Advances in Phenotyping

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GK12 INSIGHT

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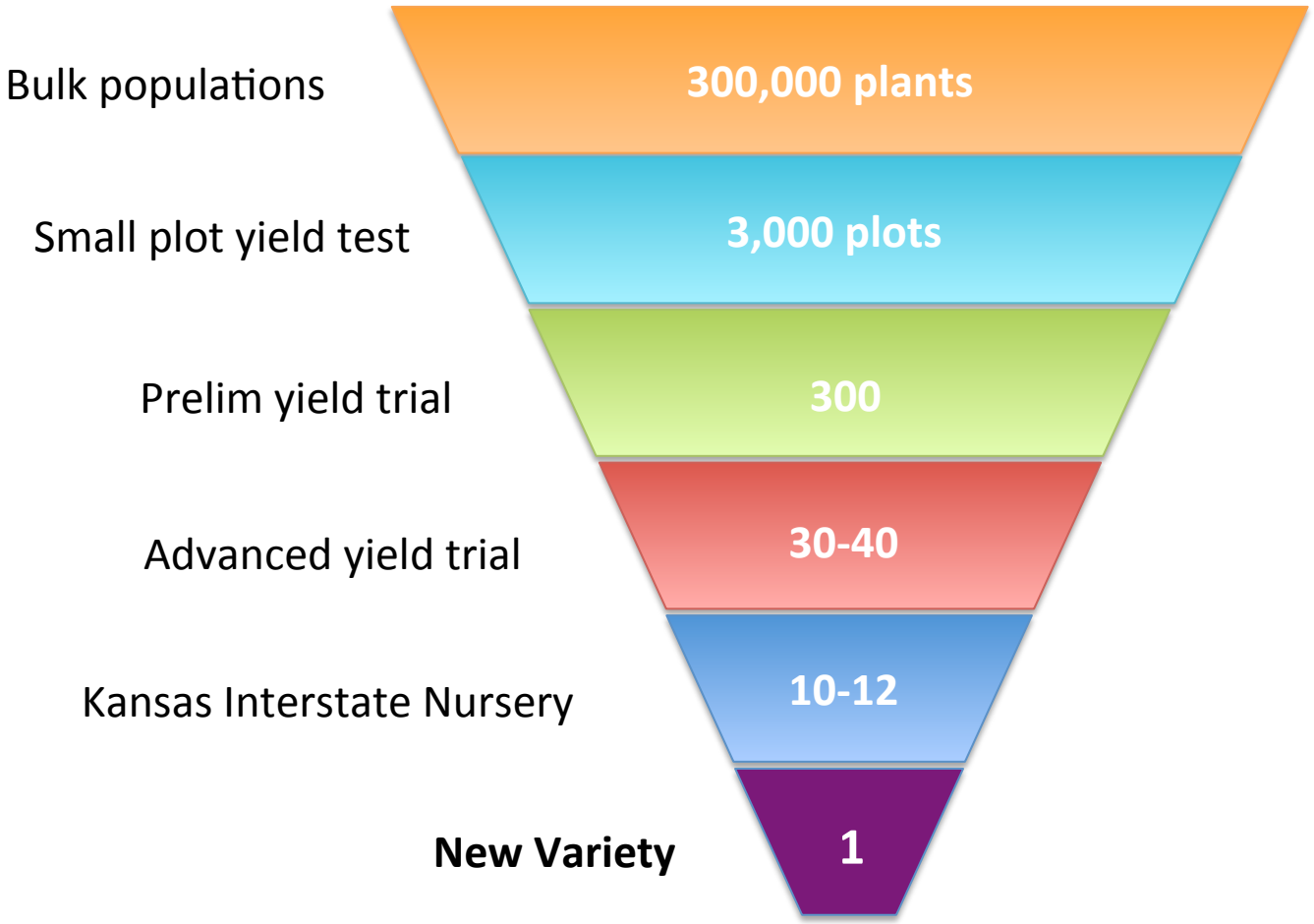
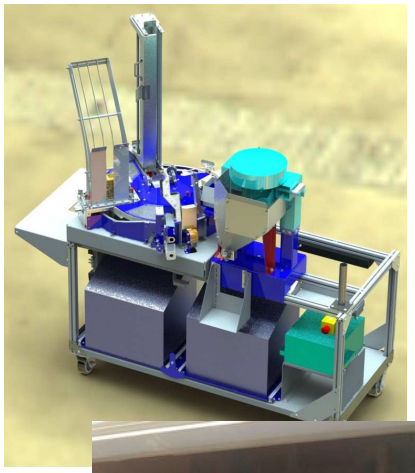
Plant Breeding – It's a numbers game



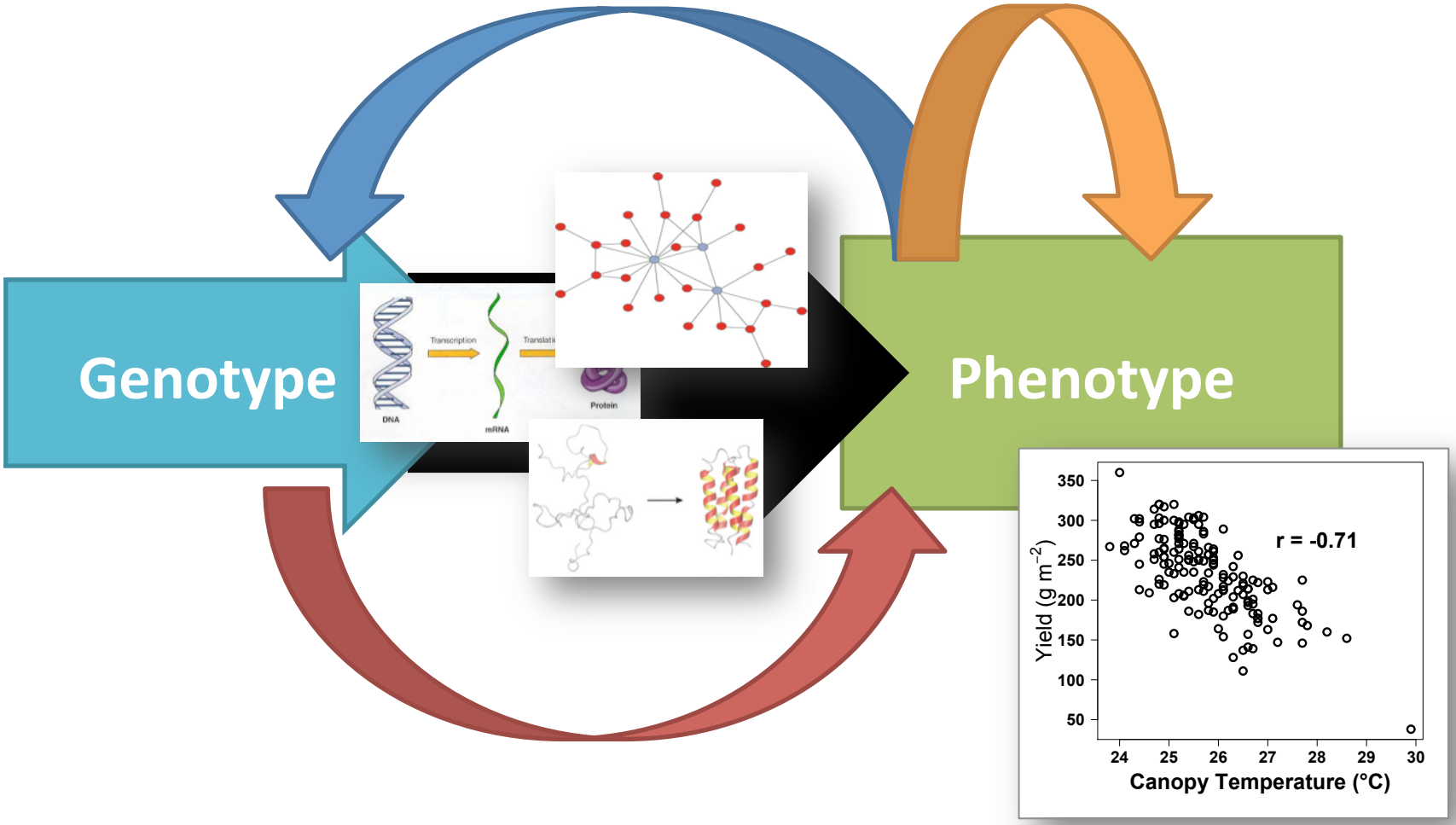
Increasing selection intensity = more to chose from



