The dawn of geospatial technology for smart farming in India

GEO SMART INDIA 2023

Theme: Digital Agriculture and Irrigation - Transforming the Future of Indian Agriculture

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Indian agriculture

Current Scenario

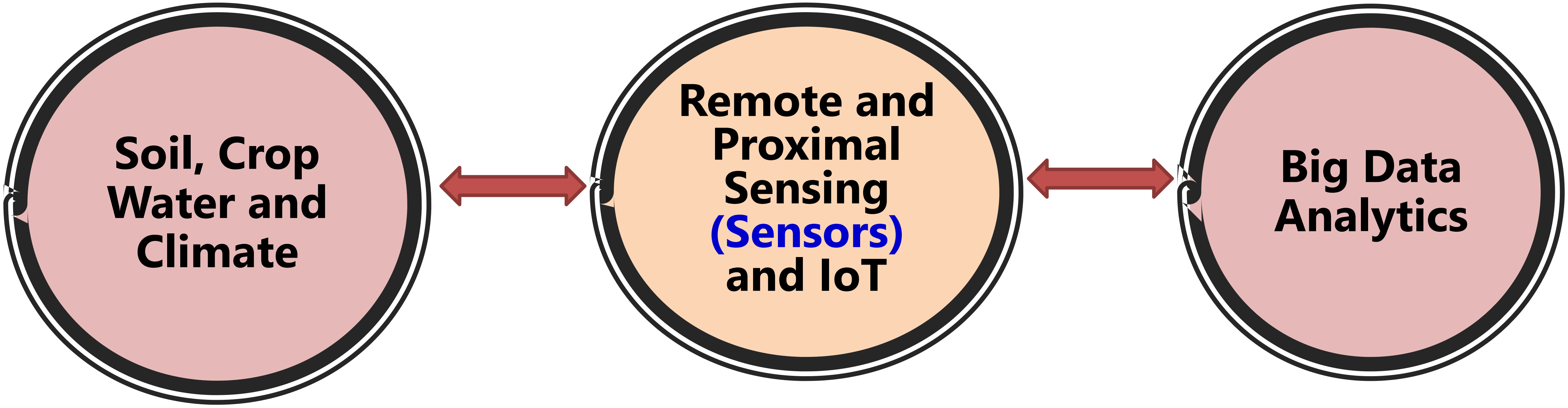
- Largest area under wheat, rice and cotton.
- Second largest producer of rice, wheat, cotton, and sugarcane.
- 195 m ha under cultivation (63 % rainfed (appx. 125m ha) and 37 % irrigated (70m ha).
- Nearly 3/4 of India's families depend on rural income.

Source: Ministry of A&FW, Govt of India and Economic Survey, 2022

Major Challenges

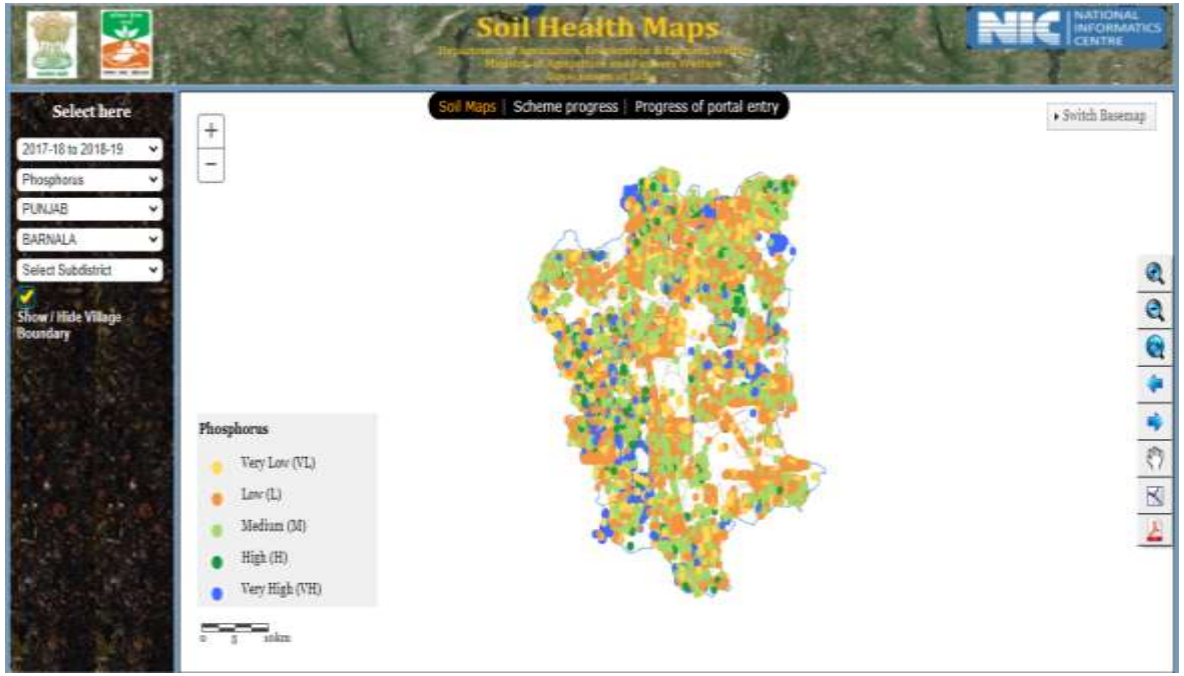
1. Raising agricultural productivity per unit of land
2. Reducing rural poverty through a socially inclusive strategy that comprises both agriculture as well as non-farm employment.
3. Ensuring that agricultural growth responds to food security needs

Major component of smart farming



GIS based assessment of soil fertility

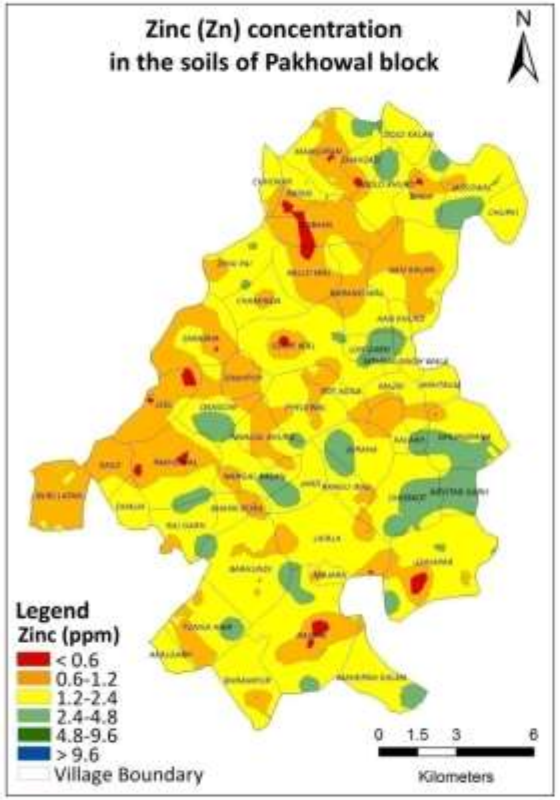
Point data of Soil Health Card available on MoAF, Govt of India

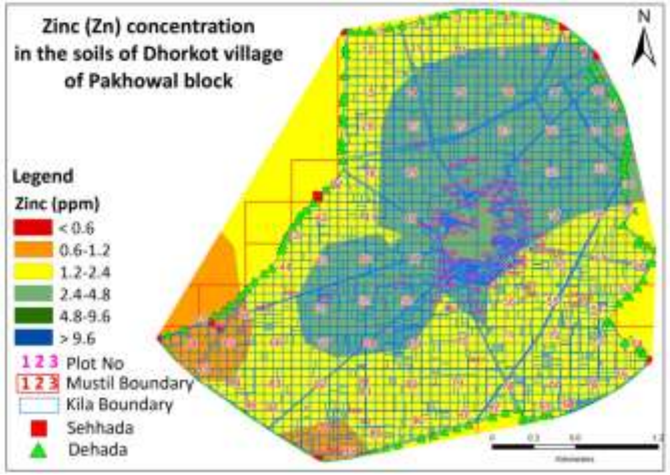


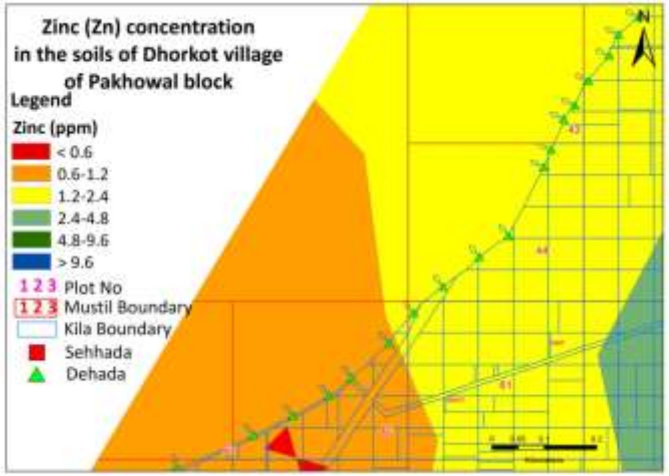
Current Status : Mainly GIS based- very few using hyperspectral data

Smart Farming Requirement: Sensor based and big data analytics for precision nutrient management

