

Mapping vineyard foliage density with multispectral proxidetection imagery

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AGRO SUP Institut National de la Recherche Agronomique
INRA UDR



Introduction

I- Our motivation

II- Materials

- ✓ Vineyard field
- ✓ Experimental set-up

III- Methods

- ✓ Image correction and calibration
- ✓ Calcul of vegetation Index : NDVI

IV- Results and discussion

- ✓ Results of radiometric calibration
- ✓ NDVI Comparison between Imagery and Greenseeker

Conclusion and further works



Introduction



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Precision Viticulture: a new concept



To develop an adaptative management to each plant of the vineyard field

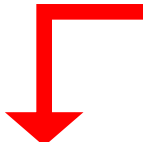
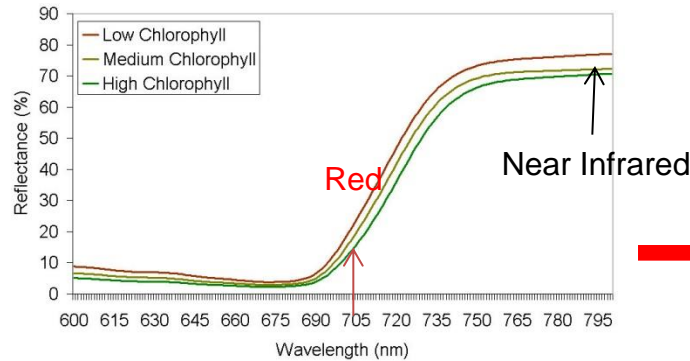


Collect Data for a site-specific management



Remote or proximal sensing

Precision agriculture

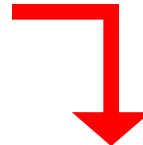


Remote sensing

Far characterization

GPS Hyperspectral or multispectral imagery

SPOT, © CNES



Proximal sensing

Close characterization

GPS

RGB or multispectral camera



I - Our motivation



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- 2013: Mapping vineyard foliage density: potential of multispectral proxidetection imagery (PhD. MA. Bourgeon, in progress)

Proximal sensing



Precision viticulture



In field characterization :

Multispectral Camera



R,G,B and NIR

Greenseeker (Trimble)



Vegetation index: NDVI

II - Materials

- ✓ Experimental Field
- ✓ Experimental Set-up



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■ Experimental vineyard field

• **Localization:**

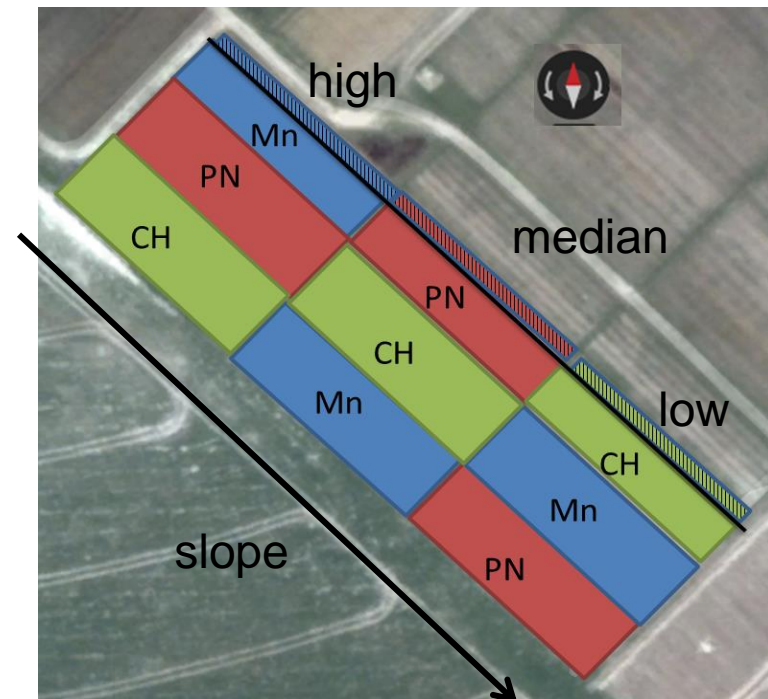
Experimental field of Comity of Champagne (C.I.V.C.),
Localized in Chouilly, Marne, France

