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Geo Spatial Technologies for Agriculture
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Outline of the Presentation

- Challenges posed to Agriculture Sector in the coming years
- What are the Geo Spatial Technologies?
- How Geo Spatial Technologies can help?
- Some Case Studies
- Situation of India in use of Geo-spatial technologies in India

CHALLENGES POSED TO AGRICULTURE

Agricultural Development Challenge

Increase in demand for Agricultural Produce

- **Increase in World Population:** 6.7 billion to 9 billion by 2050 (FAO, 2010)
- **Demand for food** is expected to increase by 60 % (FAO, 2012).

Climate Change: Patterns of Temperature and Precipitation

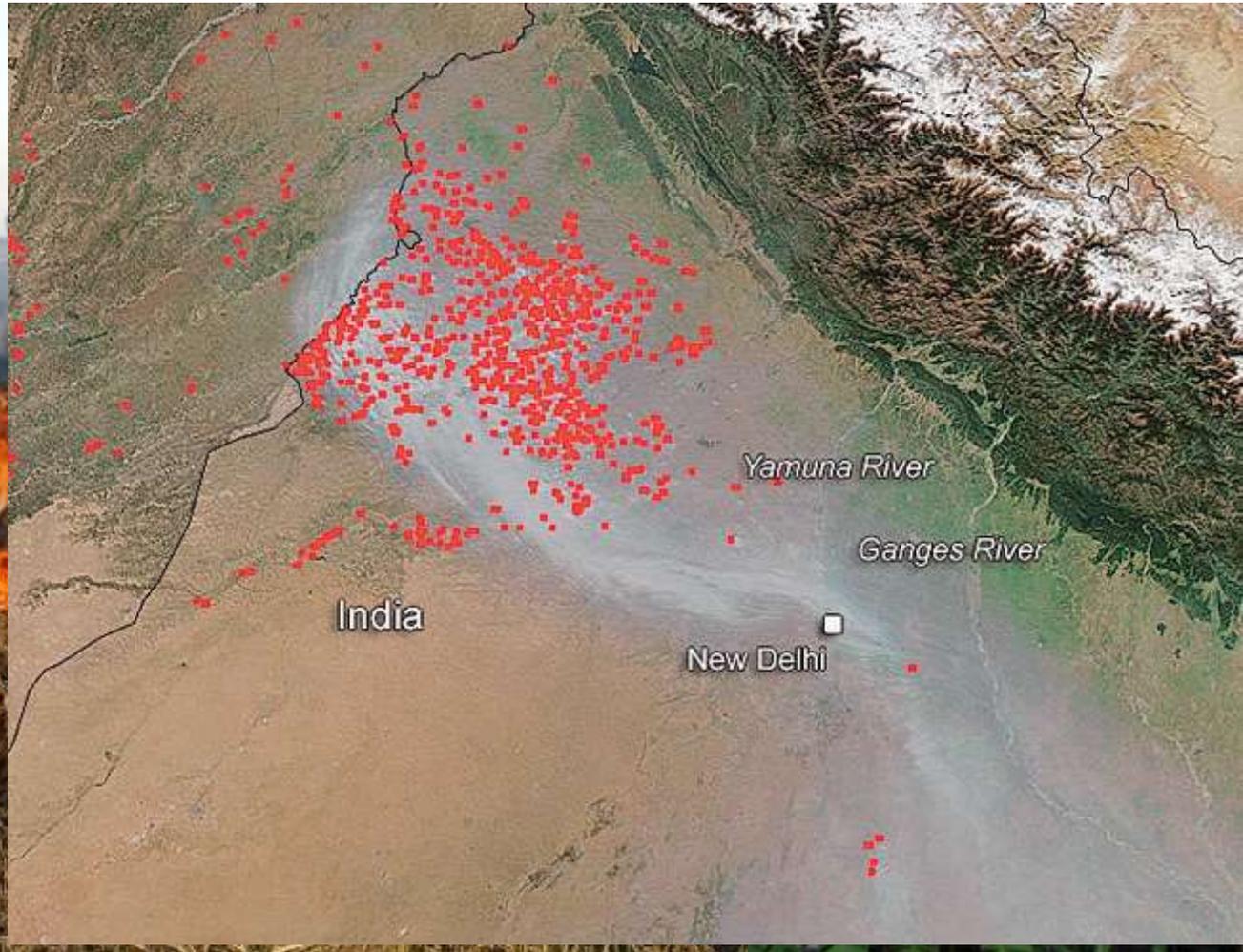
- Changes in average temperature and rainfall, increasing droughts and floods, extreme, changes in pests and diseases, changes in nutritional content of food
- Agriculture contributes 13.5 percent of global GHG emissions (IPCC, 2007).
- Besides the environmental and health impacts, it will nearly double the price of corn, rice, and wheat (IFPRI, 2010, UN FAO, 2012).

