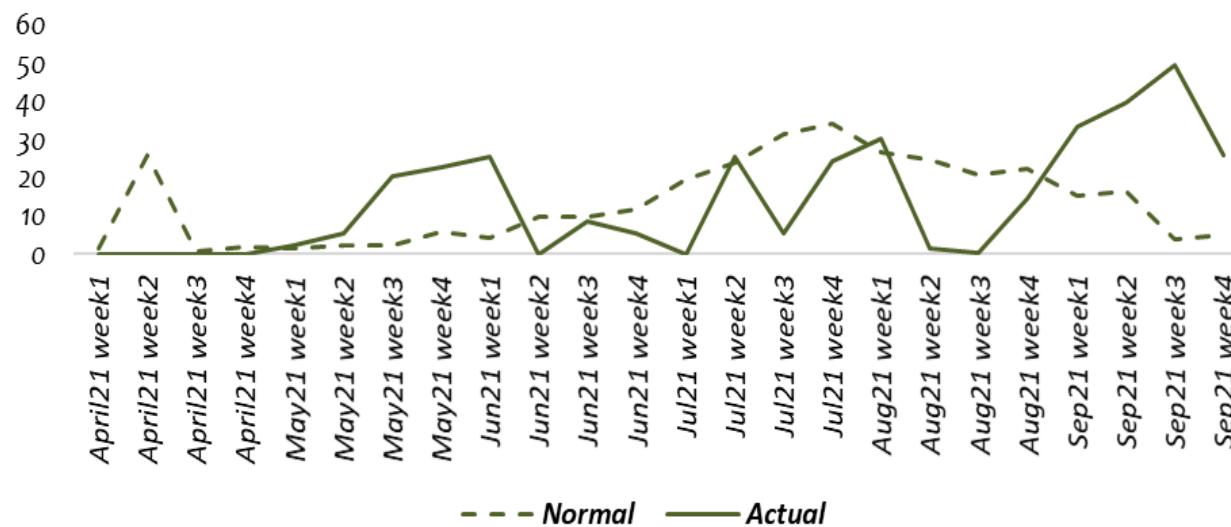
(District Wise)

Crop Health Monitoring on fortnightly basis using NCML AWS Data



LE E N D LD NR ND

Jodhpur : Rainfall analysis (Normal Vs Actual)

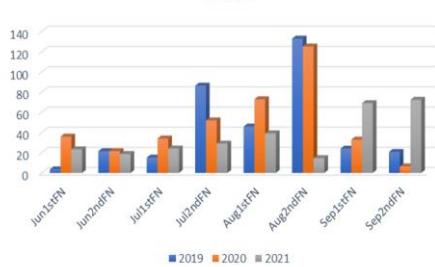


Crop Health Monitoring- Rainfall Status

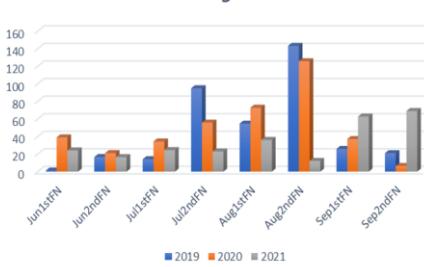
(Tehsil Wise)