• **Grapevine varieties:**

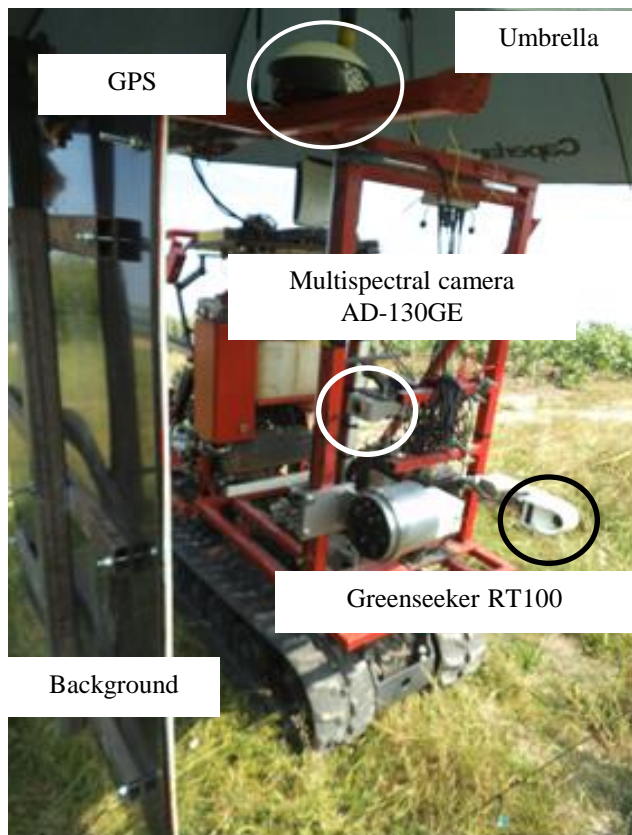
- Pinot Noir (PN) (black grappes)
- Chardonnay (CH) (white grappes)
- Meunier (Mn) (black grappes)

• **Datasets of images:**

- 4 datasets 2013 (~5500 images)
- Dataset N°1: 5 360 images



■ Experimental set-up :



Camera adaptation:

- Umbrella
- Black background

Greenseeker RT-100:

comparison method for vine vigor estimation

GPS: Data georeferencing

Acquisition system embedded on track laying tractor

■ The commercial multispectral camera AD-130GE (JAI, Japan)

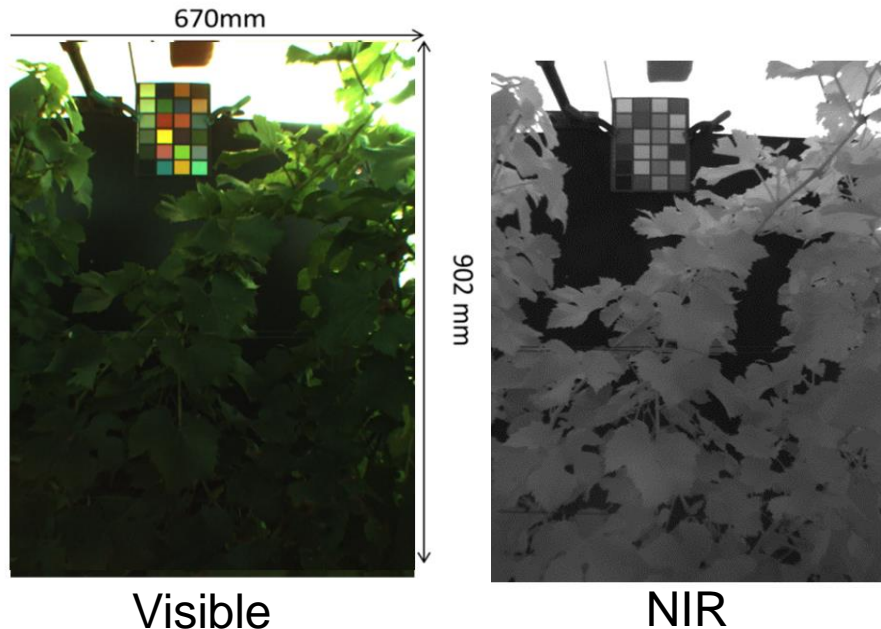
Bi-CCD camera:

- Visible (R,G,B): [450 - 700] nm
- Near Infrared (NIR): [750 – 850] nm

Both CCD size: 1296 x 966 px

Wide angle lens ($f= 2,8$ mm)

Example of a couple of RGB and NIR image:



III - Methods

- ✓ Image corrections and calibrations
- ✓ Calculation of Vegetation Index



Geometric calibration

- Optical devices entailed image distortions: forms and areas altered

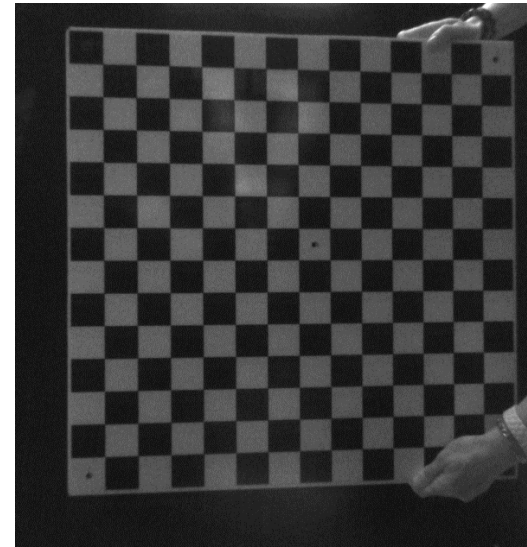
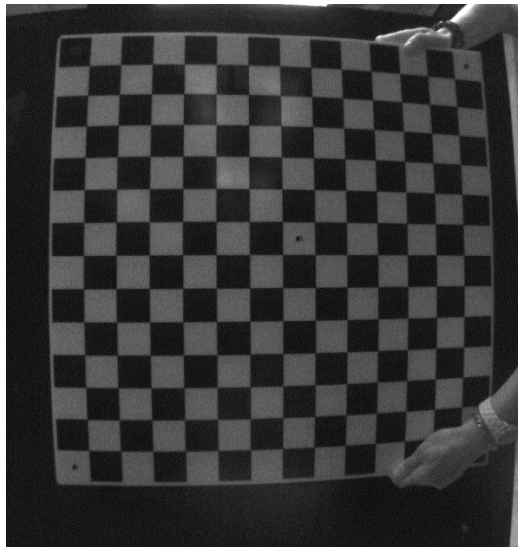


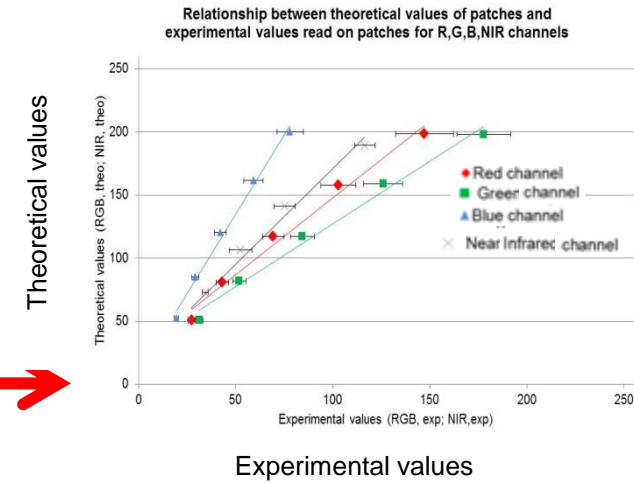
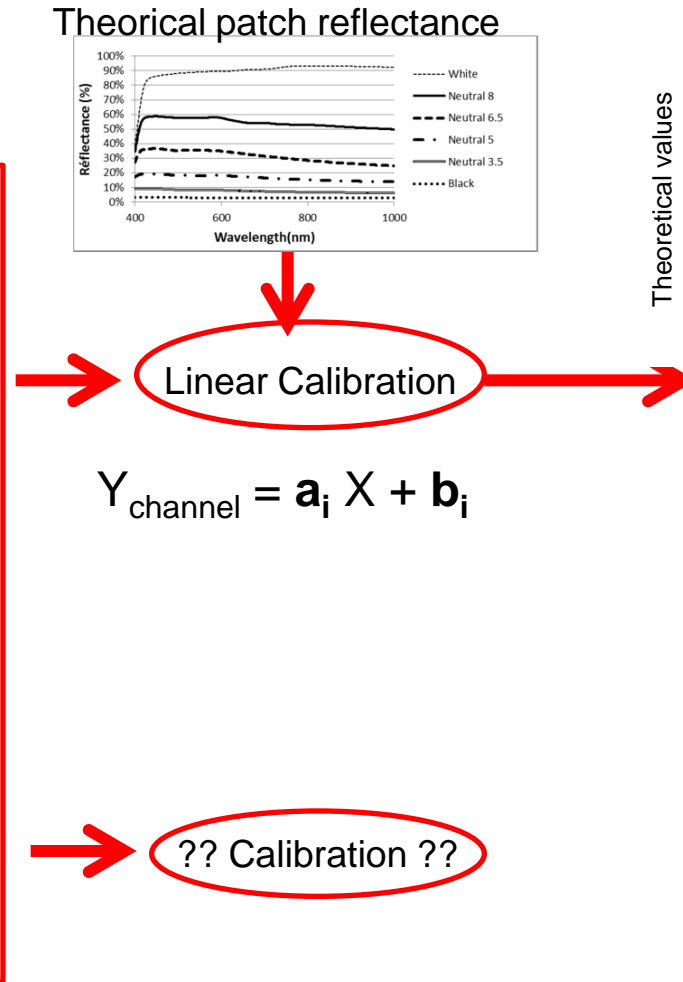
Image with distortion 