Resource Constraint

- **Land degradation:** About 1.2 billion hectares (ha) (almost 11 per cent of the Earth's vegetated surface) has been degraded by human activity over the past 45 years (IFAD, 2012)
- **Water Constraint:** Increasing droughts due to climate change, increasing competition in use of water for other purposes

Sustainability Challenge: To meet the demands of higher production and increasingly declining land, water and other resources

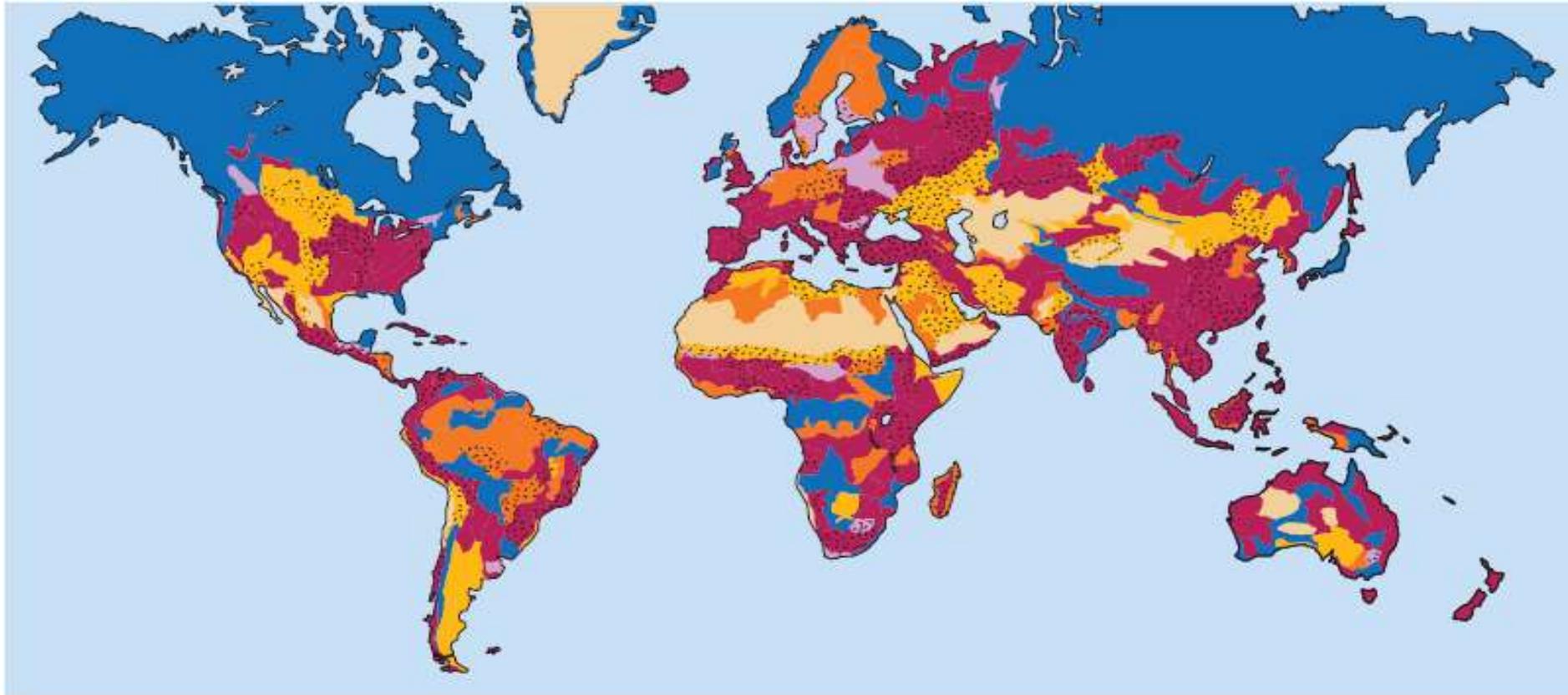
Agriculture Development Challenge



Sustainable Agriculture & Climate Change

Agriculture Development Challenge

Fragility of Soil



Soil degradation types

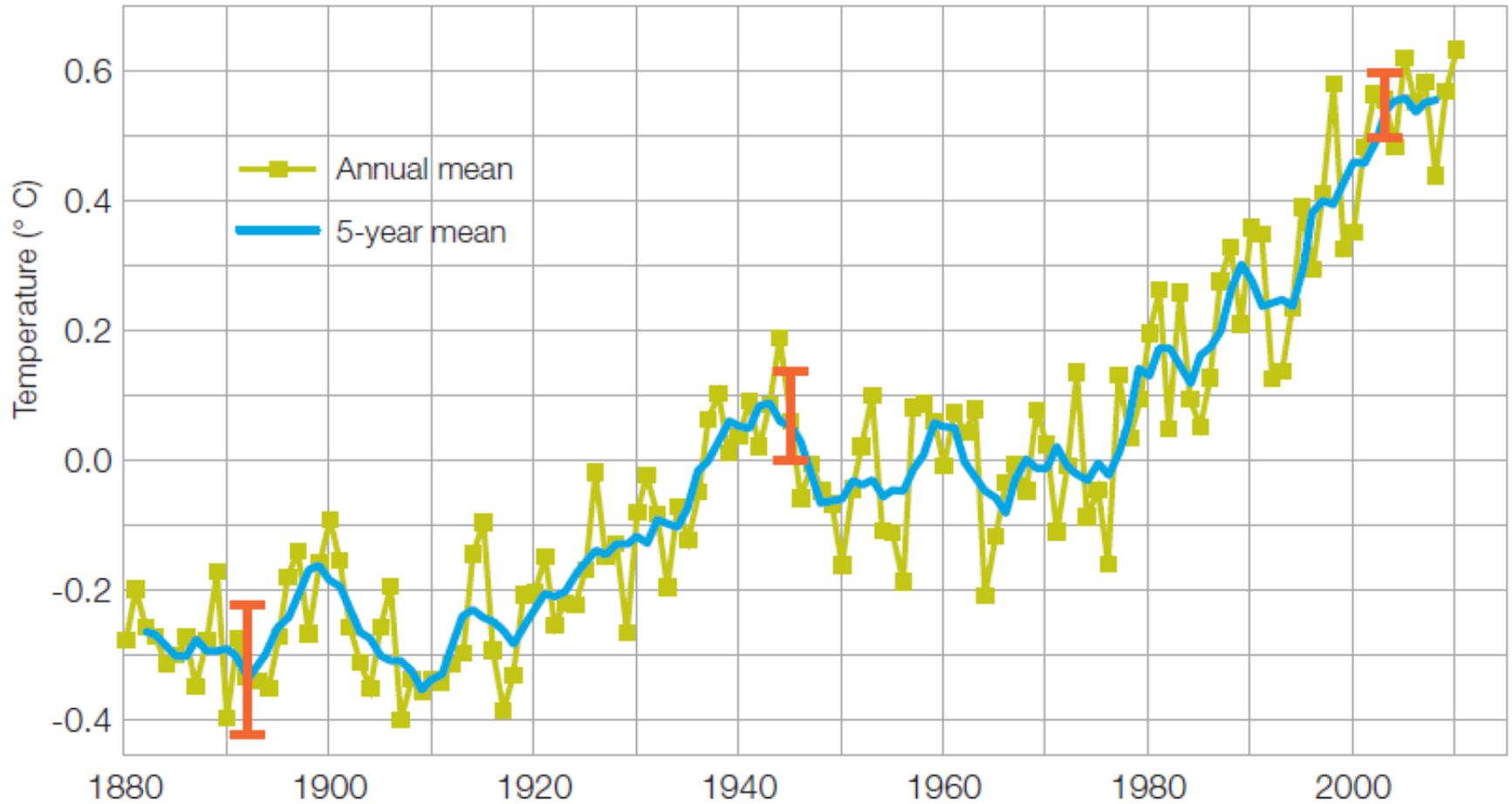
- Water erosion
- Wind erosion
- Chemical deterioration