Crop Health Monitoring on fortnightly basis using NCML AWS Data

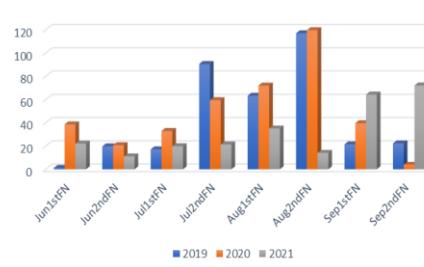
Osiyan



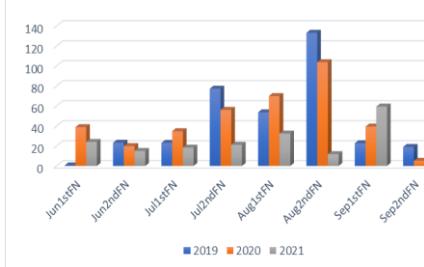
Shergarh



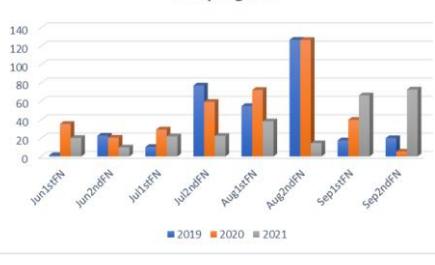
Bilara



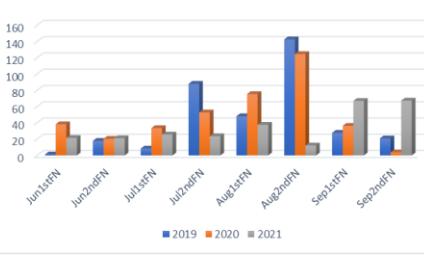
Looni



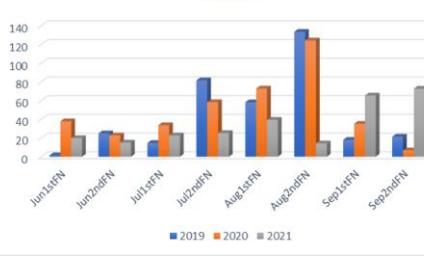
Bhopalgarh



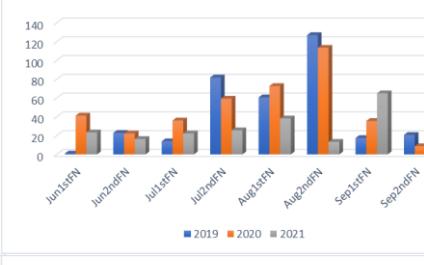
Baap



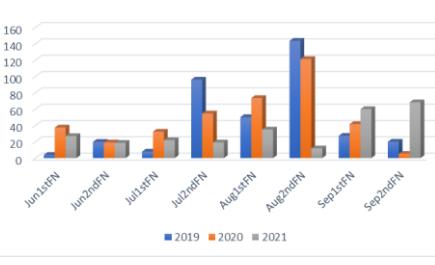
Bavari



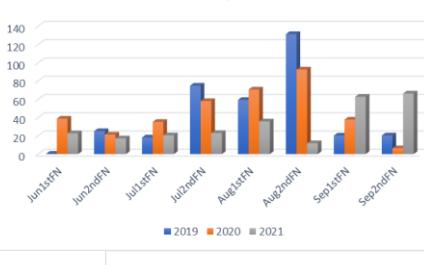
Pipar City



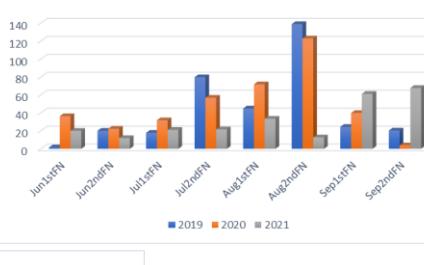
Phalodi



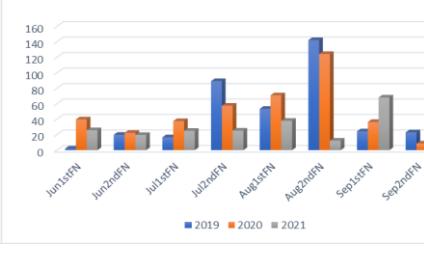
Jodhpur



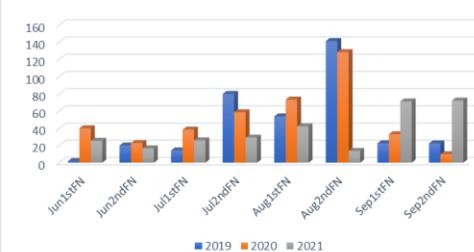
Lohawat



Balesar



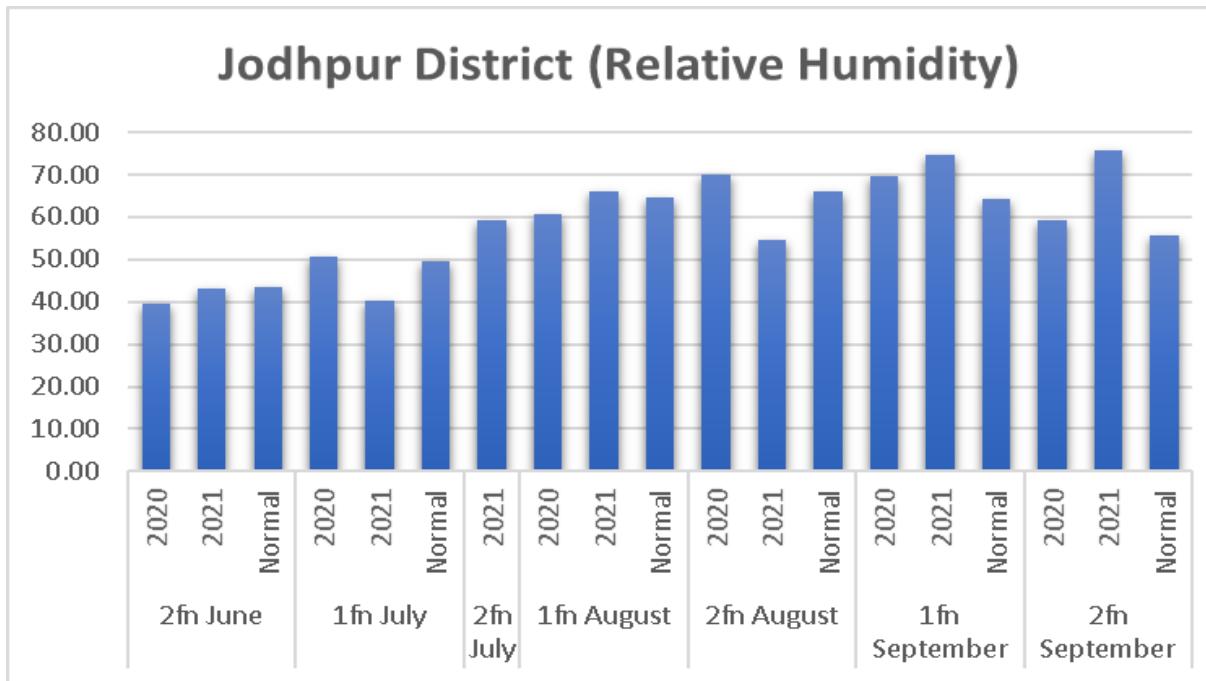
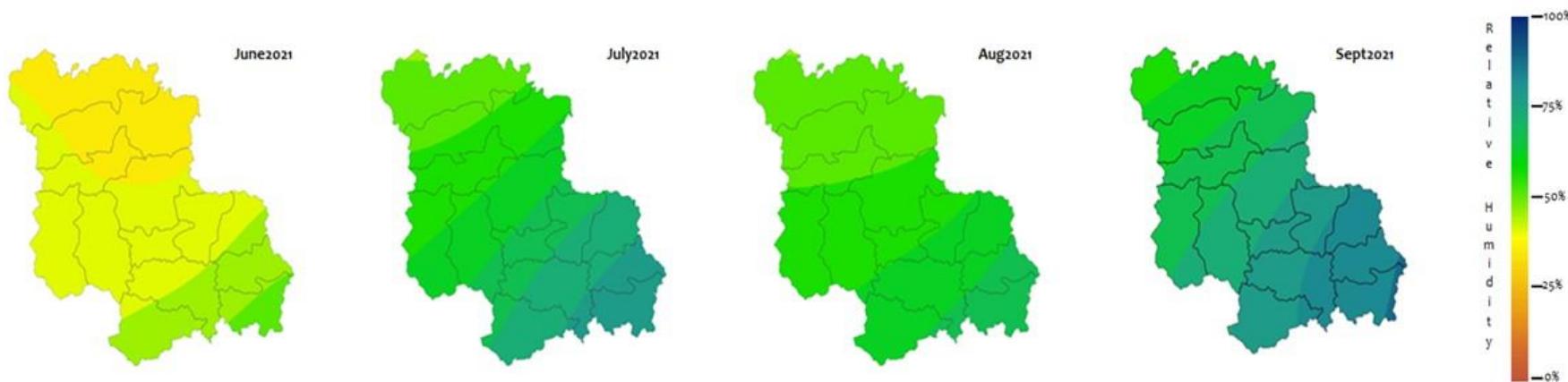
Tinwari



Crop Health Monitoring- Relative Humidity Status

(District Wise)

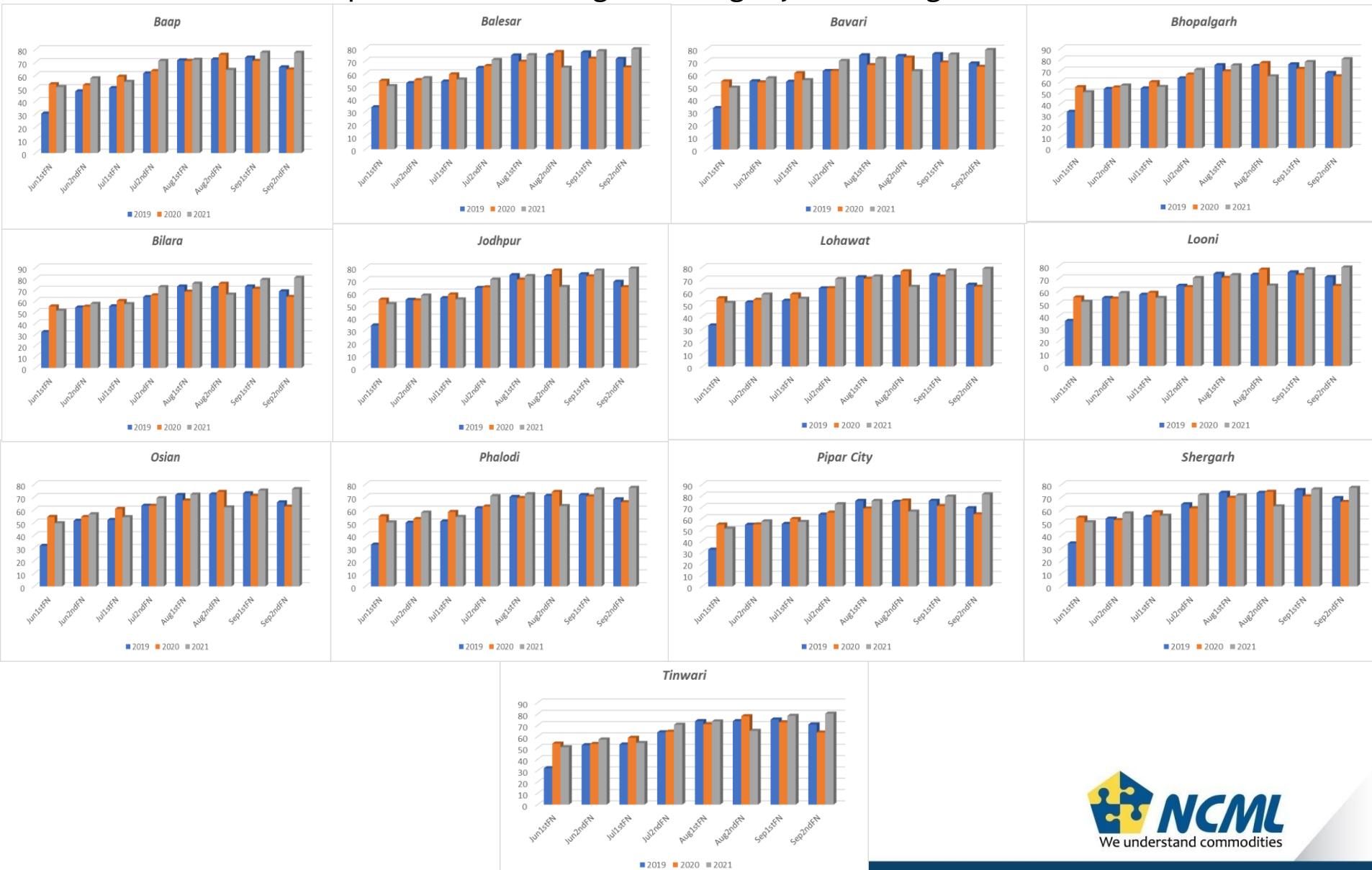
Crop Health Monitoring on fortnightly basis using NCML AWS Data



Crop Health Monitoring- Relative Humidity Status

(Tehsil Wise)

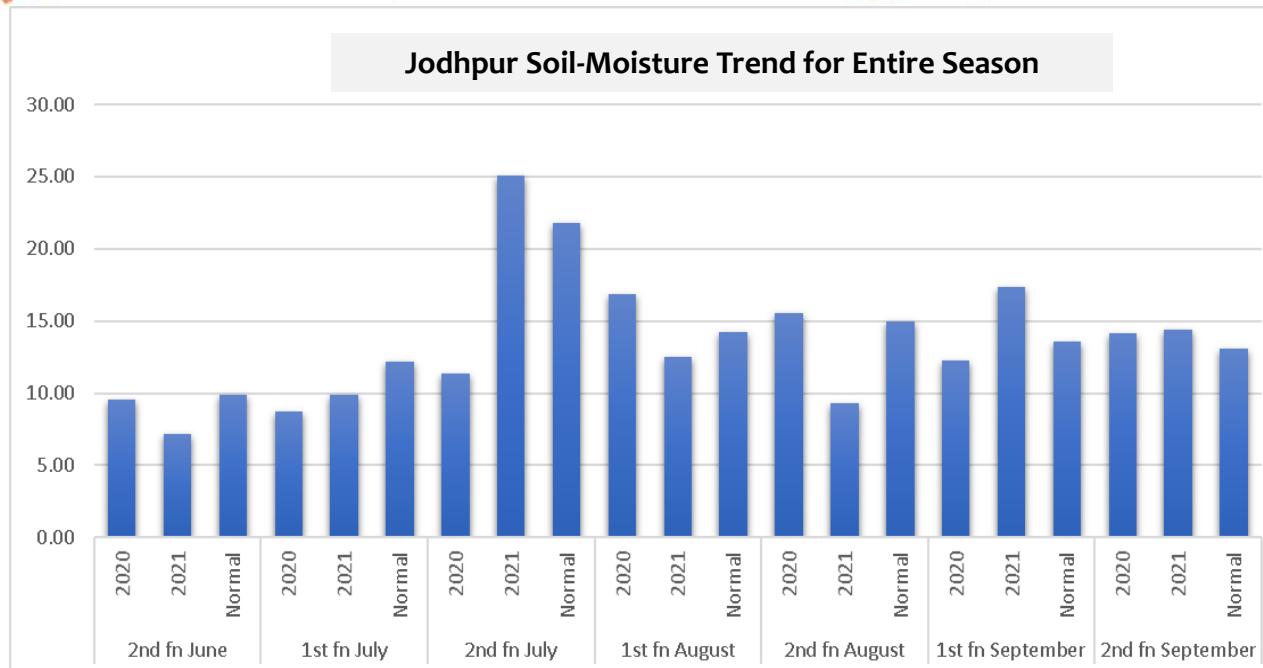
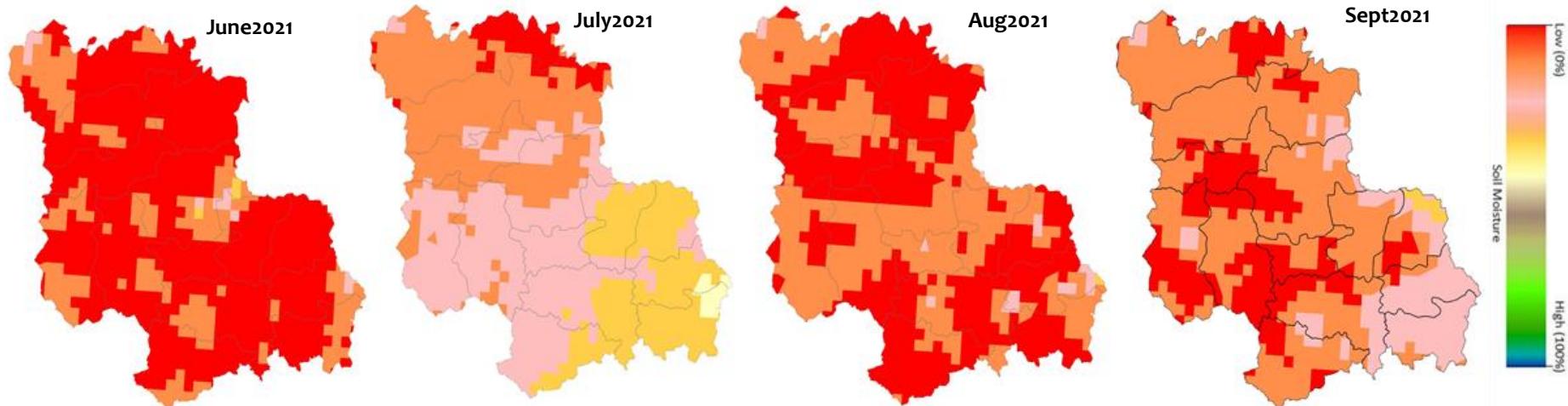
Crop Health Monitoring on fortnightly basis using NCML AWS Data



