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# INTRODUCTION TO THE COURSE

# QUANTITATIVE REMOTE SENSING OF VEGETATION- VEGETATION PARAMETERS

TMT Bangladesh

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# SUGGESTED READINGS…

- Biophysical and biochemical sources of variability in canopy reflectance, Asner, GP, 1998. Remote Sensing of Environment, volume: 64 Issue: 3 Pages: 234-253
- Impact of Vertical Canopy Position on Leaf Spectral Properties and Traits across Multiple Species. Gara, T. W., Darvishzadeh, R., Skidmore, A. K. & Wang, T., 23 Feb 2018, In : Remote sensing. 10, 2, p. 1-17 17 p., 346.
- Mapping Grassland Leaf Area Index With Airborne Hyperspectral Imagery : A Comparison Study of Statistical Approaches and Inversion of Radiative Transfer Models, Darvishzadeh et al. (2011), ISPRS Journal of Photogrammetry and Remote Sensing.
- Biophysical and Biochemical Characterization and Plant Species Studies, (2018) , Chapter 2, Hyperspectral Assessment of Ecophysiological Functioning for Diagnostics of Crops and Vegetation

# THE COURSE OVERVIEW

- In this course we will focus on the retrieval of quantitative information from vegetation. In particular, the focus will be on vegetation traits, namely leaf area index and phenology and how they can be estimated using remote sensing.

- Definitions and details about these parameters, how they are measured in the field, and how they are estimated using remote sensing data will be provided during the course.

# BIOPHYSICAL & BIOCHEMICAL PARAMETERS

- Vegetation biophysical & biochemical variables
- Plant traits
- Biophysical parameters, biophysical characteristics, structural parameters
- Plant's nutrients, biochemical variables, biochemical content, leaf biochemistry, foliar Biochemistry;
- Essential variables (minimum set of fundamental variables required to characterize state and change in a system) (EBV, EAV, ECV, EWV)
- Plant morphology (structure of plants), plant ecology (interactions with the environment), phytochemistry (biochemistry of plants)

# BIOPHYSICAL AND BIOCHEMICAL PARAMETERS

- The way plants respond to changing environmental conditions is often reflected by immediate/ slow change in their biophysical and biochemical properties
- Accurate quantitative estimations of vegetation biophysical and biochemical characteristics is necessary for a large variety of agricultural and ecological applications
- Many of these traits are inputs to agricultural, ecological, and meteorological models and recognized as essential variables

# BIOPHYSICAL & BIOCHEMICAL PARAMETERS

- They are referred as indicators of health/growth and stress, change for the management practice, and when to apply fertilizers, water, and growth regulators or pesticides

