Aerial imagery for site specific weed management

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Aerial imagery for site specific weed management

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Weed control with less reliance on herbicides
Workshop 26-28 May 2014

Contents

Introduction

- Impact of weeds on yields and crop quality

  → Control mainly based on the use of herbicides

- Environmental and health effects of herbicides

  → Reduction policies (i.e. Ecophyto)

- Increase of herbicide cost

→ Toward herbicide reduction

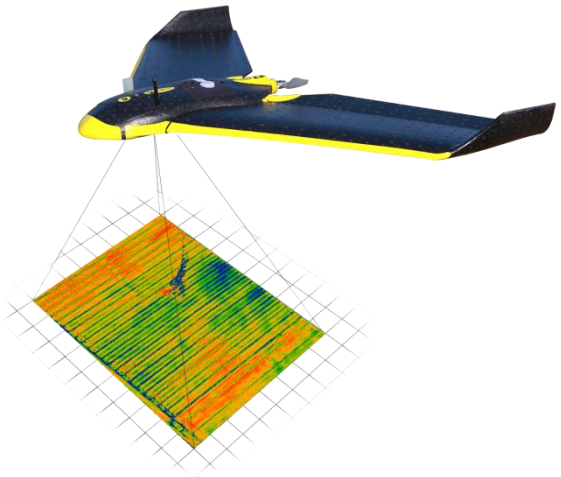
Identifying weed distribution for a better control

A need to localize weeds in a field :

- For farmers, to adapt their agricultural practices
- For researchers, to monitor trial plots

Using an Unmanned Aerial Vehicle (UAV) :

- Image acquisition of the whole field
- High resolution to identify weeds
- Information in real time



The project : weed localization by UAV

Collaboration between :

- AIRINOV, specialized in aerial image acquisition and processing for agriculture
- Team of Agricultural machinery engineering, AgroSup Dijon, works on imagery for weed detection

→ To evaluate a spectral imagery method for agro-system observation

→ To develop a new service of weed management

Contents

Acquisition system

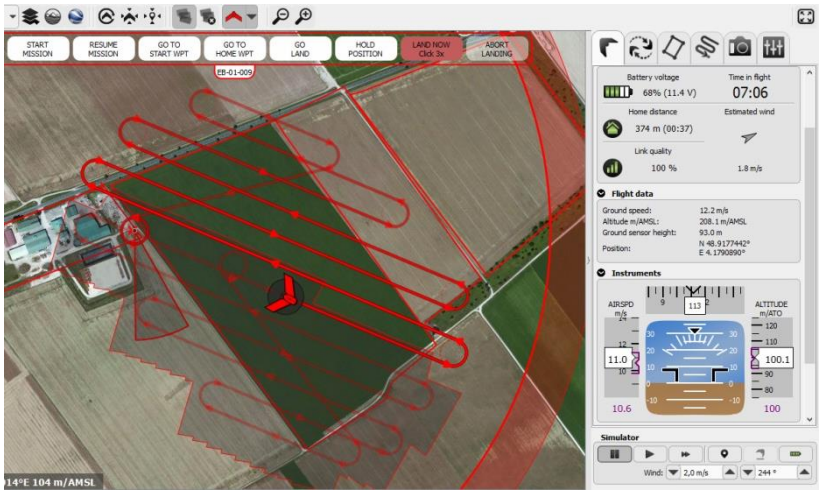
- UAV : flying wing of 1m

- Optical sensors for image acquisition :
  - Red Green Blue camera
  - Multispectral camera (4 filters)

- Positioning sensors : GPS, inertial unit

→Automated flight

→Georeferenced images



Orthoimage characteristics

- Orthoimage:
  - Image corrected from distortions and light variations
  - Flat image of the whole field

- Colors :
  - Red, Green, Blue
  - Multispectral : Green, Red, Red Edge zone, Infra-Red
- Spatial resolution : up to 1 cm/pixel

