

# BIOMAP – MAPPING OF BIOMASS USING UAV

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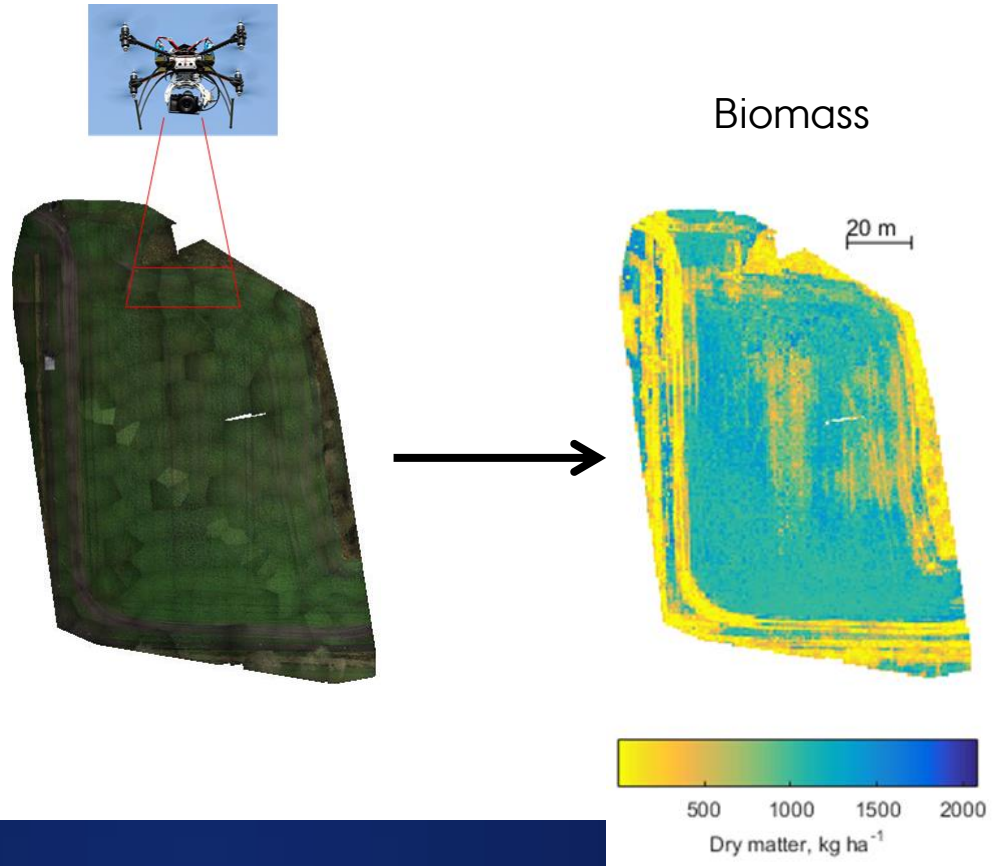
# MOTIVATION

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- ▶ Commercial fertilizers
- ▶ Reduce Nitrogen leeching
- ▶ Heavily regulations in Danish agriculture
- ▶ Catch crops stores Nitrogen
- ▶ Optimize use of applied and available Nitrogen