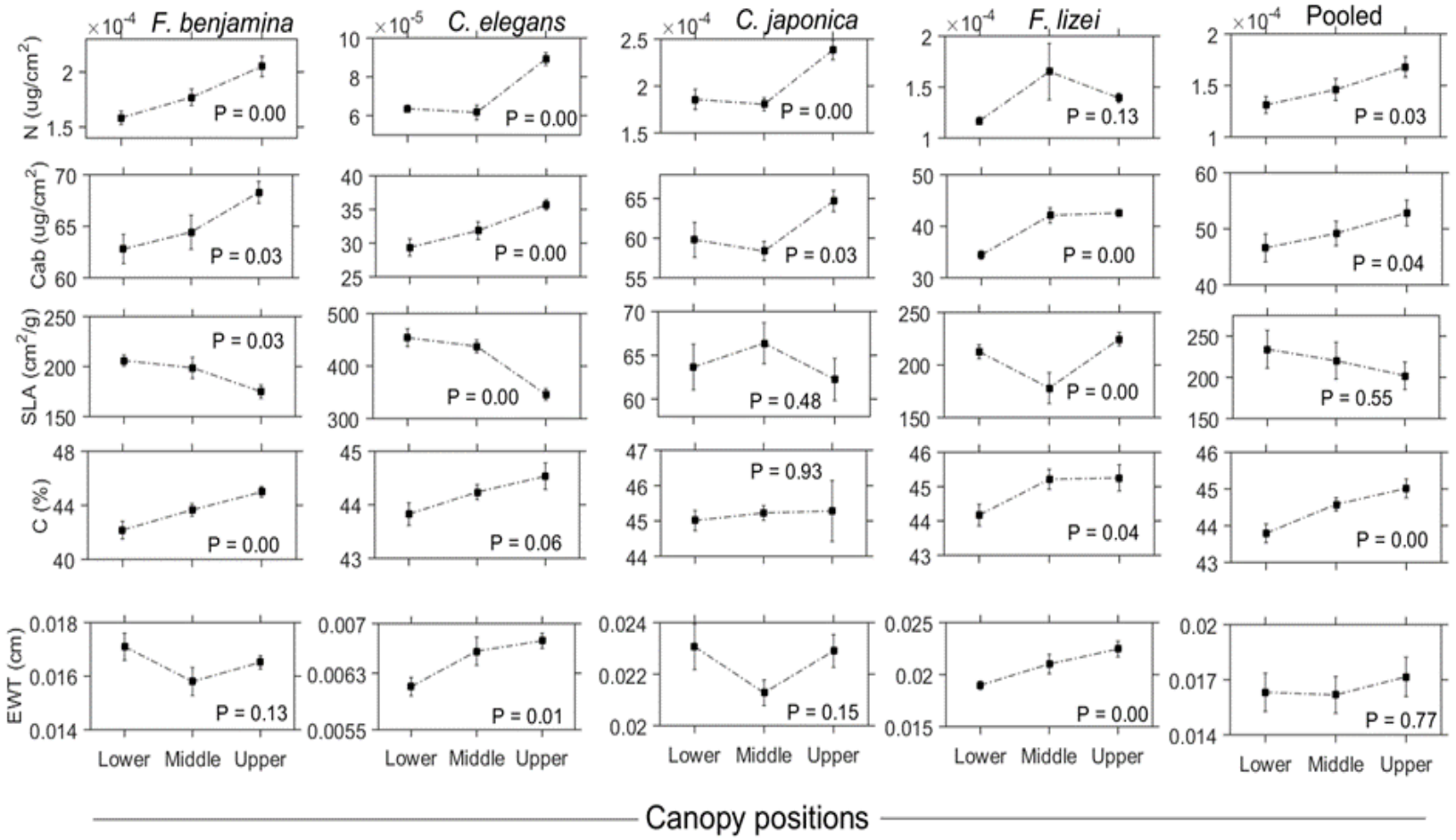
- Understanding how the traits vary between species, functional types and the vegetation of different biomes is vital for modelling how nutrient fluxes and vegetation boundaries will shift with land-use and climate change.

- They can then be used to find evolution and compare similar vegetation covers at two different locations in time with no bias.
- Traits as tools to quantify ecosystem delivery

# ON WHAT SCALE

- Individual plants
- Stands/fields (e.g. structure, age class, condition)
- Patches (areas of equal ecological quality/area of equal varieties)
- Landscape (a sum of patches or stands/ fields/farms)
- Globally