Image undistorted

Radiometric calibration



Radiometric calibration



Dataset of images

Images « with reference »
B,G,R, NIR

Images « without reference »
B,G,R, NIR

Radiometric calibration

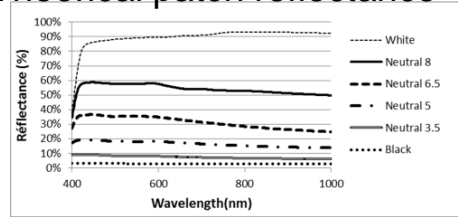
Images « with reference »
B,G,R, NIR



Images
« without reference »
B,G,R, NIR



Theoretical patch reflectance

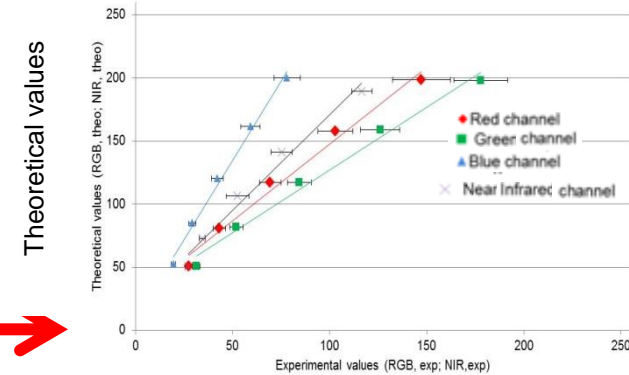


Linear Calibration

$$Y_{\text{channel}} = a_i X + b_i$$

Calibration

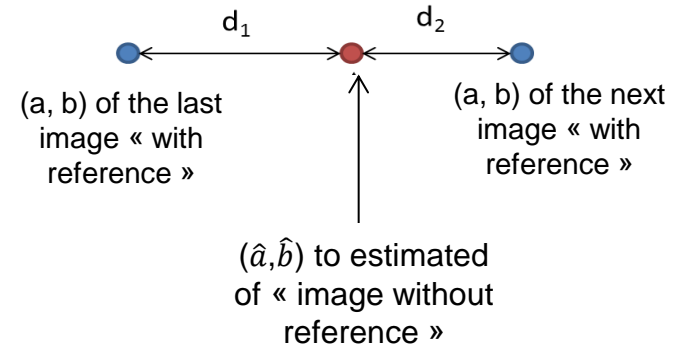
Relationship between theoretical values of patches and experimental values read on patches for R,G,B,NIR channels



Experimental values

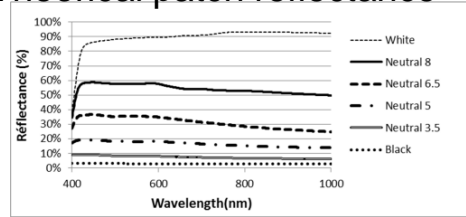
Interpolation

Spatial Interpolation Method: IDW

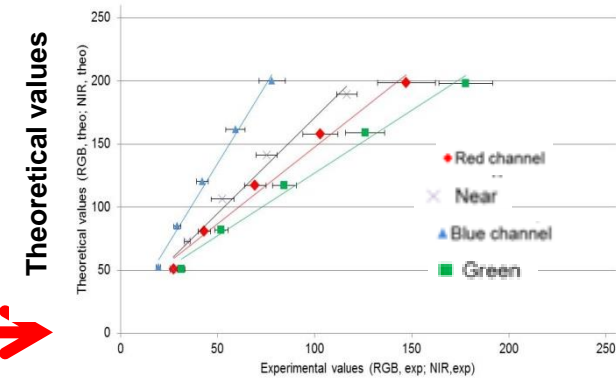


Radiometric calibration

Theoretical patch reflectance



Relationship between theoretical values of patches and experimental values read on patches for R,G,B,NIR channels