Crop Health Monitoring - Soil Moisture

(District Wise)

Crop Health Monitoring on fortnightly basis using Satellite indices and ground truthing



Crop Health Monitoring - Soil Moisture

(Tehsil Wise)

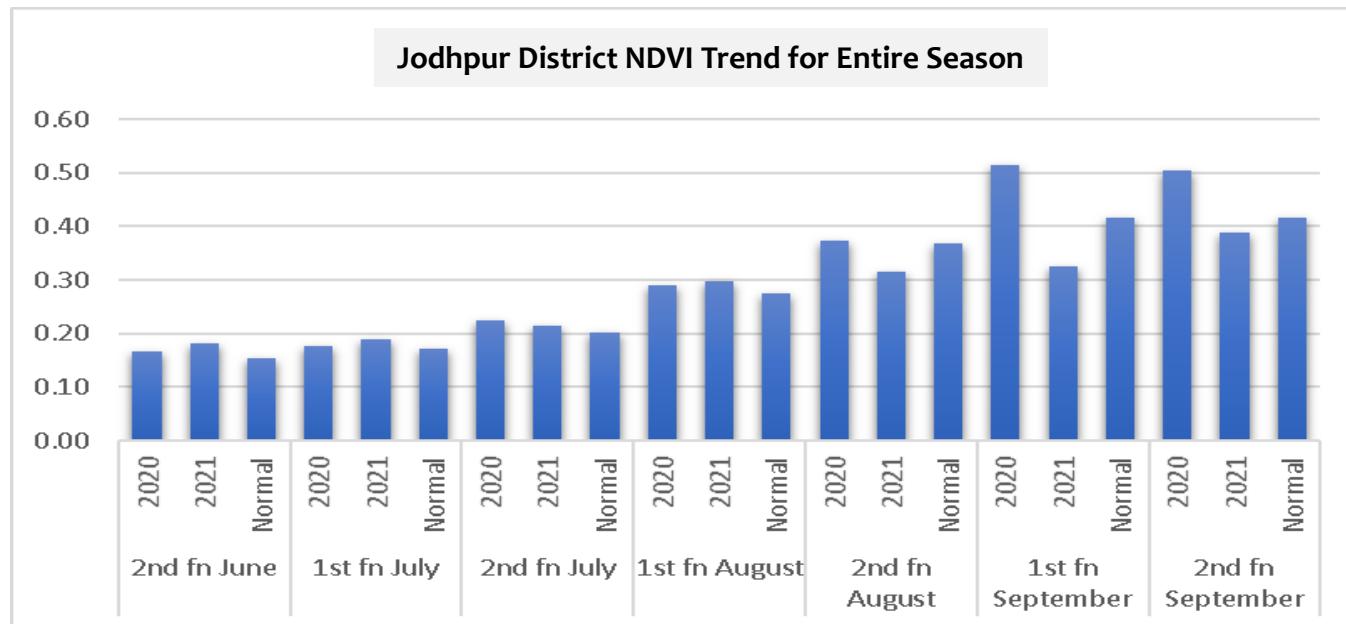
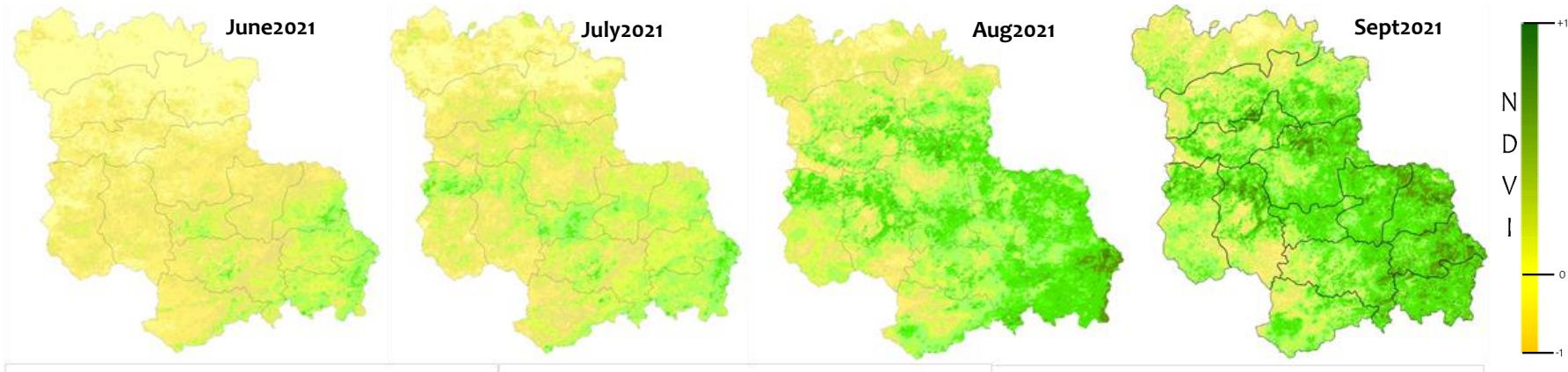
Crop Health Monitoring on fortnightly basis using Satellite indices and ground truthing



Crop Health Monitoring - NDVI Status

(District Wise)

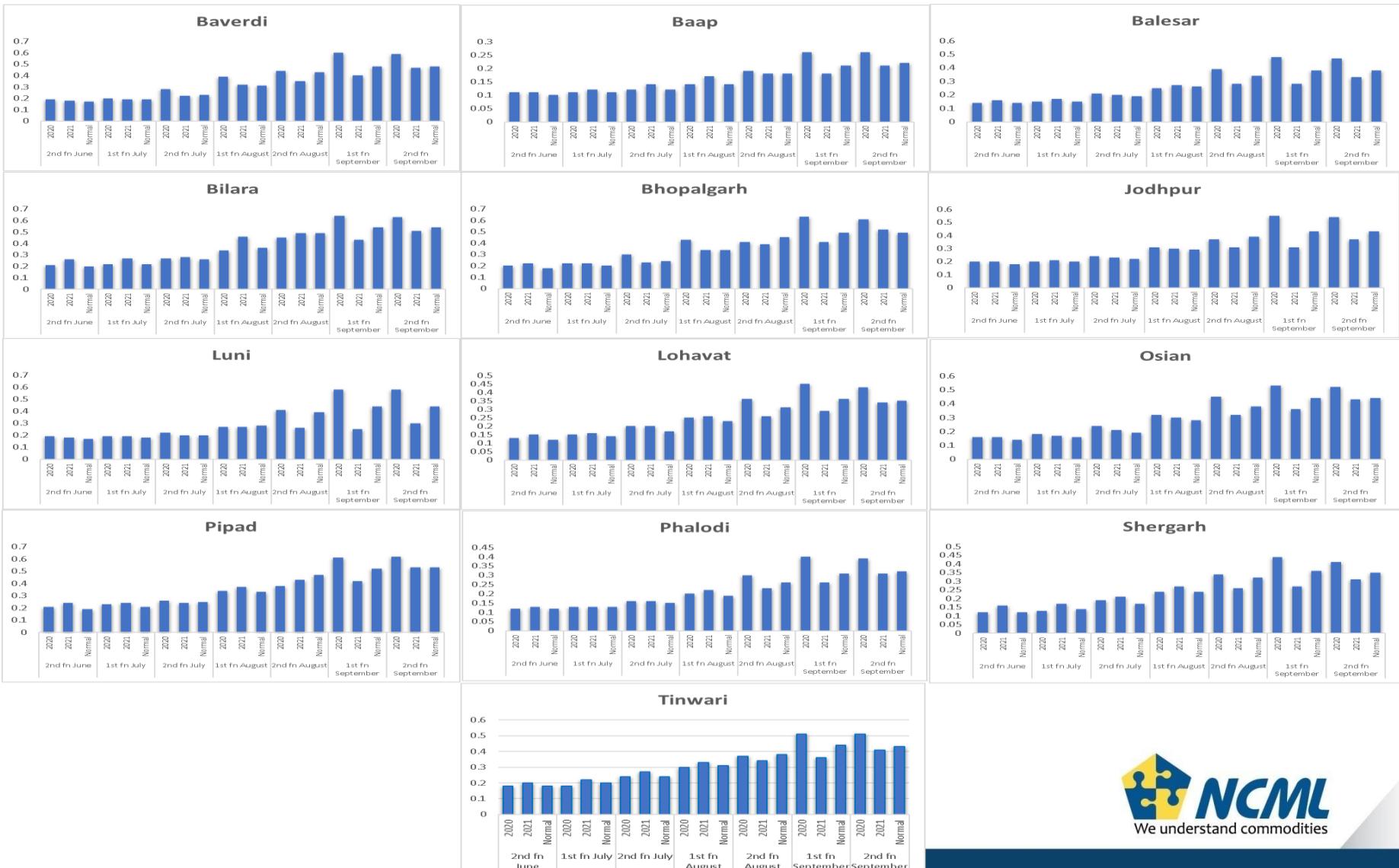
Crop Health Monitoring on fortnightly basis using Satellite indices and ground truthing