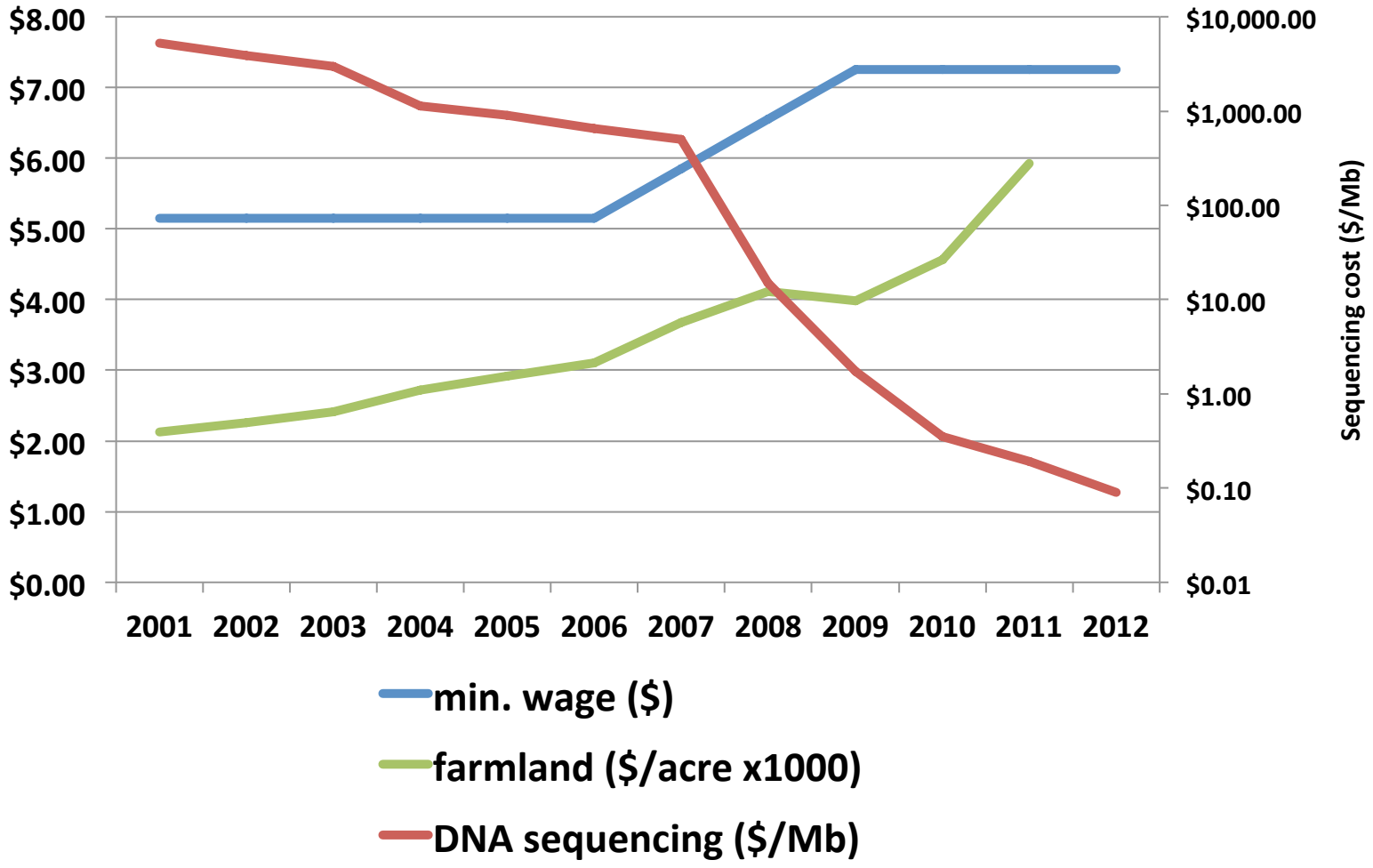
The need for phenotypes:

1. more efficient selection (breeding)
2. understanding the parts (genetics)

G2P: connecting genotype to phenotype



Trending: Phenotyping vs Genotyping

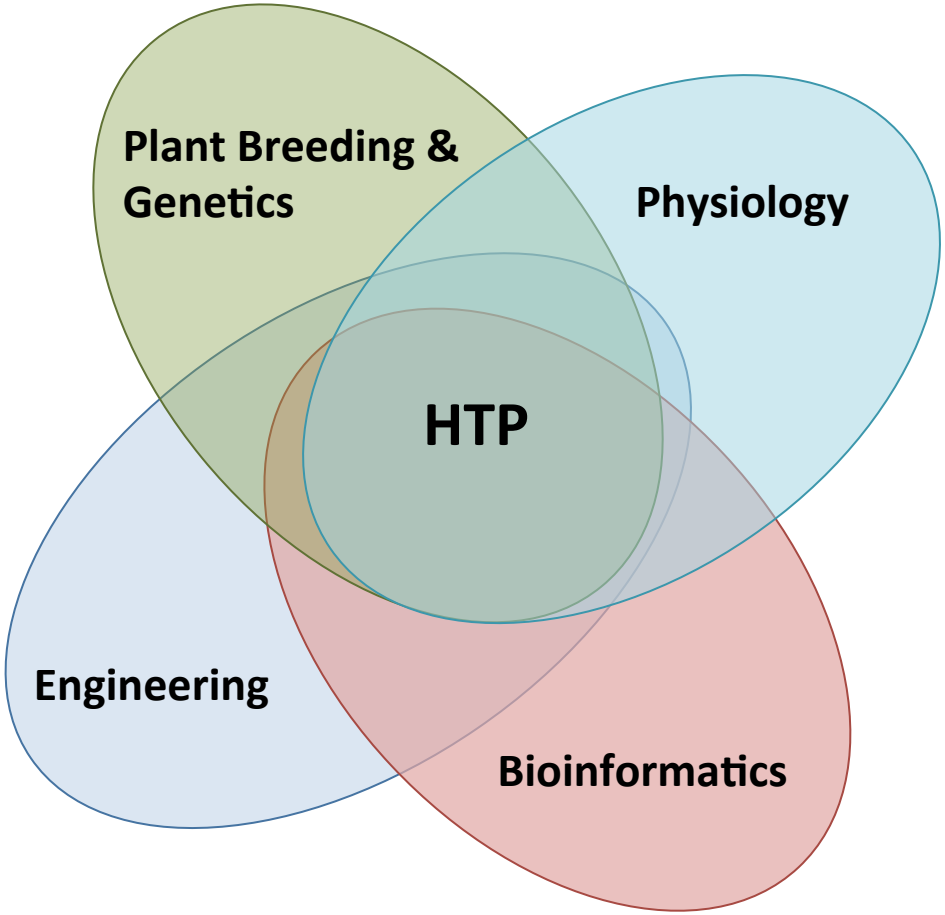


Field-based high throughput phenotyping

Defining "field-based high throughput"

- ✓ Fully- (or mostly) automated data collection
- ✓ <1 second per plot (3h for 10,000 plots)
- ✓ Data analysis must be "pipelined"
- ✓ High-resolution ≠ high-throughput
- ✓ Field conditions targeting production systems
- ✓ Automated data processing

A multi-disciplinary approach



Phenotyping vehicle

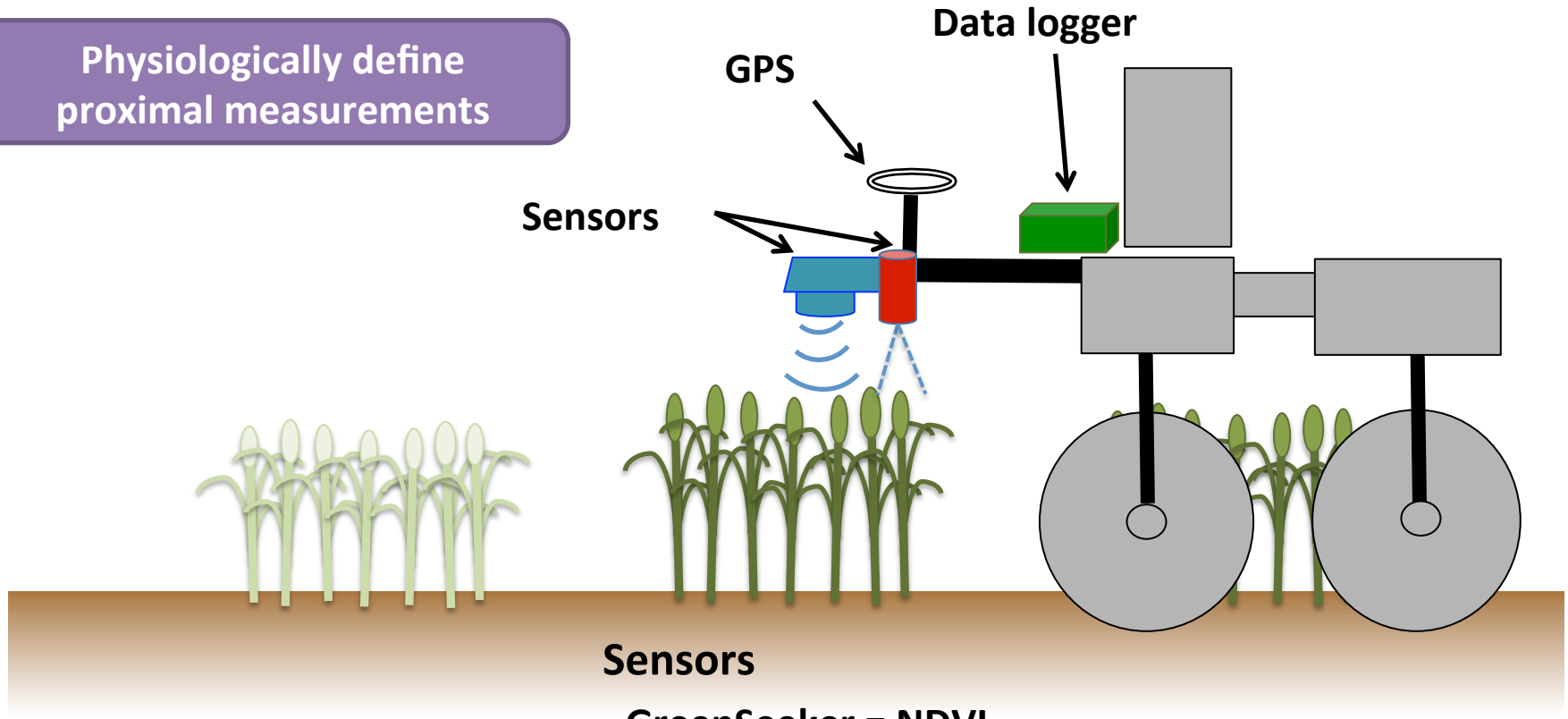
+ Carry lots of equipment
+ flexible deployment
+ easy to operate