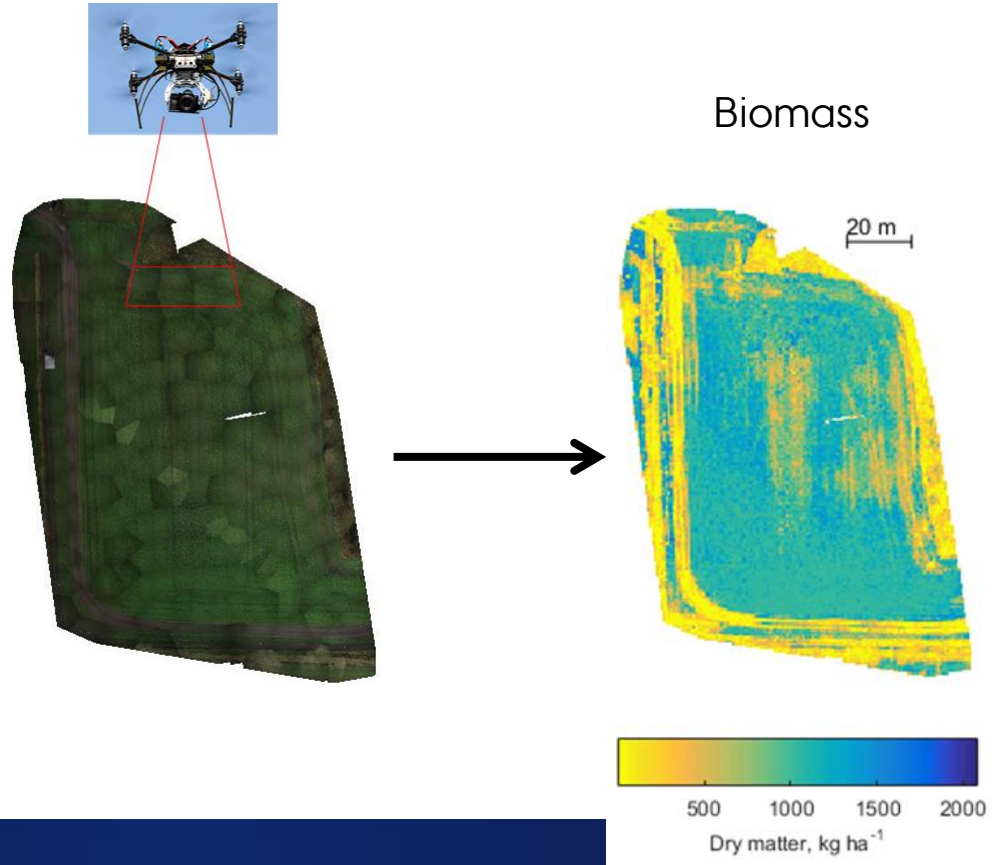
# METHOD

1. Capture images of field
2. Stitch images to orthophoto
3. Extract features
4. Estimate coverage
5. Estimate biomass
6. Create map of biomass

