UAS applications in agriculture

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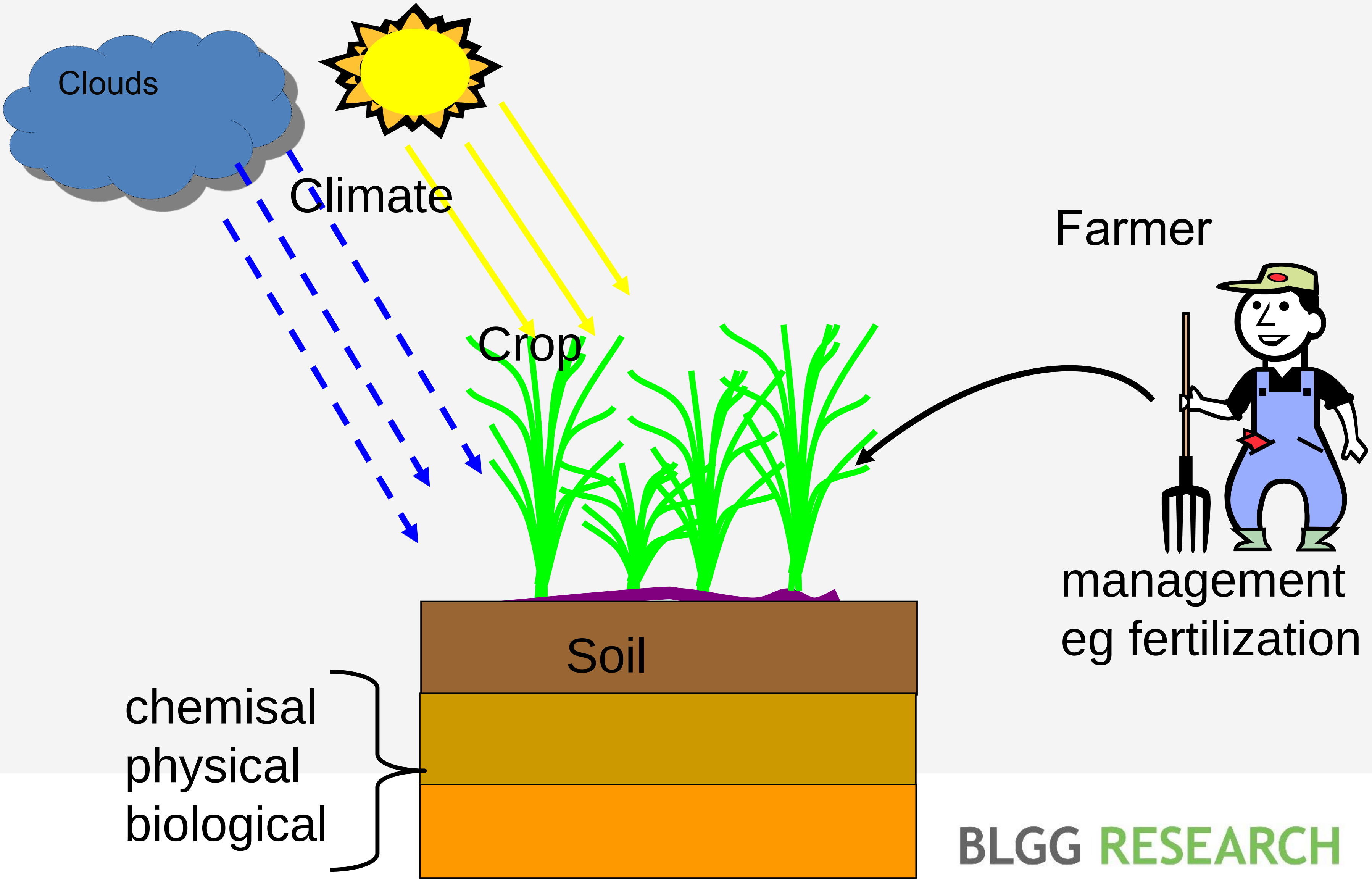
Introduction

- Challenges for farmers
- UAV's in agriculture
  - Literature search
- Examples
  - Haus Riswick
  - Grass parcel Reusel
- UAV usage in agriculture
  - Translation sensor result to action
  - Resolution
- What needs to be done?

Challenges when farming



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Challenges famers

- Reasonable income
- "Sharing the land": agriculture, environment, recreation
- Fertilization
- Plant protection

} stronger regulations

Possible solution:

- Increasing nutrient use efficiency
  - Applying the right amount at the right time and the right spot

Precision farming

Precision farming

- Site specific management
  - No longer parcel/company based

- "on-the-fly" management
  - 'Measurement' at the front, 'action' at the rear

→ New techniques needed

Agricultural machinery with gps

- Plowing
- Planting/seeding
- Spraying
- Weeding
- Fertilization
- Irrigation
- Harvesting

Farmers actions

- Variable seeding
- Variable planting of potatoes
- Variable rate of application
  - fertilization
  - plant protection
- Estimating yield
- Estimating grass quality using sensors
  - for determining time of mowing/grazing

→ **Site specific management**

Information needed for site specific management

For each parcel:

- Variation in crop status → integration of
    - Soil characteristics
    - Crop characteristics
    - Weather
    - Management

This information is needed for action by the farmer:

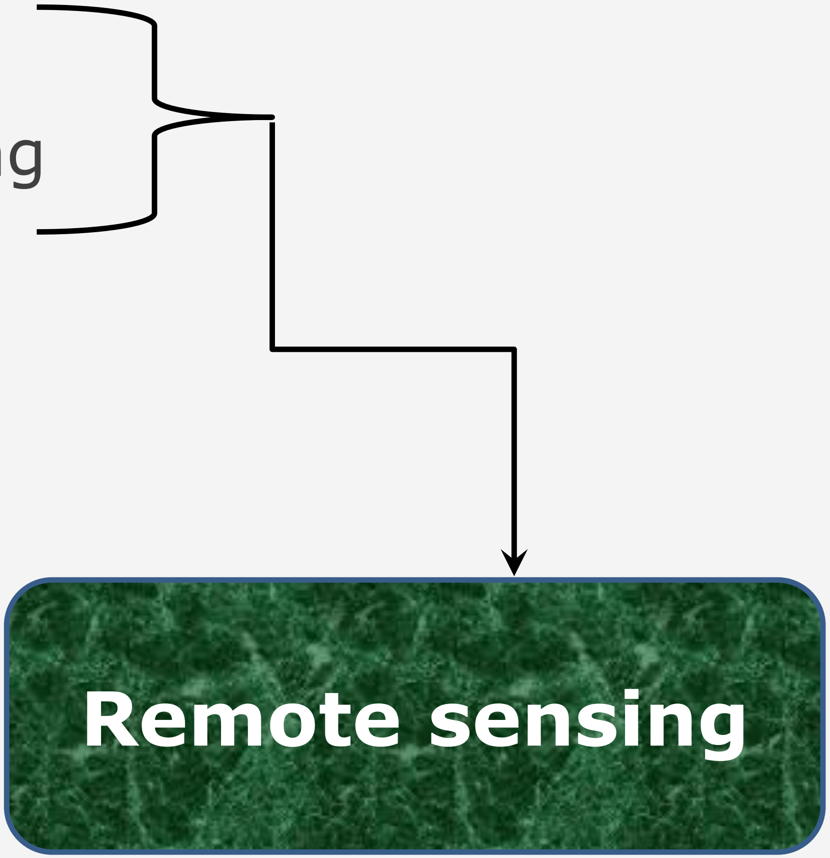
- What to do?
- Where to do it
- How much?

} Appropriate decision support system

Precision farming

Phases

1. Data collection
2. Field variability mapping
3. Decision making
4. Management practice



Zhang, Korvacs, 2012

Sources of information → sensing

- Remote sensing
  - satellite images
  - Uav ??

- Near sensing
  - Greenseeker
  - Crop Circle/OptRx
  - Yarasensor
  - Fritzmeier Isaria

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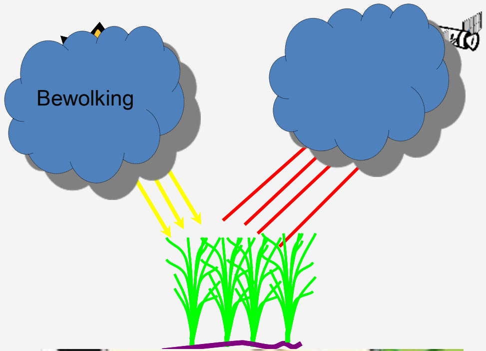
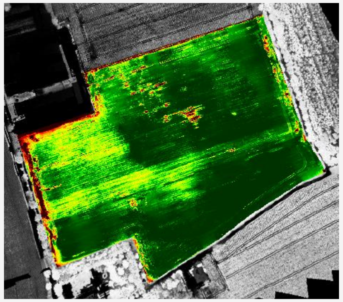
Remote and near sensing

Remote sensing



+ large surfaces
+ relatively cheap
+ covers the parcel
- cloudy: no image
- resolution (10x10 m)
- no request for image possible

UAV



+ covers the parcel
+ no effects of clouds
+ image on request
+ resolution (1 x 1 m)
- not possible at high wind speeds
- relatively expensive

Sensors on tractor or handheld

+ image on request
+ self management
- need to buy sensors
- measures parts of parcel
- data analysis: do it yourself

UAV's in literature -1

2 databases searched,

- Scopus
  - Search terms: UAV, agriculture; subject area:agricultural and biological sciences
  - 42 papers found
- Web of science
  - Search terms: UAV agriculture
  - 40 papers found

- In total 62 papers

UAV's in literature -2

- Subject of the papers:
  - Technology: 34 > 50%
  - Crop recognition: 5
  - Yield/biomass: < 10

- Crops
  - 36 of 62 papers cover crops
  - Vineyard: 6
  - Orchards: 5
  - Wheat: 5
  - Trees: 5

UAV's in literature -3

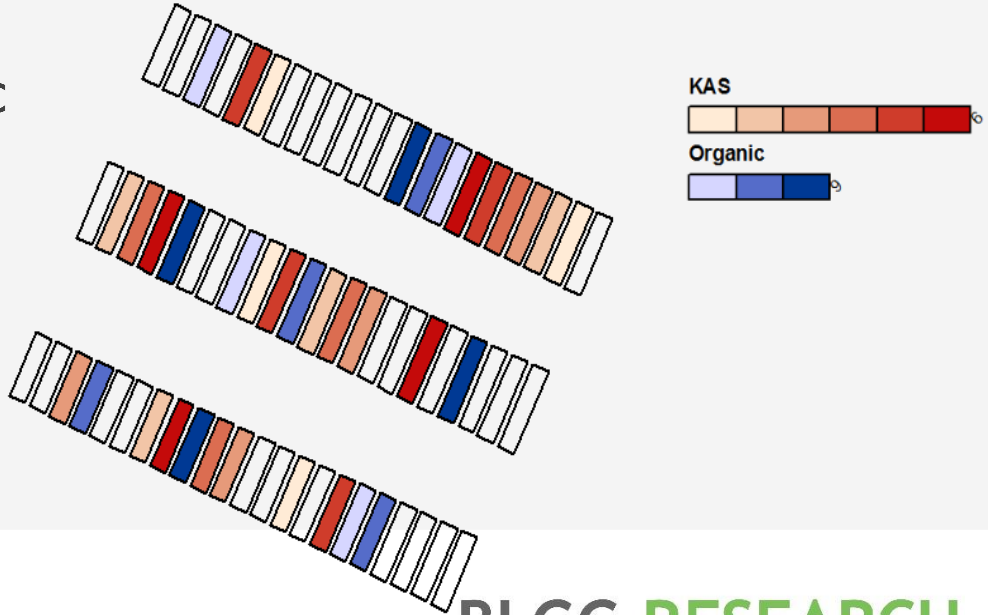
- Lots of information about technology
- Hardly any about application/usage
  - What does the farmer need to do?