- Can not assay whole field simultaneously
- Not completely automated

Precision Ag meets Plant Genetics

“Geo-referenced proximal sensing”

Physiologically define proximal measurements

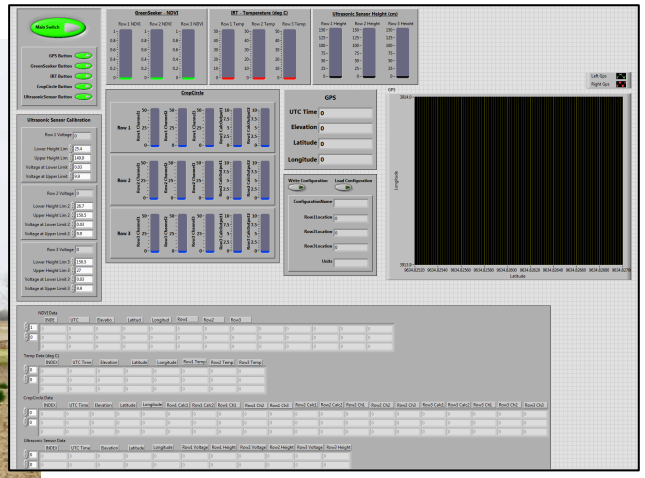


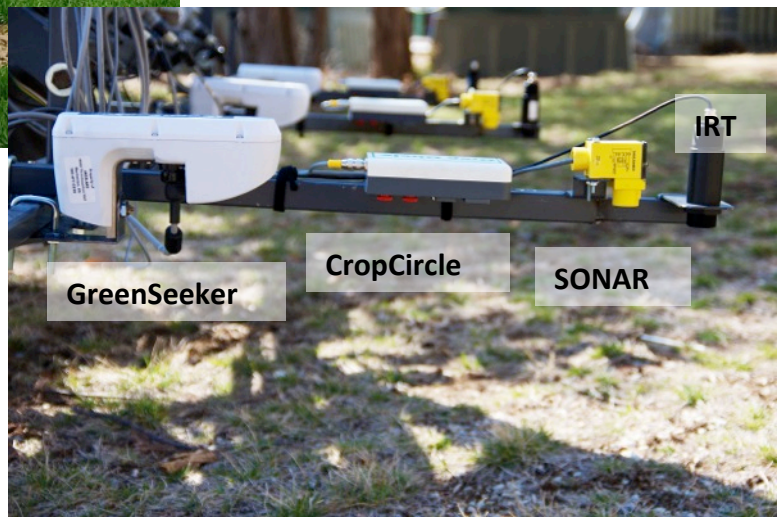
RTK-GPS
(cm level accuracy)

Sensors

- **GreenSeeker = NDVI**
- **IRT = canopy temperature**
- **SONAR = plant height**