Geospatial based Soil Health Card







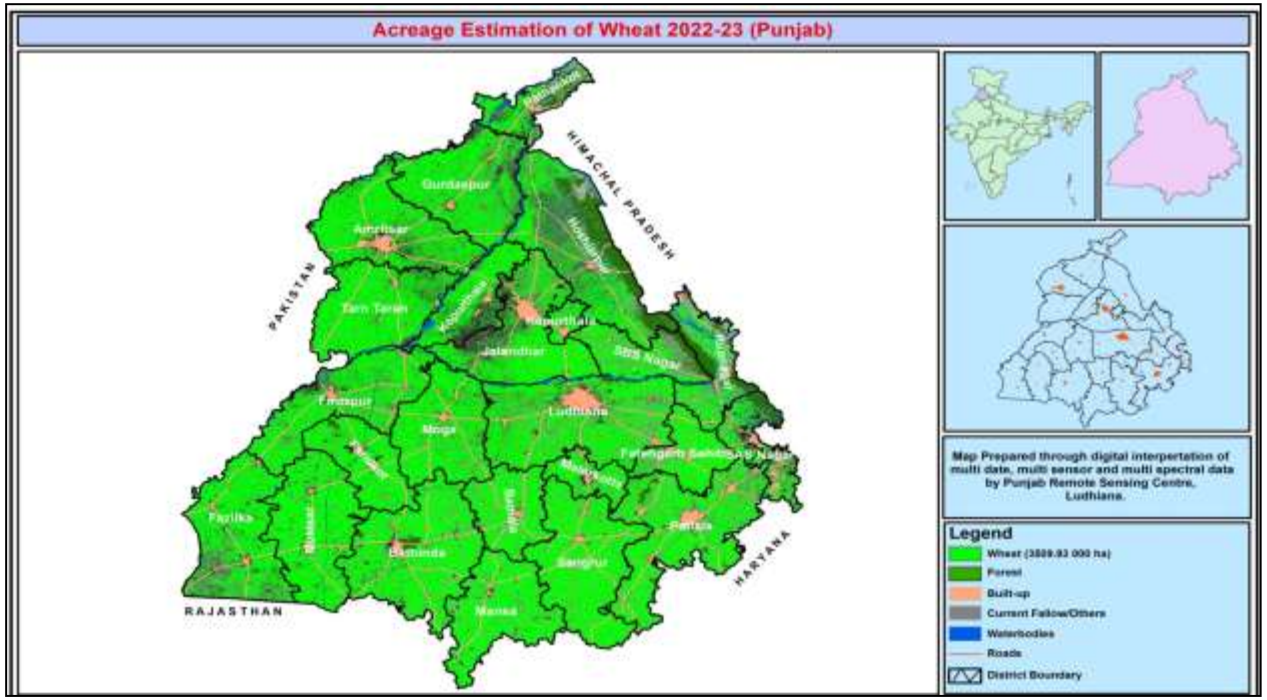
Estimation of soil properties from hyperspectral data (AVIRIS spectra)using machine learning model

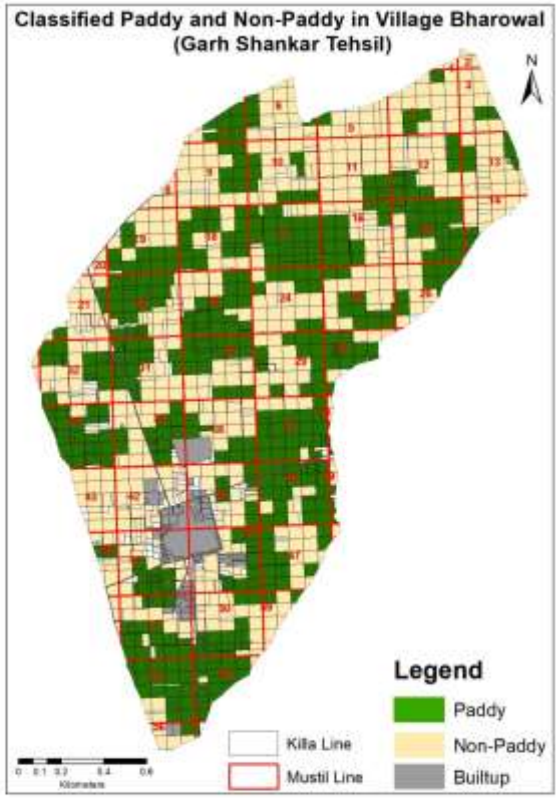
Soil Property	Anand		Surendranagar	
	R^2	Optimum wavelength (nm)	R^2	Optimum wavelength (nm)
OC	0.93	547,632,652,742,762,777,807,842,952,1043,1053,1058,1068,1073,1308,1313,1433,1714,1989,2134,2139,2390	0.77	481,542,547,672-782,997,1153-1178,1293,1298,1458,1478-1503,1759-1769,1954-1964, 2014-2039, 2059,2139,2144,2159,2345
K	0.75	542-2495	0.83	582-592, 762, 1218, 1228, 1233,1468,1548,1744,1769,1774,1959,1964,2209
P	0.70	512,647,1088,2064,2415	0.79	521-682,922-942, 1228-1438,1468,1573,1759,1764,1769
S	0.97	1523,1954	0.47	587,942,957,1533,2084,2239, 2264

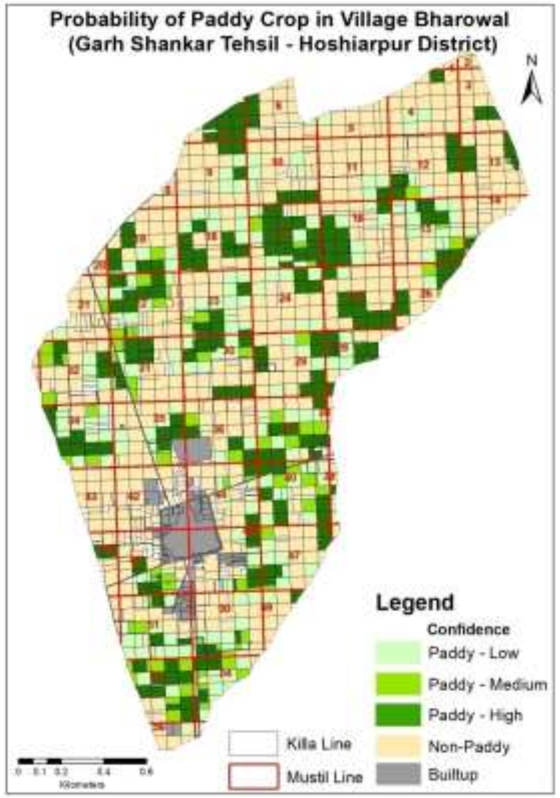
Study area : Anand in Gujarat, ML Model : Partial Least Square Regression

District level crop acreage

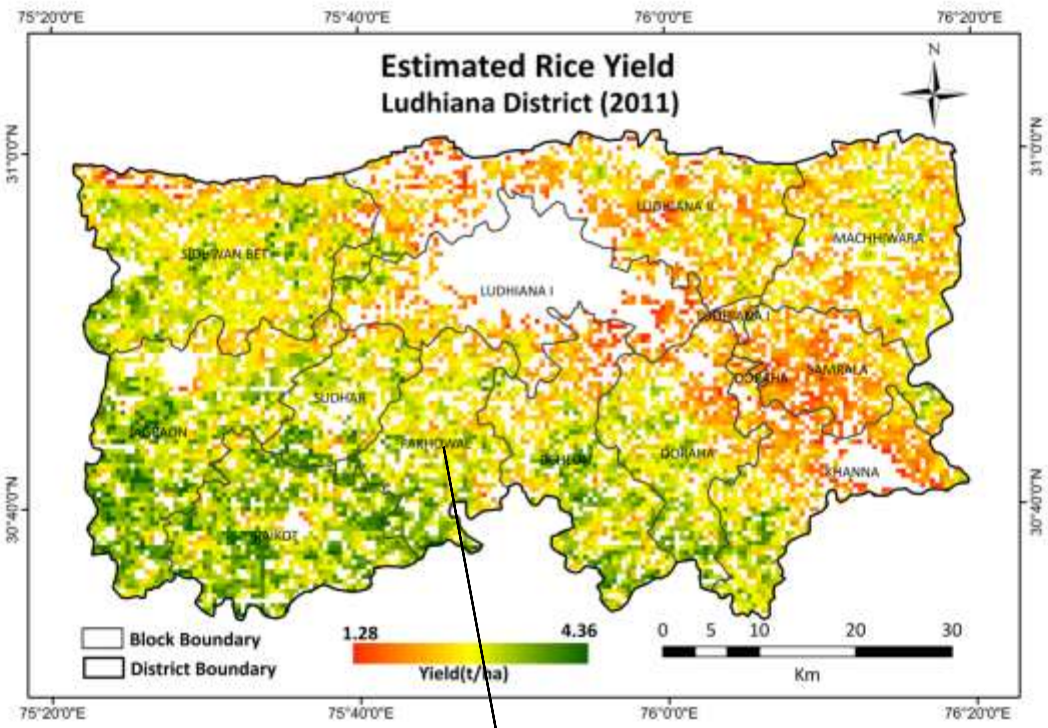
Geospatial based cadastral level crop mapping

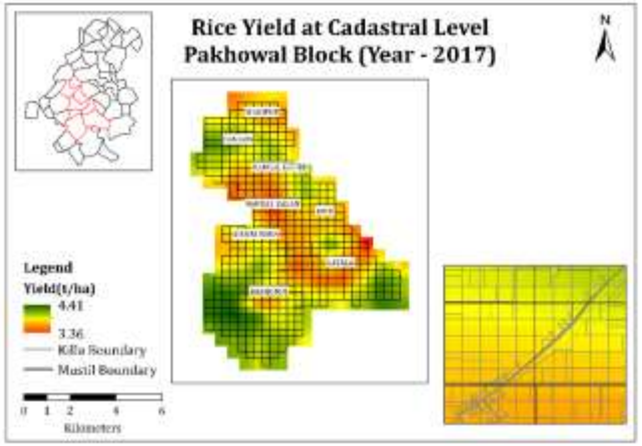






Estimated Rice Grain Yield in Ludhiana District (2011-2022)