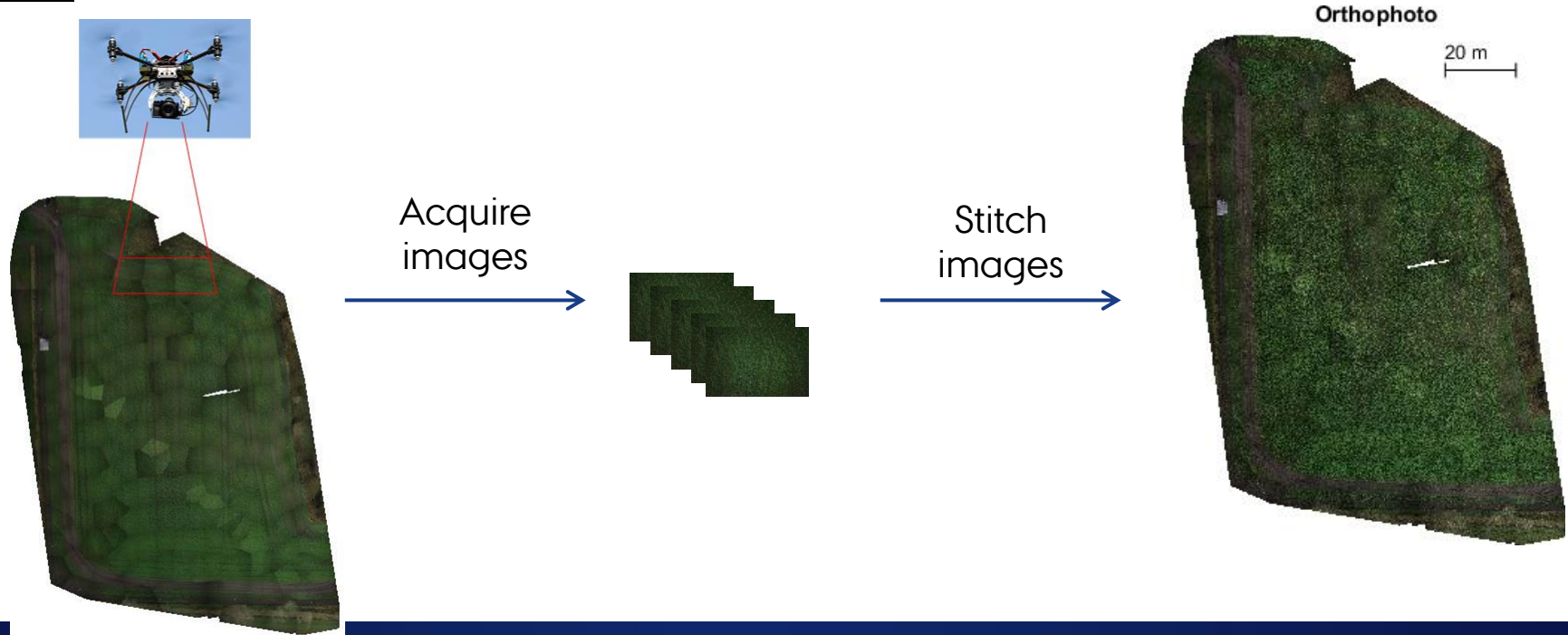


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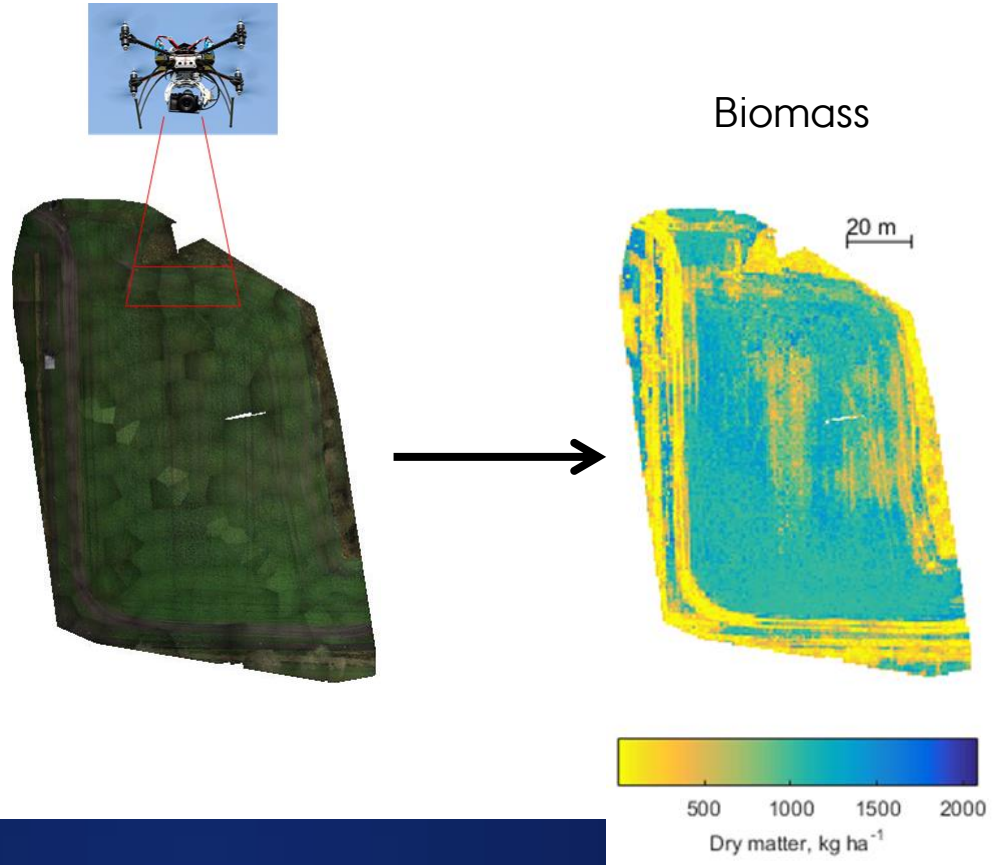


# ORTHOPHOTO



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# FEATURE EXTRACTION

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Pixel	Radish	Wheat	Features
Variation	Low	High	Entropy, range, std. dev., local homography, gradient (max, mean and std. dev.)
Intensity	High	Low	Mean and median intensity