Studied species

Crops : maize, sunflower, sugar beet, wheat and rape

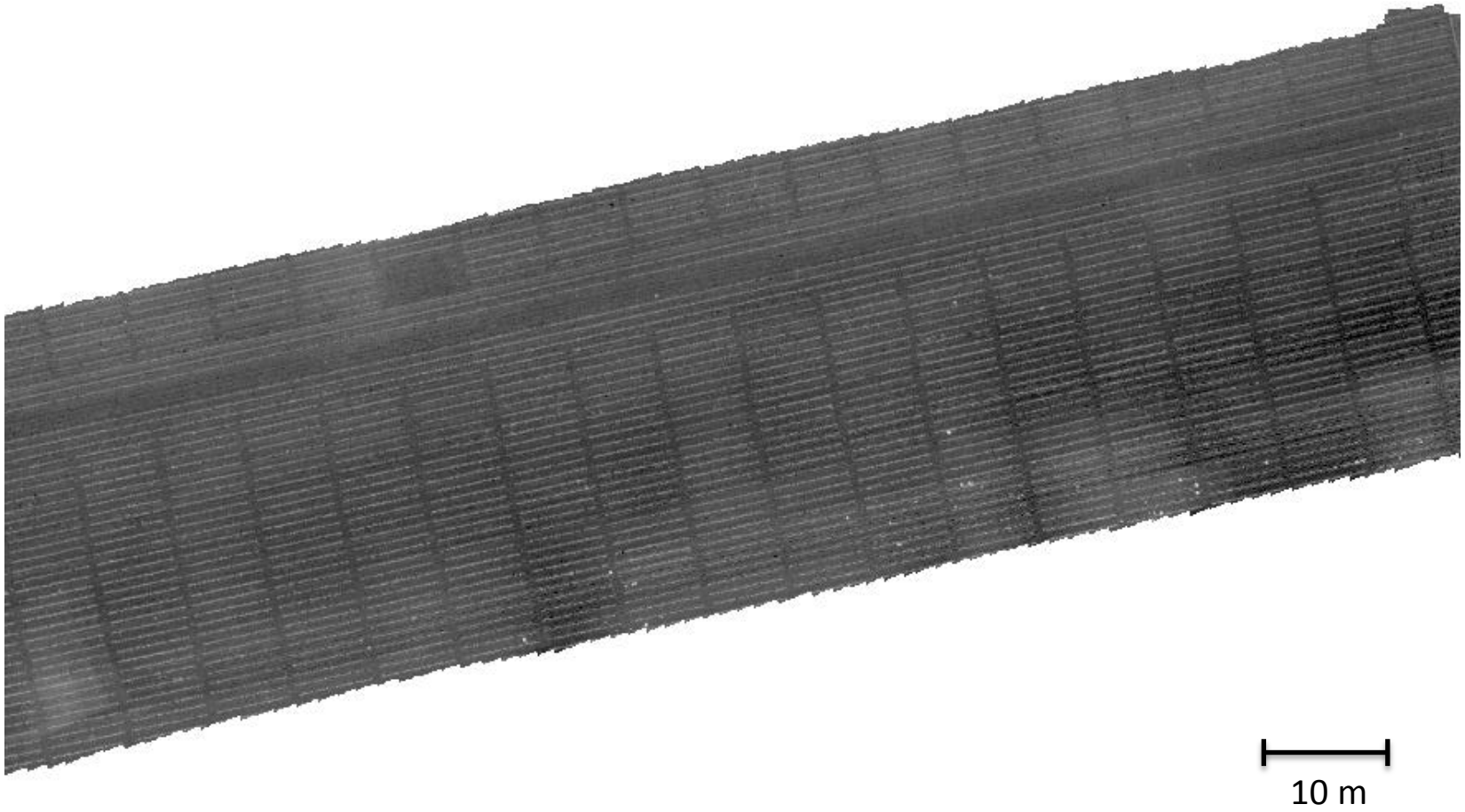
Weeds encountered on these crops

Characteristics :

- Seedling of row-crops :
  - distinct parallel lines
  - constant inter-row
- Weeds : mainly distributed in patches
- With a specific spectral signature (varies with the species and the physiologic state)