HTP: Platform configuration

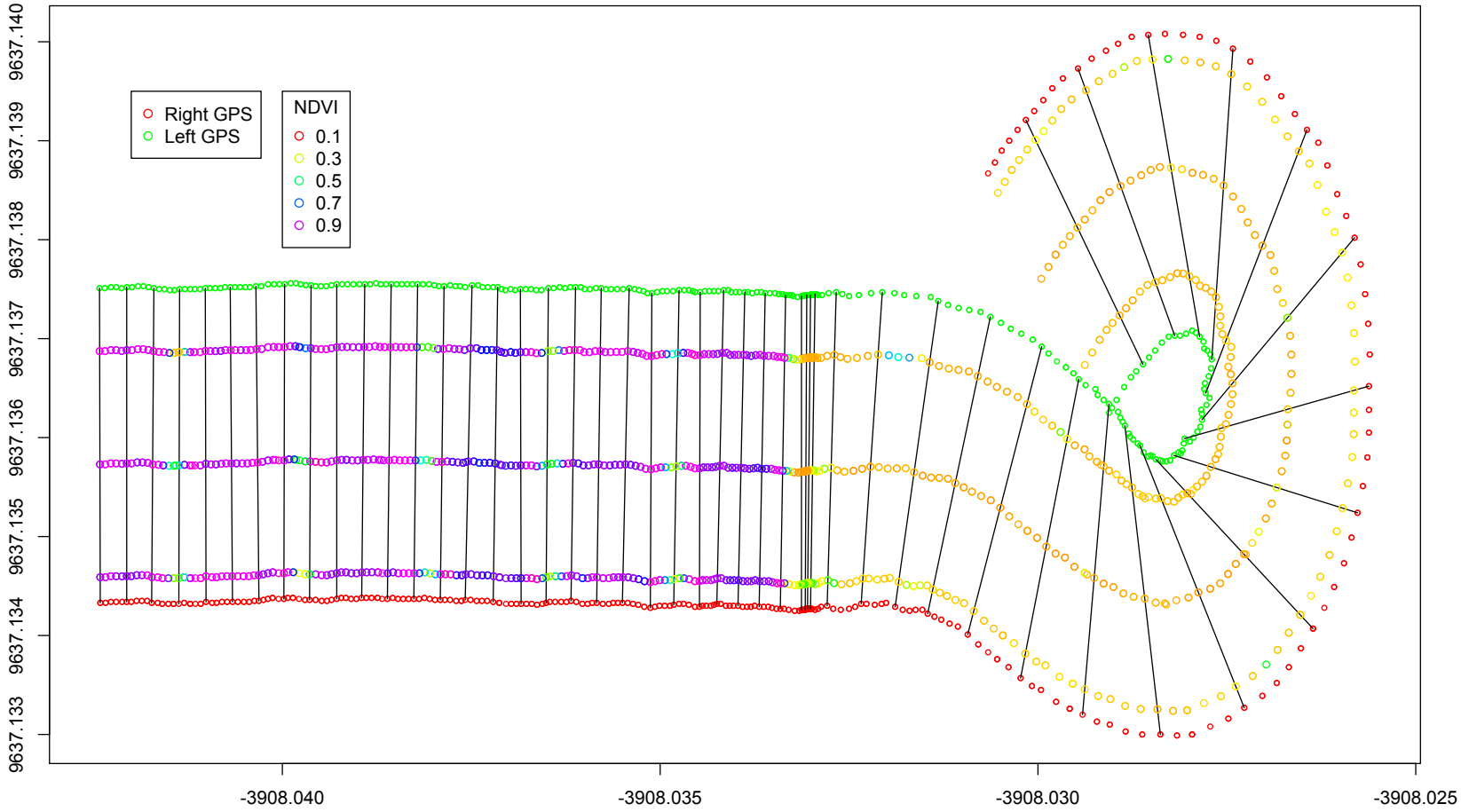




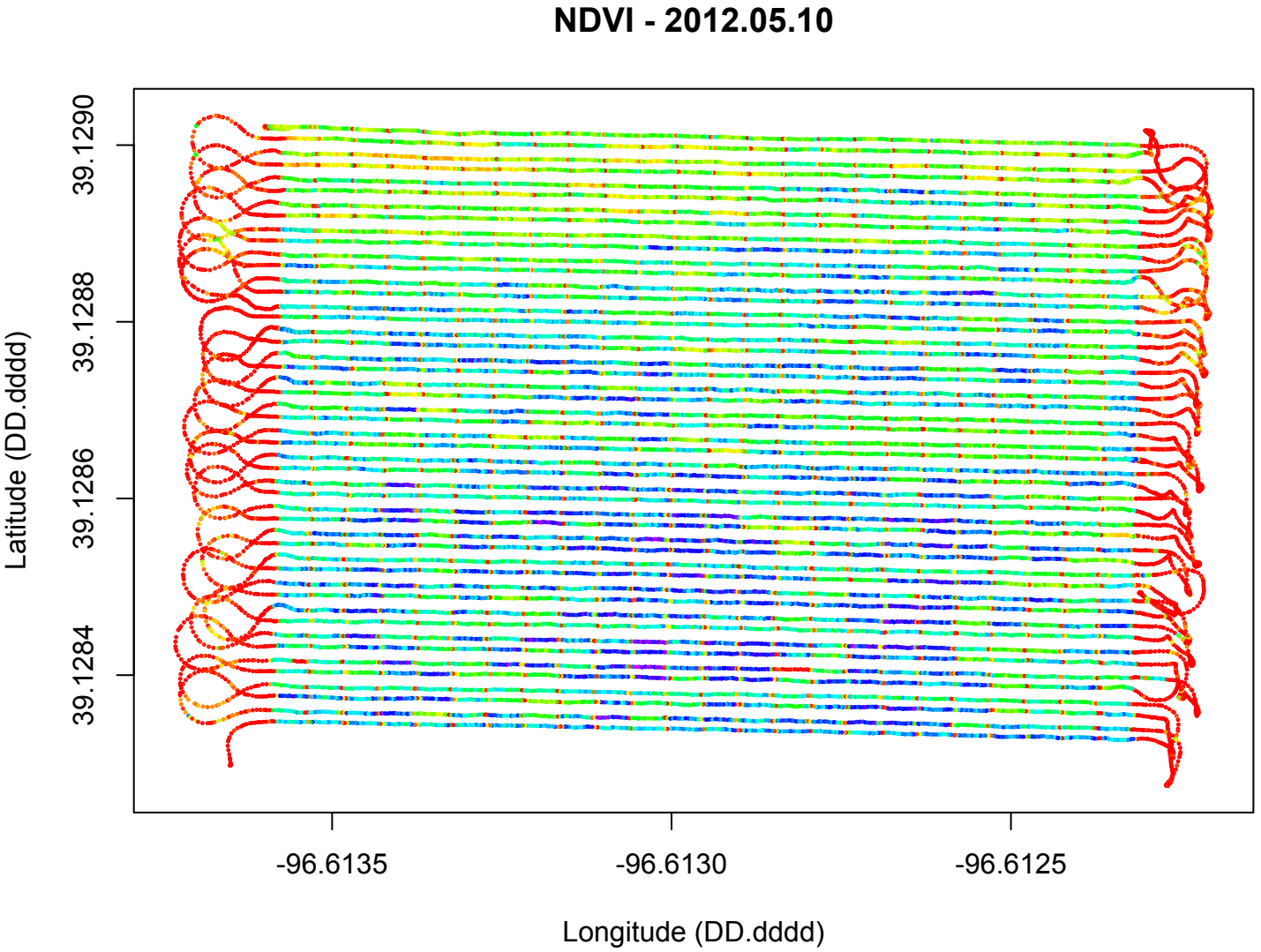
LabView program

- ✓ **10 Hz sampling**
- ✓ **Real-time feedback**
- ✓ **Flat file output**

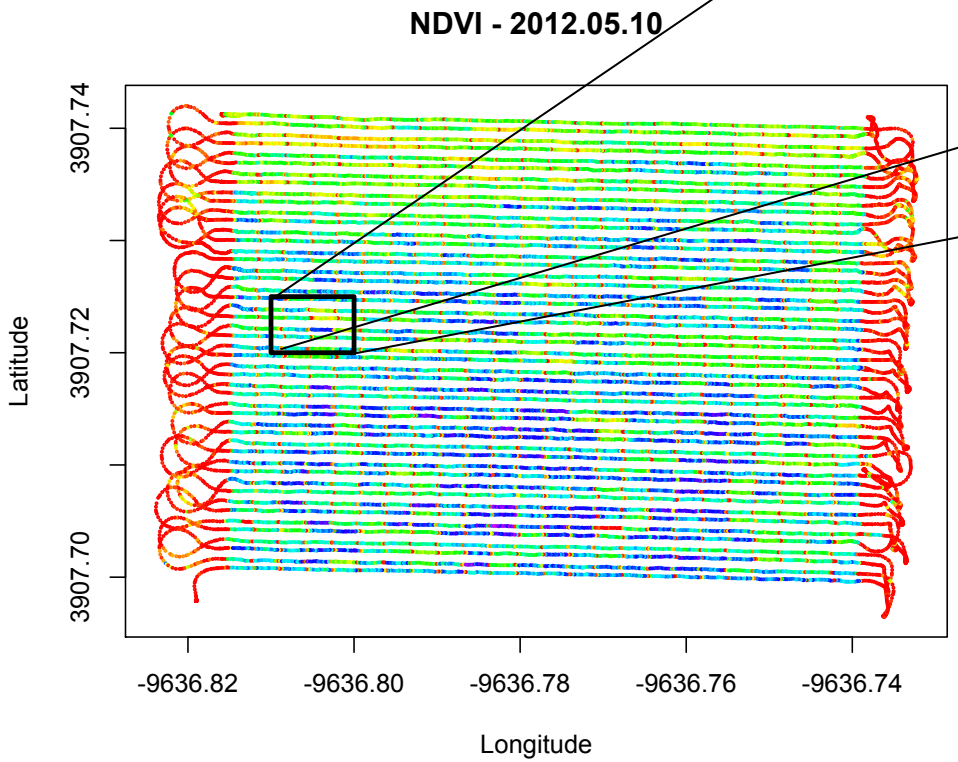
HTP: Multiple sensor orientation

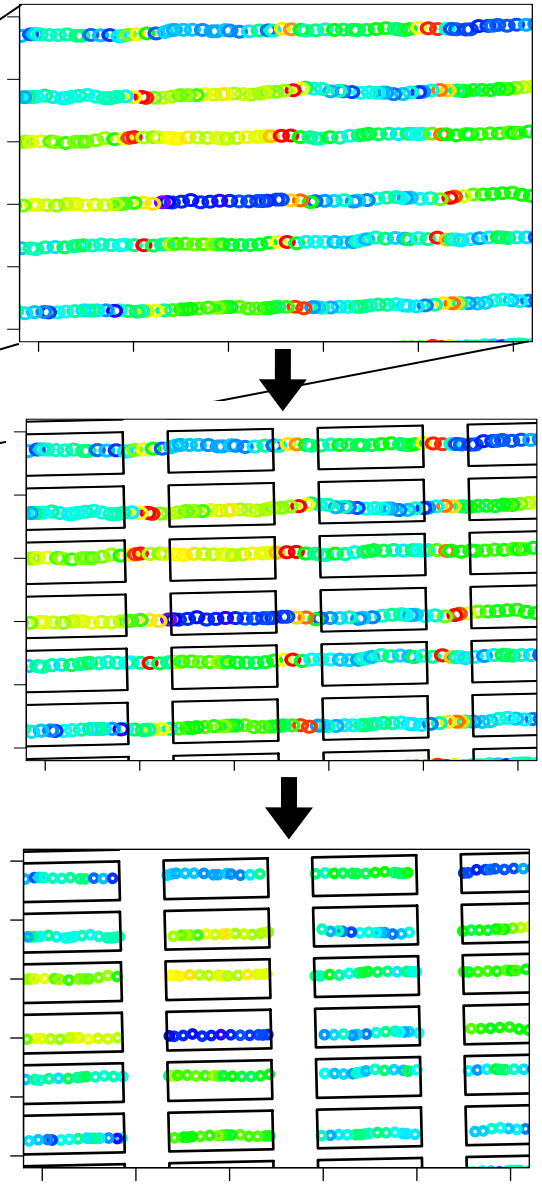


NDVI – raw data



Assigning data to field entries



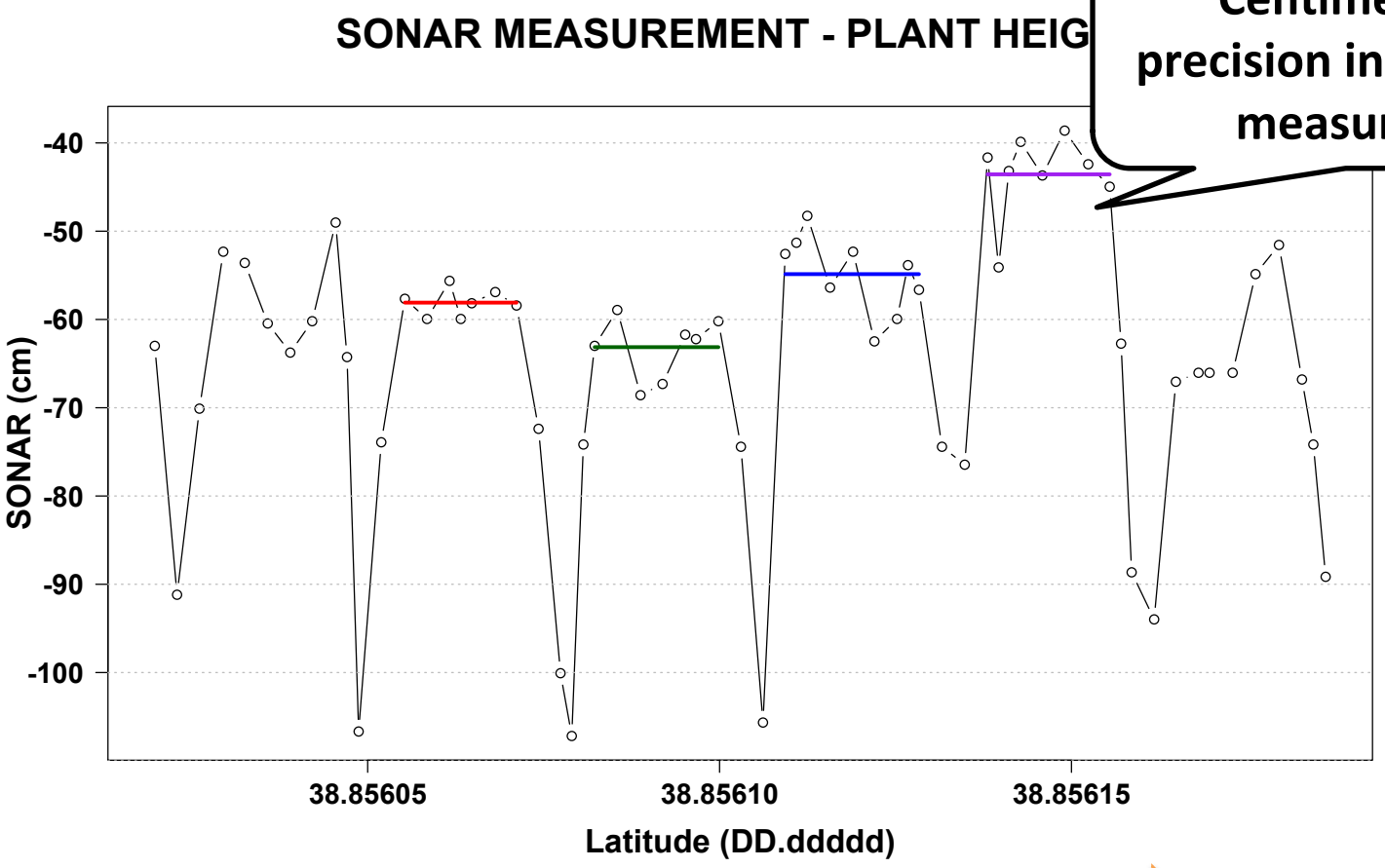