# VARIATION IN LEAF TRAITS ACROSS CANOPY PROFILE (EXAMPLES OF INDIVIDUAL PLANTS)

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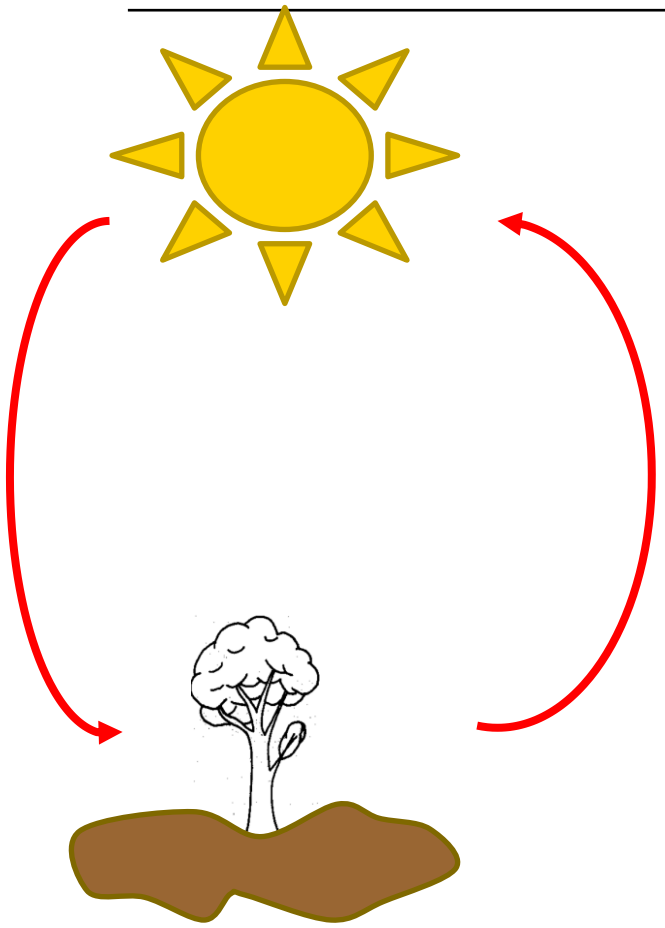
Impact of Vertical Canopy Position on Leaf Spectral Properties and Traits across Multiple Species, (2018). Gara, T. W., Darvishzadeh, R., Skidmore, A. K. & Wang, T., 23 Feb 2018, In : Remote sensing. 10, 2, p. 1-17 17 p., 346.

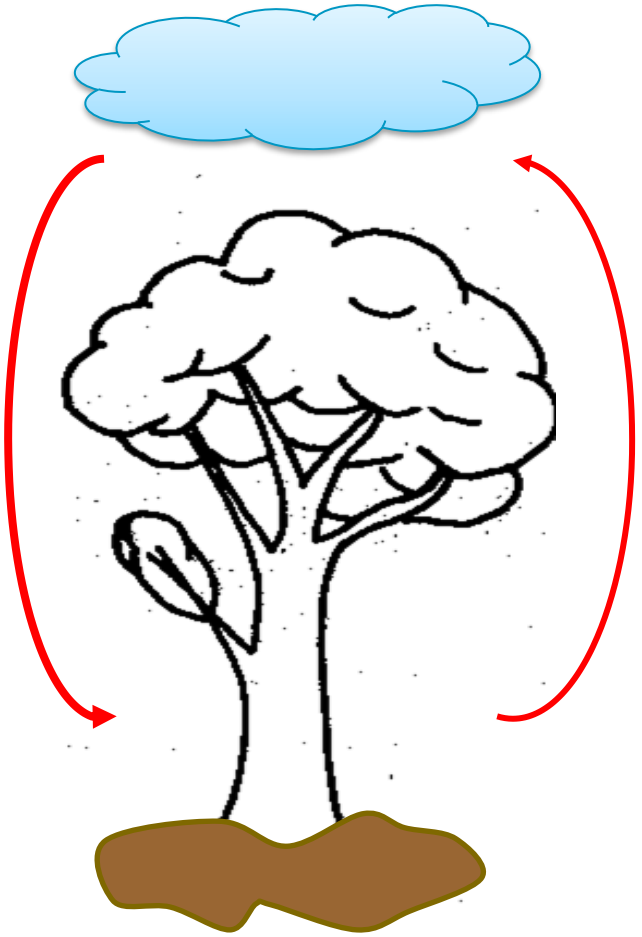
# RESPONSE AND EFFECT TRAIT



Short plant (species A)

Stem (DBH)
Height
Cover
LAI
LAD
Crown width

Photosynthesis activity (Chl, N, P, C)



Tall plant (species B)

# BIOPHYSICAL VARIABLES

- Leaf area index (LAI)
- Leaf area
- Canopy height
- Cover percentage
- Stem density
- Stem diameter
- Crown width
- Inclination angle (leaves/stems)