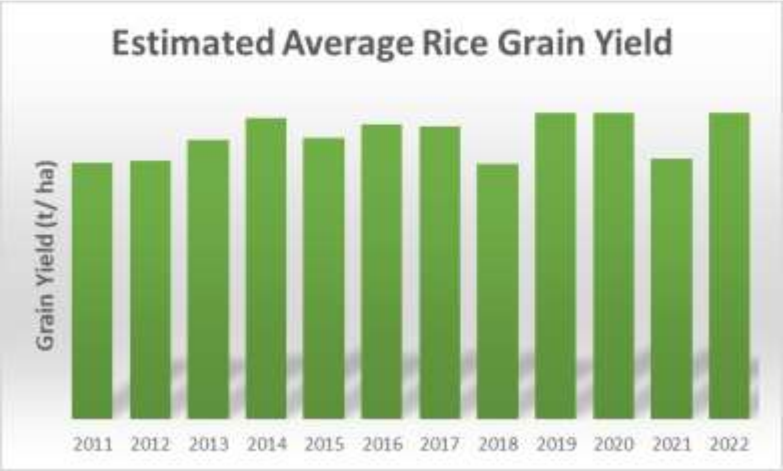
Approach

Satellite Data

CCEs

Climate Data

ML



r= 0.71 between measured (from crop cutting experiments) and predicted rice grain yield

Uncertainty need to be reduced using soil fertility and other factors

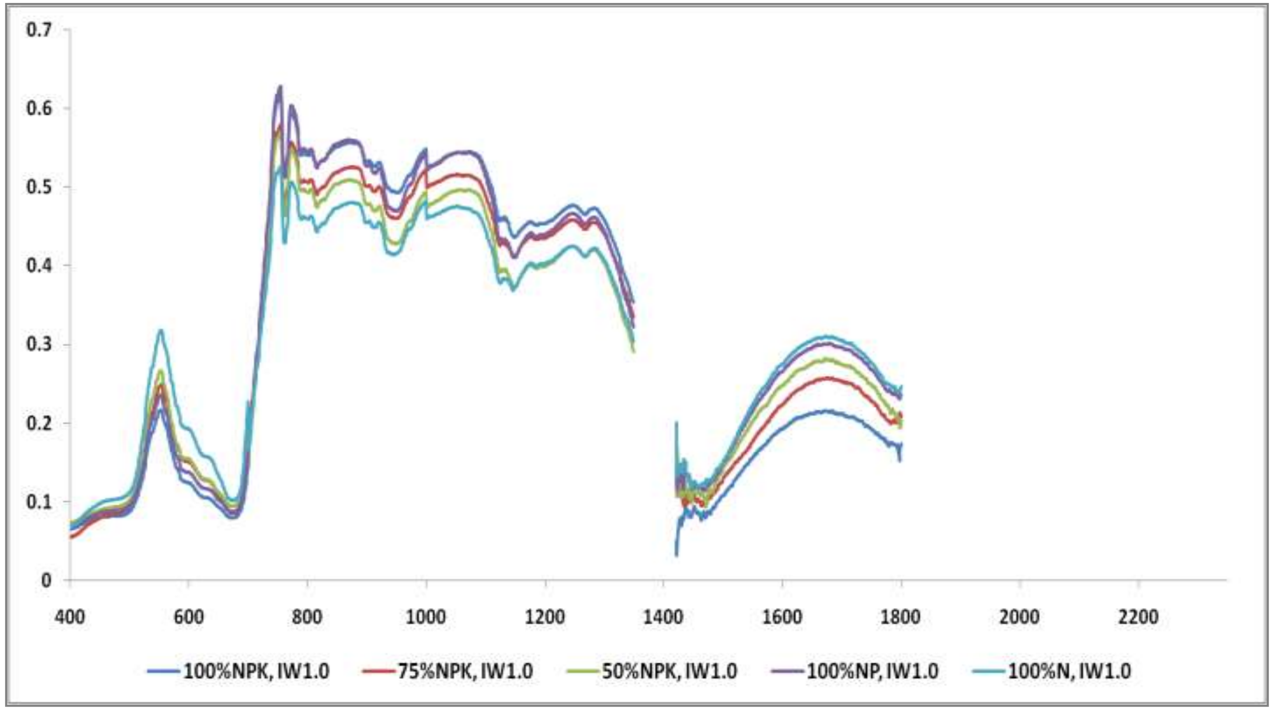
Hyperspectral data for detecting the nutrient stress in wheat

ML Algorithms

Algorithms	N	P	K
Random Forest	0.72	0.63	0.72
Support Vector Regression	0.51	0.33	0.46
Gradient Boosting Regression	**0.82**	**0.71**	**0.78**
Partial Least Square Regression	0.63	0.63	0.64

Optimum Wave lenghts

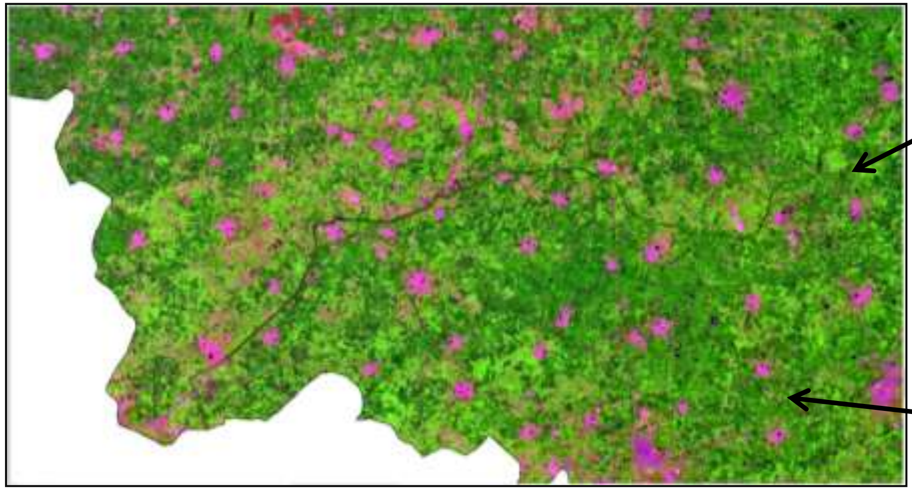
Algorithm	N	P	K
Gradient Boosting Regression	443, 449, 597, 885, 450	1304, 1305, 810, 1259, 1505	1305, 1504, 1091, 1259, 1505



Current Status : ***Limited*** **proximal and UAV remote sensing**

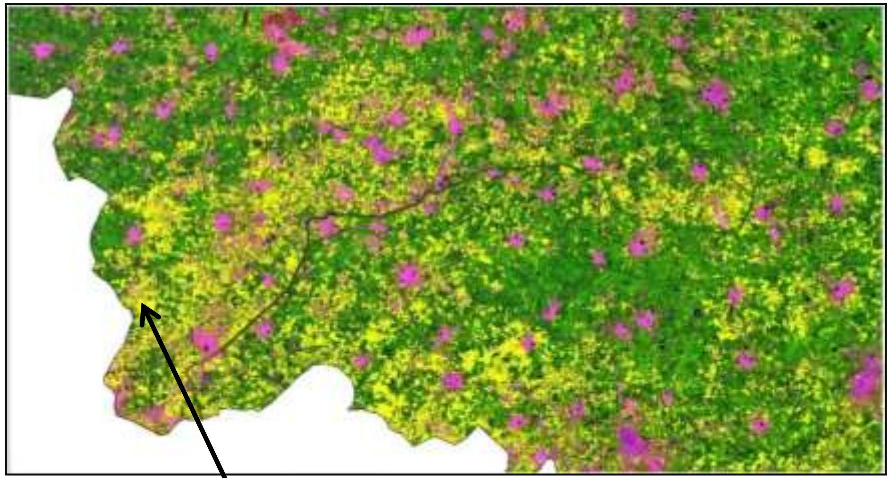
Smart Farming Requirements: UAV remote sensing coupled with machine learning techniques in different agro-climatic regions for translation of ML algorithms on satellite data

Assessment of biotic stress in cotton : Pink bollworm (Mansa District)



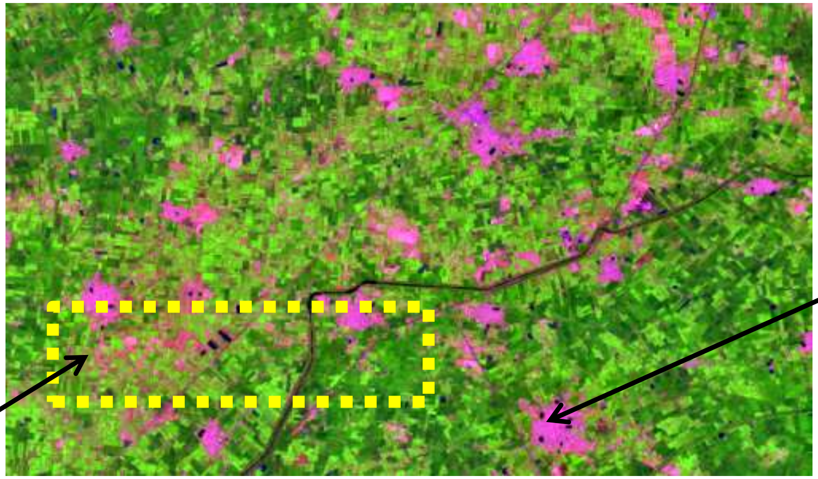
Cotton as seen in the satellite imagery

Paddy as seen in the satellite imagery



Cotton (Yellow Color)