Raw data

Define plot boundaries

Trim data
Assign to plots

HTP: Plant Height

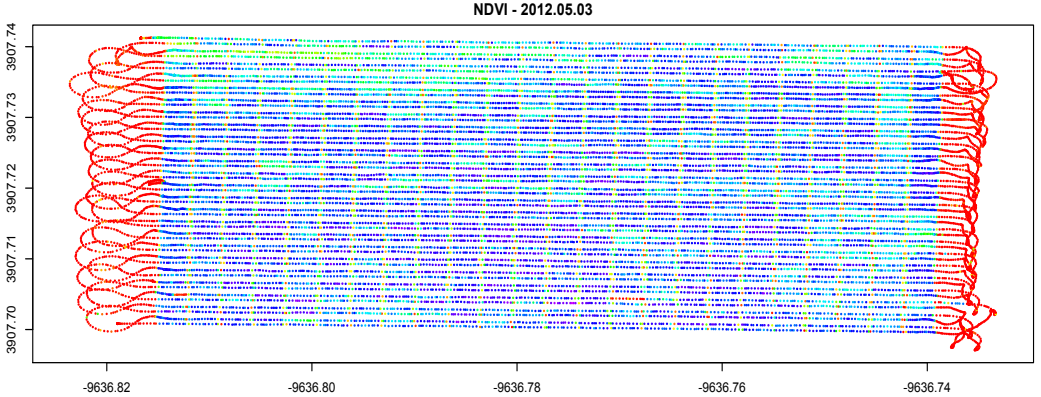


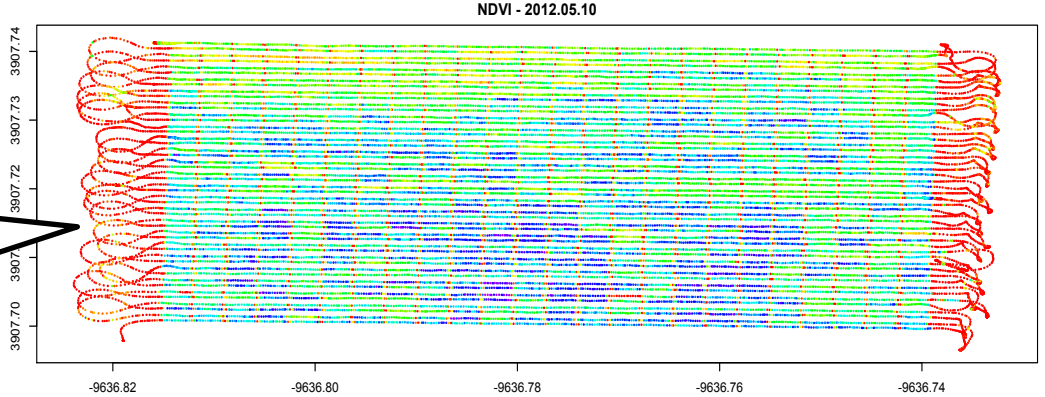
Centimeter level precision in plant height measurements

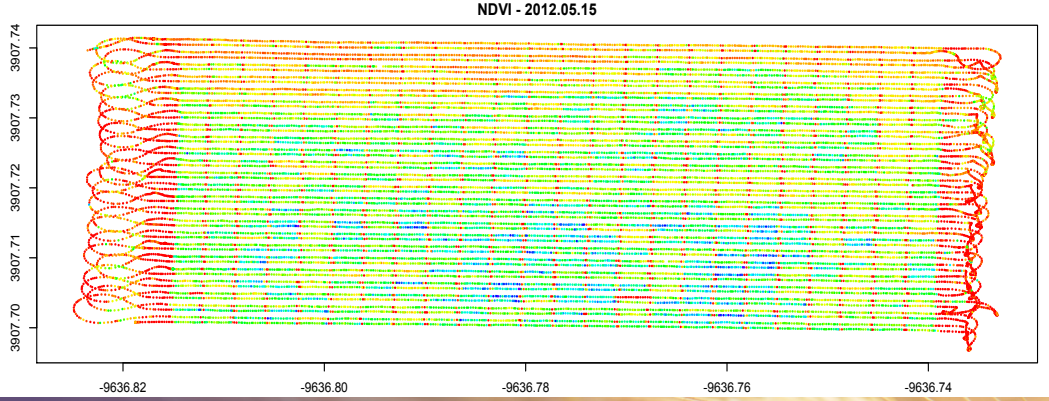
Single pass down one column

NDVI: Multi-temporal measurements

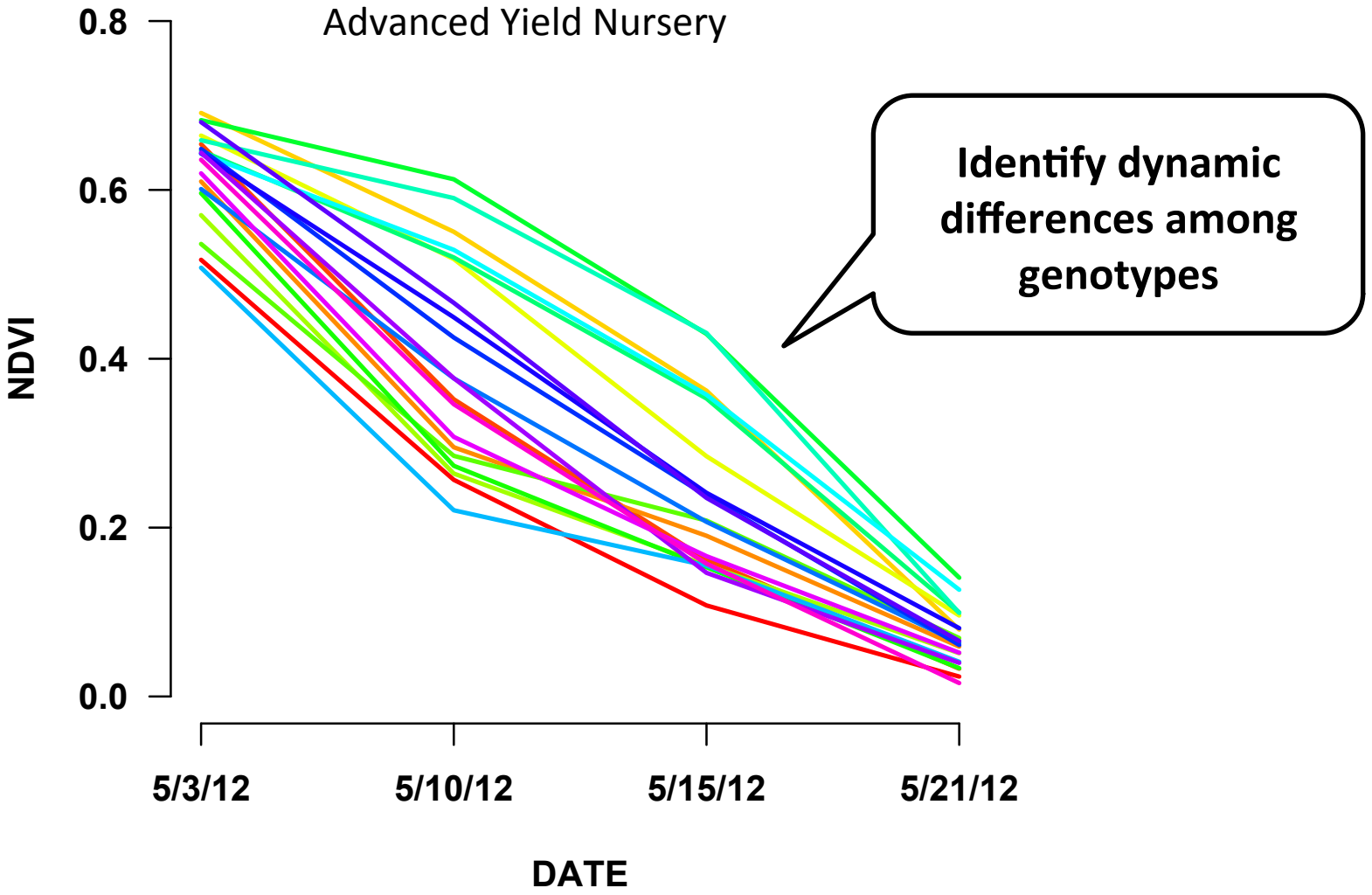
Rapid assessment enables repeated measurements over time