Contents

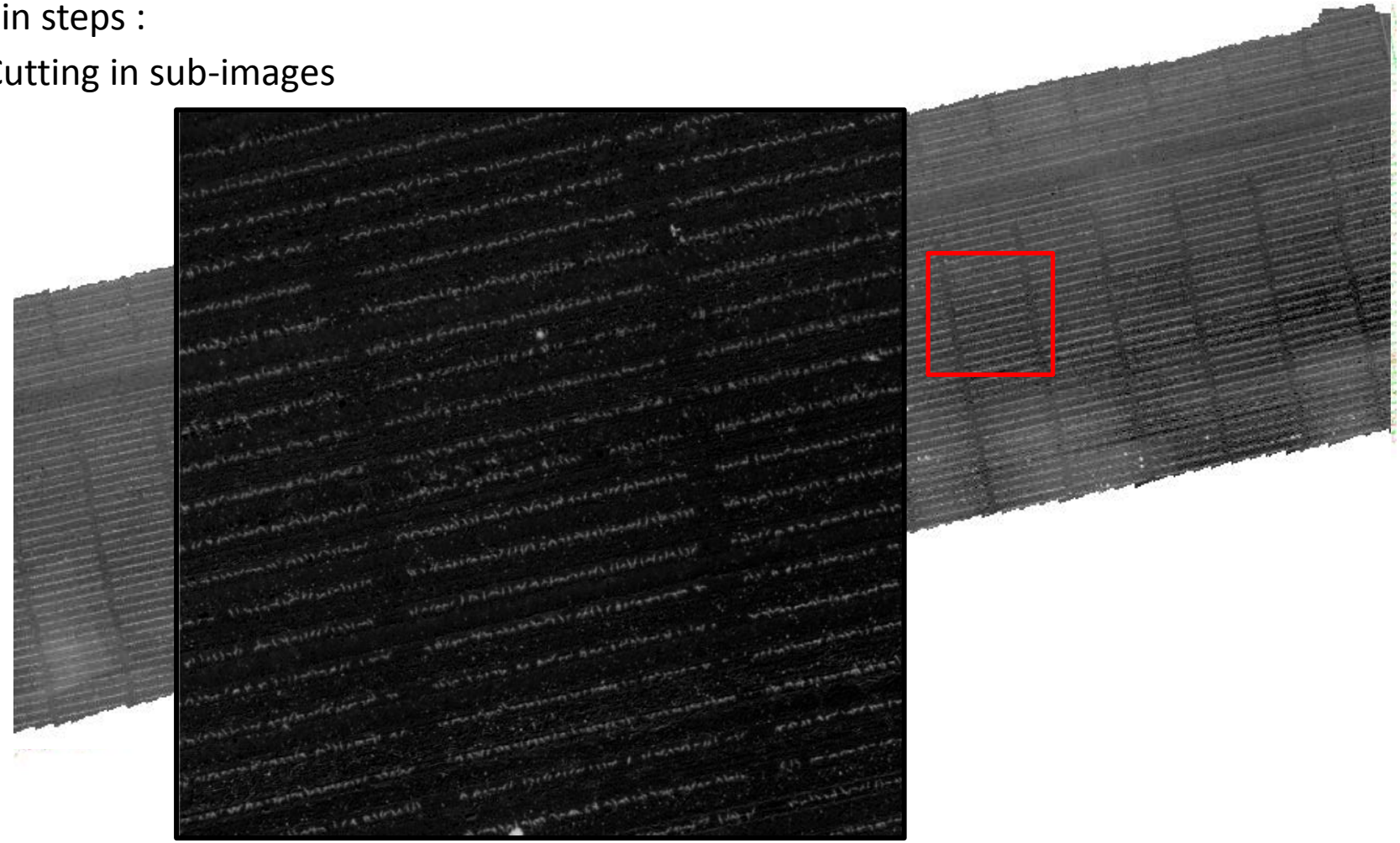
A method based on row crop detection



A method based on row crop detection

Main steps :