- Physical deterioration
- Severe degradation

Other symbols

- Stable terrain
- Non-used wasteland
- Water bodies

Agriculture Development Challenge

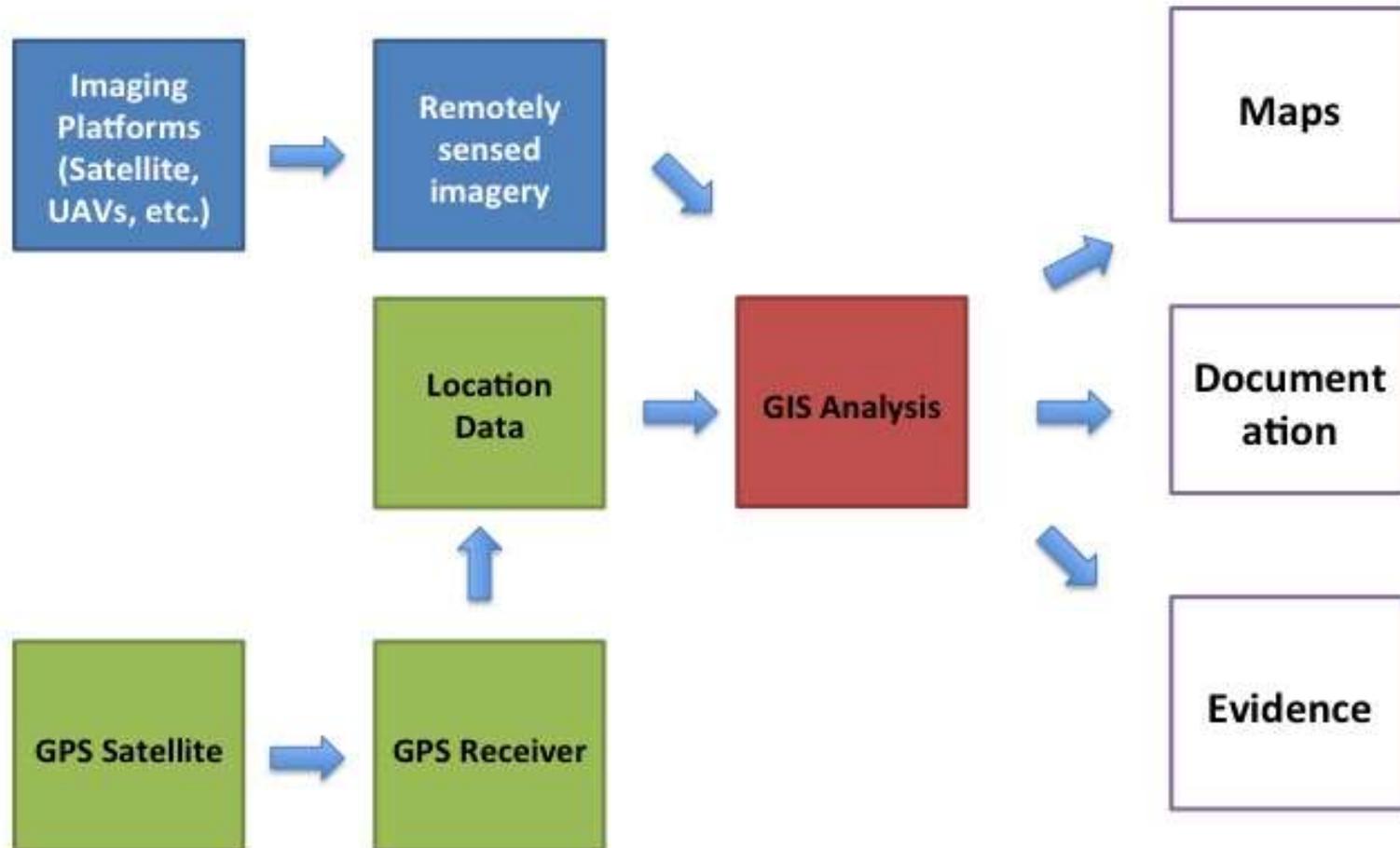


**WHAT ARE GEO SPATIAL
TECHNOLOGIES?**

What are Geo Spatial Technologies?

- The most common GTs are:
- **Remote sensing:** imagery and data collected from space- or airborne camera and sensor platforms (satellites, aerial, UAVs, terrestrial sensor). Some commercial satellite image providers now offer images showing details of one-meter or smaller.
- The **Geographic Positioning System (GPS):** a network of U.S. Department of Defense satellites which can give precise coordinate locations to civilian and military users with proper receiving equipment (note: a similar European system called Galileo will be operational within the next several years while a Russian system is functioning but restricted).
- The **Geographic Information System (GIS):** is a system designed to capture, analyse store, manage and present all types of spatial or geographical data. GIS use the space and time dimensions as the key index variable for all other information.

What are Geo Spatial Technologies?



HOW GEO-SPATIAL TECHNOLOGIES CAN HELP?

How Geo-Spatial Technologies can help?

Approaches to Agriculture using Geo Spatial Technologies

- Climate Smart Agriculture
- Precision Agriculture
- Conservation Agriculture

The objective is common to use the available information to guide agricultural production:

- To optimizing the use of inputs and resources including water, land, and other inputs – which helps to reduce cost of production
- To improve productivity through more precise use of inputs
- To minimize agricultural risk due to pests and diseases and climatic variances
- Hence overall improvement in farm incomes while minimizing risk

How Geo-Spatial Technologies can help?

Climate-Smart Agriculture (CSA) coined by FAO:

“Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals.”

How Geo-Spatial Technologies can help CSA ?

“If we enable rural farmers to innovate and use climate-smart practices, it’s not only hunger and poverty that will decline. Economic growth increases. Jobs are created. And climate change’s grip on our food supply will loosen.”

[Climate Change, Agriculture and Food Security \(CAAFS\), CGAIR](#)



Building Climate-Smart Farming Communities – ICRISAT's Climate Smart Village Approaches

Rehabilitating ecosystems and building
resilience



Watershed management
approach

Customizing adaptation packages to
reduce vulnerability



Futuristic multi-model
approach

Integrating climate
information and eco-
conservation technologies



Agricultural and digital
technologies approach

Cropping advisories

Using climate information
to build resilient agro-
ecosystems



Climate and crop modelling
approach



Meteorological advisory and
farm systems approach

How Geo-Spatial Technologies can help Precision Agriculture ?