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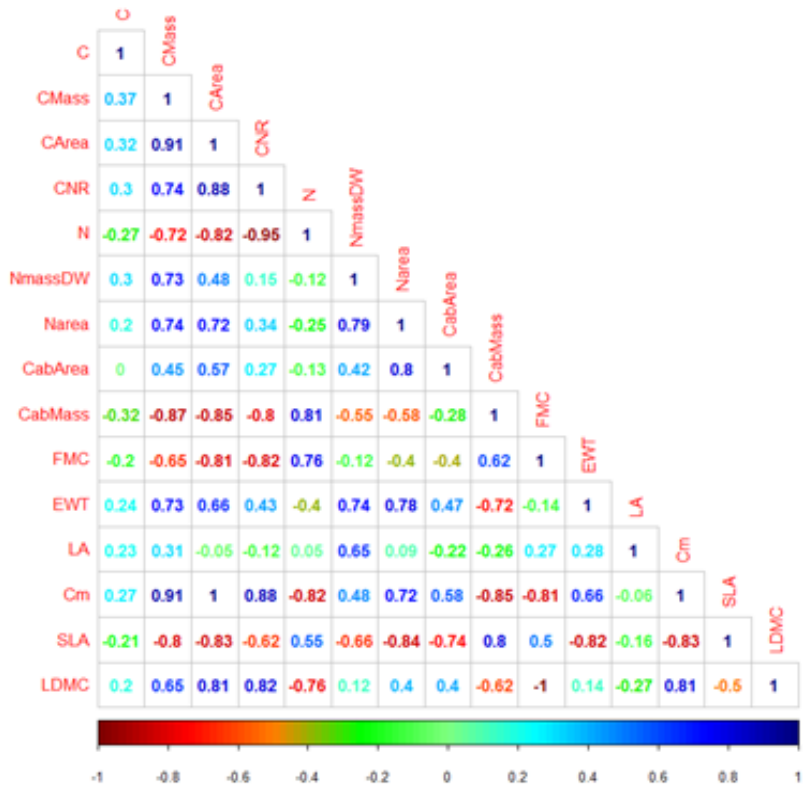
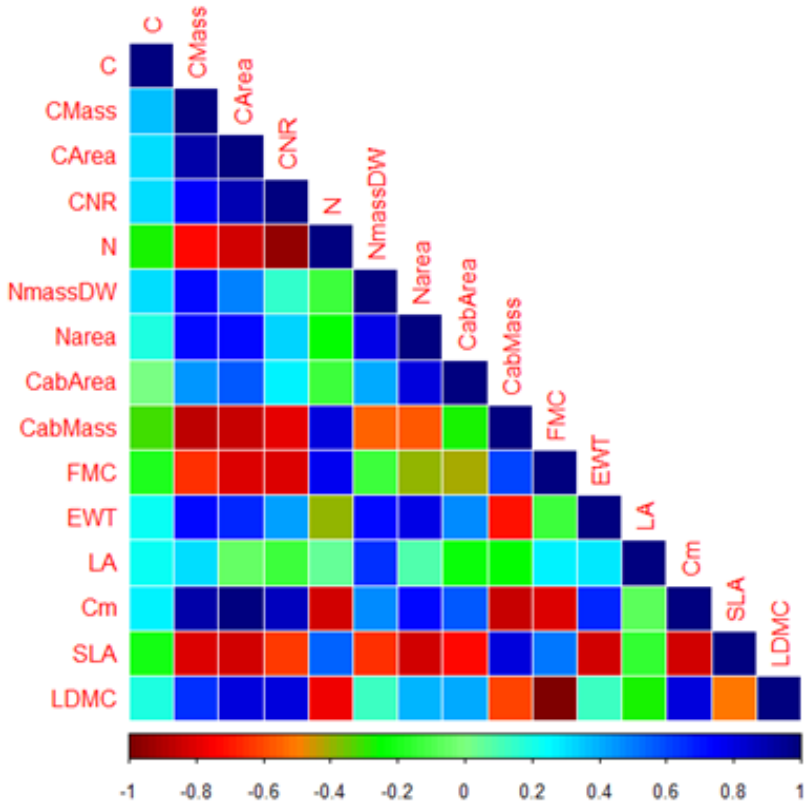
# BIOCHEMICAL: NUTRIENTS & PRODUCTIVITY

- Productivity is the rate of production of organic material by biological processes, such as photosynthesis.