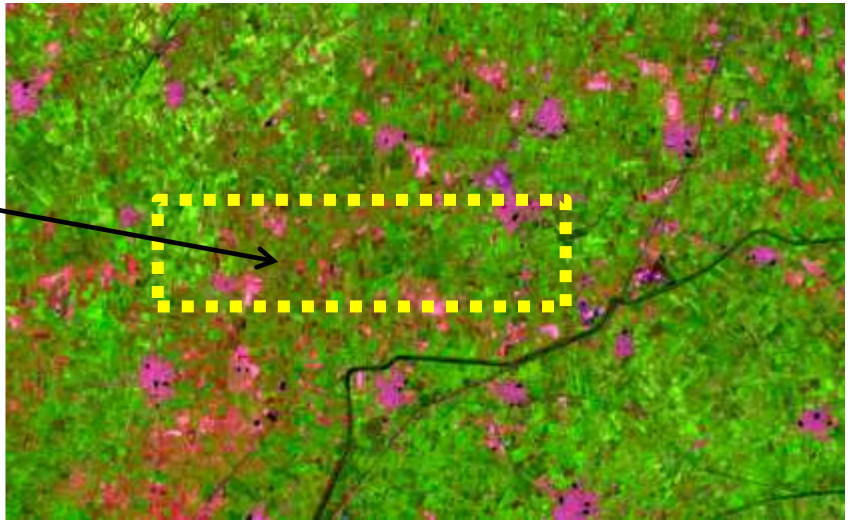
Crop condition on 24th September 2021



Built-up

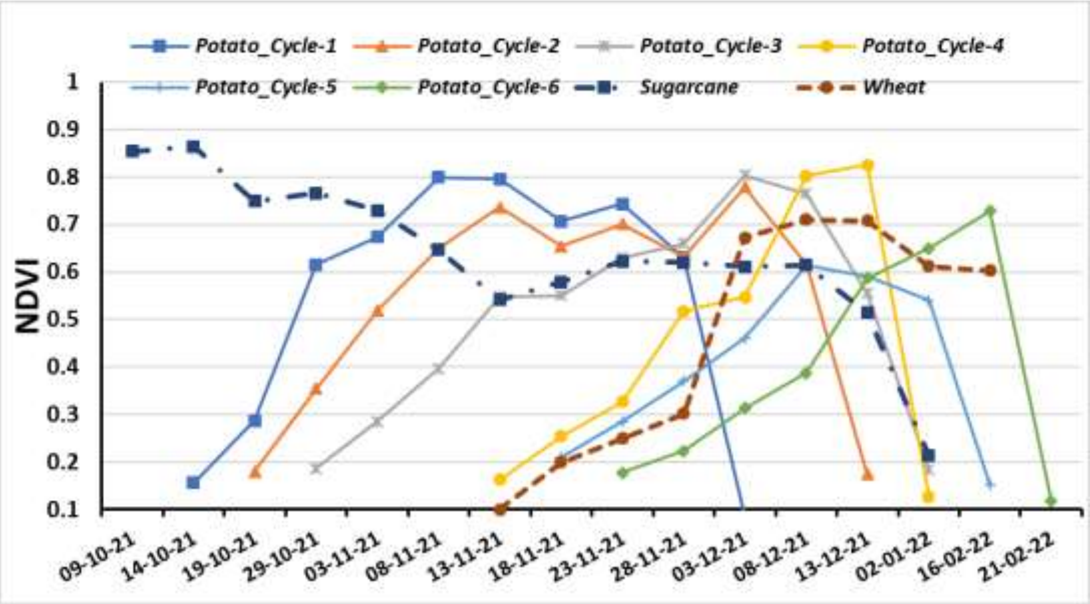
Pink bollworm affected area

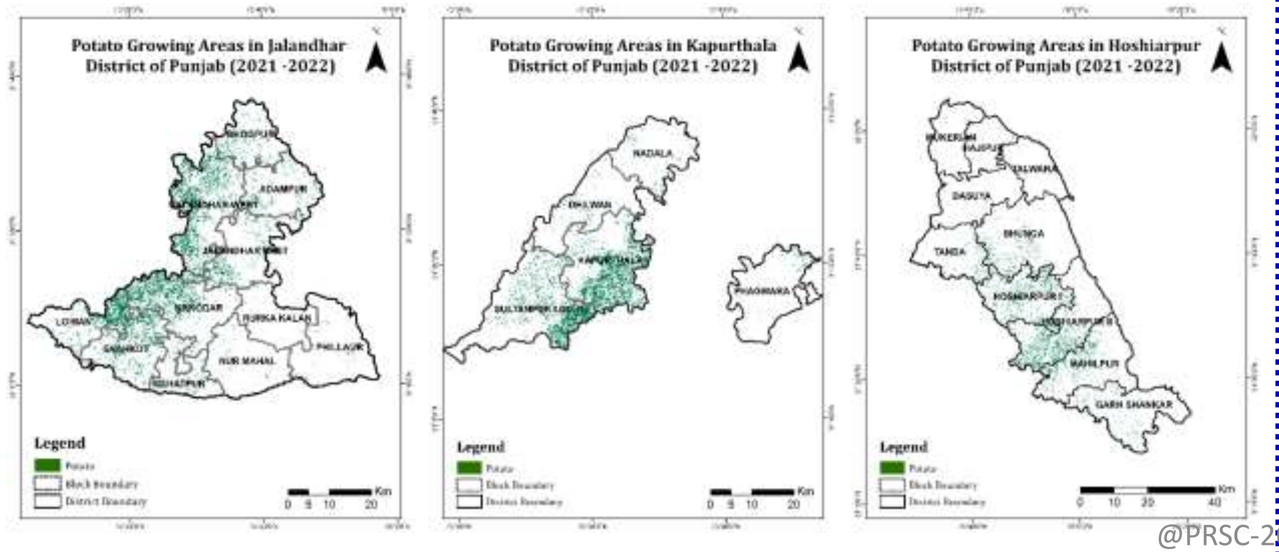
Crop condition 4th October 2021

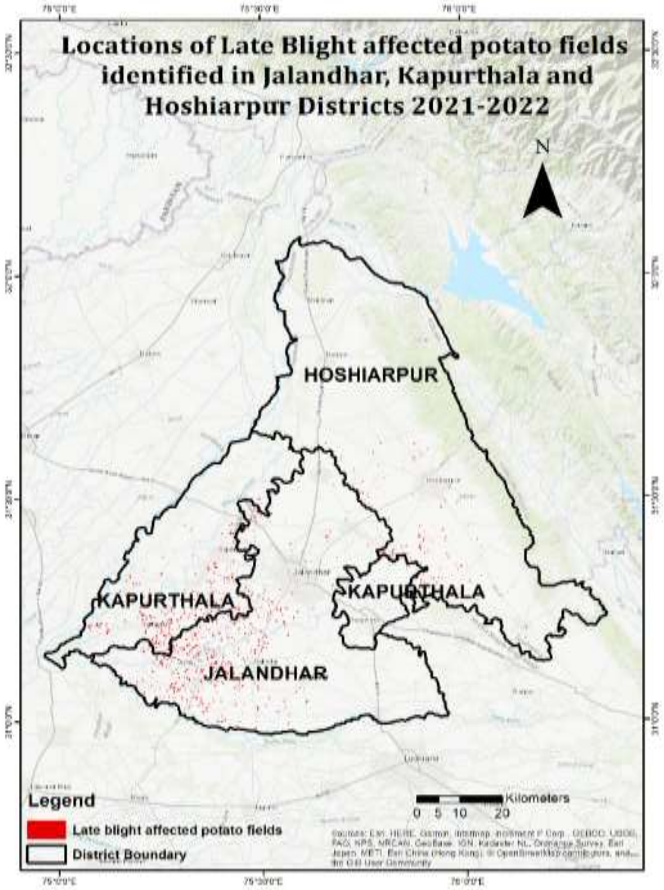


Sentinel-2 : 24 September, 29 September, 4 October, and 9 October 2021

Late Blight of Potato





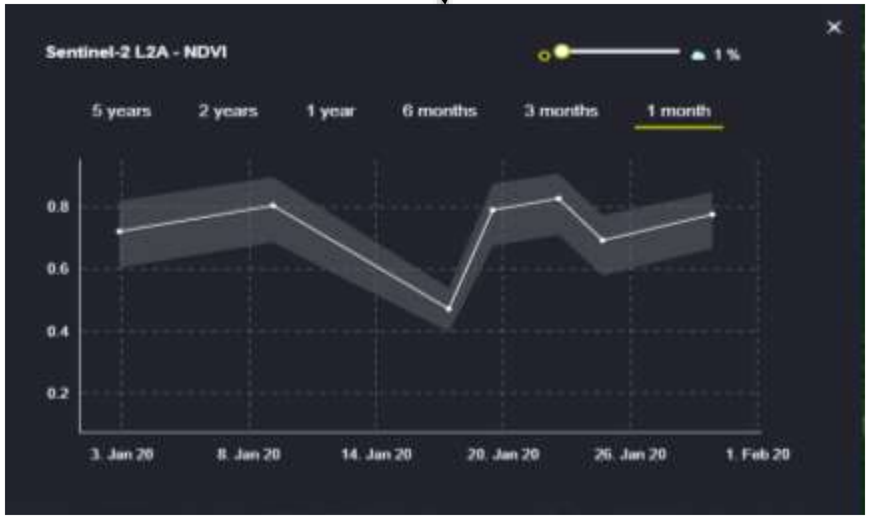


Model: **Disease water stress index (DWSI)**

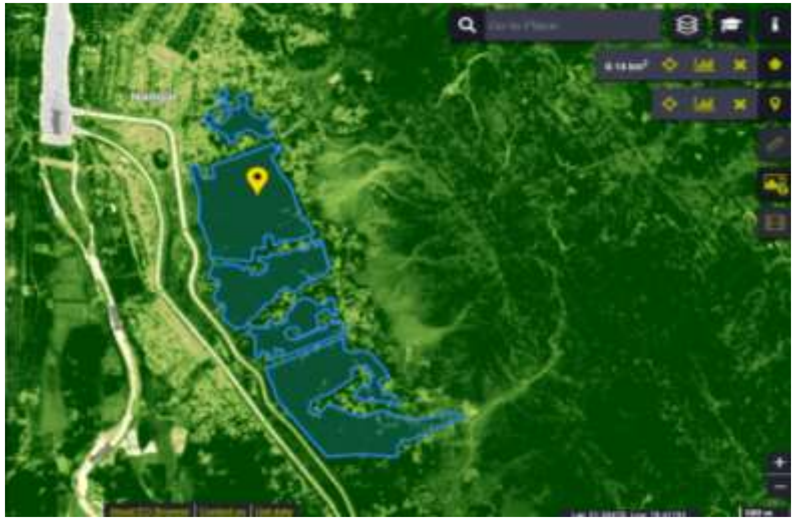
DWSI = -7.1896 + 0.2816*Rainfall + 0.421*Tmax - 0.115*Tmin