Precision agriculture (PA) is an approach to farm management that uses information technology (IT) to ensure that the crops and soil receive exactly what they need for optimum health and productivity. The approach is also known as satellite agriculture, as-needed farming and site-specific crop management (SSCM)

- Precision farming techniques are employed to increase yield, reduce production costs, and minimize negative impacts to the environment (Zhang et al., 1999).
- Site-specific data (e.g. soil characteristics, fertility and nutrient data, topographic and drainage characteristics, yield data, harvester-mounted yield sensor data, and remotely-sensed vegetation indices) are collected from different sources and stored and managed in a spatial database

How Geo-Spatial Technologies can help Precision Agriculture ?

Precision Farming/Site-Specific Crop Management

- GIS-GPS-RS technologies are used in combination for precision farming/site-specific crop management.
- GIS analytical capabilities measures variable parameters that can affect agricultural production include
 - Yield variability & Crop variability (e.g., density, height, nutrient & water stress, chlorophyll content)
 - Physical parameters of the field & Soil chemical and physical properties
 - Anomalous factors (e.g., weed, insect, and disease infestation, wind damage)
 - Variations in management practices (e.g., tillage practices, crop seeding rate, fertilizer and pesticide application, irrigation patterns and frequency)

Geospatial Technology in Precision Farming

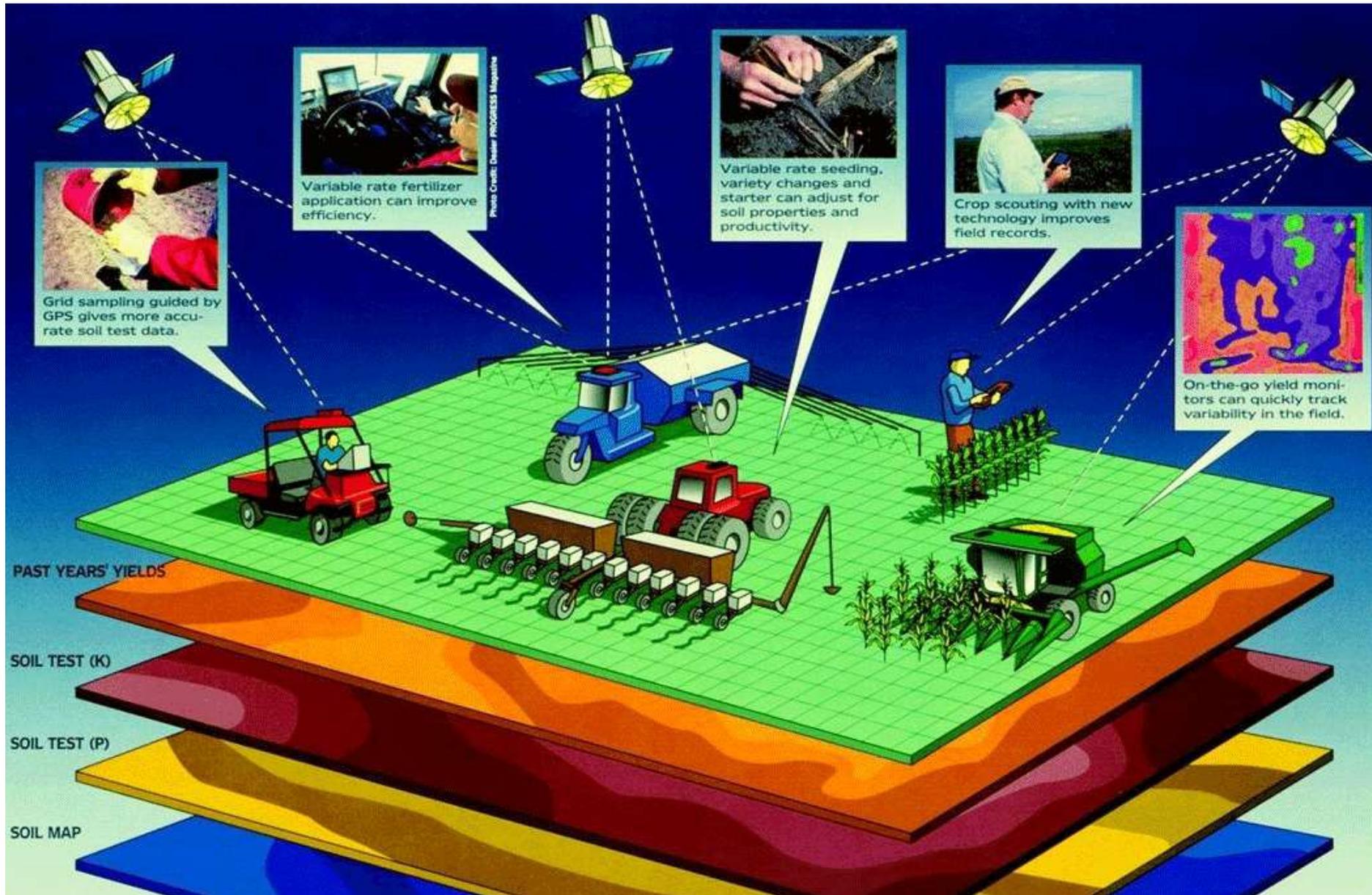


Photo Credit: Dealer PROGRESS Magazine

Novel Technologies for Climate-Smart Agriculture

Space-Technology derived applications developed at NASA

- **MicroRadiometer** for Climate-Smart Applications to reveal Climate Change in shallow waters close to land and in deep waters.
- **Sensors Enable Plants to Text Message to Farmers** to improve the nutrition, safety, and durability of food on Earth.
- **Photo-catalytic Solutions Create Self-Cleaning Surfaces** : A materials technology developed has future promising application, not only to keep surfaces clean, but potentially germ free.

Other Technologies

- Climate Smart Agriculture Mechanization Using Robotics- Driverless tractors, Portal crop scouting platform, weed mapping, weeding, micro spraying, irrigation, and selective harvesting etc
- Drones for Climate-Smart Agriculture