Crop Health Monitoring - NDVI Status

(Tehsil Wise)

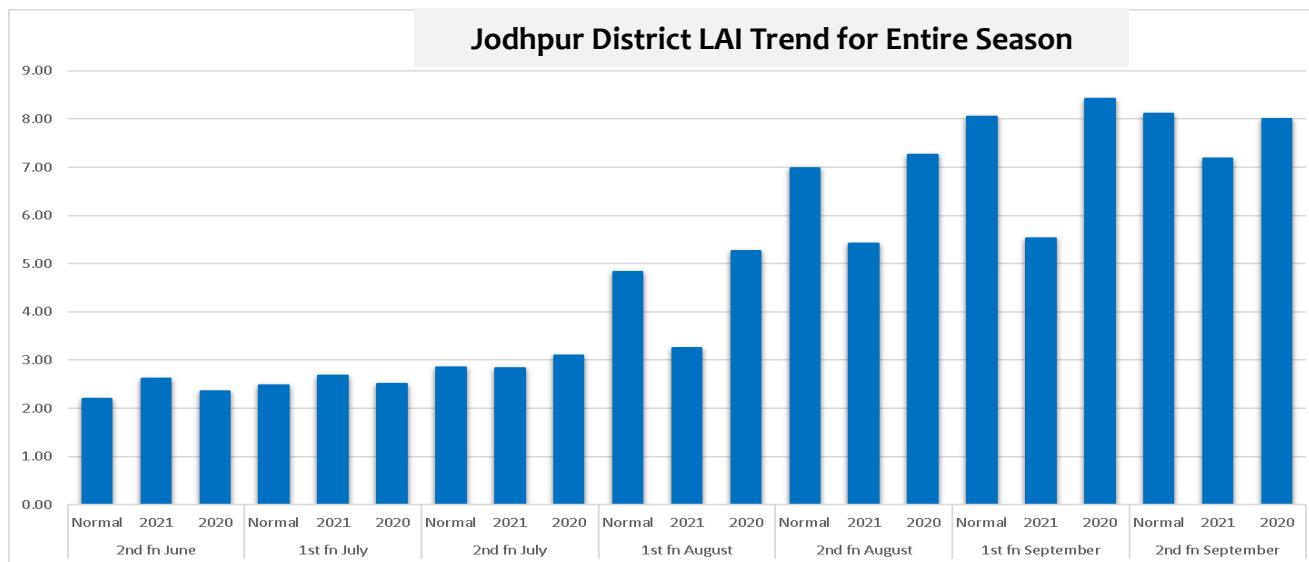
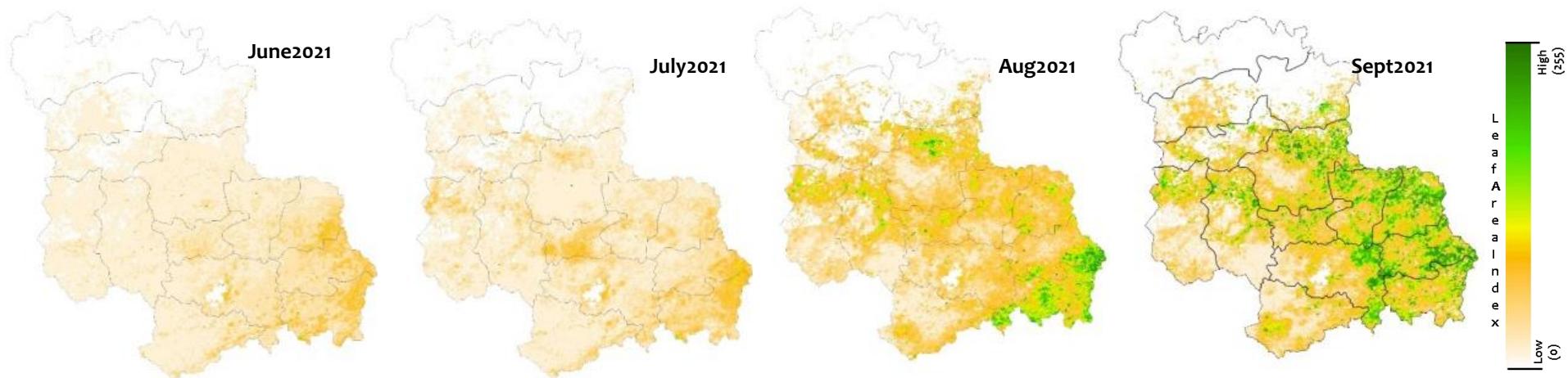
Crop Health Monitoring on fortnightly basis using Satellite indices and ground truthing



Crop Health Monitoring – LAI Status

(District Wise)

Crop Health Monitoring on fortnightly basis using Satellite indices and ground truthing



Crop Health Monitoring - LAI Status

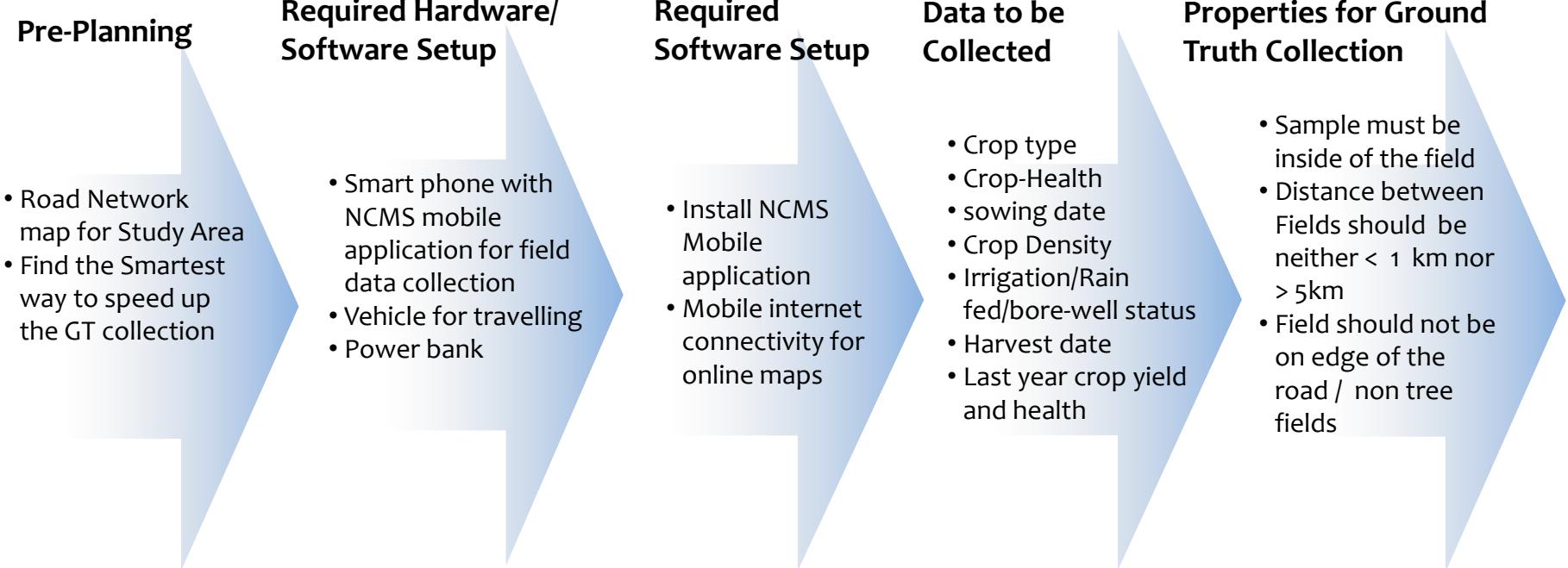
(Tehsil Wise)

Crop Health Monitoring on fortnightly basis using Satellite indices and ground truthing