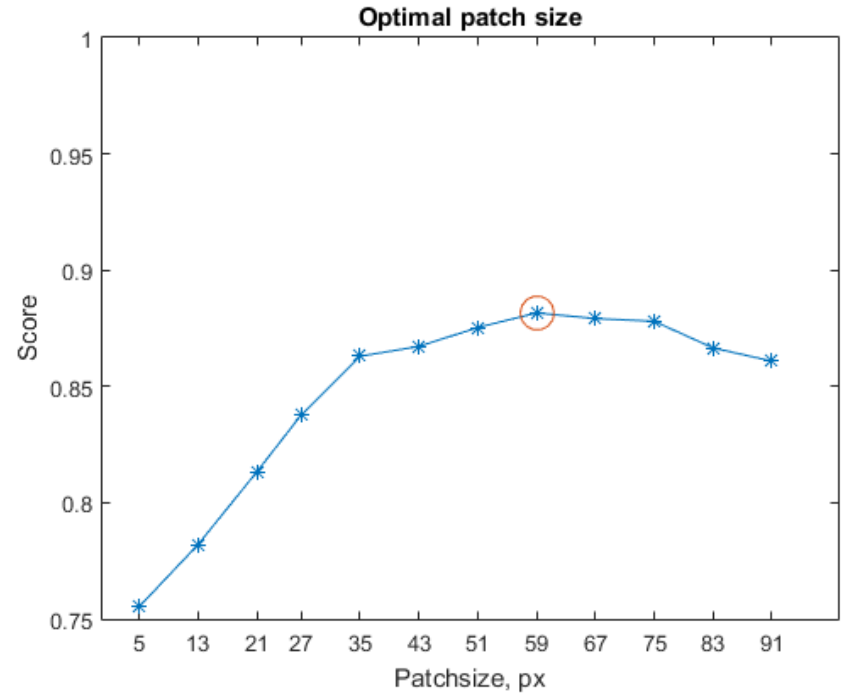
- ▶ Gray, red, green and blue colour bands used
- ▶ Artificial neural network used as classifier



# FEATURE EXTRACTION



- 5x5 px ( $1.6 \times 1.6 \text{ cm}^2$ )
- 59x59 px ( $18 \times 18 \text{ cm}^2$ )
- 91x91 px ( $28 \times 28 \text{ cm}^2$ )



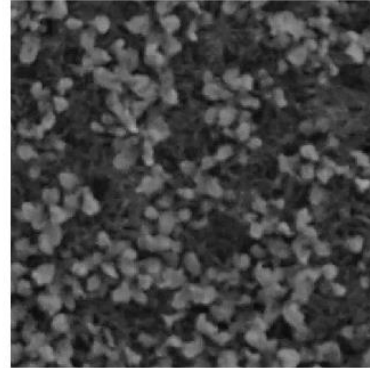


# FEATURE REDUNDANCY

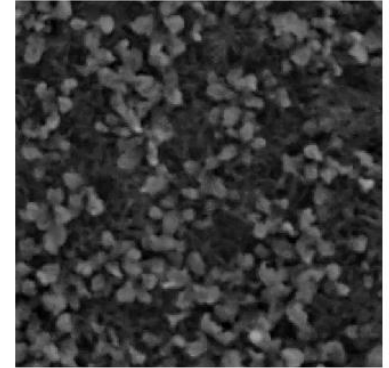
Original image



Gray

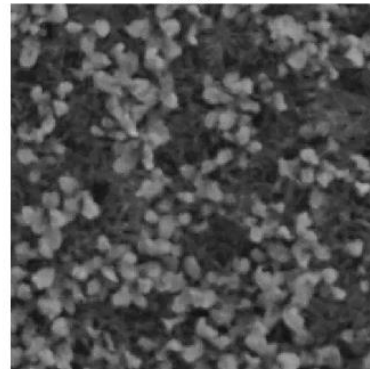


Red

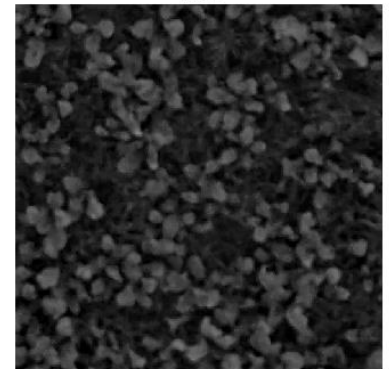


- ▶  $\text{Gray} = 0.2989 \cdot \text{Red} + 0.587 \cdot \text{Green} + 0.114 \cdot \text{Blue}$

