Field Visit to Indian Agricultural Institute (IARI), New Delhi

Introduction:

The following report outlines the details of a field visit to the Indian Agricultural Research Institute (IARI) in New Delhi.

Aim:

The primary aim of the field trip was to acquaint students with the latest advancements in remote sensing and GIS applications in the field of agriculture. The emphasis was particularly on the crucial role that Unmanned Aerial Vehicles (UAV) play, along with Multi-and-Hyper-spectral sensors.

Objective:

- Understand the process of data collection, field surveys, and data analysis using geospatial tools.
- Learn about precision farming techniques and the crucial role of geoinformatics in optimizing resource utilization, such as fertilizer and pesticide application.
- Explore the application of geoinformatics in crop management, including crop monitoring, yield prediction, and precision agriculture.

Visit Highlights:

The field trip took place on 1st November 2023 and involved 22 students from M.Sc Geoinformatics. They were accompanied by Faculty and Programme Coordinator, Dr. Ayushi Vijhani and Professor of Practice, Dr. B. K. Bhadra.

MSc Geoinformatics Batch (2022-2024)

Research and Training Facilities**:** The students were taken on a guided tour of the various research and training facilities at IARI, New Delhi. They visited the laboratories where scientists and researchers conduct experiments and analyze crop samples. The students gained insights into the cutting-edge technologies and techniques employed in the field of agriculture. The students visited the following laboratories:

- Hyperspectral Remote Sensing Laboratory
- Drone Remote Sensing and Big Data Analytics Lab.
- Nanaji Deshmukh Plant Phenomics Centre

HYPERSPECTRAL REMOTE SENSING LABORATORY

In the Hyperspectral Remote Sensing Laboratory, the primary focus is hyperspectral imaging, a technique that entails capturing images at numerous narrow and contiguous spectral bands across the electromagnetic spectrum. This lab is equipped with various sensors, spectrometers, and specialized software for data analysis. The hyperspectral lab serves a vital role in enabling effective crop health monitoring, soil analysis, and disease detection.

During the visit to the lab, the students were introduced to the functioning of a spectrometer and gained an understanding of the specific environmental conditions required for its operation within the laboratory. They received practical training on how to set up an active spectroradiometer and how to collect data from various materials and objects. Additionally, they were provided with hands-on experience in data acquisition and were guided on how to display and analyze the collected data. This practical exposure to hyperspectral imaging techniques equipped us with essential skills for future research and applications in the field of agriculture and remote sensing.

DRONE REMOTE SENSING AND BIG DATA ANALYTICS LAB

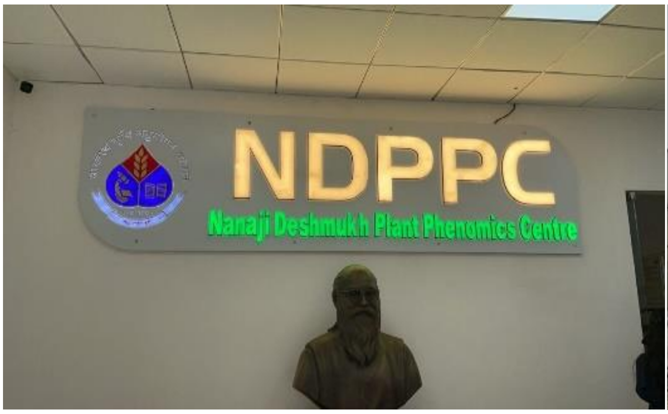
The Drone Remote Sensing and Big Data Analytics Lab at IARI, New Delhi is equipped with a fleet of multi-rotor drones designed for the precise collection of data using various sensors such as multispectral, hyperspectral, and LiDAR. The data acquired through these drones plays a pivotal role in several critical aspects of agriculture, including crop and irrigation management, soil analysis, pest and disease detection, yield estimation, and crop monitoring.

During the visit to the lab, they received a comprehensive briefing on the process of planning data collection missions using drones. They were also given a firsthand demonstration of how drones gather data in one of the institute's agricultural fields. This practical experience provided valuable insights into the intricacies of data collection using drones.

Furthermore, the visit served to familiarize the students with the specialized terminology and jargon associated with data collection in the context of drone remote sensing. They were also educated about the essential protocols and requirements that must be adhered to when conducting data collection operations with drones. This knowledge is crucial to ensure the accuracy and reliability of the data collected and its subsequent application in agricultural practices.

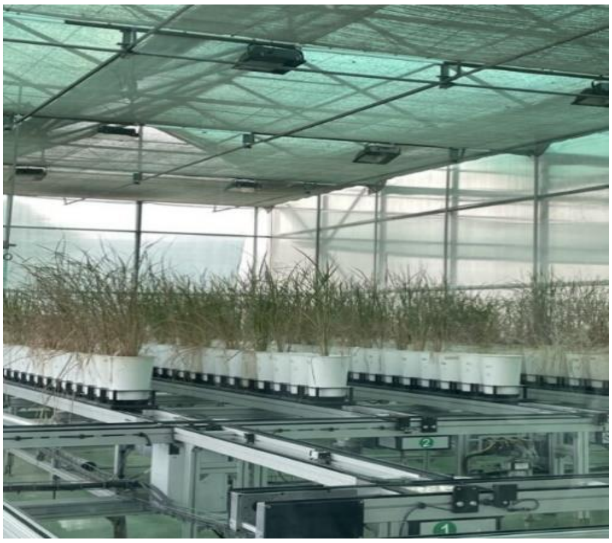
NANAJI DESHMUKH PLANT PHENOMICS CENTRE

The Nanaji Deshmukh Plant Phenomics Centre (NDPPC) at ICAR-Indian Agricultural Research Institute (IARI) is a state-of-the-art facility dedicated to using non-destructive high-throughput phenotyping techniques to study plant growth, development, and response to environmental stresses. The centre was established in 2017 with the aim of accelerating the development of climate-resilient and high-yielding crop varieties.