Images « with reference »
B,G,R, NIR



Images « without reference »
B,G,R, NIR



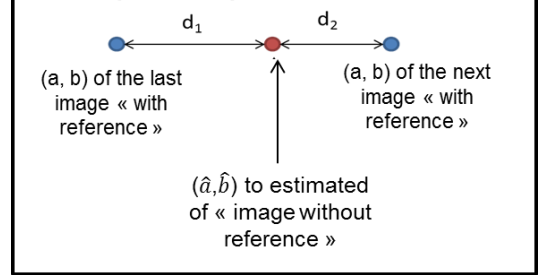
Linear Calibration

$$Y_{\text{channel}} = a_i X + b_i$$

Calibration

Interpolation

Spatial Interpolation Method: IDW



Vegetation index calculation:

$$NDVI = \frac{\rho_{IR} - \rho_R}{\rho_{IR} + \rho_R}$$

Dataset of images calibrated in reflectance

IV - Results

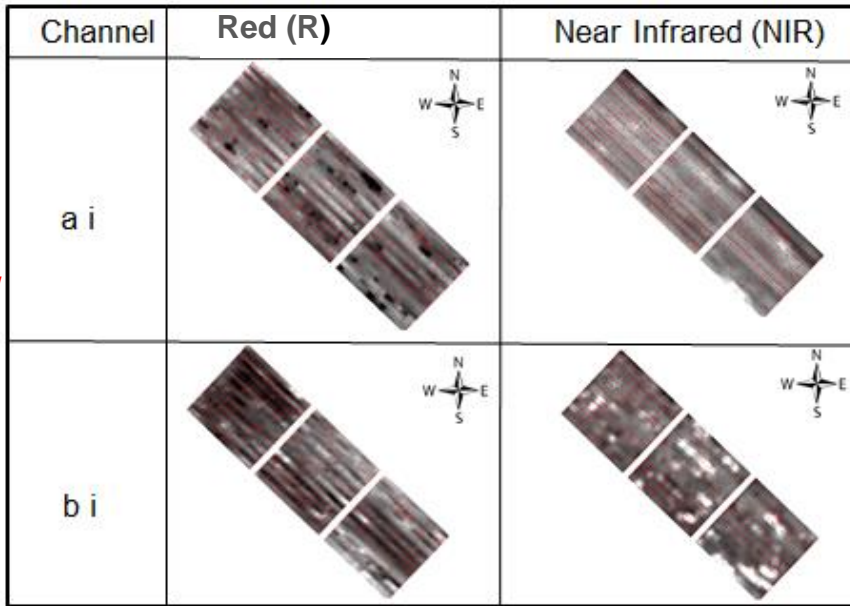
- ✓ Results of radiometric calibration
- ✓ NDVI Comparison



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■ Results of image calibration for dataset N°1:



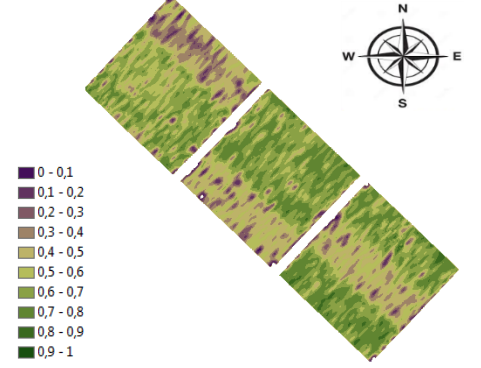
Dataset of images

IDW →

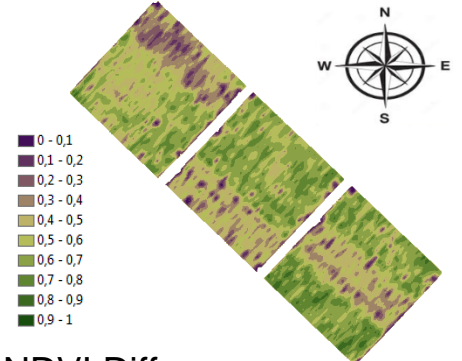
Calibration and NDVI calculation →

Example of mapping of (a,b) parameters estimated (Dataset N°1)

NDVI mapping - Greenseeker



NDVI mapping - Imagery



NDVI Differences =
Greenseeker – imagery



Conclusion and further works



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- **Capacity to calibrate images with and without reference in field conditions:**
 - Simple methodology of image calibration
 - Estimation of regression parameter with spatio-temporal statistic

- **First NDVI maps with calibrated images provided by proximal multispectral imaging system.**