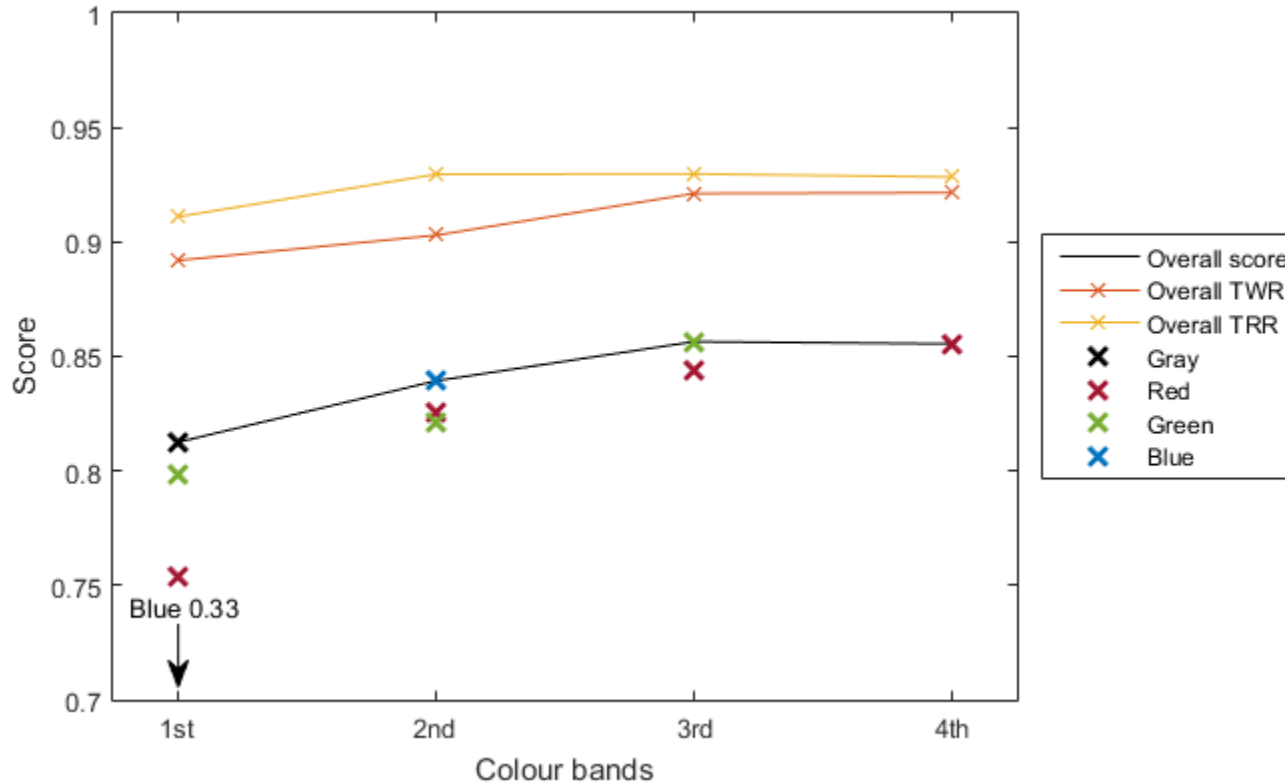
Green



Blue

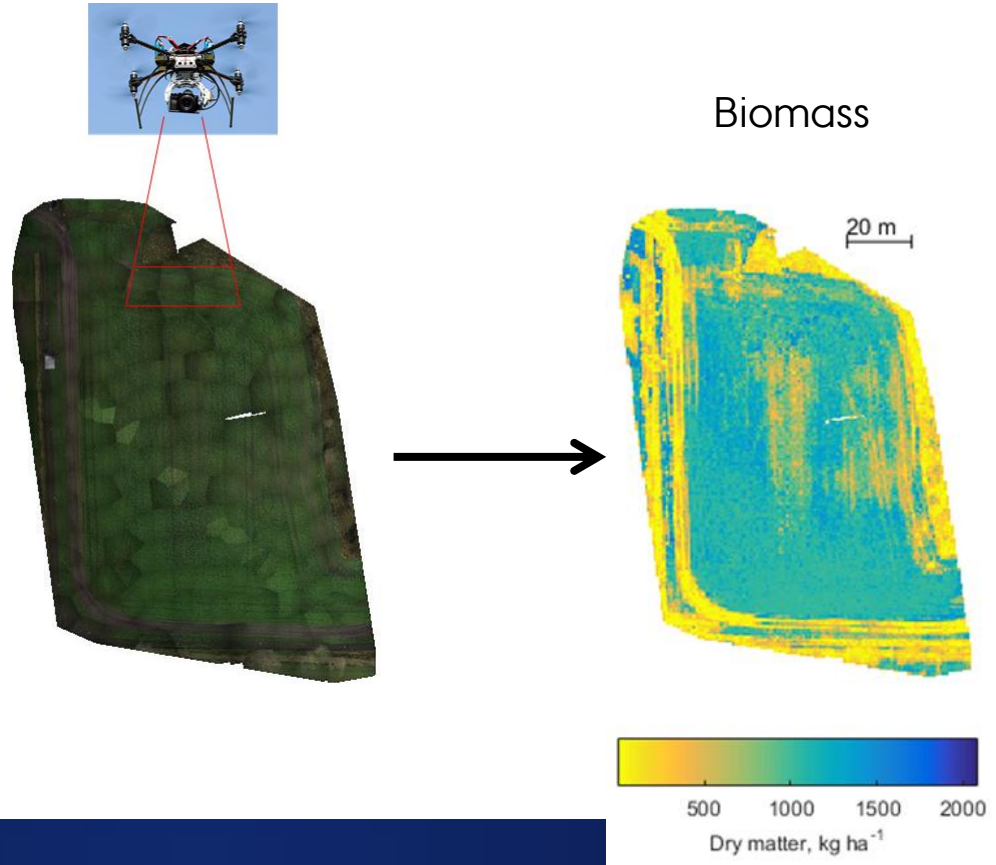


# COLOUR BAND IMPORTANCE



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# COVERAGE ESTIMATION

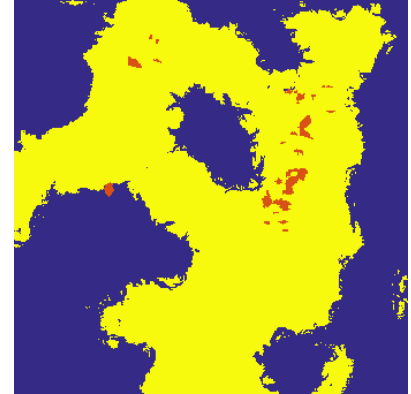
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- ▶ Radish and wheat
  - > Output from ANN
- ▶ Soil
  - > Difference in excess green and excess red
- ▶ Coverage
  - > Count number of pixels