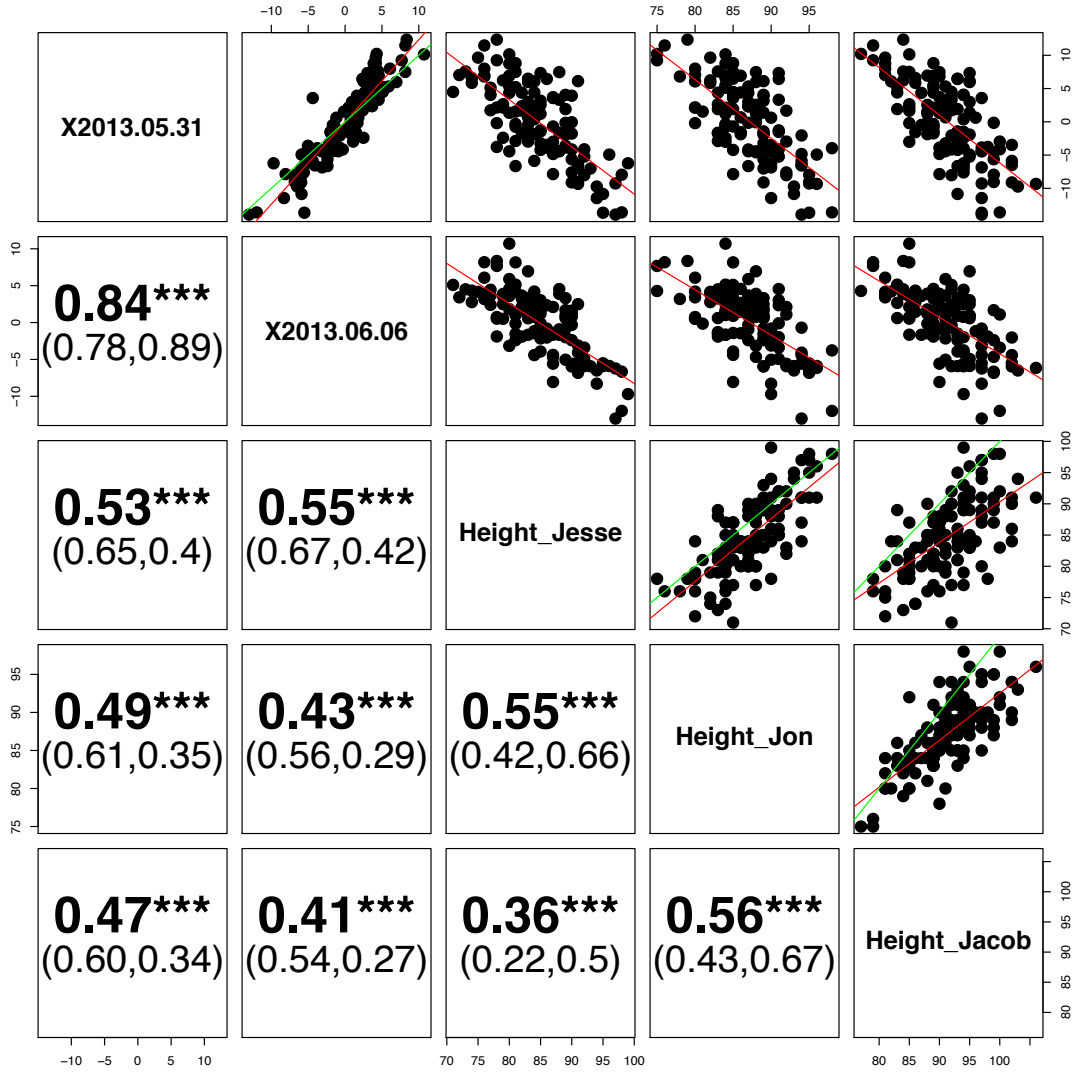
NDVI: Multi-temporal measurements



Phenotyper: Increased accuracy

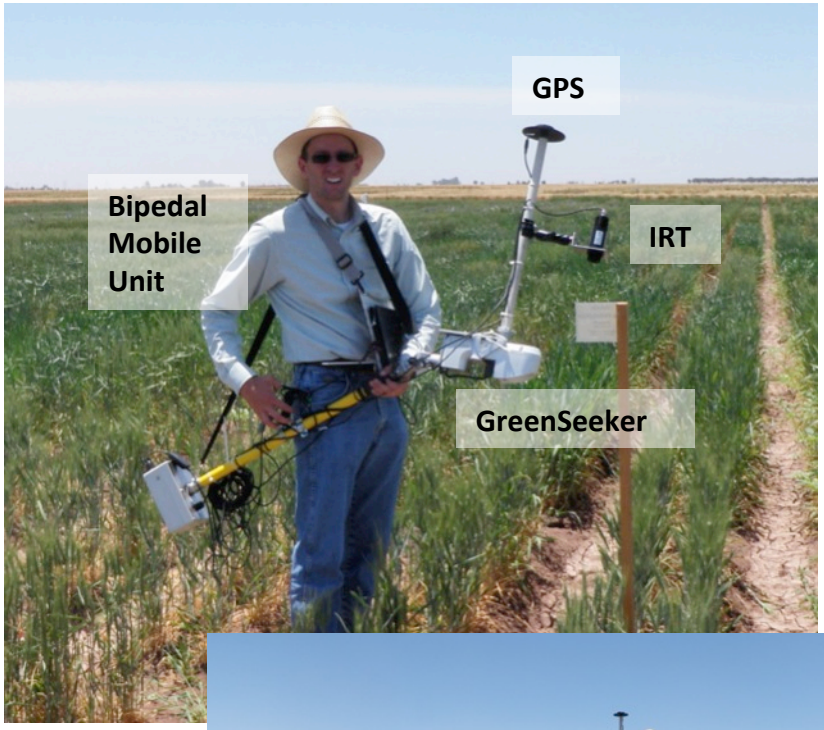
Plant Height w/ SONAR

- 40 varieties
- 3 reps
- 1.3m x 3m plots



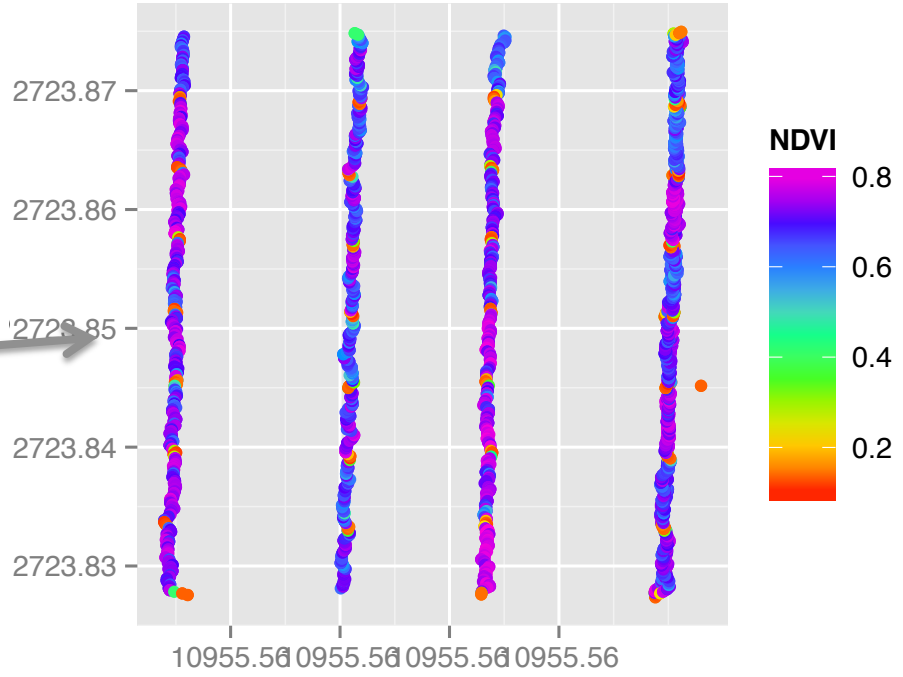
PheMU

Phenotyping Mobile Unit



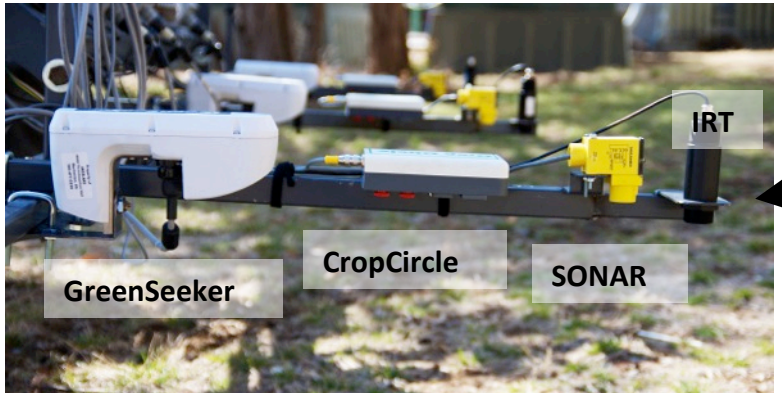
Phenocorn:

- ✓ Global Deployment
- ✓ Low(er) cost



HTP platforms of all shapes and sizes…

HTP: Imaging



HTP: small Unmanned Aerial Systems (sUAS)