This facility automatically observes the plants through imaging sensors under controlled environmental condition. The facility has three segments i.e., four climate-controlled greenhouses, automated weighing, and watering mechanism and six imaging chambers. The six imaging chambers are (i) visual high resolution RGB imaging, (ii) IR thermal imaging, (iii) Chlorophyll fluorescence imaging, (iv) Near Infra-Red imaging, (v) VNIR hyperspectral imaging and (vi) SWIR hyperspectral imaging. The voluminous imaging data taken in imaging chambers are processed through automated image-processing pipeline to derive the various phenotypic traits. These phenotypic traits are analysed for associated gene through bioinformatics data mining with the aim to understand genotype x environment interactions in a better way.

Key Features of the Nanaji Deshmukh Plant Phenomics Centre:



Climate controlled greenhouses

The facility has four hi-tech climate-controlled greenhouses with capacity of total 1200 pots. These pots are placed on carrier of moving field conveyer system runs over belt which randomizes plants within the greenhouse based on unique Radio Frequency Identification (RFID) chip tag.

Automated weighing and watering stations

The automated weighing and watering stations measures and record the weight of pots before and after watering, in order to impose various drought/ waterlogging/ nutrient/ estimate water use.

IMAGING CHAMBERS

Visual high resolution RGB imaging chamber

The RGB camera used to take the photos in this chamber has a spatial resolution of 6576 × 4384 pixels and can be viewed from both the side and the nadir. Crop canopy reflectance is captured by an RGB camera in the visible (400–700 nm) spectrum. The stereoscopic image of the plant is created using the two angle photos, and it is from these that spatial information on factors related to plant growth and development—such as leaf area, growth rates, height, biomass, etc is extracted.

IR thermal imaging chamber

IR thermal sensor acquires the emissivity of plant object based on its body temperature from 8000 to 14000 nm. Information of emittance in thermal wavelength band is used to compute plant temperature by utilizing Stefan–Boltzmann law. Utilising thermal imaging, one can learn about the temperature of leaves and tissue as well as factors that affect plant temperature regulation, such as evapotranspiration, stomatal conductance, the plant's capacity to regulate its own temperature, and the effect of abiotic stress on plant temperature changes.

Chlorophyll fluorescence imaging chamber

During the process of light reaction chlorophyll absorb light at short-wave length and emit fluorescence at red/far-red wavelength (680 & 735 nm). Light reemitted by chlorophyll molecules during its return from excited to non-excited states is used as an indicator of photosynthetic energy conversion and defined as photosystem II efficiency or Chlorophyll fluorescence. Chlorophyll fluorescence imaging chamber is a dark chamber and plants are first dark adopted by placing in dark tunnel before imaging. Fluorescence sensor (CropReporter, PhenoVation Life Sciences) is a multispectral imaging camera sensitive to capture data from 400nm to 1700nm.

Near infrared (NIR) imaging

The reflectance of plants in the range of 900 to 1700 nm depends upon leaf structure and water content. Plants reflects large amount of incident radiation in 800 to 1400 nm wavelength region while soil reflectance is negligible. NIR shoot imaging system is used to measure water content and distribution in plants, leaf thickness and leaf area index, while NIR root imaging system is used to phenotype root soil moisture extraction pattern and root growth.

Hyperspectral imaging systems

Hyperspectral imaging chambers capture the reflectance images in the Visual-Near Infrared (VNIR) & Shortwave Infrared (SWIR) regions of plant canopy at 1 nm spatial resolution in the spectrum over 350 to 2500 nm. It provides the precise detection on absorption/reflectance bands over the VNIR and SWIR wavelength region. This precise information may be translated to accurately assess about plant chemistry and composition, pigment content, water stress status, nutrient content, early detection of plant stress etc. based on optical spectroscopy. Several hyperspectral indices are available to assess chlorophyll content, relative water content, nutrient status, chemical composition, plant health, photochemical reflectance index, genotype bar-coding.

The images captured through various imaging sensor can be processed to derive large number of digital phenotyping traits. Analysing these large digital traits have the potential to bridge the bottleneck in understanding the genetic basis of complex traits governing genotype and environment interactions. Thus, high-throughput phenotyping allows the rapid screening of genotypes based on the digital traits and improves the efficiency of conventional and molecular breeding programs.

Remarks:

The visit to IARI proved to be extremely beneficial for the students as they explored the state-of-the-art facilities at IARI, including the laboratories equipped with cutting-edge technology used in agricultural research. They were able to witness firsthand how remote sensing and GIS technologies are employed to study various aspects of agriculture, including crop monitoring, land cover classification, and precision farming.

Prepared by:
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