(r=0.74)

Yellow rust of wheat using machine learning techniques



NDVI, NDWI, MNDWI, NDMI, ClRed, mCari, S2Rep



Deep Learning Artificial Neural Network Classification Model

X -> 7 important indices

Y-> rust/non-rust (1/0)

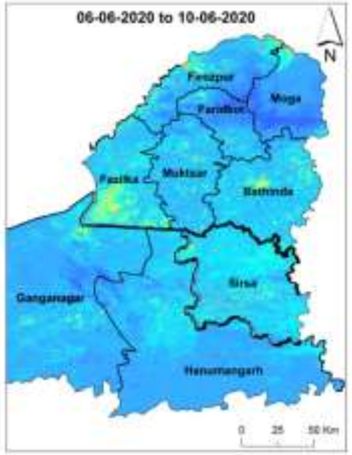
S. No	Index	Details	General Formula
1	NDVI	Normalized difference vegetation index	(NIR - RED) / (NIR + RED)
2	NDWI	Normalized Difference Water Index	(NIR - SWIR) / (NIR + SWIR)
3	MCARI	Modified Chlorophyll Absorption in Reflectance Index	((700nm - 670nm) - 0.2 * (700nm - 550nm)) * (700nm /670nm)
4	CI-Red Edge	Chlorophyll red-edge	([760:800][690:720])pow (−1)
5	NDMI	Normalized Difference Moisture Index	(820nm - 1600nm) / (820nm + 1600nm)
6	S2REP	Sentinel-2 red-edge position	705 + 35 * ((((NIR + R)/2) − RE1)/(RE2 − RE1))

AGRICULTURE DISASTER

Current Status : Mostly Girdwari by Patwaris

Smart Farming Requirements: Use of UAV/ satellite remote sensing and machine learning algorithms for providing the quick results

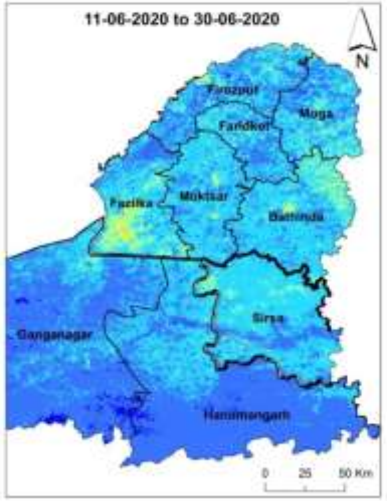
Locust



Possible effect on crop growth in Fazilka district during 01-10 June 2020

1.53% area of the district

No effect on crop growth due to locust infestation



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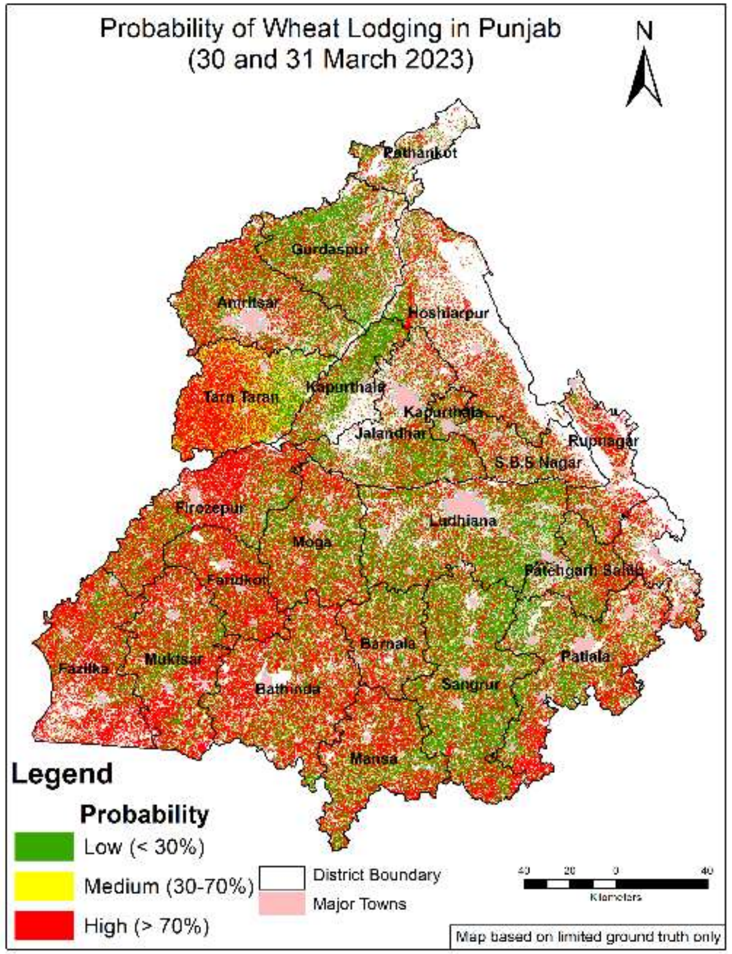
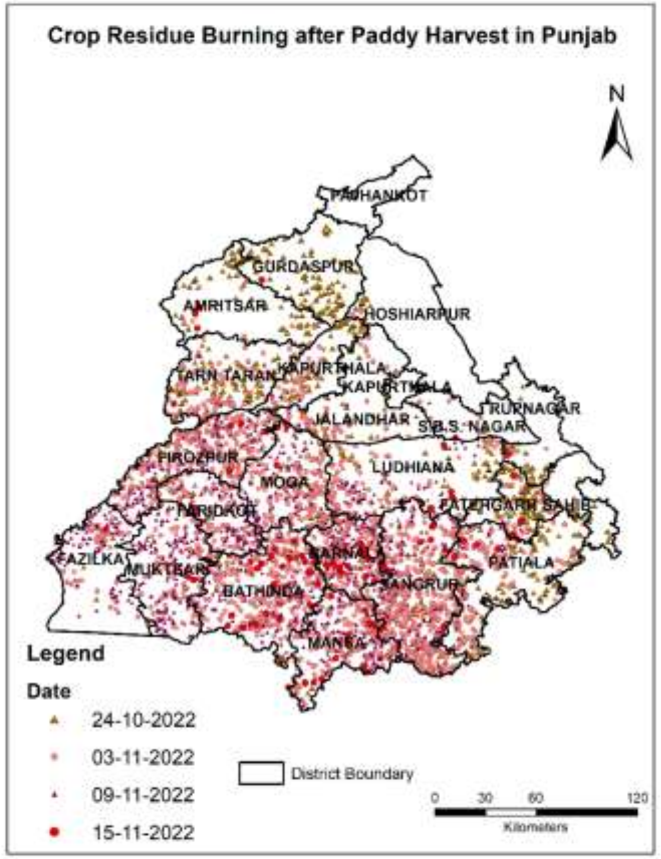
Wheat Lodging