Input image



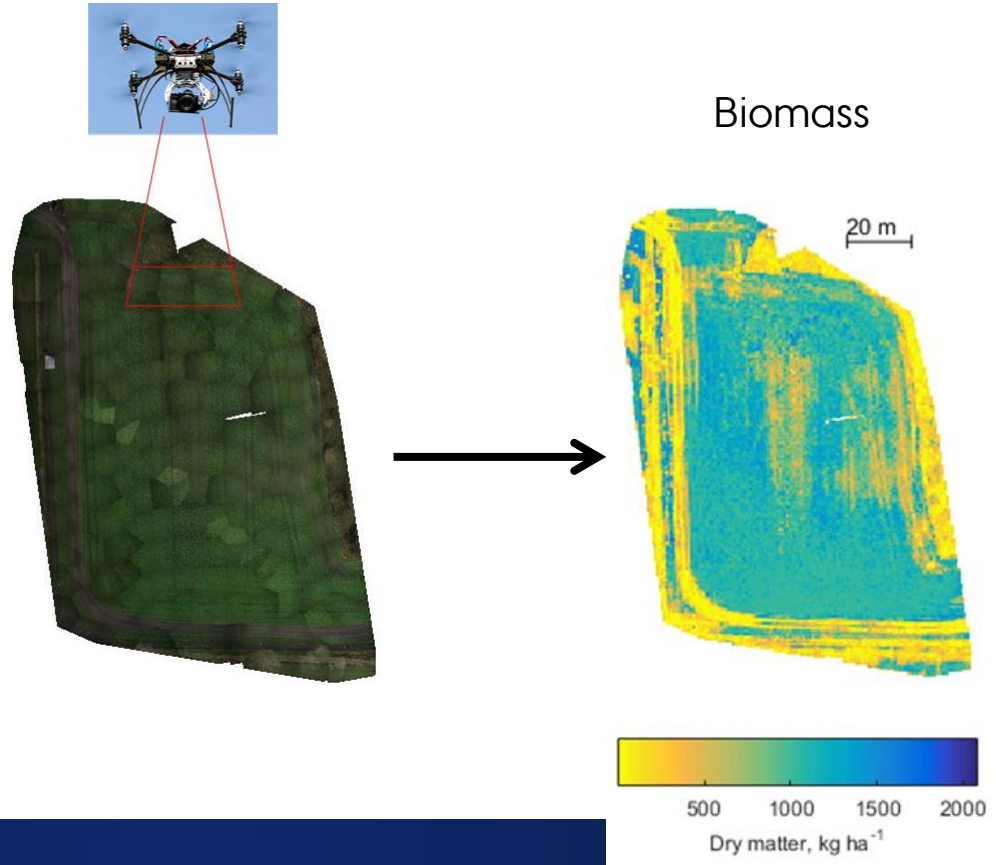
Final classification



Blue = oil radish  
Yellow = wheat  
Red = soil

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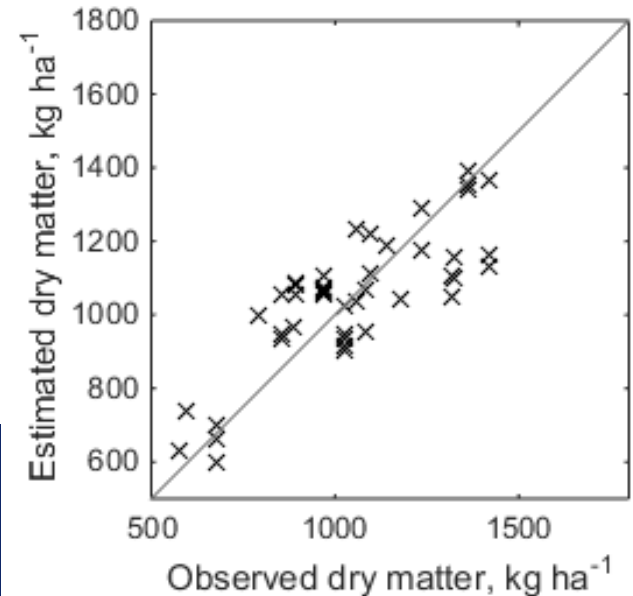