- **Coherence with usual proximal sensor (Greenseeker)**



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Thanks for your attention





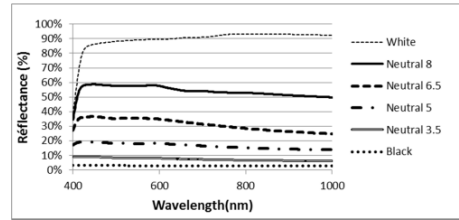
APENDIX



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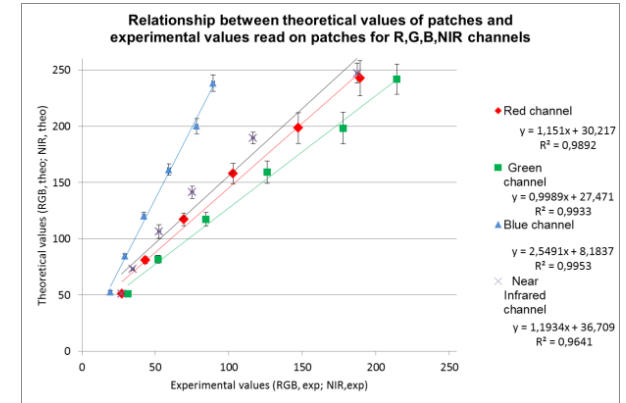


Radiometric calibration

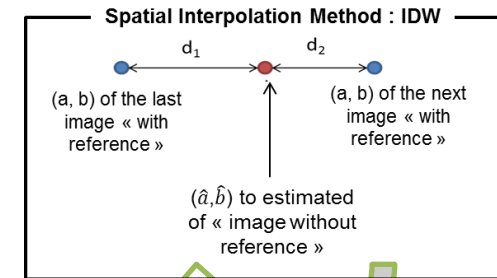


Calibration

Extension of IDW



IDW



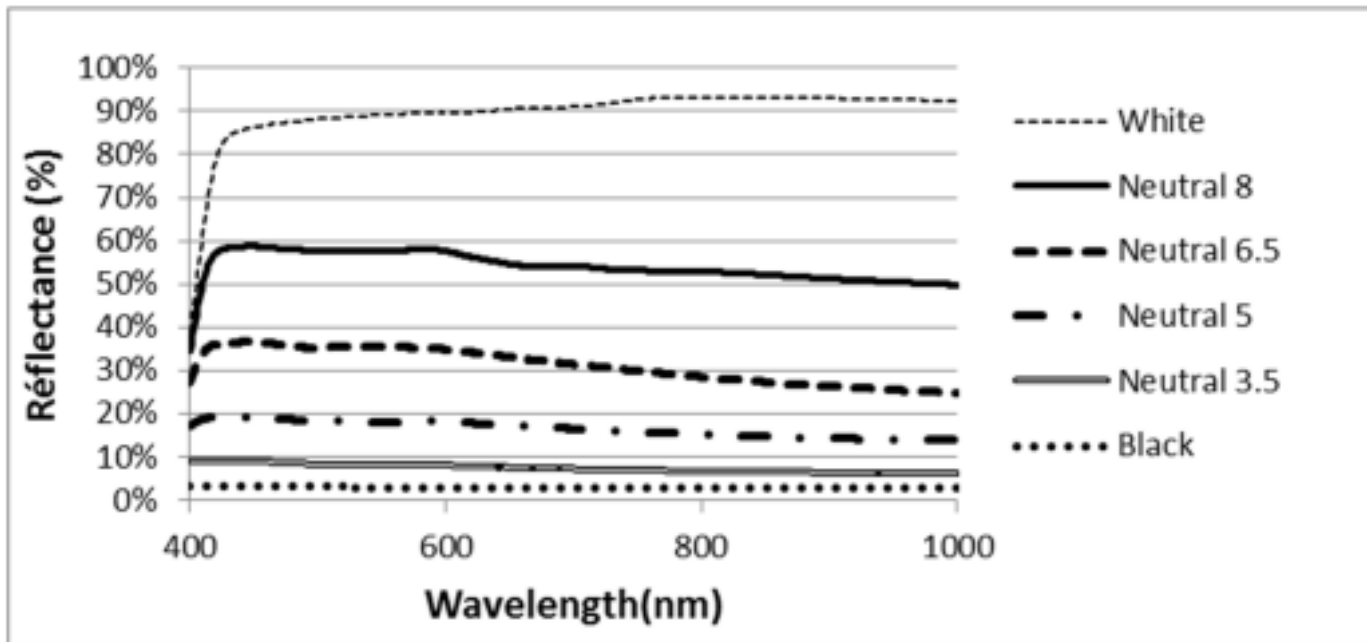
Cross-validation

Images calibrated in reflectance (ρ)

Agronomic Index:

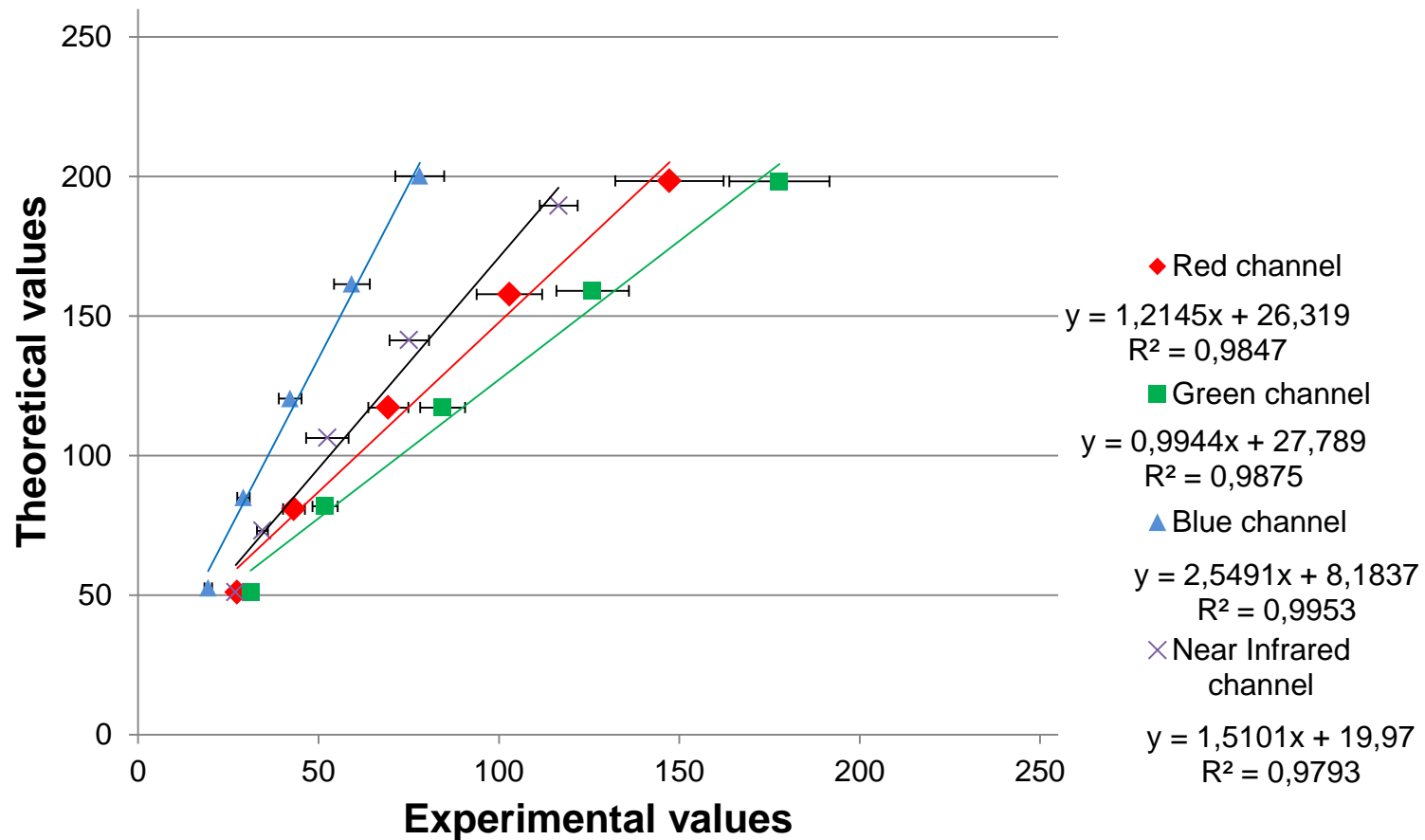
$$NDVI = \frac{\rho(IR) - \rho(R)}{\rho(IR) + \rho(R)}$$

Radiometric calibration



Radiometric calibration

Relationship between theoretical values of patches and experimental values read on patches for R,G,B,NIR channels