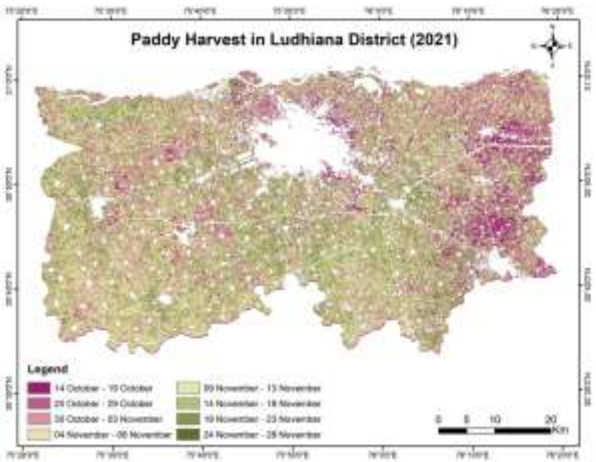


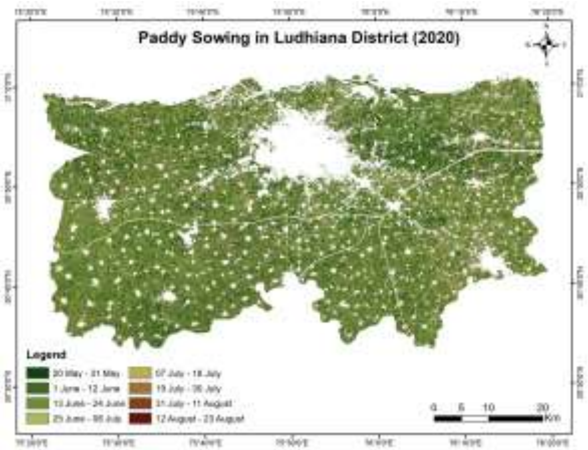
Crop Residue Burning

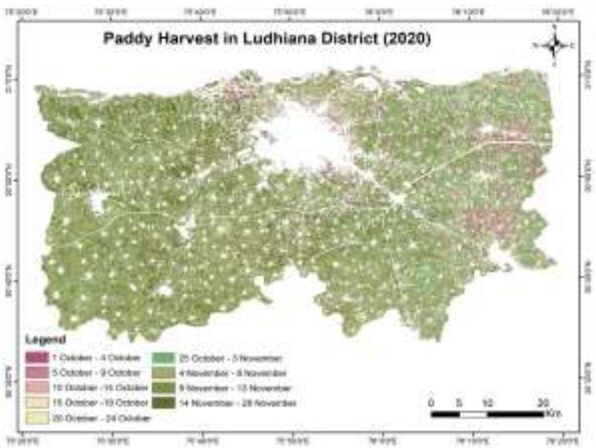
Current Work



Predictability of crop residue burning using satellite remote sensing



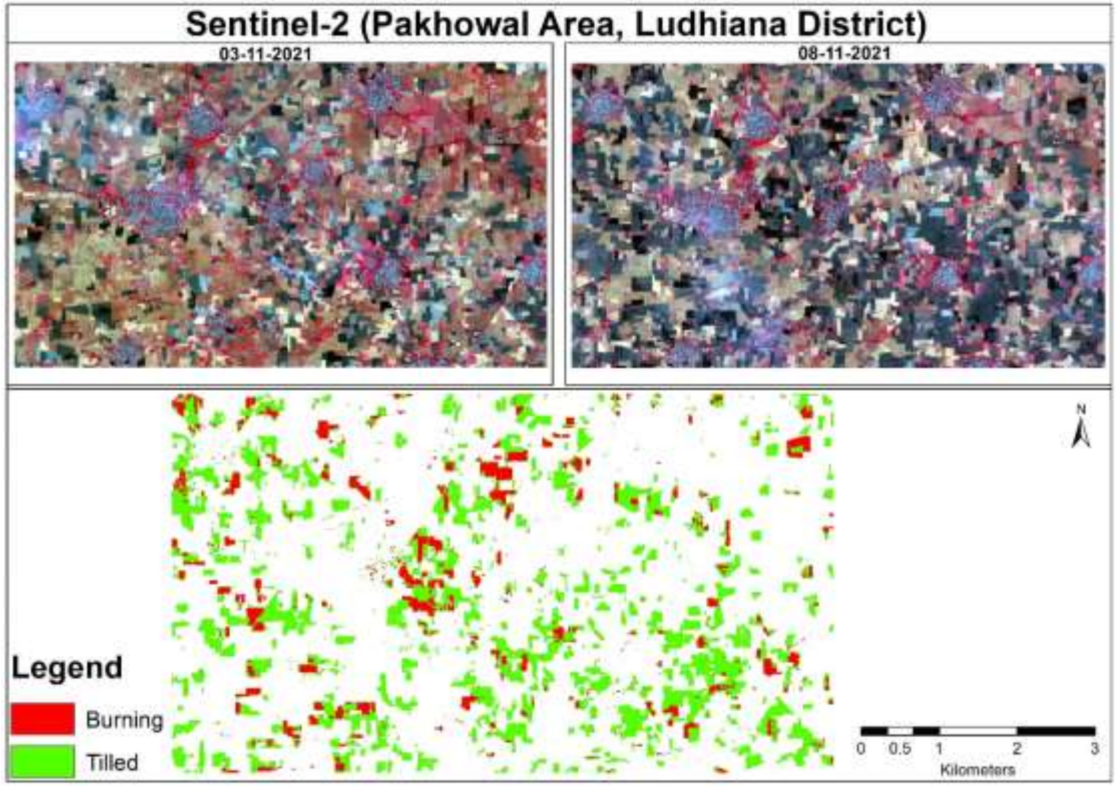


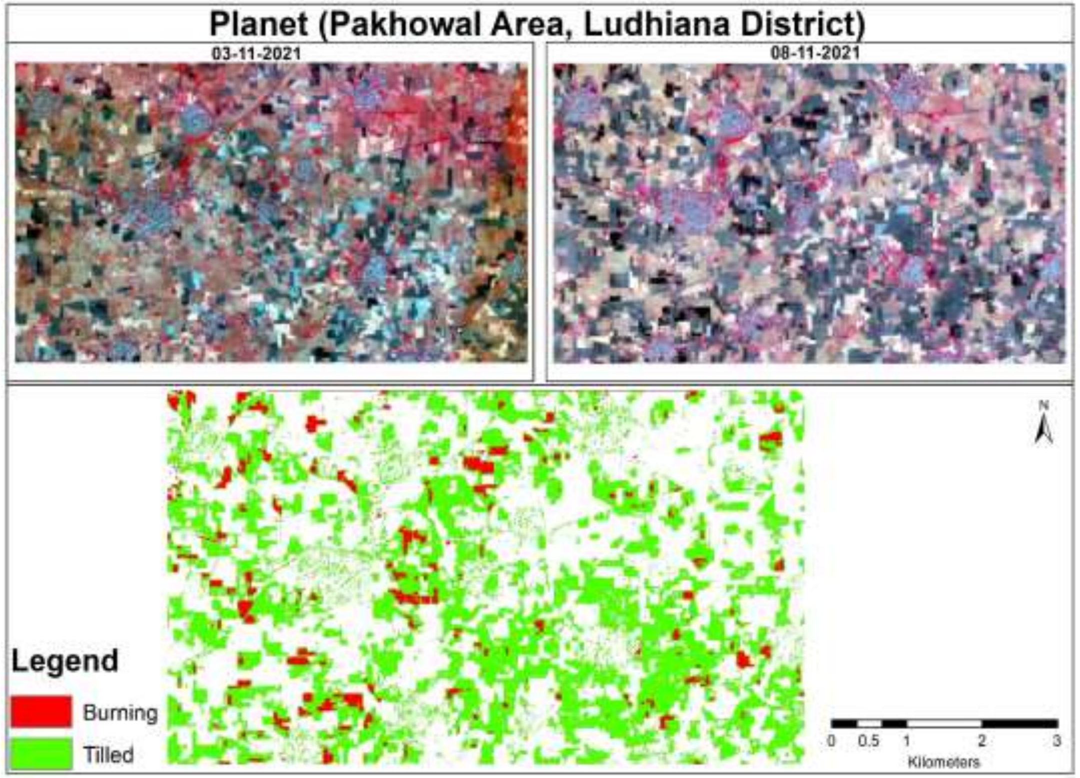


Crop Residue Burning

Current Status : Satellite data with spatial resolution of 375 m and 1 km.

Smart Farming Requirements: High resolution satellite data along with effective and cost saving strategies for management of crop residues

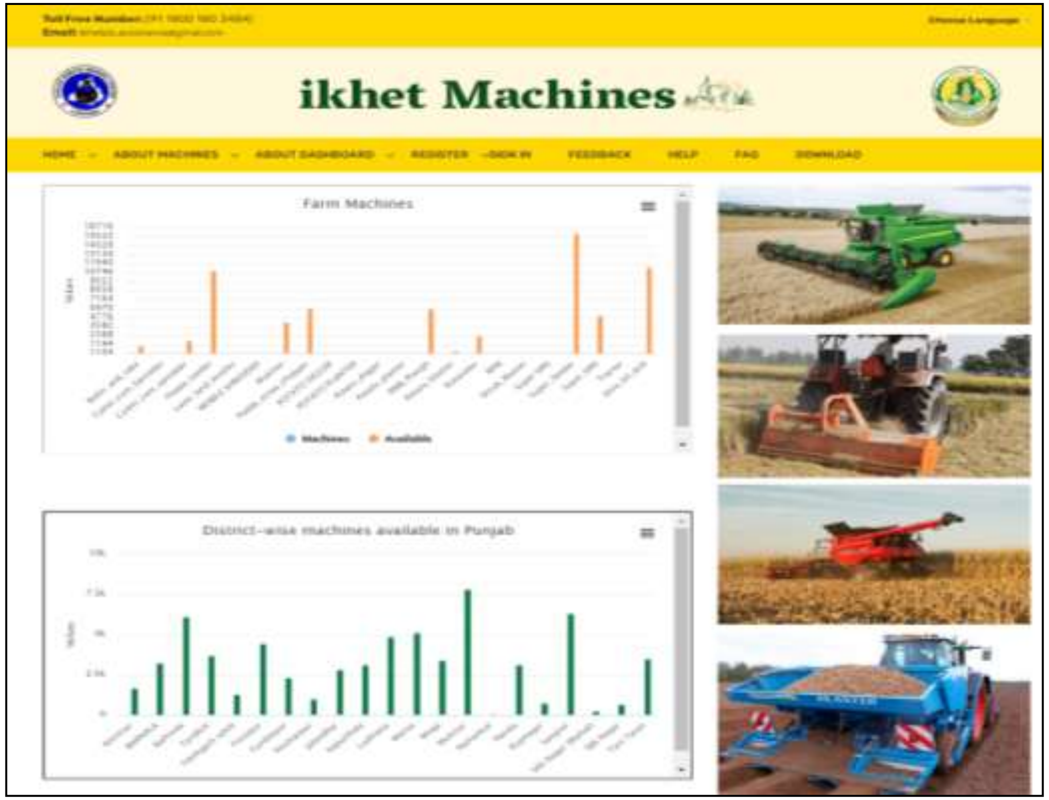




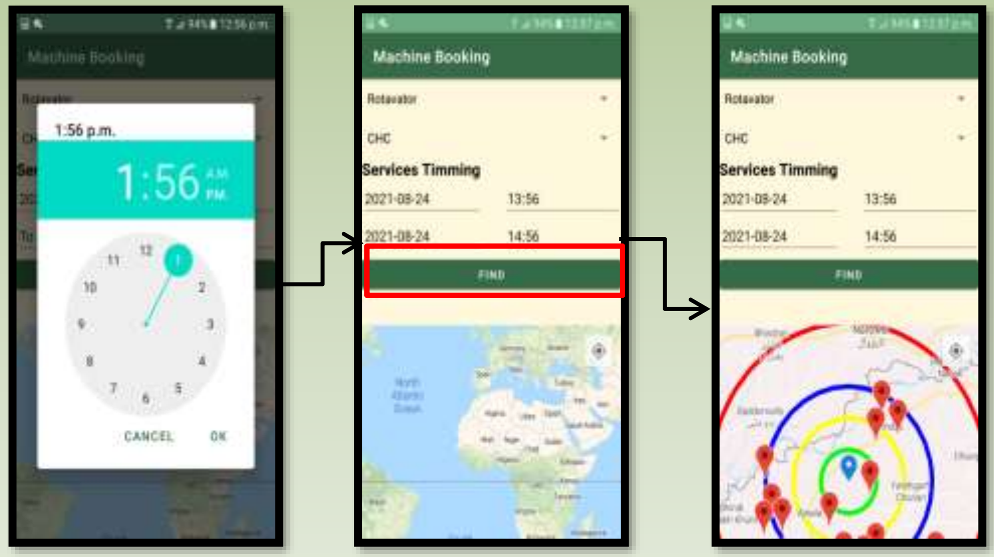
25 ha lesser with high resolution satellite data