Range of Applications of GIS-GPS-RS in Agriculture



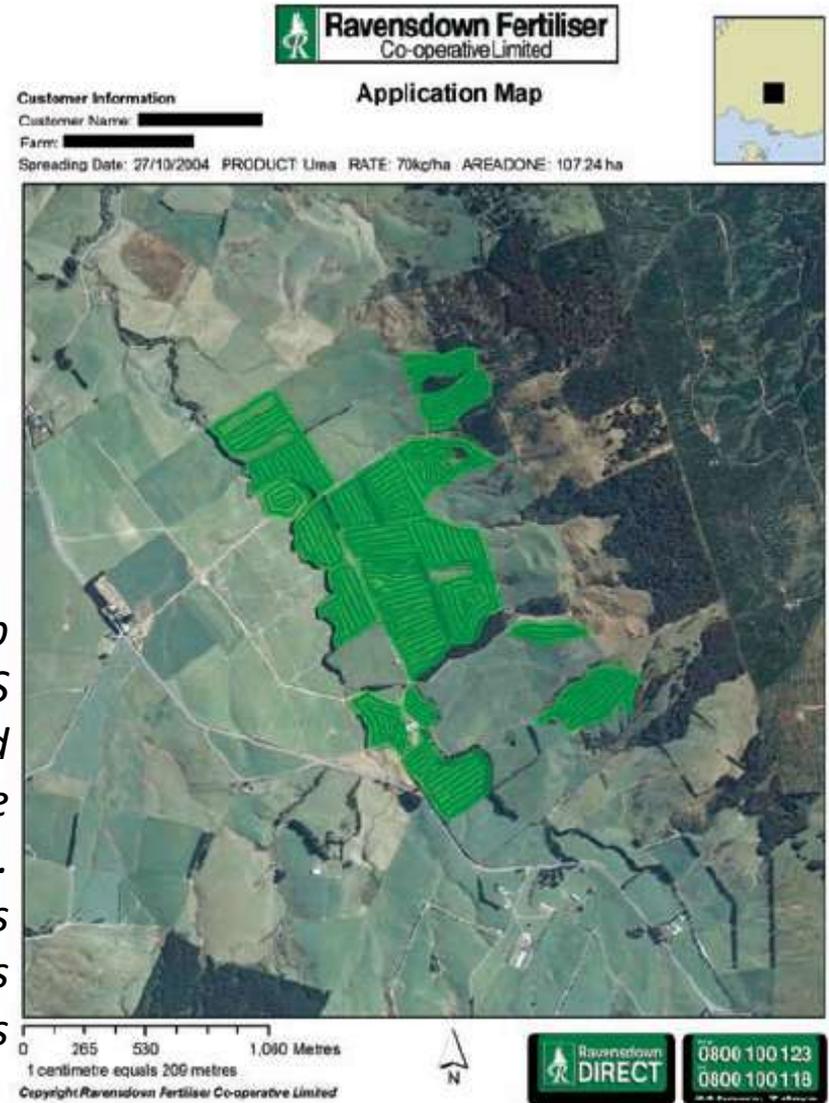
SOME CASE STUDIES

Improving Crop Yield

Case Study—Ravensdown, New Zealand

- Ravensdown, New Zealand's largest manufacturer and distributor of fertilizers, is using geospatial technology to improve the way New Zealand farmers manage their inputs.
- By using GIS and GPS to guide the application of fertilizers, farmers are decreasing the amount of wasted resources that can potentially cause harmful runoff into streams and waterways. At the same time, they are reducing their total fertilizer expenditure by up to 10 percent per year.

Ravensdown worked with Eagle Technology Group to design the solution that is built on ESRI's ArcGIS software. Once the data has been uploaded and processed, Ravensdown field staff can log on to the system from a remote location via the Internet. They can call up a customer's farm, view the results of earlier soil tests, see what types of fertilizers have been applied, then make recommendations about which type of fertilizers are appropriate.



GIS Helps Farmers See the Big Picture – A Case from Malawi



- Nearly 80 % of its people are smallholder farmers.
- Low production with farmers' limited capacity for taking on risk, coupled with limited access to sustainable technologies and financial services, further reinforces low agricultural productivity.
- Depletion of soil nutrients, loss of trees, and other environmental impacts on agriculture can exacerbate risks to future food production
- **Uses GIS to apply sustainable farming practices that can improve crop yields for smallholder farms in Malawi, Southeast African country.**