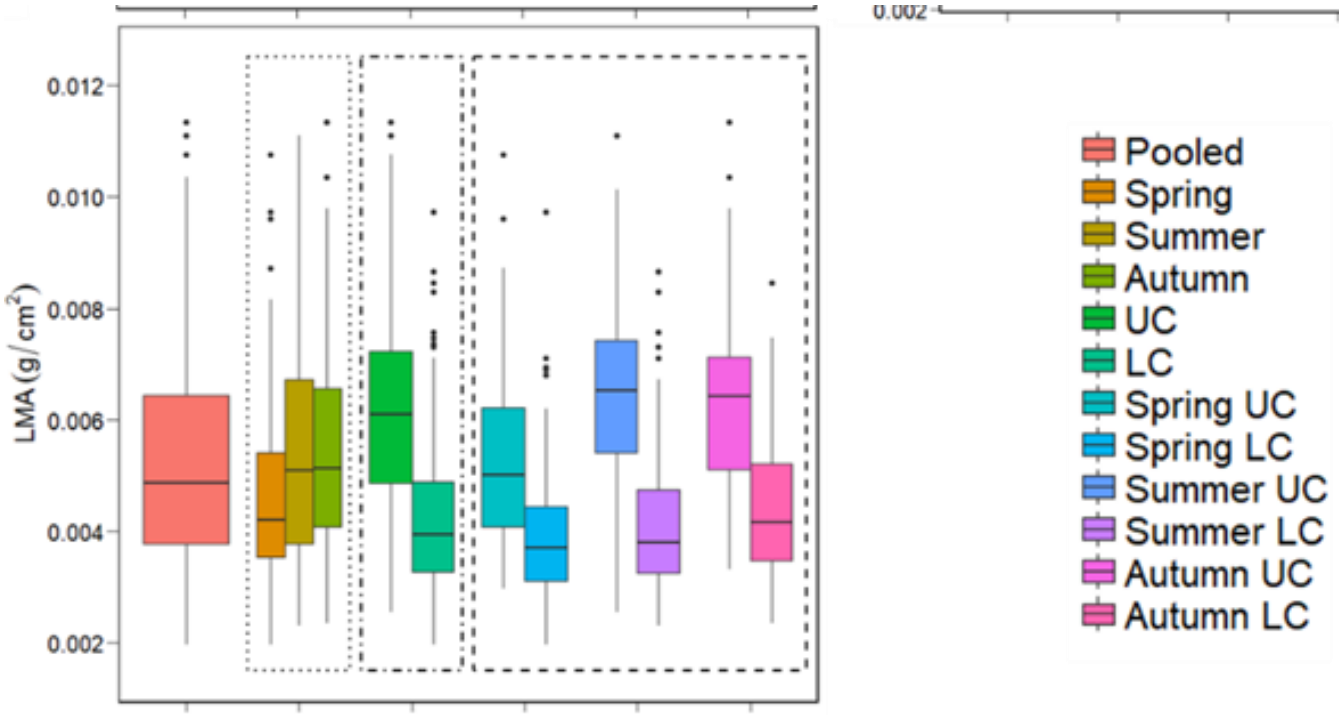
- Nutrient elements, light and temperature effect: quantity and quality in vegetative covers.
- Literature has shown that a series of interrelated plant traits that are known to affect radiation scattering (ranging from cells to canopies) are functionally associated with the nitrogen nutrition of plants (Chl, SLA, WC, LMA)
- The interrelation of these traits are highly dependent of species, phenological stage, canopy position,….