Mobile Application For Field Survey Process

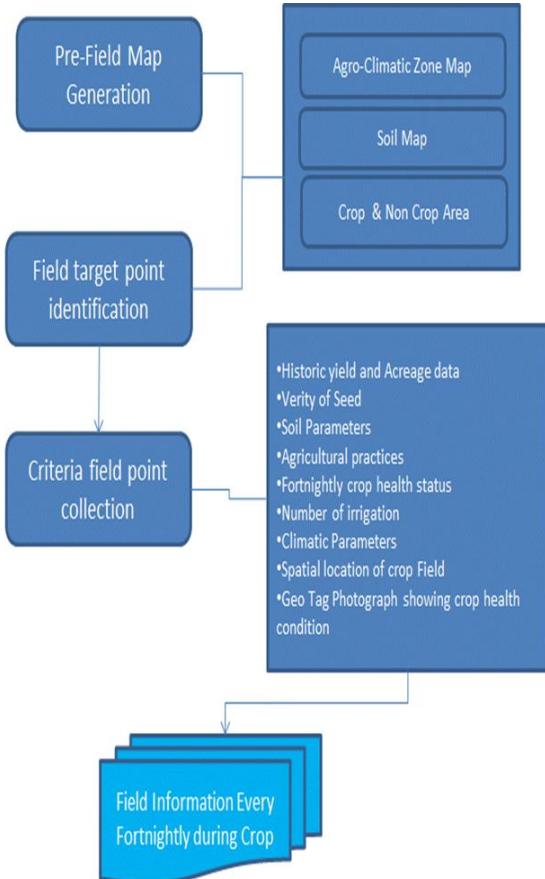
Ground Truth Work Flow & Characteristics



Mobile Applications

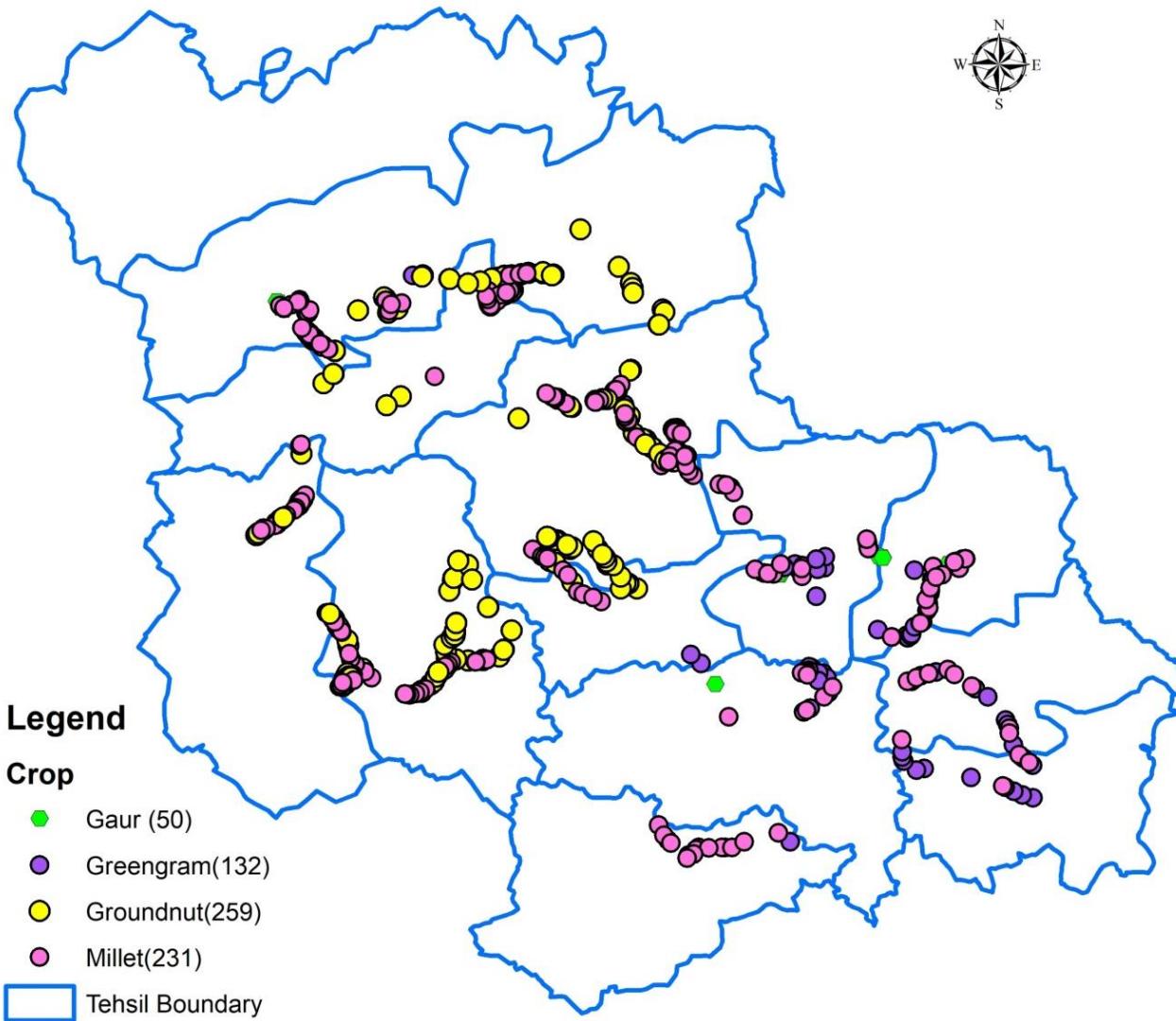
Mobile Applications

- ▲ NMCL CCE APP
- ▲ NCML Crop Survey app



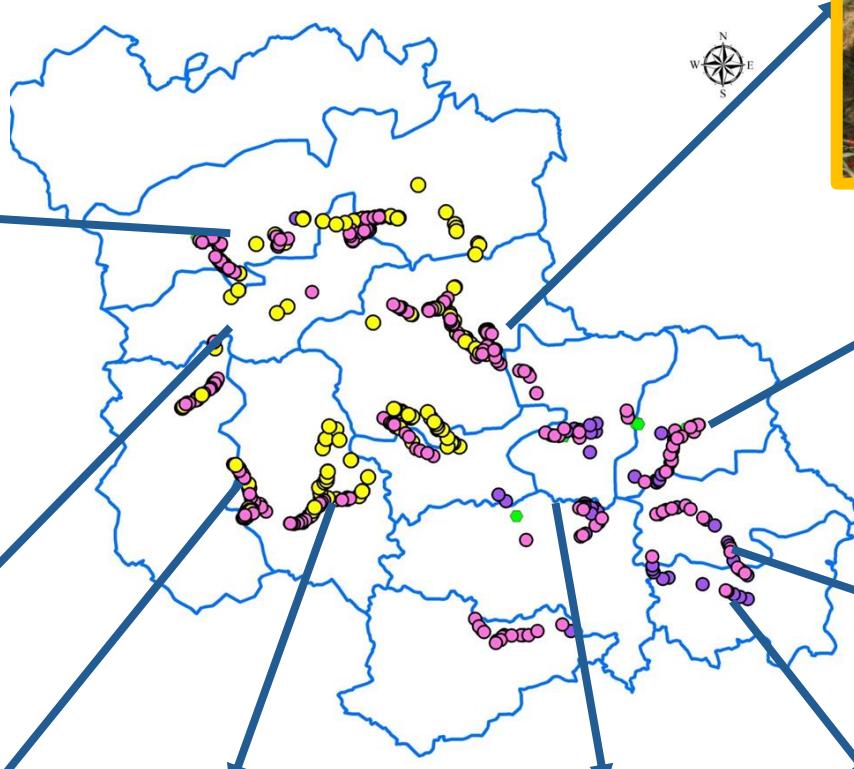
We understand commodities

Field GPS Data Map



Geotag Field Crops

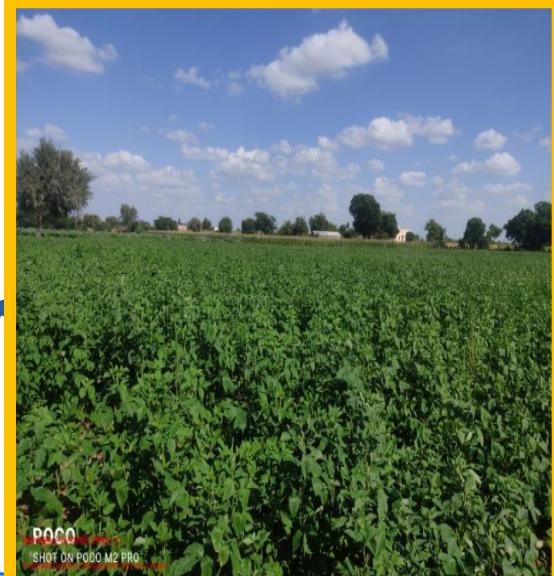
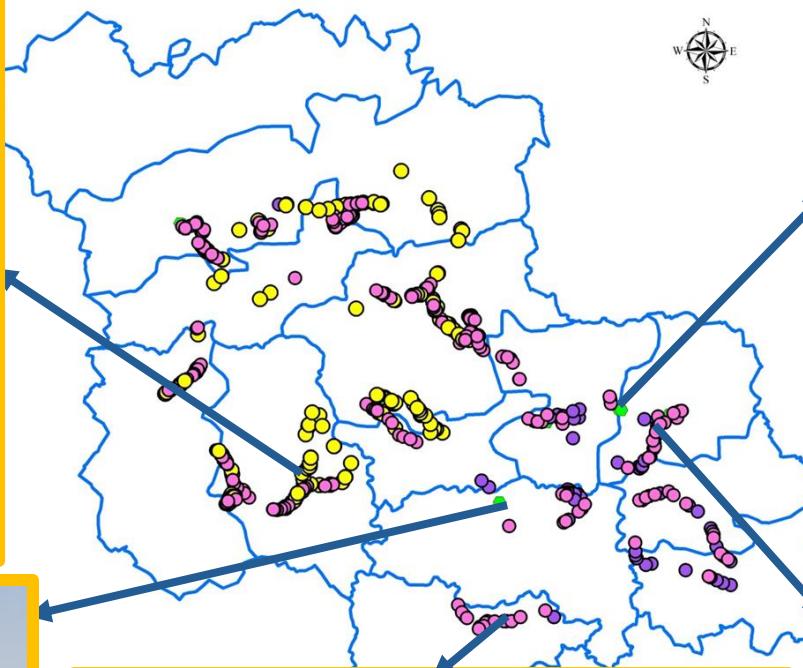
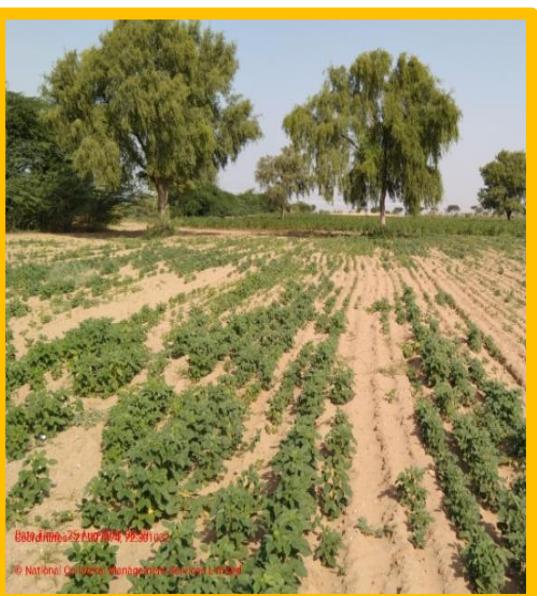
Photographs For Bajra crop