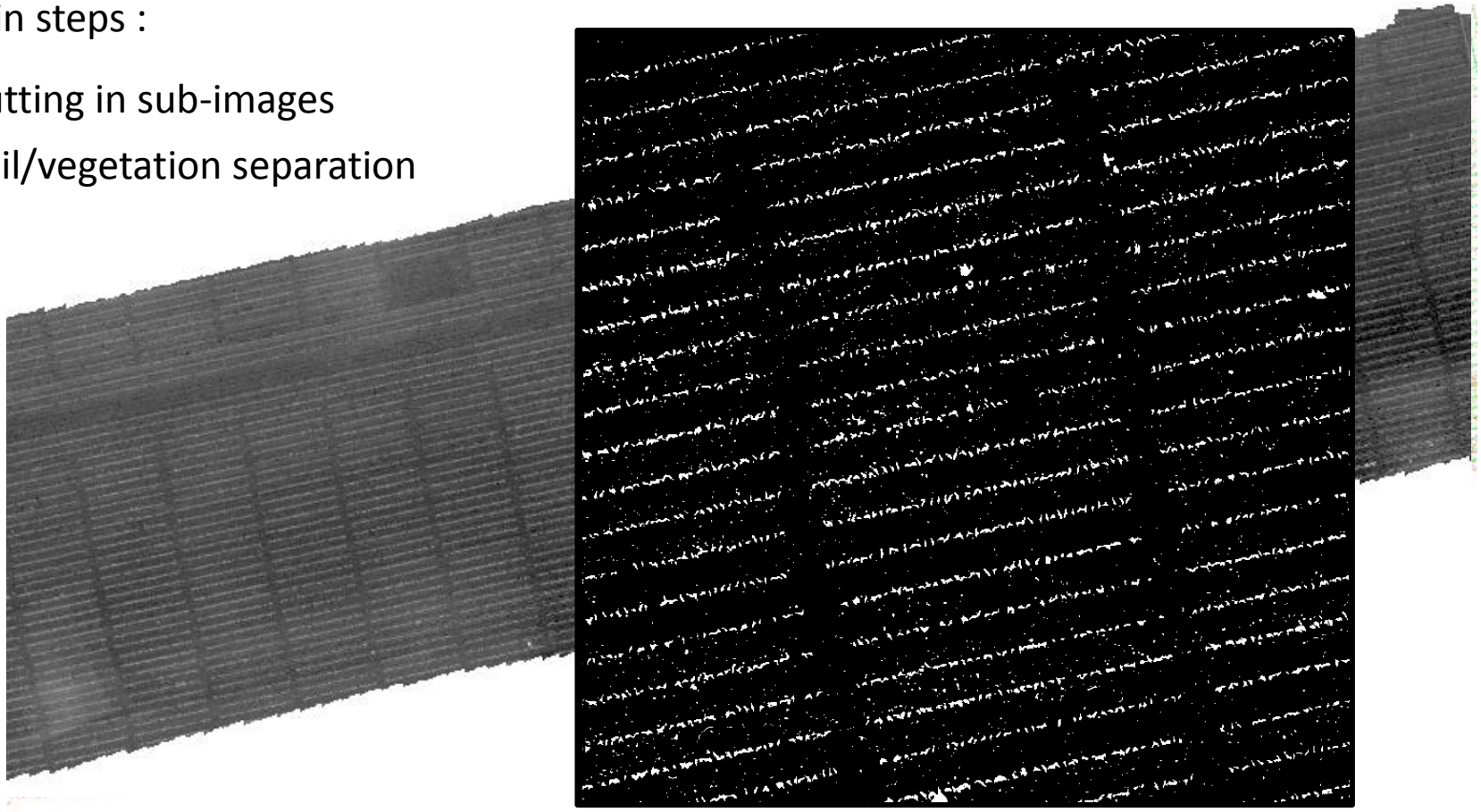
- Cutting in sub-images



A method based on row crop detection

Main steps :

- Cutting in sub-images
- Soil/vegetation separation



A method based on row crop detection

Main steps :