- More data are needed to determing usage of uav images in agriculture
- Decision support system is needed!

Example 1: Haus Riswick

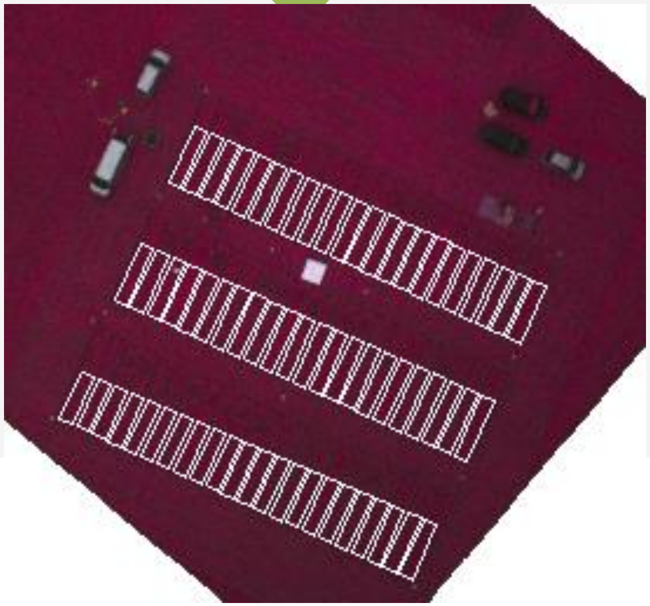
- Field set-up:
  - 60 agricultural fields
  - 4 x 15 different treatments

- Sampled:
  - 4 x 6 increasing chemical fertilization (KAS)
  - 4 x 3 increasing organic fertilization (OM)



Haus Riswick: Octocopter set-up

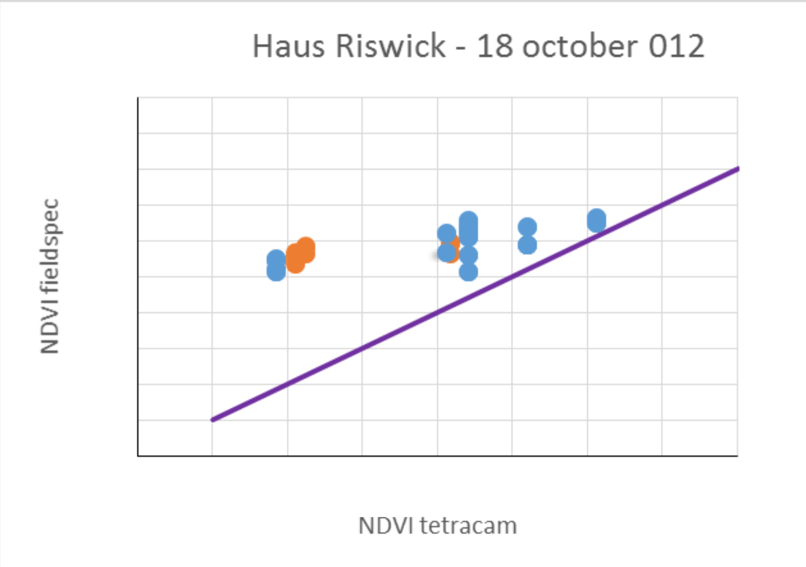
- Image taken October 2012
- Weather
  - 100% overcast
  - Not ideal for RS
- Equipped with multi-spectral 'tetracam' camera
  - Green channel (520 – 600 nm)
  - Red channel (630 – 690 nm)
  - NIR channel (760 – 900 nm)