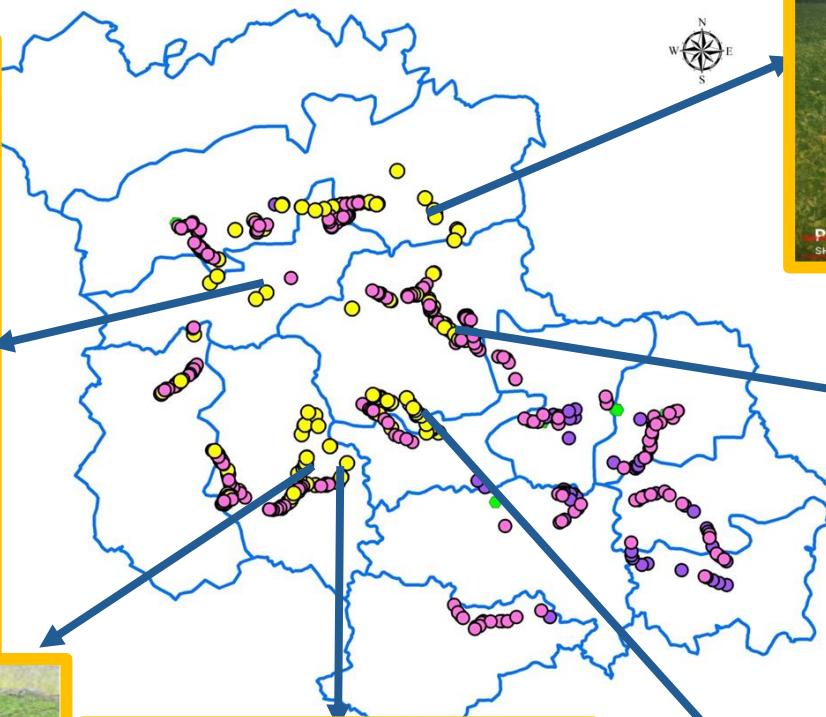
Geotag Field Crops Photographs For Greengram crop