# BIOMASS ESTIMATION

- ▶ From image, extract square area equal to 0.5m<sup>2</sup>

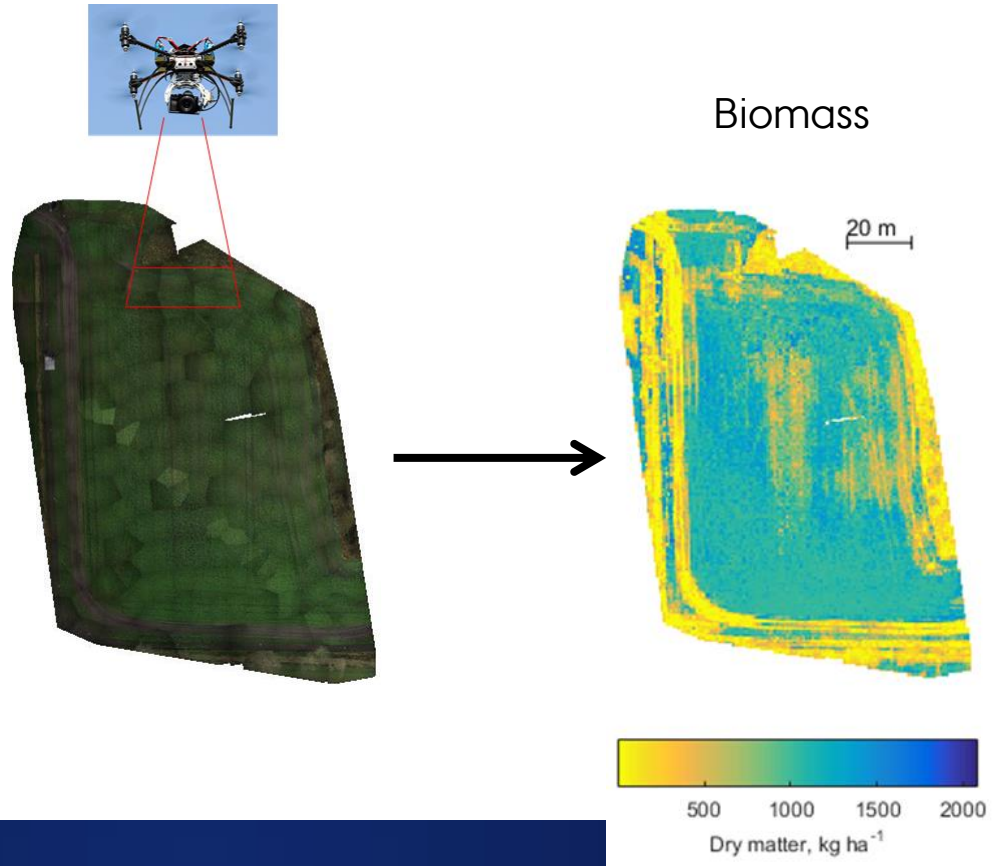
$$DM = \beta_1 R_C + \beta_2 W_C + \beta_3 R_C W_C + \beta_4 \frac{R_C}{S_C + 1} + \beta_5 \frac{W_C}{S_C + 1} + \beta_6 R_C L_A + \beta_7 L_A$$