- Cutting in sub-images
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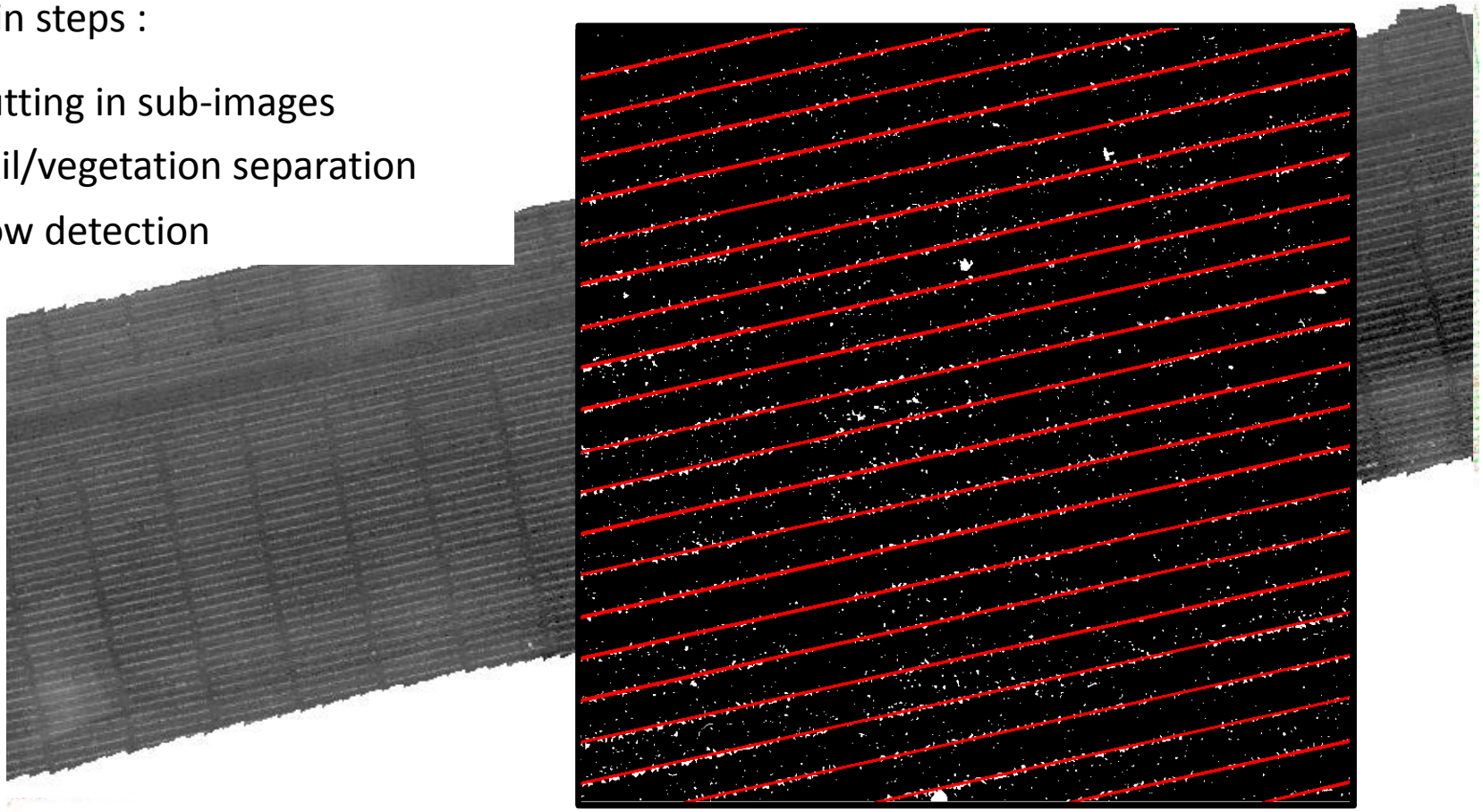
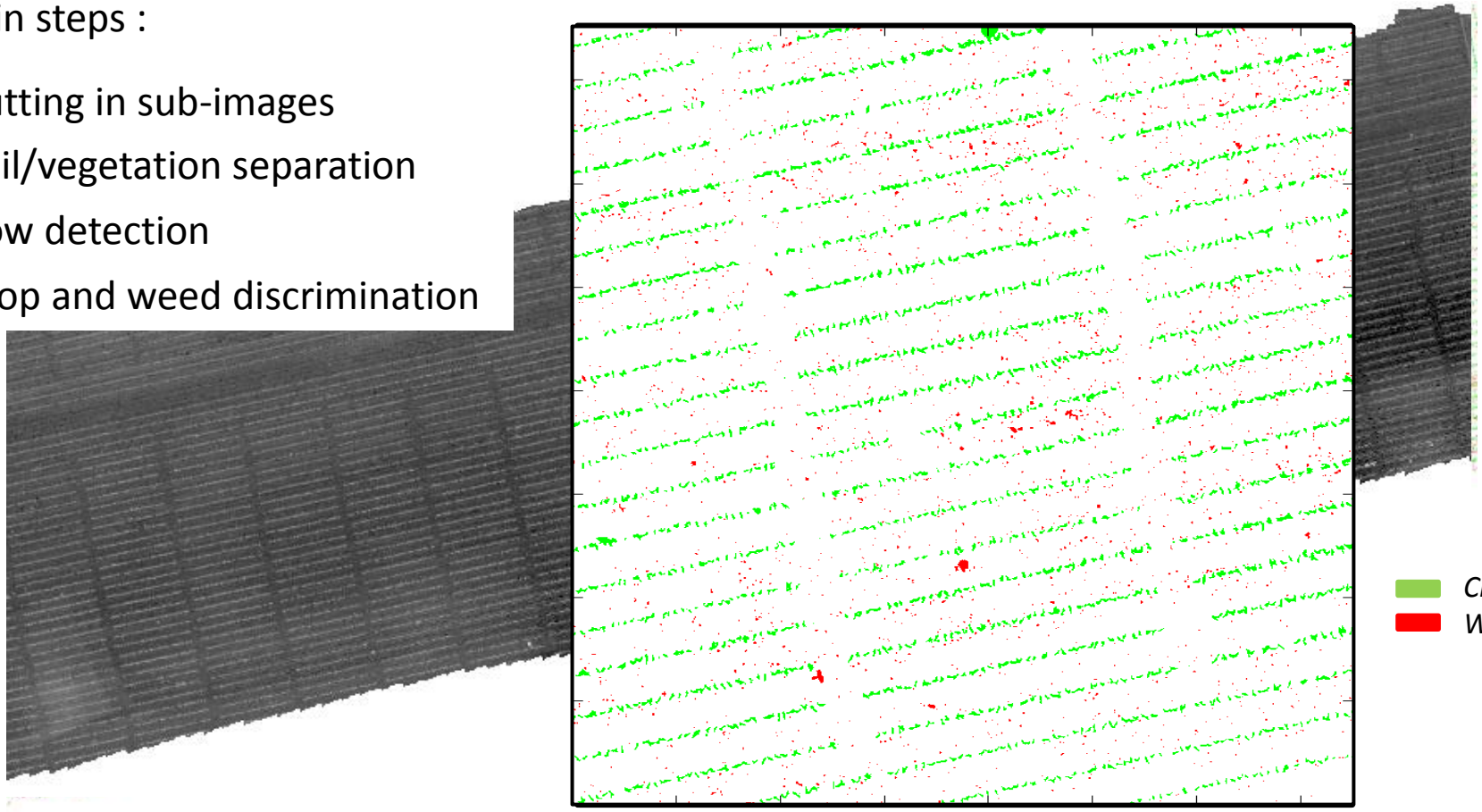