Farm Machineries Booking Application (I-Khet)

- **To support farmers for booking of farm machineries.**
- **A platform consists of spatial and non-spatial information of farming machineries, utilization at various geographical levels**
- **contains six modules namely- Service Providers (CHC Cooperatives), Block Nodal Officer, District Nodal Officer, State Nodal Officer, Admin, and End Users (Farmers).**
- **The data is centralized for mobile application and Web-GIS based Dashboard and Mobile application**



Machine Booking

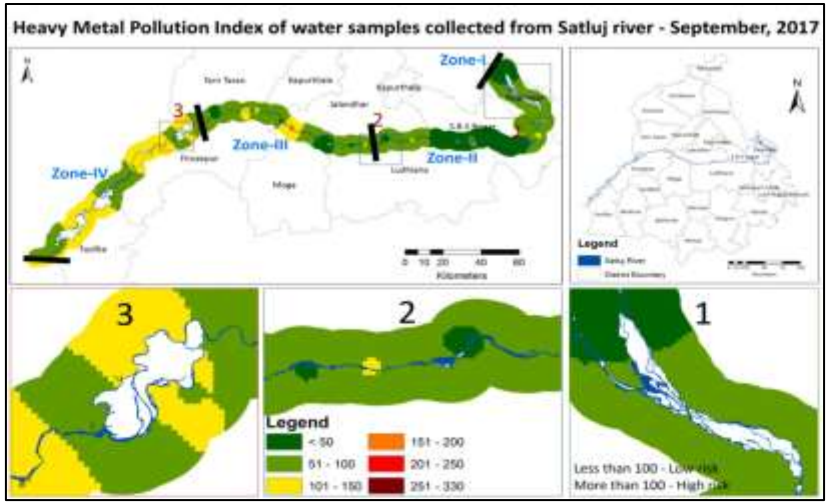


Select the Booking time from calendar .

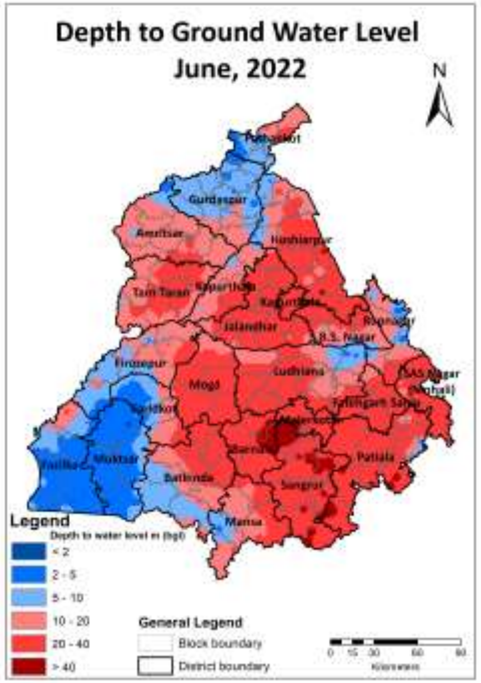
Click on Find Button

The map and list of machines is displayed on the screen

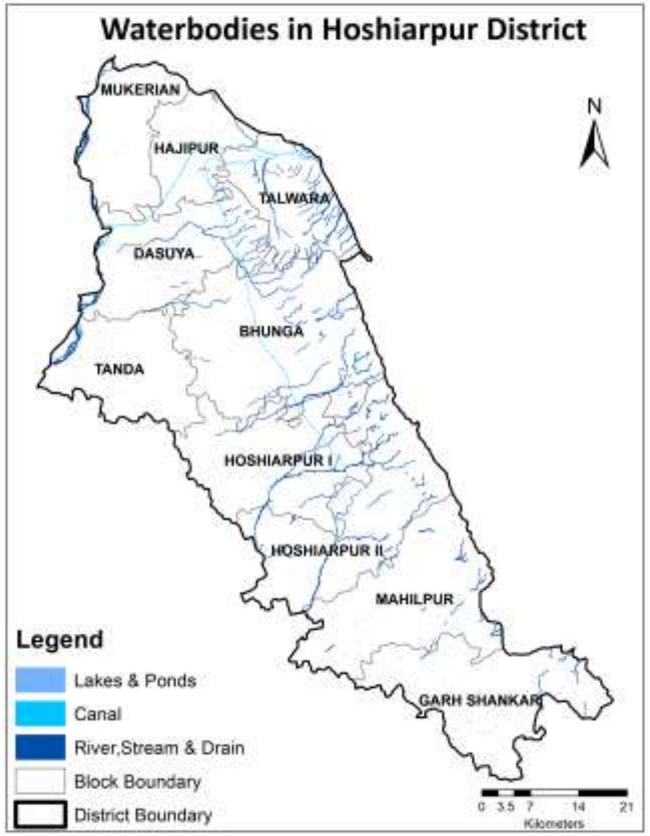
Surface Water Quality of Satluj River in Punjab using Water Sampling, Analytical WQ data and GIS



Mapping of depth to water level



Mapping of waterbodies



Satellite-based estimates of groundwater depletion in India

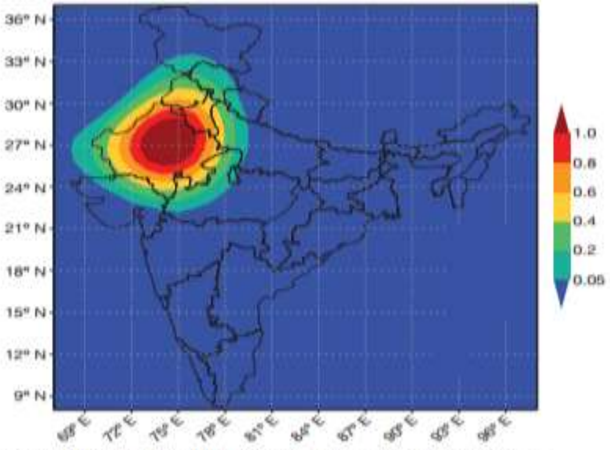


Figure 2 | GRACE averaging function. The unscaled, dimensionless averaging function used to estimate terrestrial water storage changes from GRACE data is mapped.

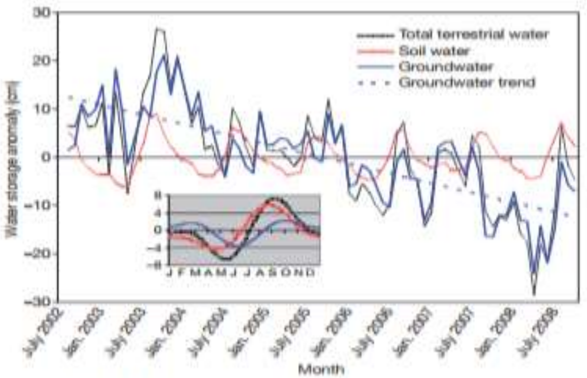


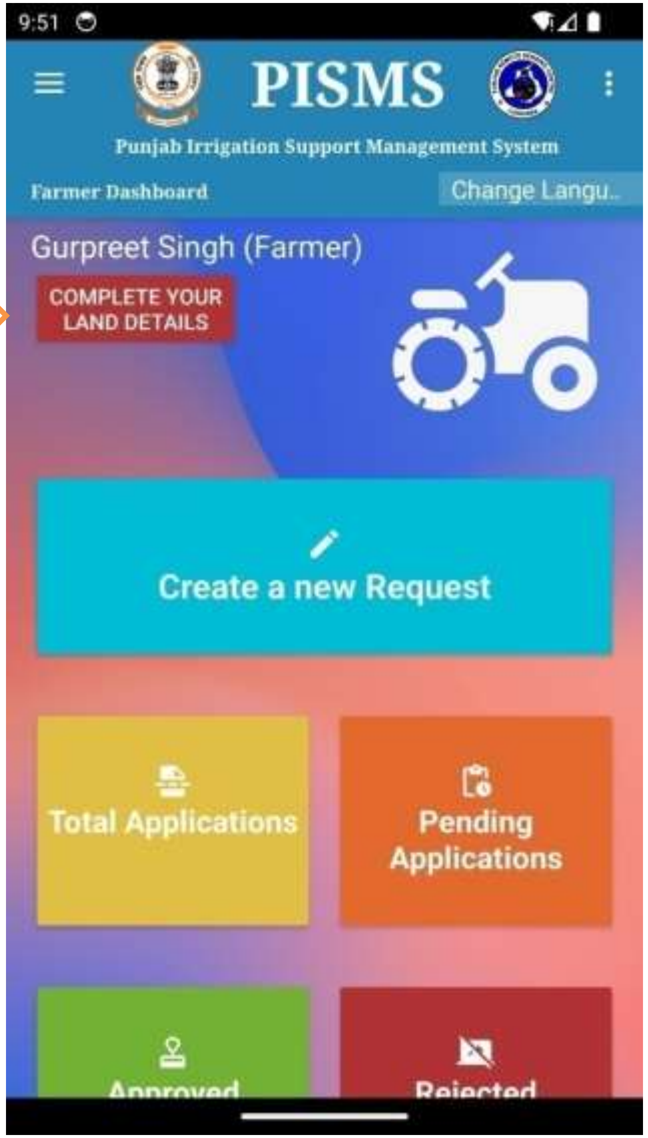
Figure 3 | Monthly time series of water storage anomalies in northwestern India. Monthly time series of anomalies of GRACE-derived total water, modelled soil-water storage and estimated groundwater storage, averaged over Rajasthan, Punjab and Haryana, plotted as equivalent heights of water in centimetres. Also shown is the best-fit linear groundwater trend. Inset, mean seasonal cycle of each variable.