IRIS+ Quadrotor with custom KSU Gimbal Cannon S100 NDVI camera

+ Not too expensive
+ flexible deployment
+ Image whole field

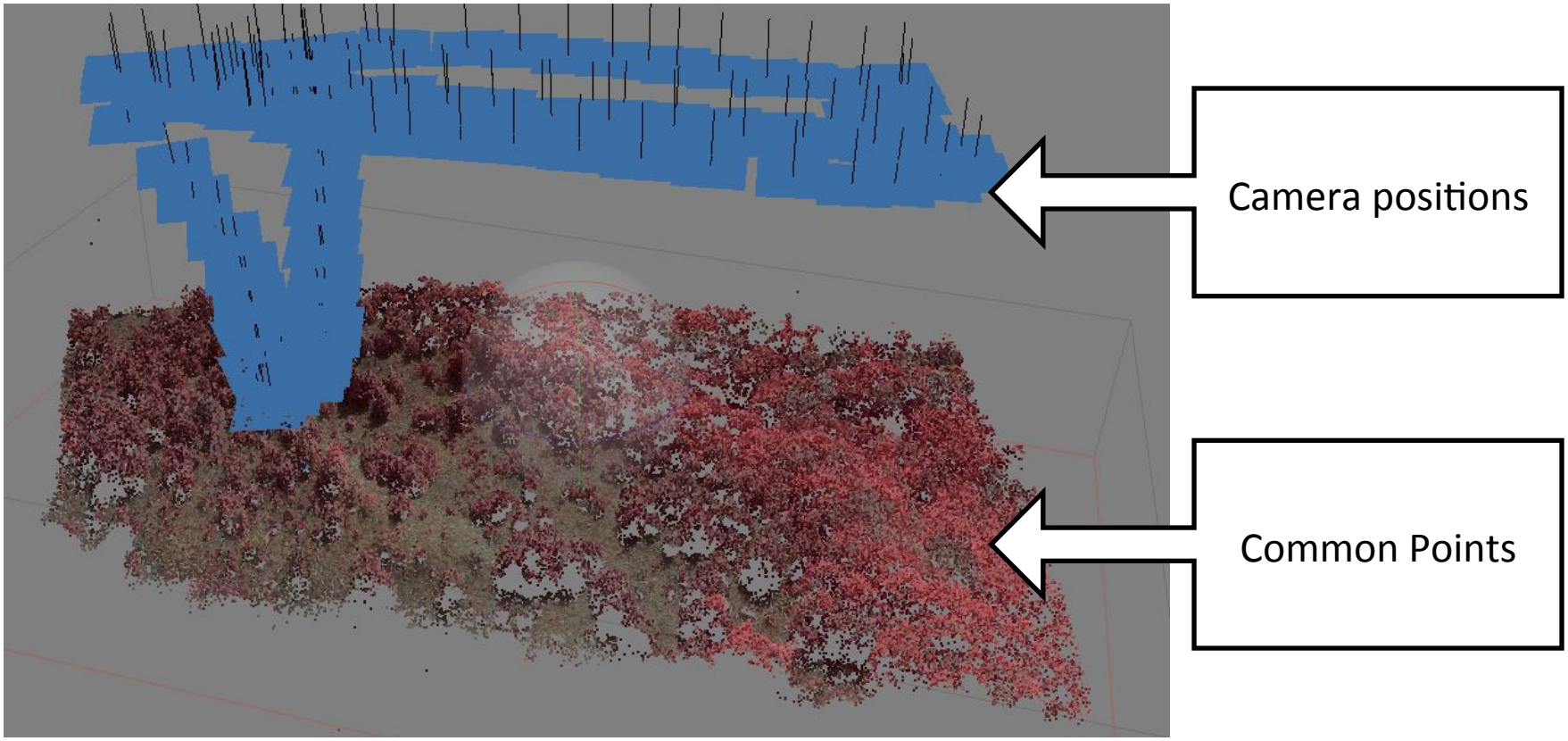
- Need trained pilot
- FAA restrictions?
- Limited payload (<1kg)
- Crashes

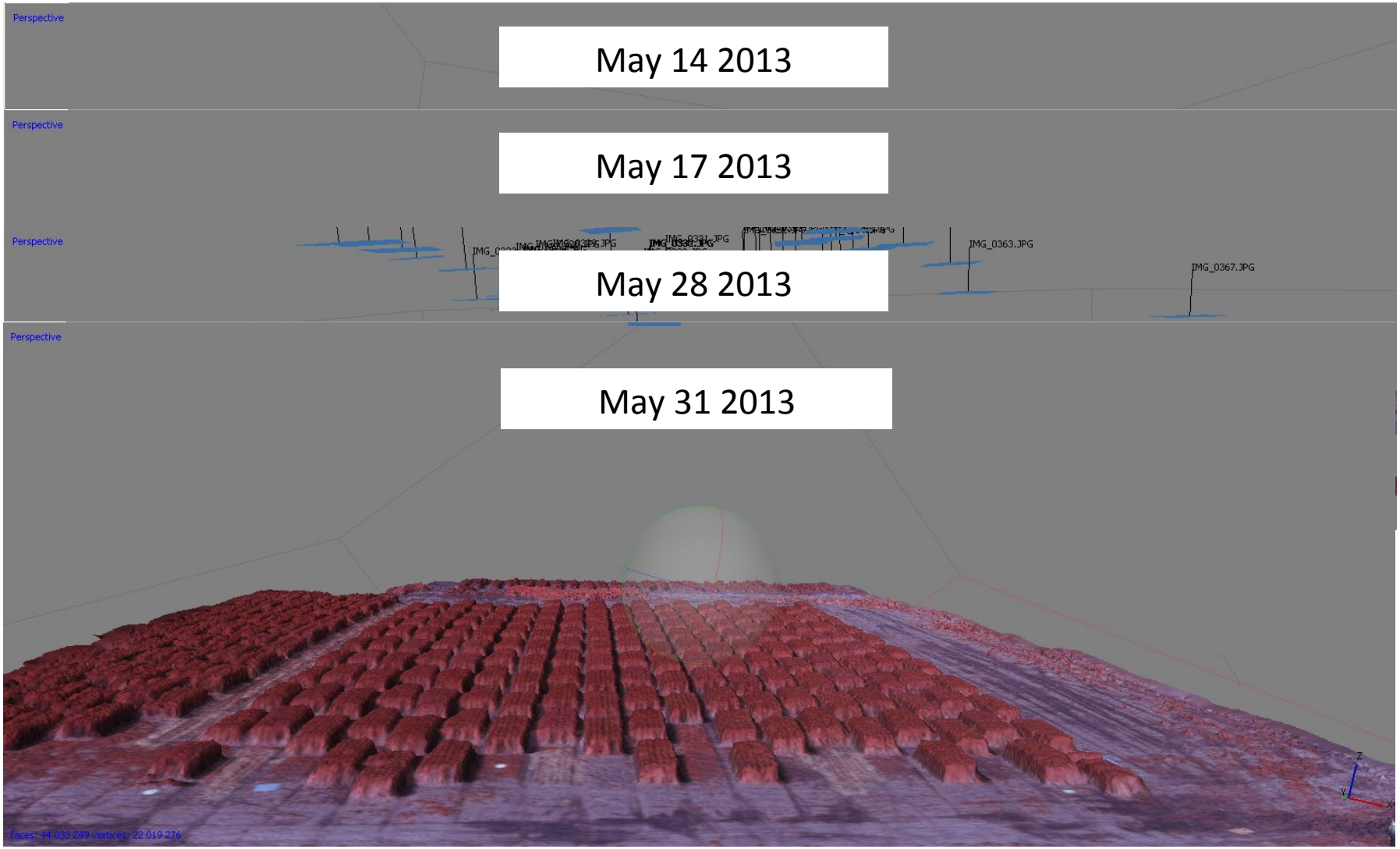
UAS: mission planner

Flight planning and field survey of wheat field nursery (Oct 2014)

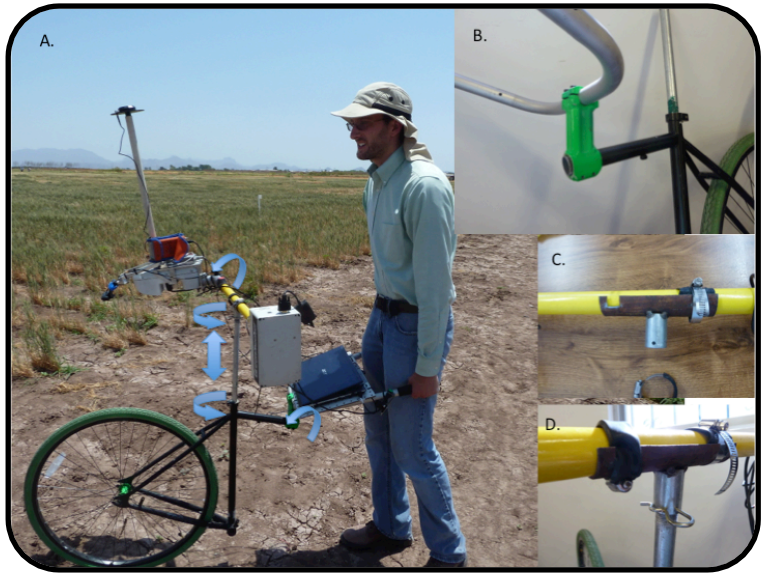
HTP: sUAS platform and 3D modeling

- Ortho mosaic from multiple images



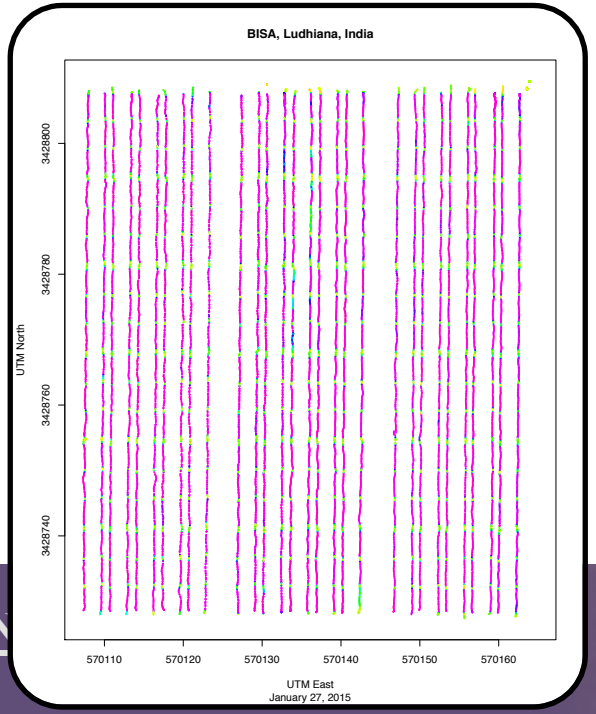

Perspective
May 14 2013
Perspective
May 17 2013
Perspective
IMG_0363.JPG
IMG_0367.JPG
May 28 2013
Perspective
May 31 2013
Faces: 44 033 249 vertices: 22 019 276