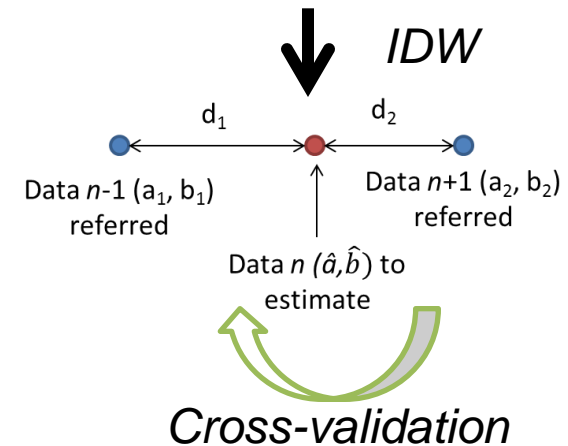
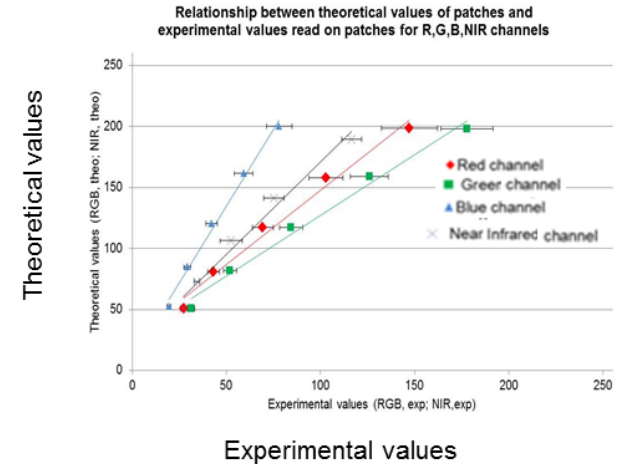
Radiometric calibration



Calibration
→

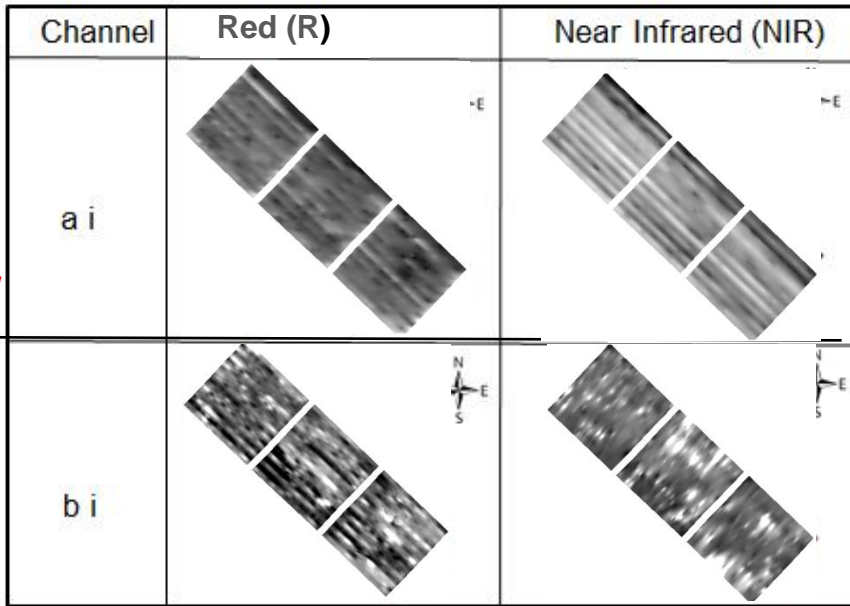
←
Extension of IDW

↓
Images calibrated
in reflectance (ρ)



→ Agronomic Index:

■ Results of image calibration for dataset N°2:



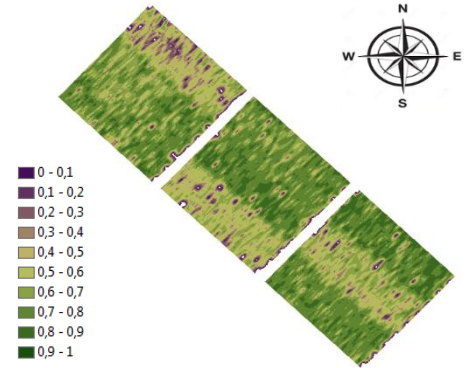
Dataset of images

IDW →

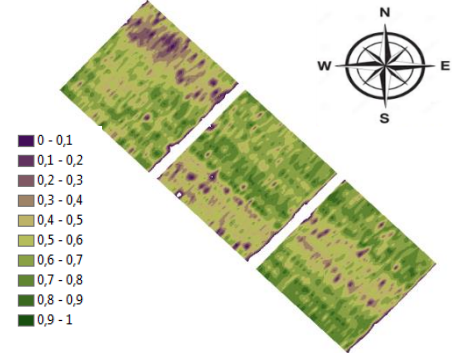
Calibration and NDVI calculation →

Example of mapping of (a,b) parameters estimated (Dataset N°2)

NDVI mapping - Greenseeker



NDVI mapping - Imagery



NDVI Difference =
Greenseeker - imagery