Geotag Field Crops Photographs For Guar crop

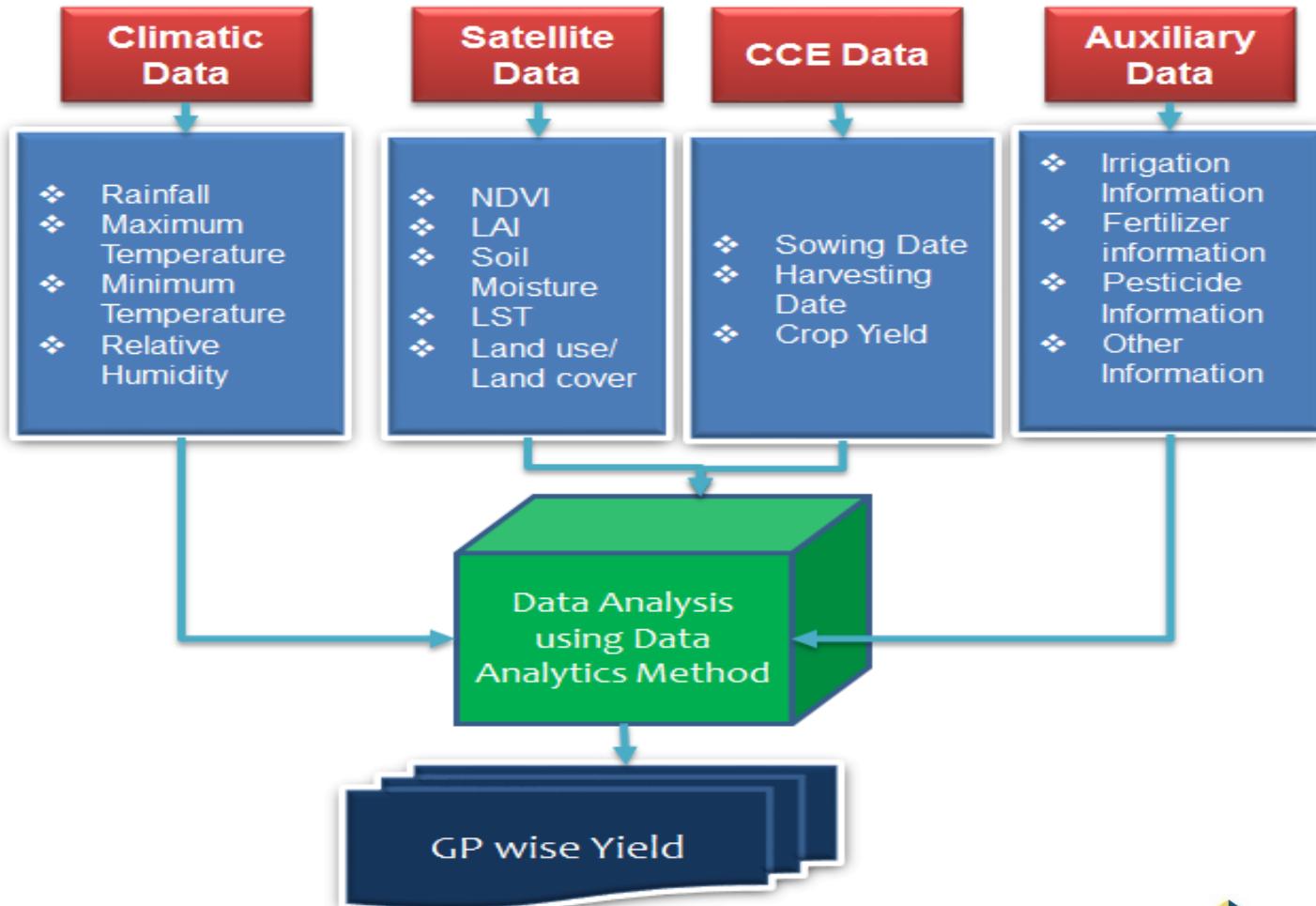


Geotag Field Crops Photographs For Groundnut crop



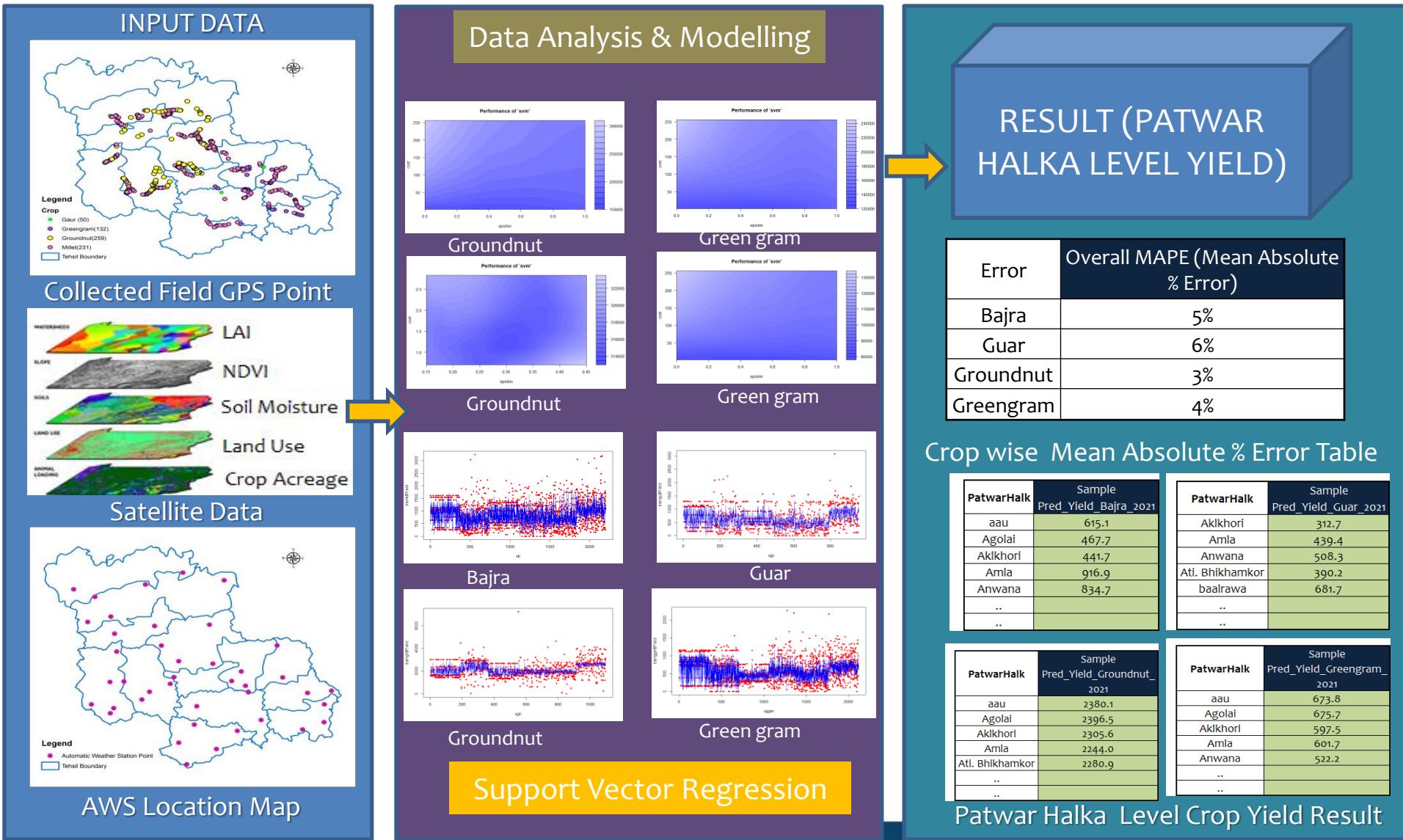
TECHNOLOGY BASED CROP YIELD MODEL

Patwar Halka Level Crop Yield Estimation & Modelling Framework



Crop Yield Estimation & Modelling - Patwar Halka Level

- Analysis & impact of important individual parameter on crop development.
- Data Analysis & yield prediction using Support Vector Regression Technique.



Statistical Model Approach

Support Vector regression (SVR) machine learning technique is used to predict crop yield

SVR is a supervised learning algorithm that is used to predict discrete values (here yield). The basic idea behind SVR is to find the best fit line. In SVR, the best fit line is the hyperplane that has the maximum number of points. SVR tries to fit the best line within a threshold value. The threshold value is the distance between the hyperplane and boundary line.

Programming language used is R for writing code. Some of the libraries/ modules used are e1071, caret, Mlmetrics.

Input data has been divided into train & test with train data used for model training & test data for checking accuracy/ error figures of the predicted yield in comparison to actual yield.

Optimized SVR model has been used for prediction using hyperparametric tuning with hyperparameters epsilon & cost.

Accuracy/ Error figures

(Mean % Error for predicted in comparison to Actual yield)

Picked optimized model has been used for predicting yield at Patwar Halka level for the year 2021 using input data for the year 2021 for NDVI, Soil moisture & Rainfall at the same level as per model training regressor data.

Below are the error figures for the predicted in comparison to actual yield for the year 2014 till 2019 at mean level for full district covering all provided Patwar Halka.

Error	Overall MAPE (Mean Absolute % Error)	Predicted yield Accuracy in %
Bajra	13%	87%
Guar	9%	91%
Groundnut	5%	95%
Greengram	10%	90%

Formula: Mean Absolute Percentage Error

$$M = \left| \frac{\frac{1}{n} \sum_{t=1}^n A_t - \frac{1}{n} \sum_{t=1}^n F_t}{\frac{1}{n} \sum_{t=1}^n A_t} \right|$$

M = mean absolute percentage error

n = number of times the summation iteration happens

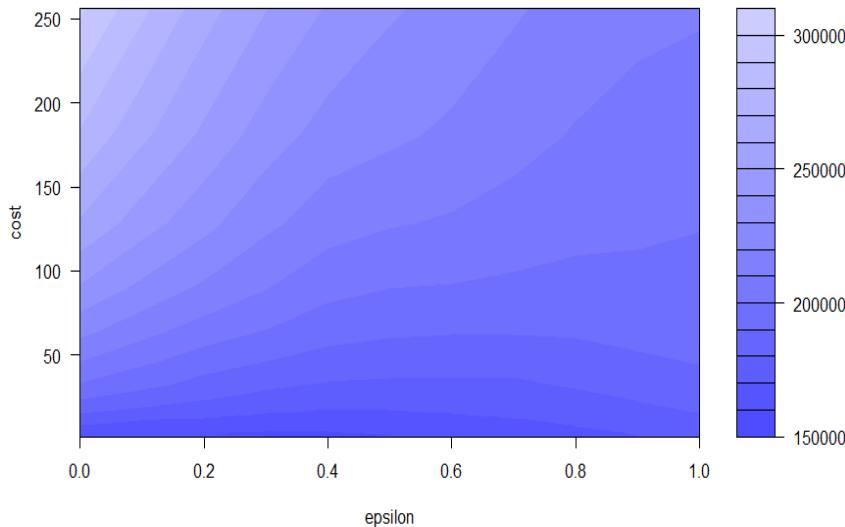
A_t = actual value

F_t = forecast value

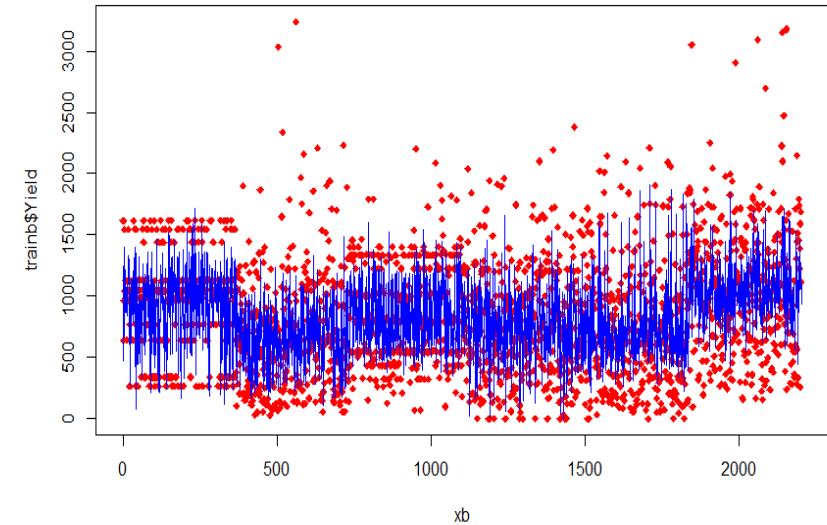
Bajra Optimized Model

Hyper-plane & Predicted yield

Performance of 'svm'



Hyperparameter tuning curve to find best parameters (epsilon & cost) associated with SVR and consider these best parameters to run the best SVR with these parameter

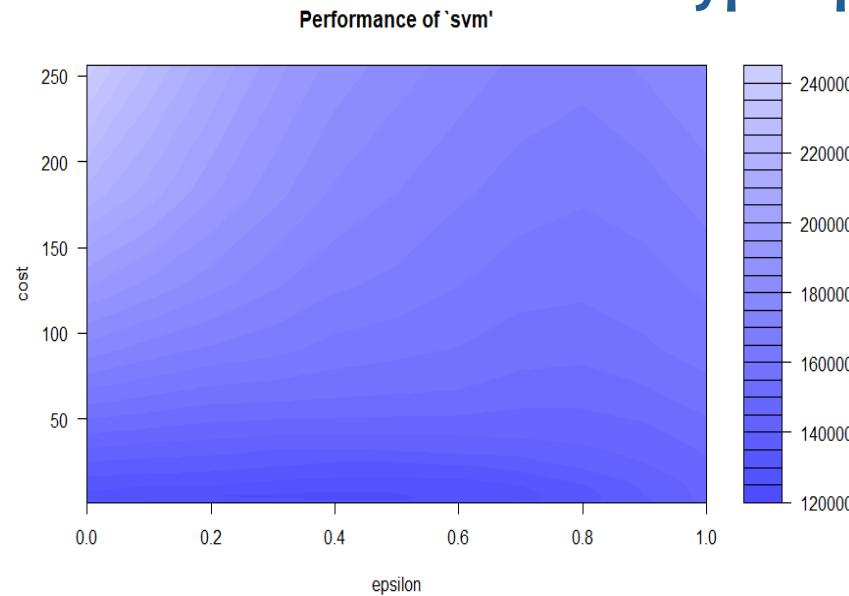


Best model graph between predicted & actual yield in testing set

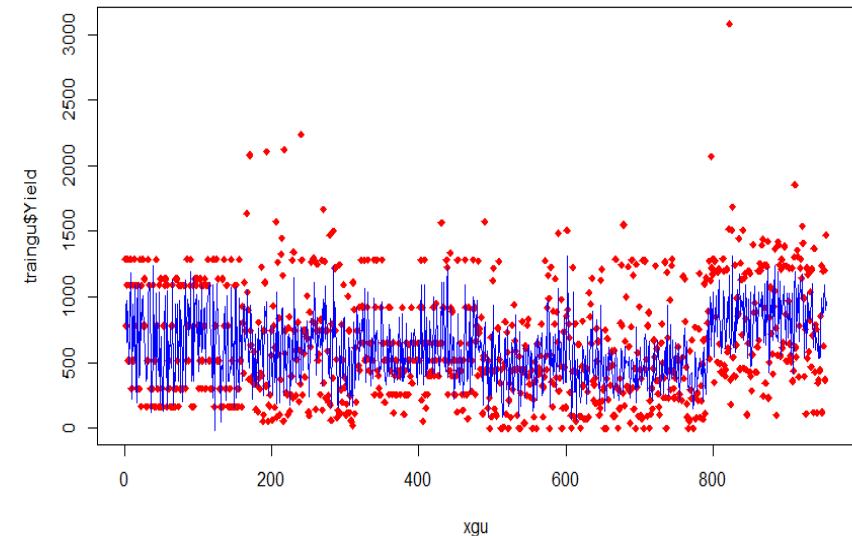
PatwarHalk	Pred_YieldRange_Bajra_2021	Pred_AverageYield_Bajra_2021
Aau	535 - 695	615.1
Agolai	407 - 528	467.7
Aklkhori	384 - 499	441.7
Amla	798 - 1036	916.9
Anwana	726 - 943	834.7
..		
..		