- **GIS Application & Approach: Landscape-level analysis for climate-smart agriculture to develop the intervention plan**
- Kusamala, a NGO employed GIS to bolster and evaluate the impact of CSA in the country.
- In 2013, implemented climate-smart practices to 1,500 households in the Dowa and Lilongwe districts of central Malawi, ultimately helping 7,500 individuals.

SITUATION OF INDIA IN USE OF GEOSPATIAL TECHNOLOGIES

Situation of India in Geo Spatial Technologies

India has demonstrated strengths in Geo-spatial technologies

- Experience of 47 years in use of remote sensing data for agriculture in collaboration with NASA-ISRO-MoA
- Strength in IT technology
- Strong Policies in place for supporting the sector
- Major National Level Programs
- **FASAL** (Forecasting Agricultural output using Space, Agrometeorology & Land based observations)
- **NADAMS** (National Agricultural Drought Assessment & Monitoring System)
- **CHAMAN** (Coordinated Horticulture Assessment and Management using geoinformatics)
- **KISAN** (C[K]rop Insurance using Space technology And geoinformatics)

Yet, there is a big gap in mainstreaming the technology

Mainstreaming Geo Spatial Technologies in India

Immense efforts will be required by all stakeholders to mainstream the use of these technologies in order to capitalize on the benefits:

- Government Agencies: policy support and resources to support the sector
- Private sector players can support effective business models
- Academia/Universities: special program for training in the sector – graduate/undergraduate programs,
- NGOs capacity building of farmers
- Donor agencies/CSR: supporting pilot initiatives
- Finance/Banking sector to support initiatives
- Industry bodies: bring together different players

Thank You