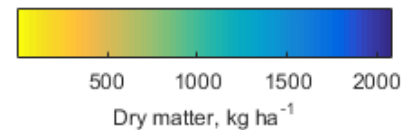
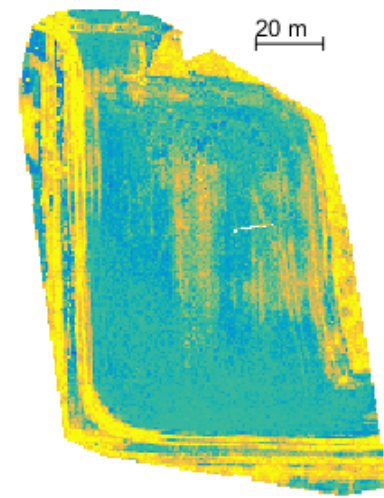
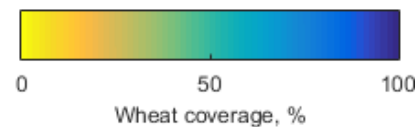
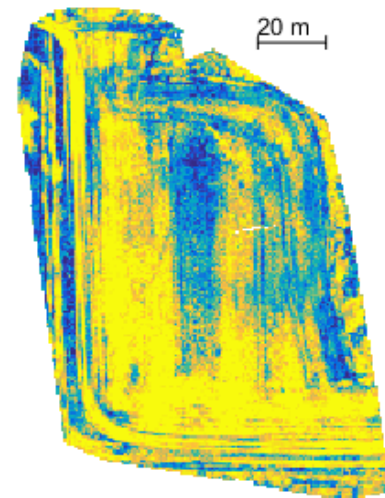
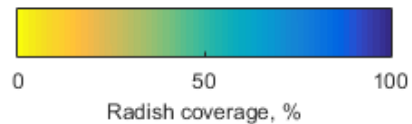
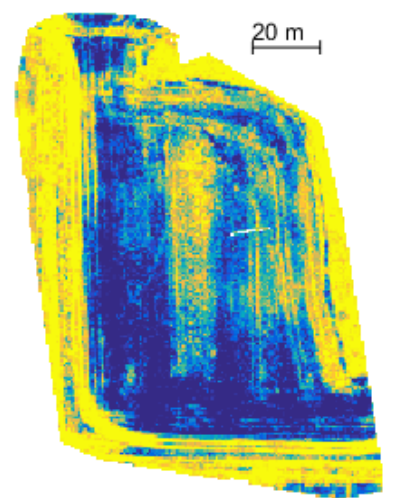
- ▶ DM = Dry matter
- ▶  $R_C$  = Radish coverage
- ▶  $W_C$  = Wheat coverage
- ▶  $S_C$  = soil coverage
- ▶  $L_A$  = Average (oil radish) leaf area
  - > Estimated using Canny edge detector
- ▶  $\beta_{1-7}$  = Model parameters



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# CONCLUSIONS

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- ▶ UAV
  - › Enables monitoring without affecting the field
- ▶ High resolution RGB images
  - › Distinguish species
  - › Biomass estimation



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