Phenocart



Phenocart design, Obregon Mexico

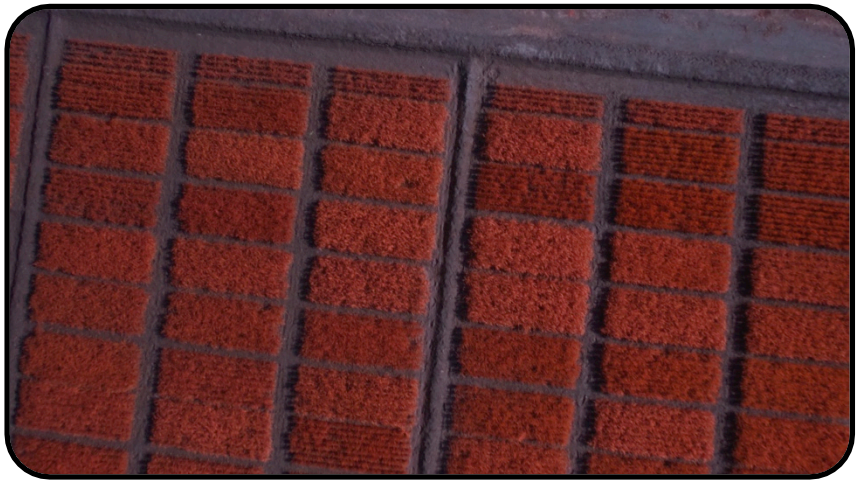
BISA, Ludhiana, India - Feb 2015



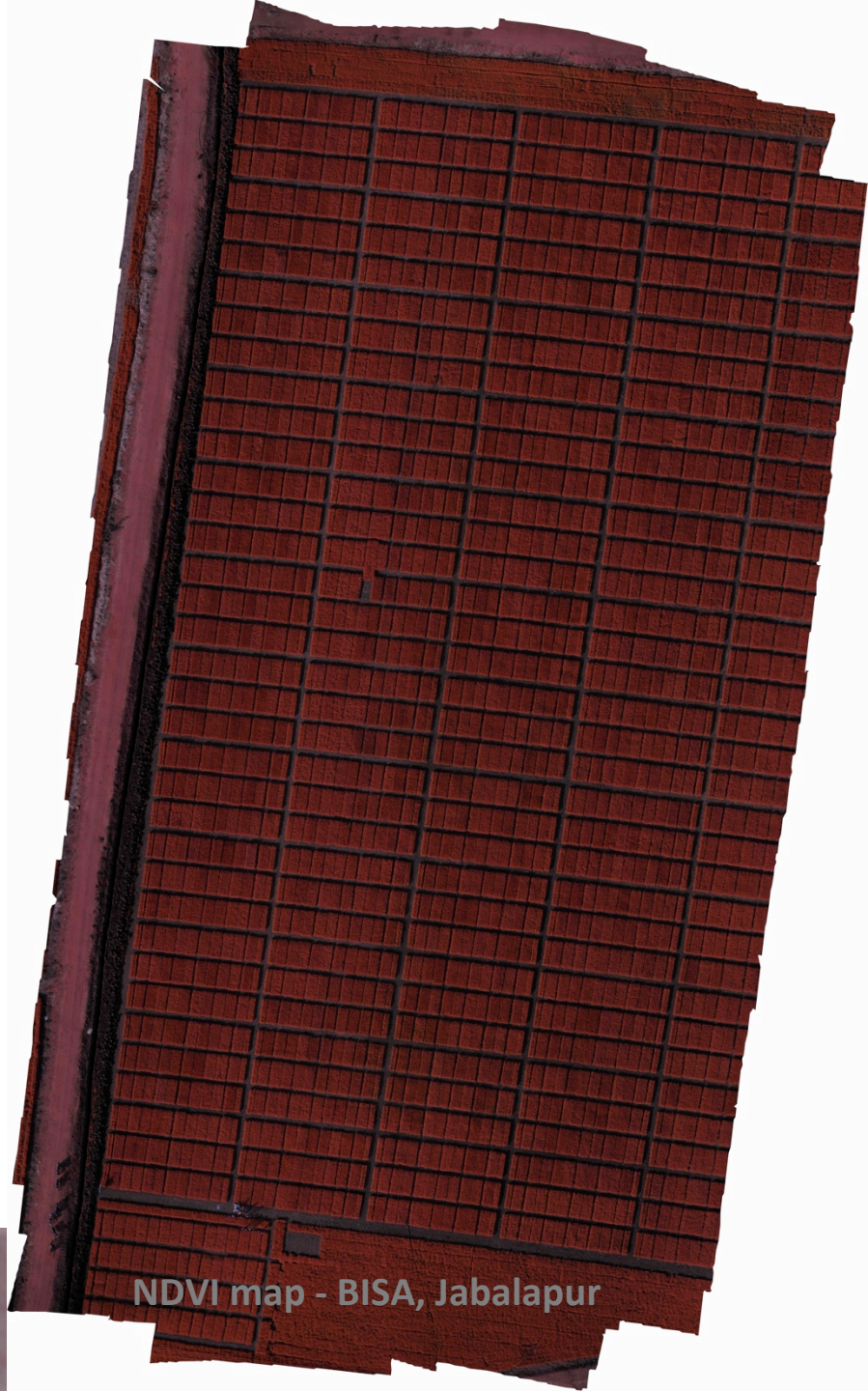
NDVI map - BISA, Ludhiana

HTP via UAV

3DR IRIS+ | NDVI converted Cannon S100



NDVI image - BISA, Ludhiana, INDIA, Jan 2015



NDVI map - BISA, Jabalapur

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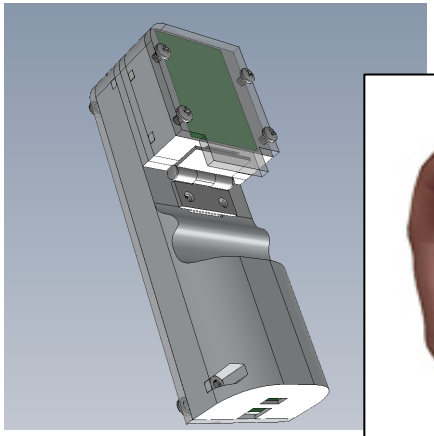
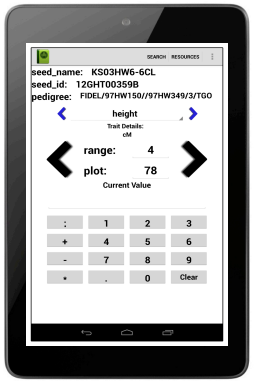
HTP: The future is here…

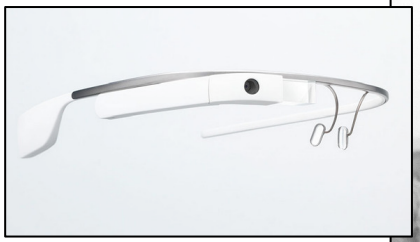
Implementation of existing technology

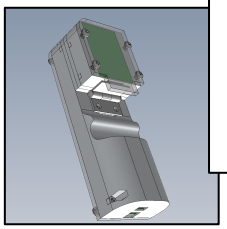
- ✓ Commercial and existing sensors
- ✓ Imaging
- ✓ Low-cost, modular ‘nodes’

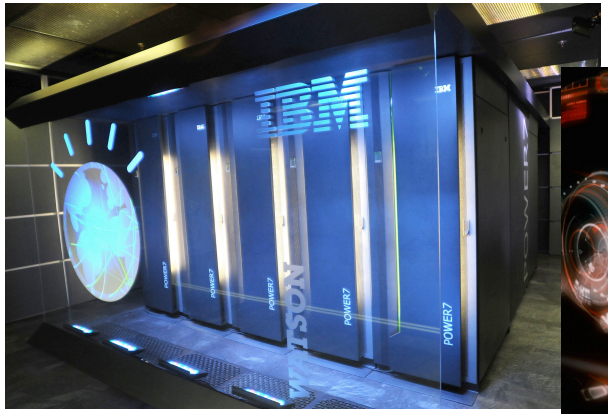


Interactive data collection and analysis







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If we knew what it was we were doing, it would not be called research, would it?
- Albert Einstein