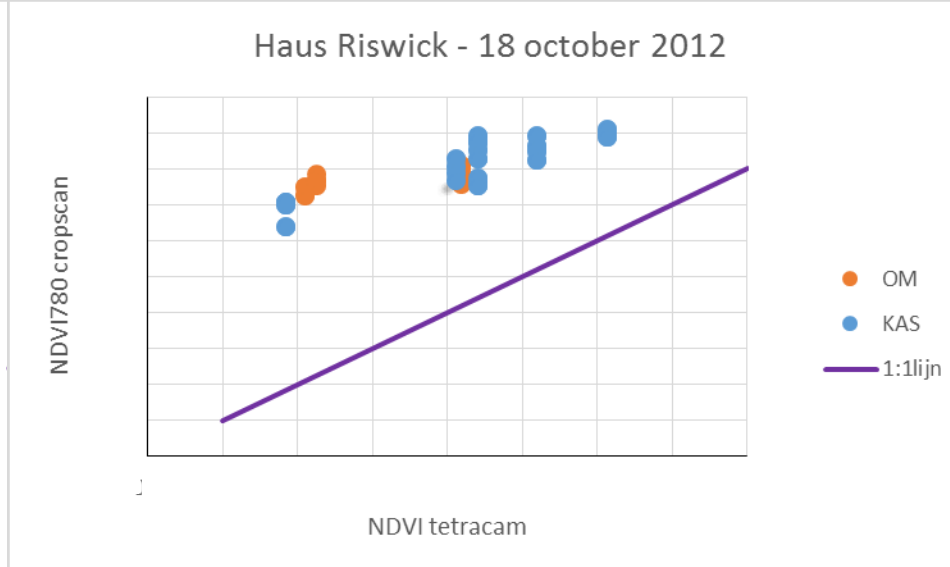


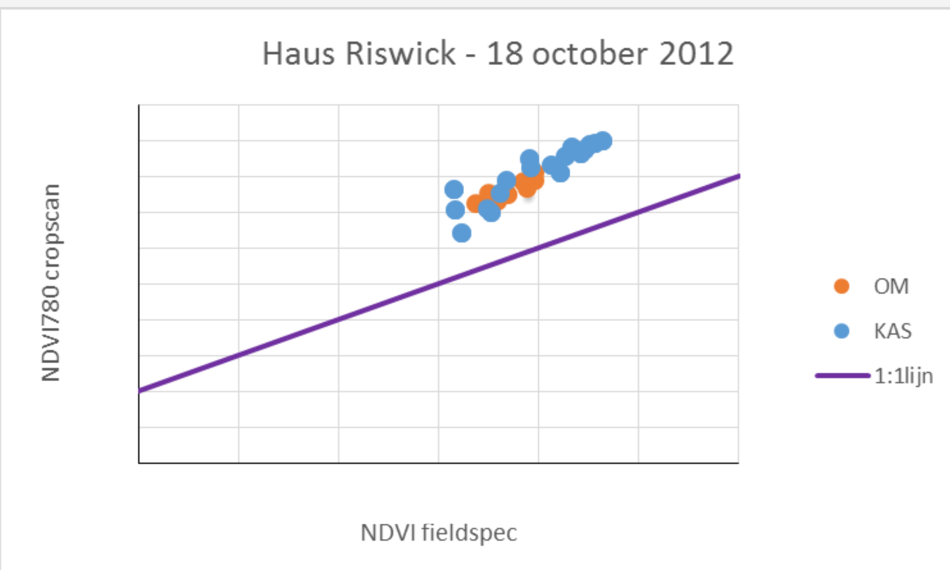
Haus Riswick: other activities

- Cropscan measurements
- Fieldspec measurements
- Grass harvesting

Results 1: NDVI -values



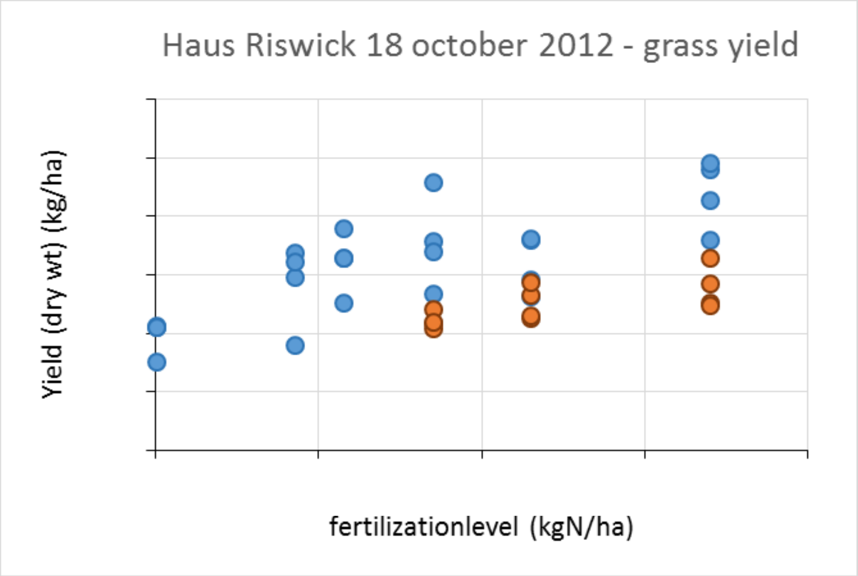


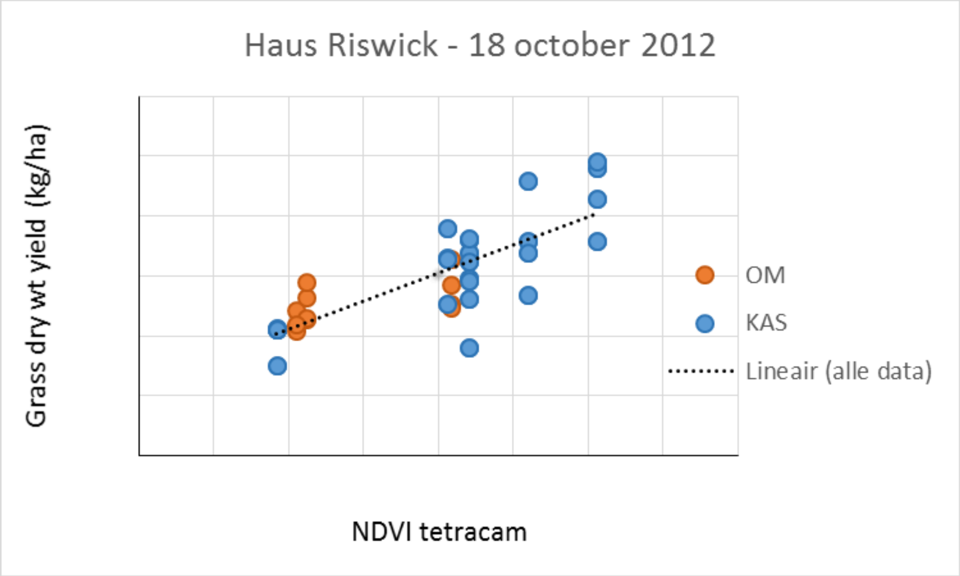


- NDVI tetracam < NDVI fieldspec
- NDVI tetracam < NDVI cropscan
- NDVI cropscan > NDVI fieldspec