A method based on row crop detection

Main steps :

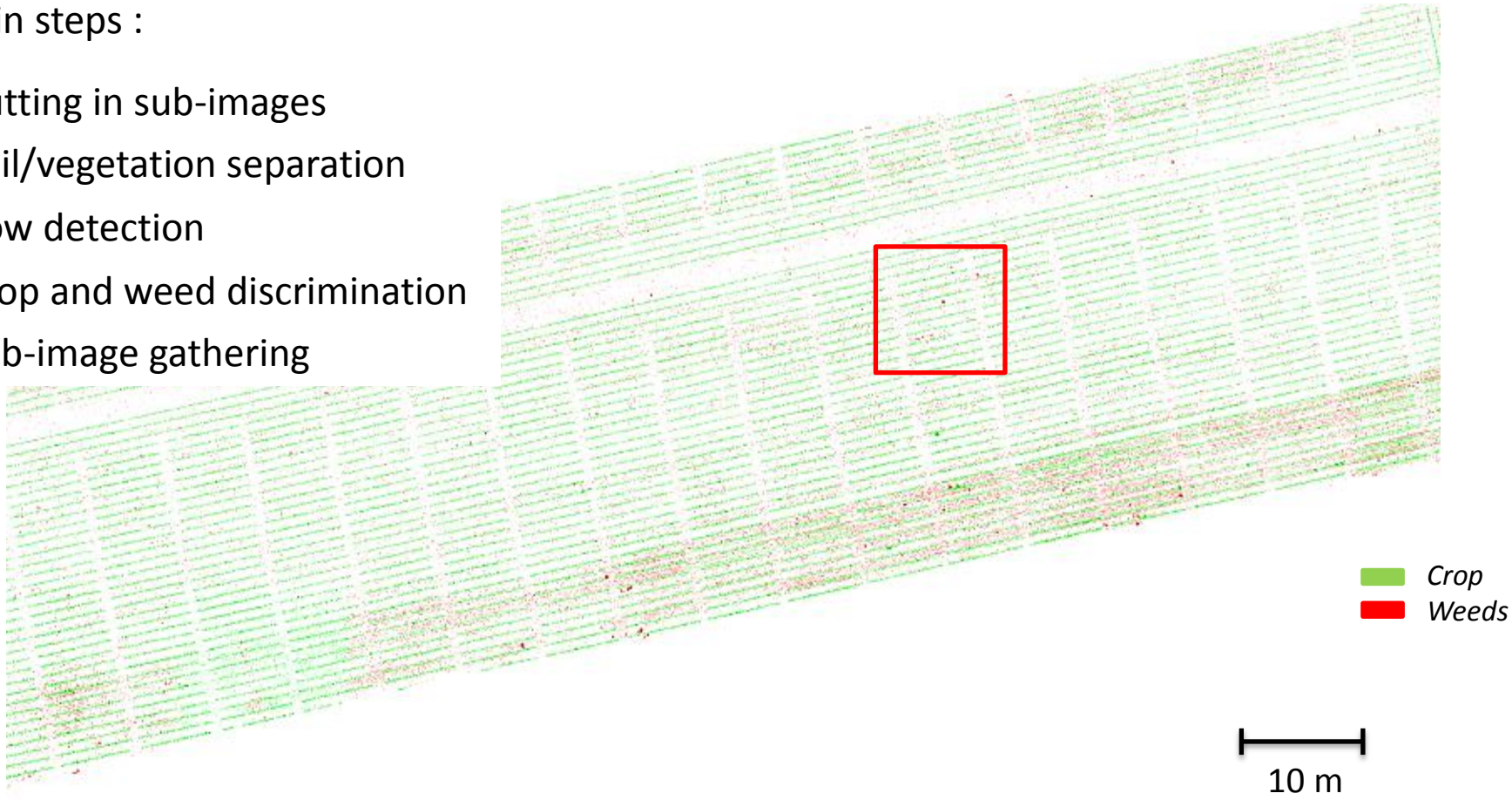
- Cutting in sub-images
- Soil/vegetation separation
- Row detection
- Crop and weed discrimination



A method based on row crop detection

Main steps :

- Cutting in sub-images
- Soil/vegetation separation
- Row detection
- Crop and weed discrimination
- Sub-image gathering



Results

Algorithm tested on RGB and multispectral images

Limits :

- Crop rows are supposed to be straight lines
- Weed detection is possible in the inter-row only
- This algorithm is only adapted to crops sowed in distinct rows
- Impact of the resolution on the detection

→ Improvement with spectral information

Contents

Spectral analysis

How to complete this spatial method with spectral analysis?

Can we discriminate soil, crops and weeds according to their reflectance spectrum ?