Rodell et al. (2009): Nature, 460 : 999-1003

Punjab Irrigation Support and Management System (PISMS): Bi-Lingual

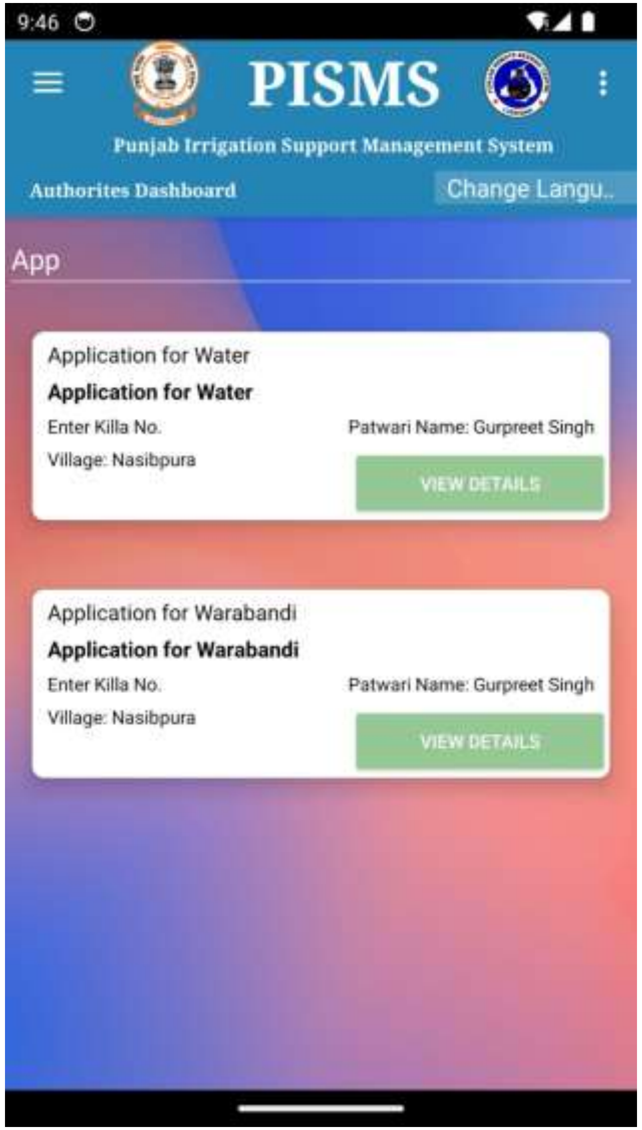
English

Punjabi



PISMS Mobile Application: Authorities Dashboard

Request Status, Pendency and Nature of objections



Benefits of smart farming using geospatial technology

For farmers

- Identification of crop health and stress
- Improve crop yield
- Monitor soil health
- Monitor crop health and stress
- Identify climate change
- Easy to check crop need

For scientists

- Identification of crop health and stress
- Guide farmers about crop diversification
- Crop management to maximize returns through the season
- Identify crop specific zones

Limitations of smart farming

- Smart farming needs continuous connectivity of internet.
- Farmers to understand and learn the use of technology.
- Technology for smart farming is expensive and small farmers cannot afford it.
- Only feasible at large farms.

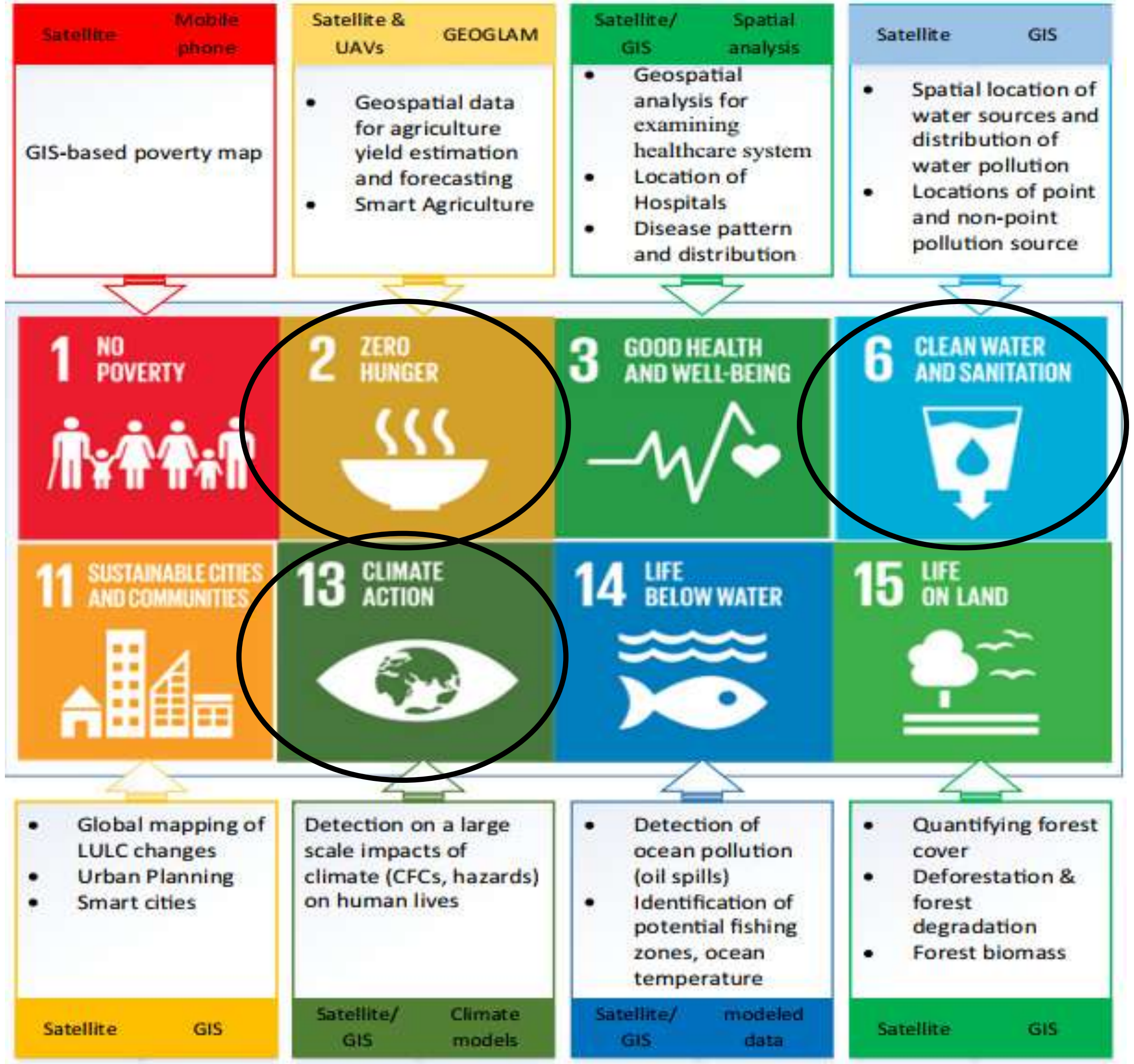
Implementation of SDGs using geospatial technology in crop, soil and water resources

Major SDGs

SDG 2 on ending hunger, improving food security and nutrition, and promoting sustainable agriculture.

SDG 6 on ensuring availability and sustainable management of water for all.

SDG 13 on mitigating and adapting to climate change will be directly supported.



Source: https://www.geospatialworld.net/blogs/geospatial-information-to-implement-sustainable-development-goals/

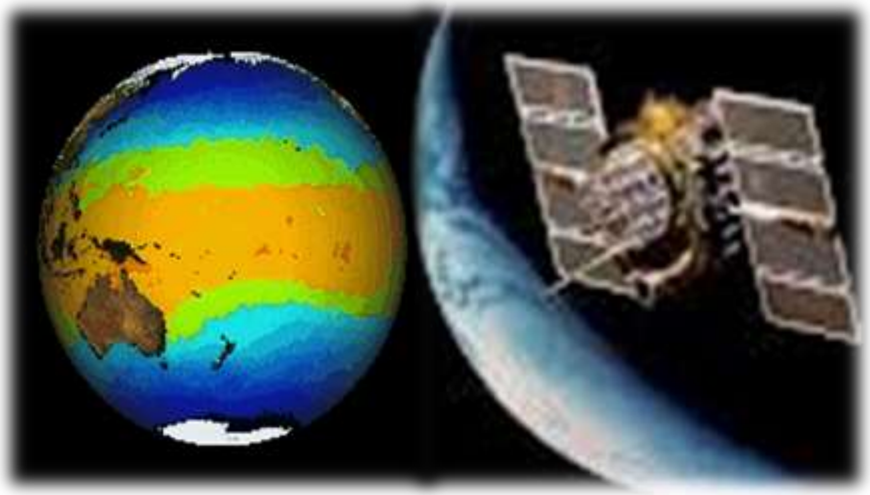
Takeaways

- By incorporating a spatial dimension into sustainable agricultural practices and policies, Geospatial technology helps the farming industry remain viable for future generations.

- Many developing countries face major challenges owing to the availability of timely and accurate geospatial data, the lack of skilled manpower, and limited awareness about these technologies among environmental decision/policy makers and their prospective users.

- The lack of budget to fund the adoption of these technologies is another major challenge, **but the ability to guarantee agriculture sustainability will only increase as technology develops.**

GEOSPATIAL FOR BETTER WORLD



THANK YOU

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