Different sensors
→ same index
→ different values

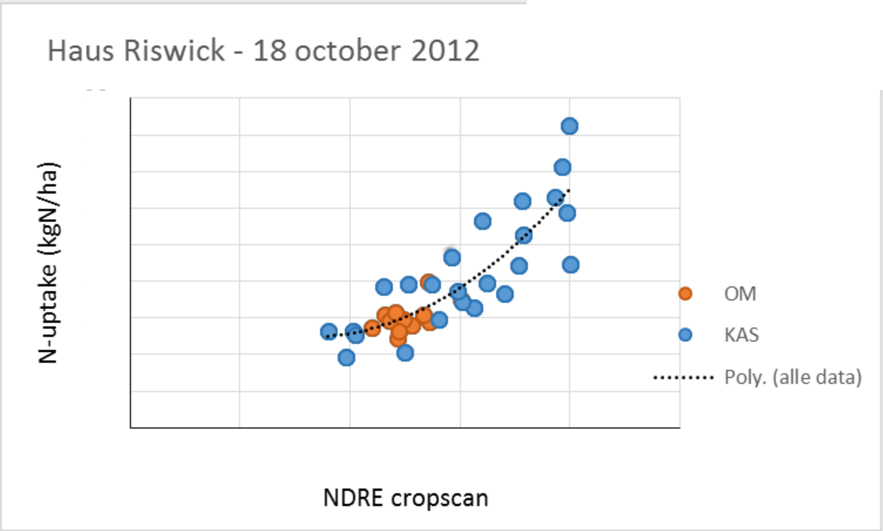
Results 2: yield estimation

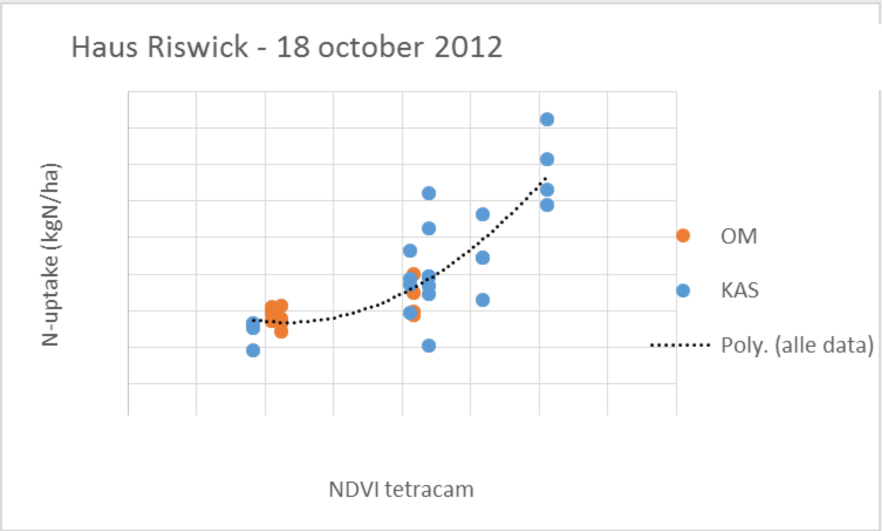




- Yield shows N-treatments
- NDVI-tetracam relationship with yield
  - KAS: reasonable R^2
  - OM: terrible R^2
  - More data are needed