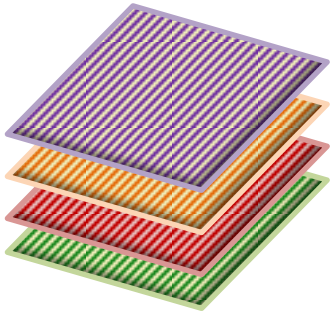
Which filters to use to detect weeds in the fields ?

Understanding the processing chain

Sensor characteristics

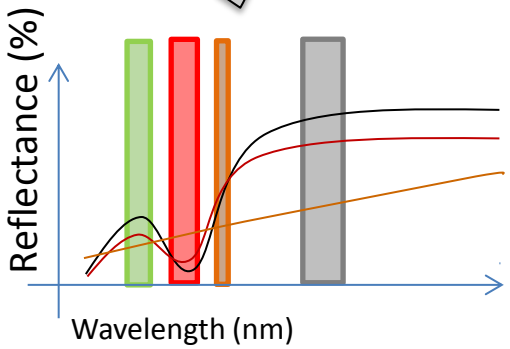
Processing

Multispectral image of the field



Filter selection

Spectrum acquisition in laboratory



Which filters allow the best discrimination between crops and weeds?

Spectrum acquisition

Spectrometer :

→ Full spectrum from 350nm to 2500 nm

→ Reflectance spectrum

Spectrum acquisition of soil, crop and weed

- At different stages
- Pure spectrum of the whole plant

  → Spectrum unmixing process

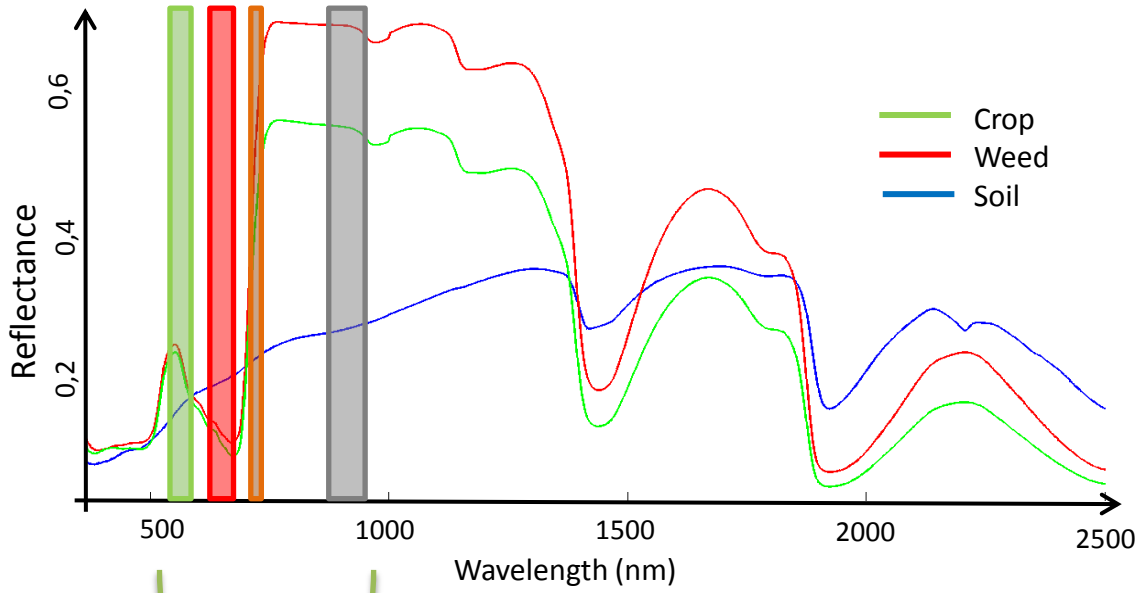
- Spectrum in the field

Colored background

Spectrum acquisition – Studied species

		Crop				
		Maize	**Sunflower**	**Sugar beet**	**Wheat**	**Rape**
Dicotyledonous weeds	**Lamb's quarters** (chenopodium album)	X	X	X		
	Wild buckwheat (Fallopia convolvulus)	X	X	X		
	Goosegrass (Galium aparine)			X	X	X
Monocotyledonous weeds	**Barnyard Grass** (Echinochloa crus-galli)	X	X			
	Black grass (Alopecurus myosuroides)			X	X	X
	Rye grass (Lolium multiflorum)				X	X
Volunteers	**Wheat**					X
	Rape				X	
	Sunflower				X	