# CORRELATION BETWEEN LEAF TRAITS ACROSS SPECIES



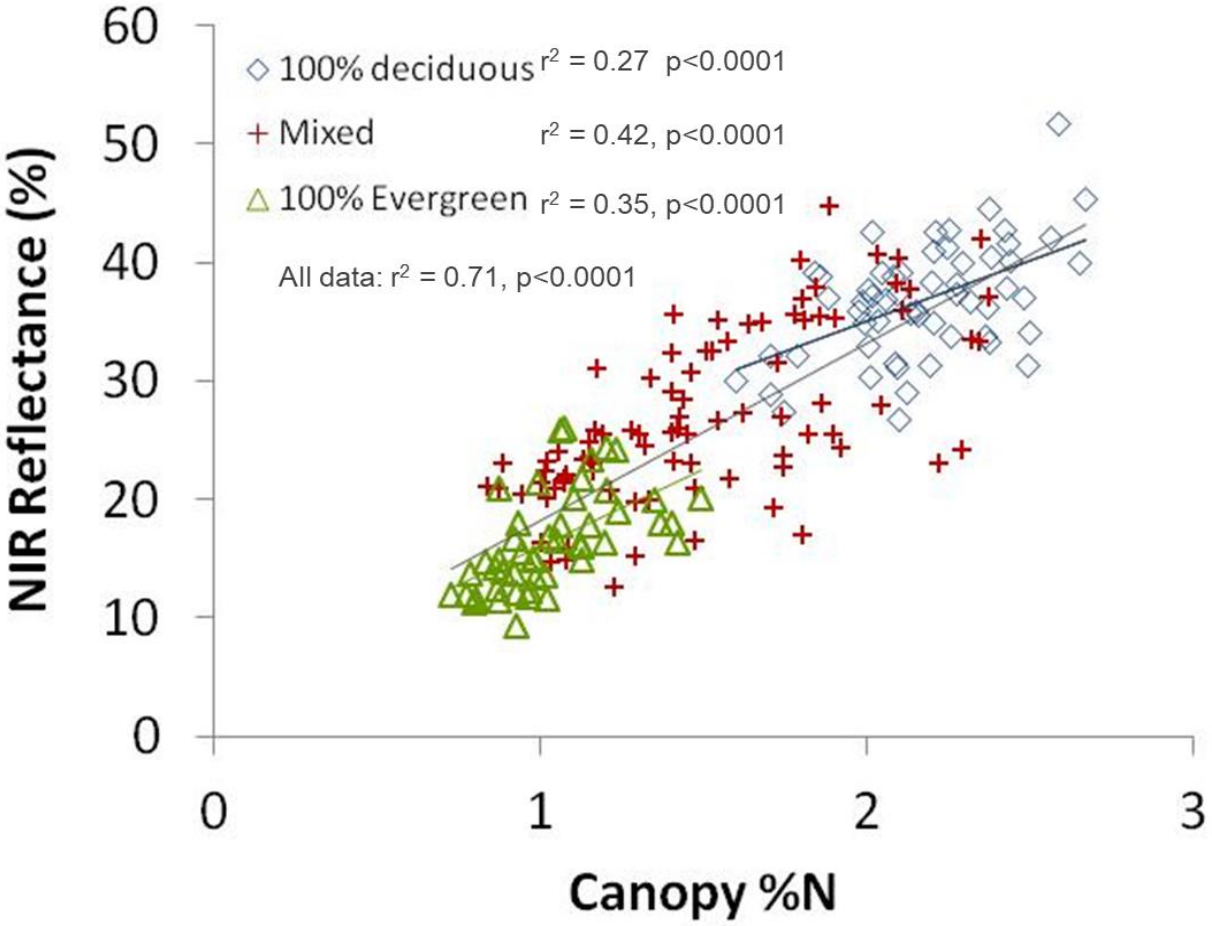
# VARIATION OF PLANT TRAITS ACROSS GROWING SEASON




## LMA across canopy throughout the growing season

Evaluating the performance of PROSPECT in the retrieval of leaf traits across canopy throughout the growing season
Gara, T. W., Darvishzadeh, R., Skidmore, A. K., Wang, T. & Heurich, M., 5 Jul 2019, In : International Journal of Applied Earth Observation and Geoinformation. 83, p. 1-15 15 p.

# %N-NIR RELATIONSHIP WITHIN DECIDUOUS, EVERGREEN, AND MIXED STANDS

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Lepine, L.C., Ollinger, S.V., Martin, M.E. (2013). **Remote Sensing of Canopy %N across Broad Spatial Scales Using Data from Multiple Platforms,** Earth Systems Research Center, University of New Hampshire, Durham, NH 03824, USA accessed on 28-8-2019 from https://cce.nasa.gov/cce/index.htm