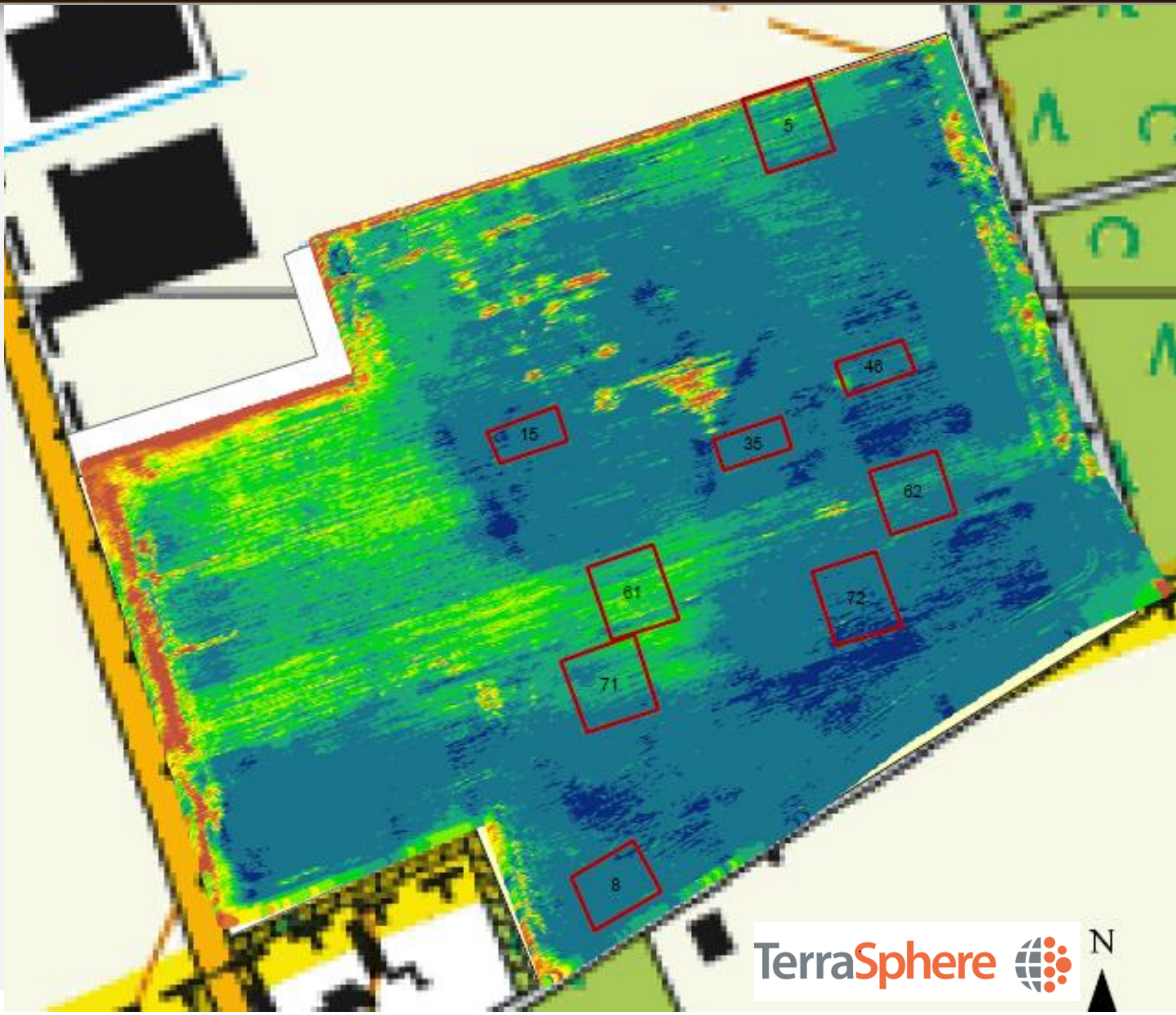
Results 3: Nuptake and vegetation index





- Best relationship found with cropscan
- Relationship for UAV data reasonable

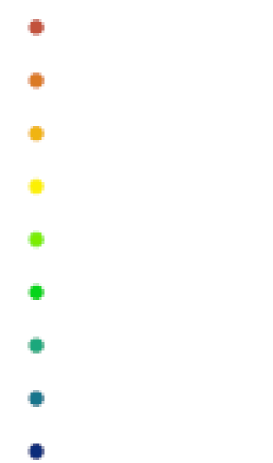
Example 2: grass parcel Reusel



UAV image

- 5 juni 2012
- Tetracam
- Terrasphere

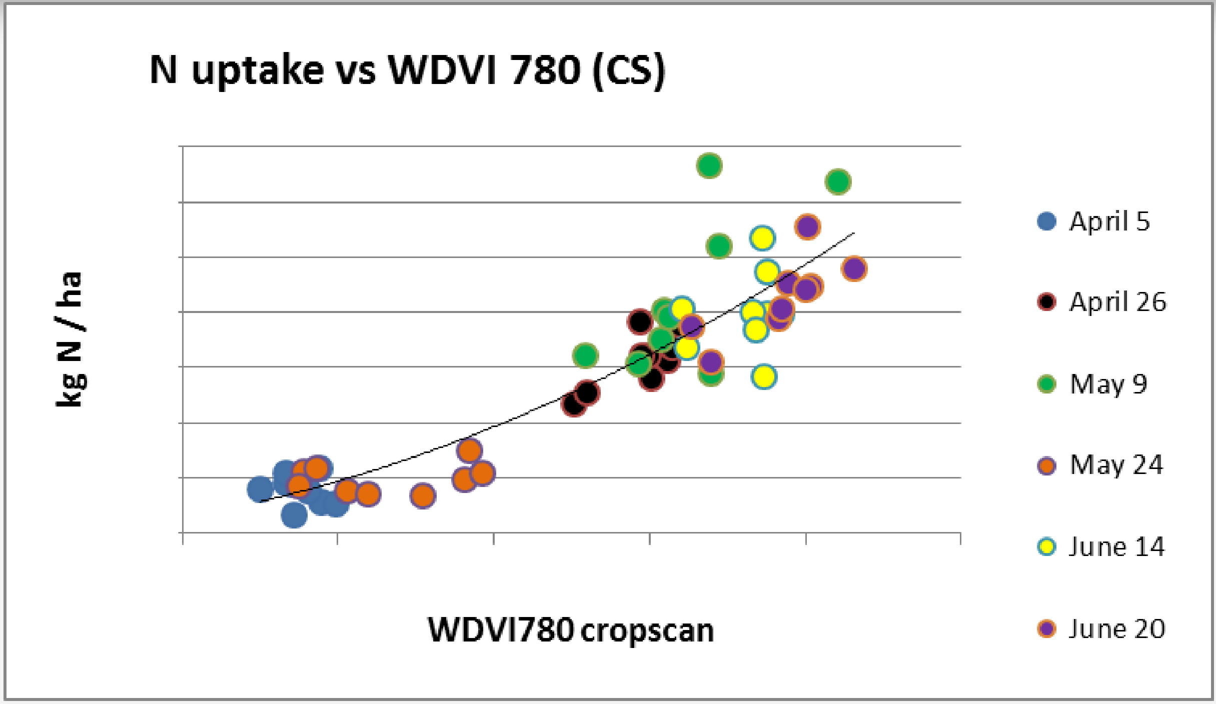
WDVI



Example 2: other activities

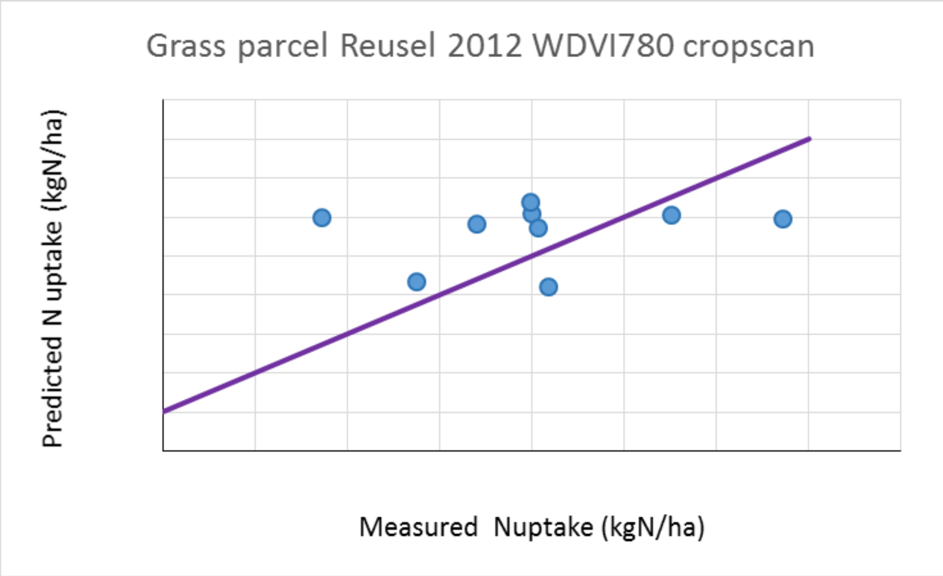
- Measurements with cropscan
  - bi-weekly
  - Including 14 juni 2012
- Harvesting
  - 2e cut 23 juni 2012