Wavelength selection

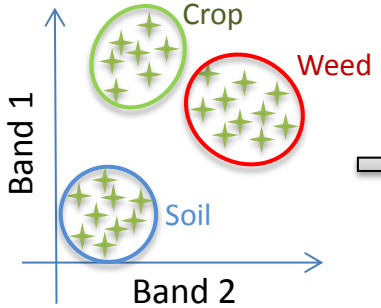


Assessment of each combination of bands → classification

Combination of 4 spectral bands (≈ pixel)

$$\begin{pmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{pmatrix}$$

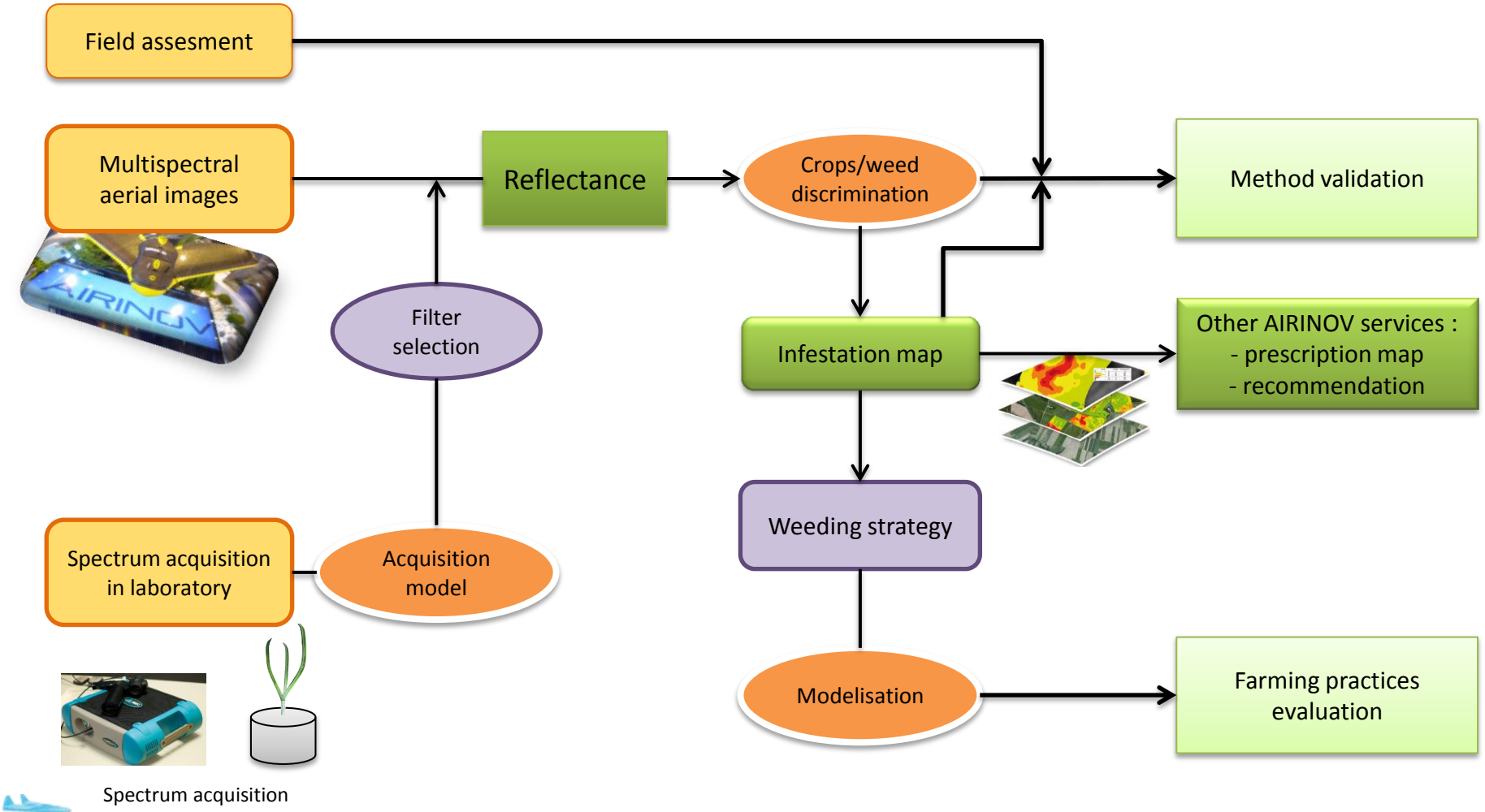
Classification of each pixel



		Predicted class		
		Crop	Weed	Soil
Actual class	Crop	? %	? %	? %
	Weed	? %	? %	? %
	Soil	? %	? %	? %

Contents

Practical application



Practical application

- Weed localization
- Weed identification (monocot/dycot, family, species)
- Annual or inter-annual monitoring of the fields

- Adapted recommendation to the field characteristics and to the equipment (i.e. precision spraying)

Conclusion

- New technologies for weed localization
- Ability to localize weeds with a UAV on crops sowed in rows
- Using spectral information to improve this method

  → Filter selection

  → Pixel classification

- Map production for recommendation or weed monitoring

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Thank you for your attention