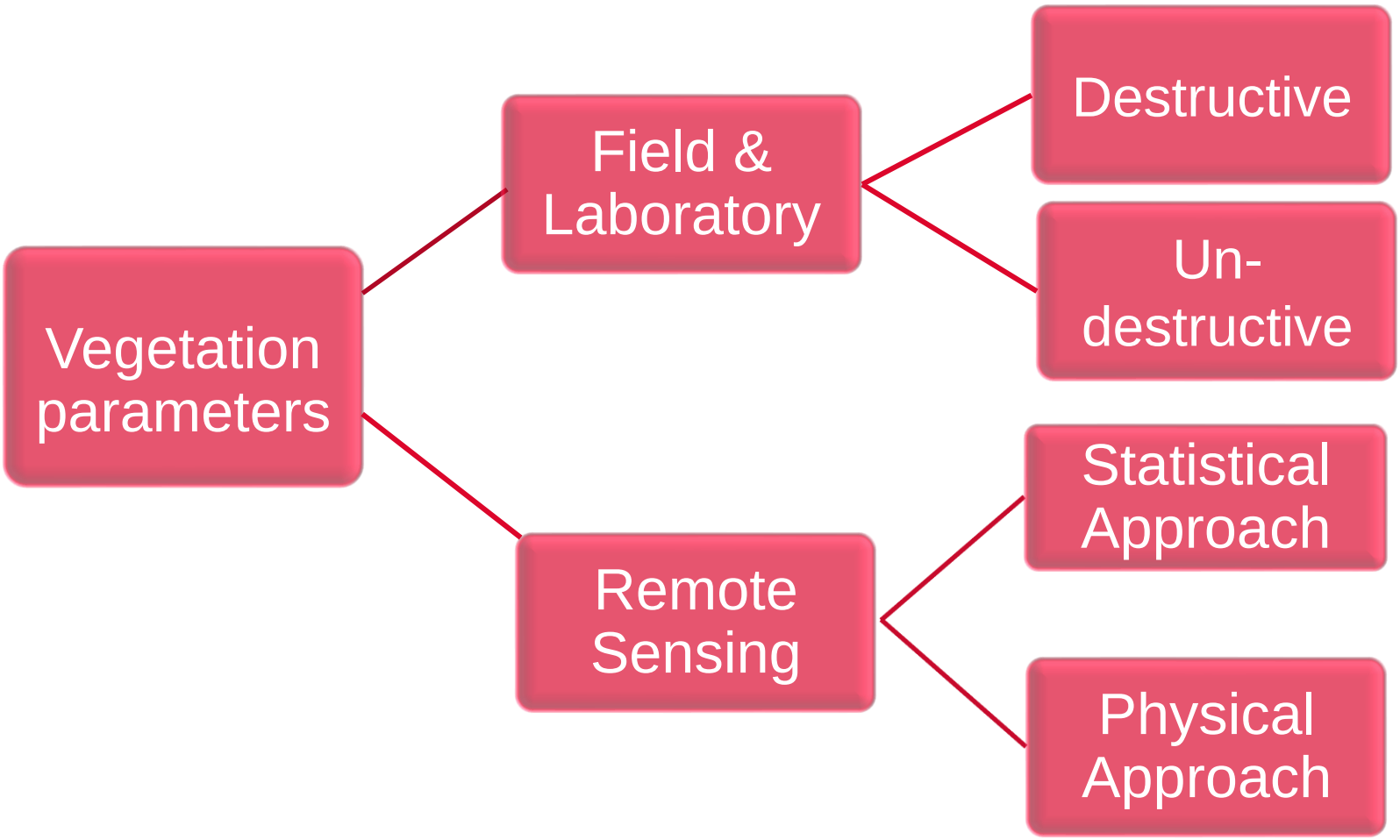
# MEASUREMENTS & ESTIMATIONS

- Field /laboratory based
  - Accurate/ time consuming
  - Field instruments

Field measurements (in situ)

- Remote sensing approaches (Un-destructive)

# RETRIEVAL OF VEGETATION TRAITS



# REMOTE SENSING ESTIMATIONS

- Remote sensing has been recognized as a reliable method and the practical means of estimating these traits in a large scale.

- Utilizing remote sensing, implies that the knowledge of vegetation type, species, growth, health and productivity is obtained from their spectral signatures.

- Neglecting exterior factors such as soil background and atmosphere, plant traits are the main features affecting the spectral signature of vegetation.

- Understanding the link between these traits and plant's spectral signature, as well as how they interact and how the combined interaction will affect the spectral signature is crucial.