Guar Optimized Model

Hyper-plane & Predicted yield



Hyperparameter tuning curve to find best parameters (epsilon & cost) associated with SVR and consider these best parameters to run the best SVR with these parameter



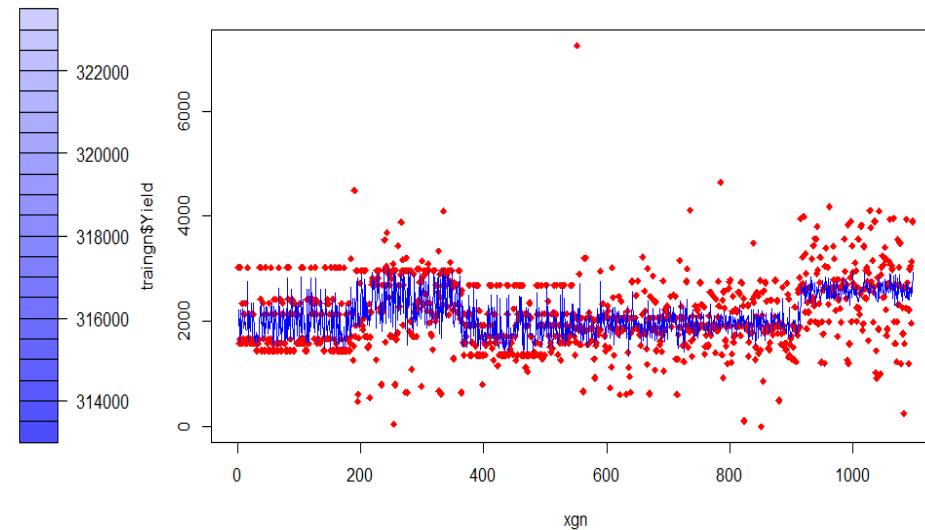
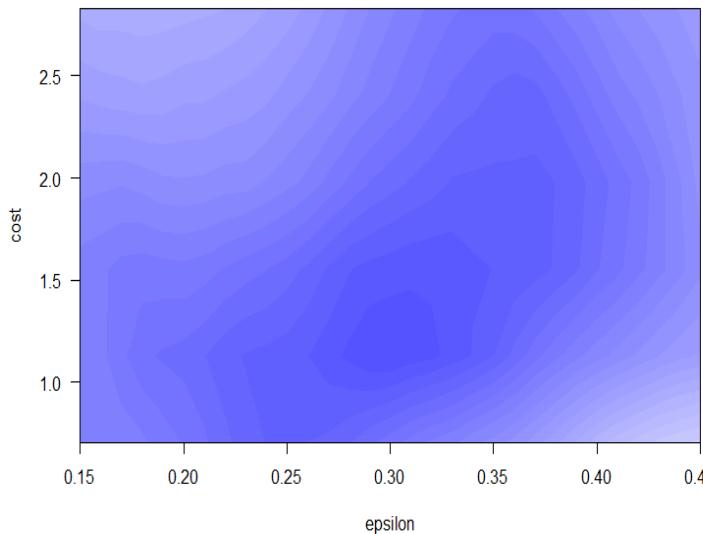
Best model graph between predicted & actual yield in testing set

PatwarHalk	Pred_YieldRange_Guar_2021	Pred_AverageYield_Guar_2021
Aklkhori	285 - 341	313
Amla	400 - 479	439
Anwana	463 - 554	508
Ati. Bhikhamkor	355 - 425	390
Baalrawa	620 - 743	682
..		
..		

Groundnut Optimized Model

Hyper-plane & Predicted yield

Performance of 'svm'



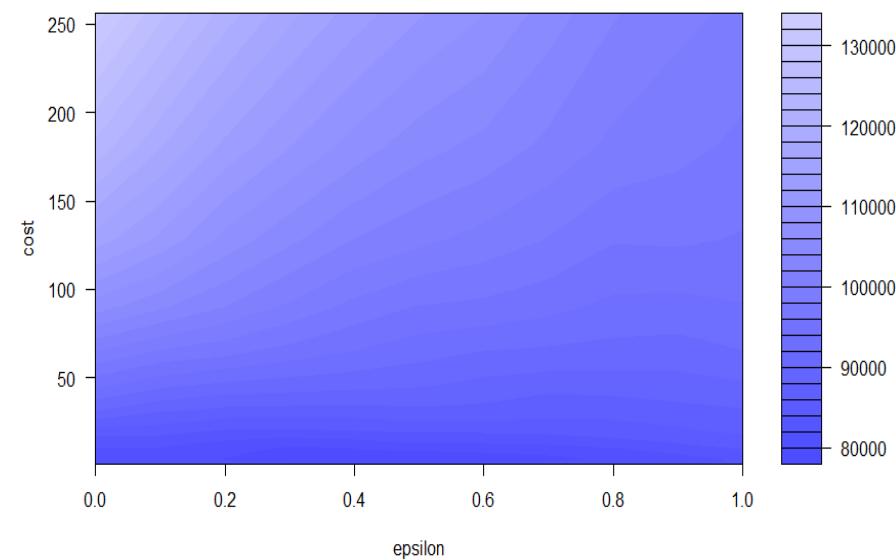
Hyperparameter tuning curve to find best parameters (epsilon & cost) associated with SVR and consider these best parameters to run the best SVR with these parameter

Best model graph between predicted & actual yield in testing set

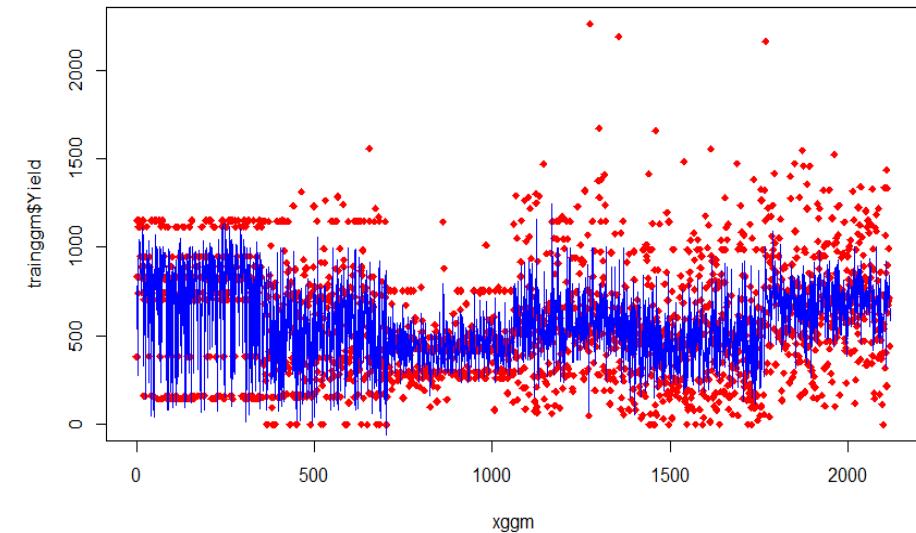
PatwarHalk	Pred_YieldRange_Groundnut_2021	Pred_Yield_Groundnut_2021
aau	2261 - 2499	2380
Agolai	2277 - 2516	2396
Aklkhori	2190 - 2421	2306
Amla	2132 - 2356	2244
Ati. Bhikhamkor	2167 - 2395	2281
..		
..		

Green gram Optimized Model Hyperplane & Predicted yield

Performance of 'svm'

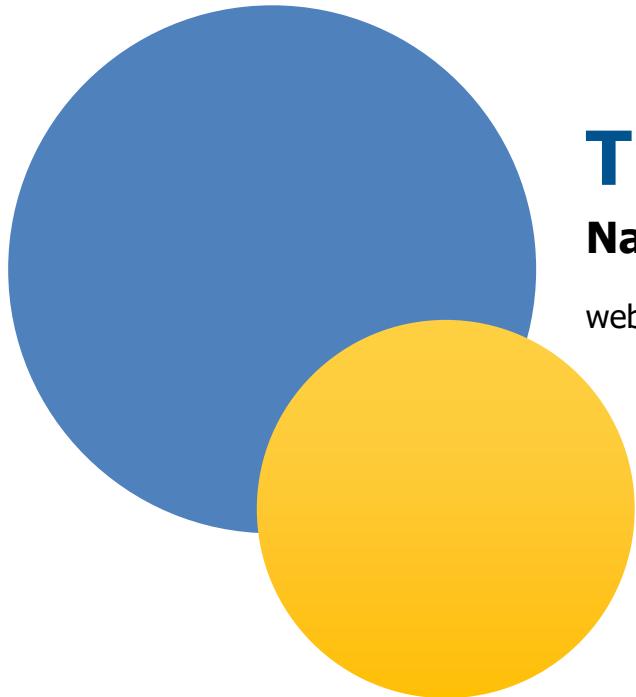


Hyperparameter tuning curve to find best parameters (epsilon & cost) associated with SVR and consider these best parameters to run the best SVR with these parameter



Best model graph between predicted & actual yield in testing set

PatwarHalk	Pred_YieldRange_Greengram_2021	Pred_AverageYield_Greengram_2021
aau	606 - 741	673.8
Agolai	608 - 743	675.7
Aklkhori	538 - 657	597.5
Amla	542 - 662	601.7
Anwana	470 - 574	522.2
..		
..		



Thank You

National Commodity Management Services Ltd.

website: www.ncml.com