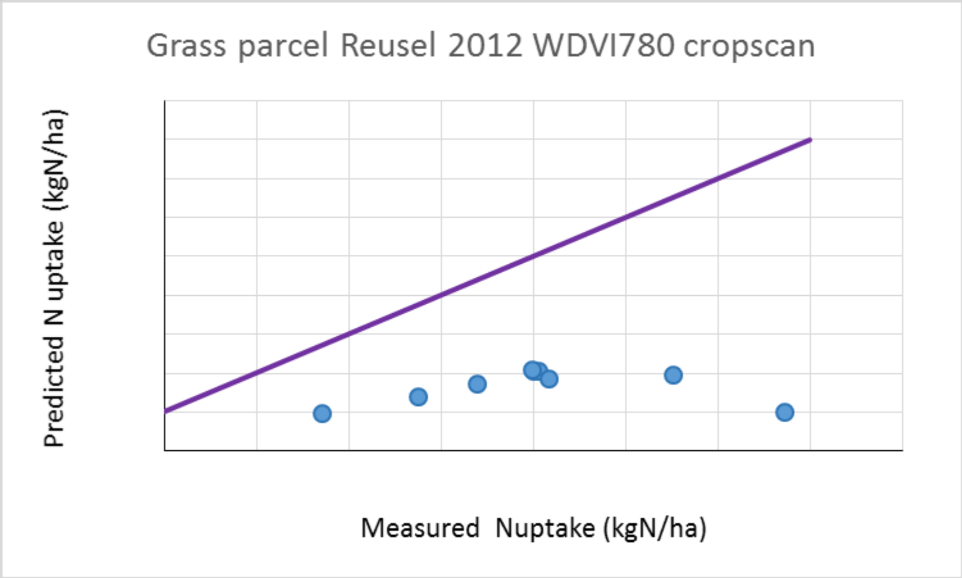
Results 2: N -uptake



- Derived with Cropscan
- Good relationship WDVI – N uptake

Results 2: predicted N uptake

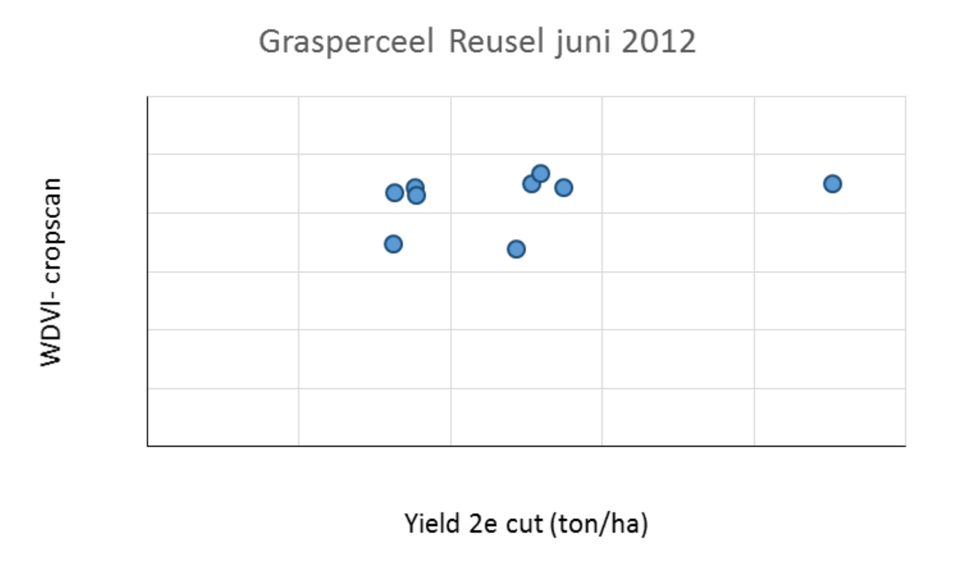


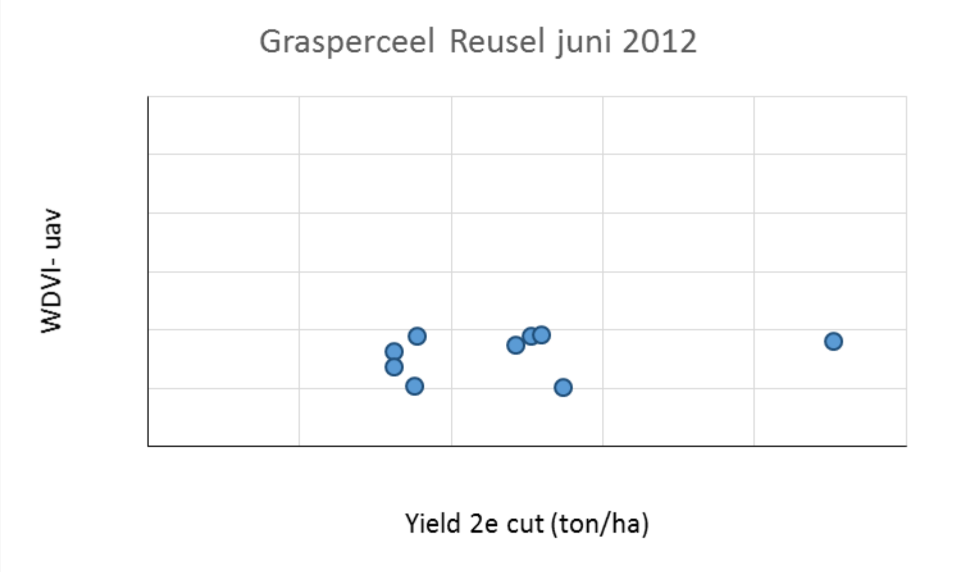


Prediction of N uptake:

- Cropscan: RMSE = ok
- UAV: RMSE = not good

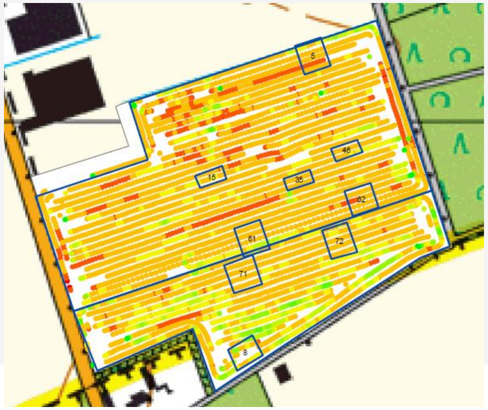
Result 3: relation with yield





- Uav image: 5 juni 2012
- Harvesting: 23 juni 2012

- No prediction possible



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UAV's – challenges

- Relationships VI's - crop status (N-uptake) are derived with the cropscan
- For different grasslands: best vegetation index differs
  - Haus Riswick: NDRE
  - Grass parcel Reusel: WDVI780
- Indices uav differ with cropscan indices
  - Tetracam → limited indices
  - Hyperspectral camera's
    - → several indices can be derived
    - → Relationships with cropscan needed

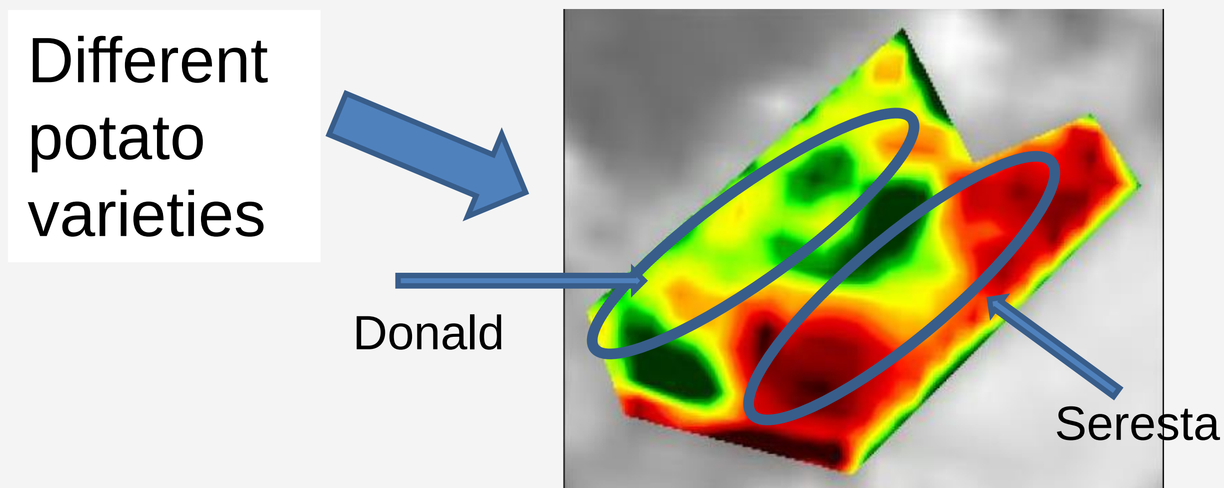
UAV usage in agriculture

- Beautiful images are available
- Farmers want to know what to do where
- Causes of variation are often unknown
- What to recommend the farmer?

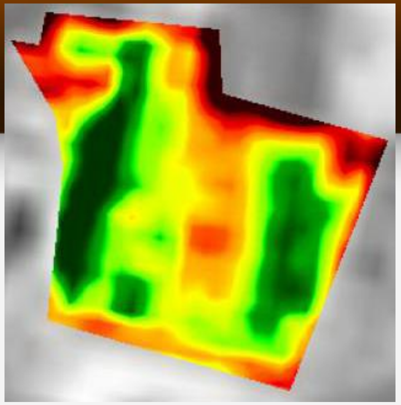
- Important for acceptance of uav images
  - **Decision support system**
    - Monitoring
    - Recommendation
    - Recalculation to required resolution
      - Equipment depended
  - Low cost
  - Quick delivery

What can we do?

- Images show variation in parcel
- Crop integrates the environment
- Use images for monitoring crop together with farmer



What to do next?



- Work on data
  - Combine
    - different sensors
    - different fields
    - different years
- Find robust VI's
- Find robust relationships VI's – crop status

Mode to measure

Questions??