Aerial imagery for site specific weed management

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Aerial imagery for site specific weed management

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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

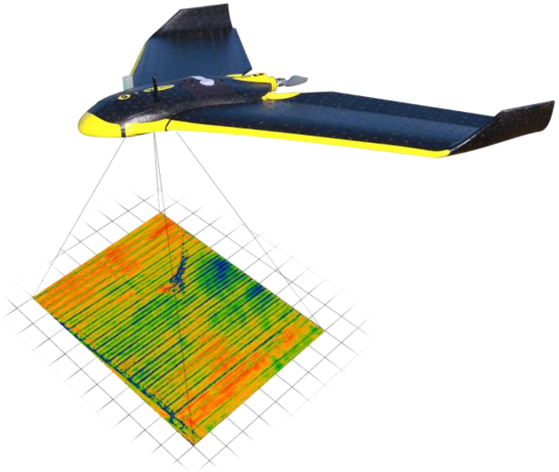
Identifying weed distribution for a better control

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

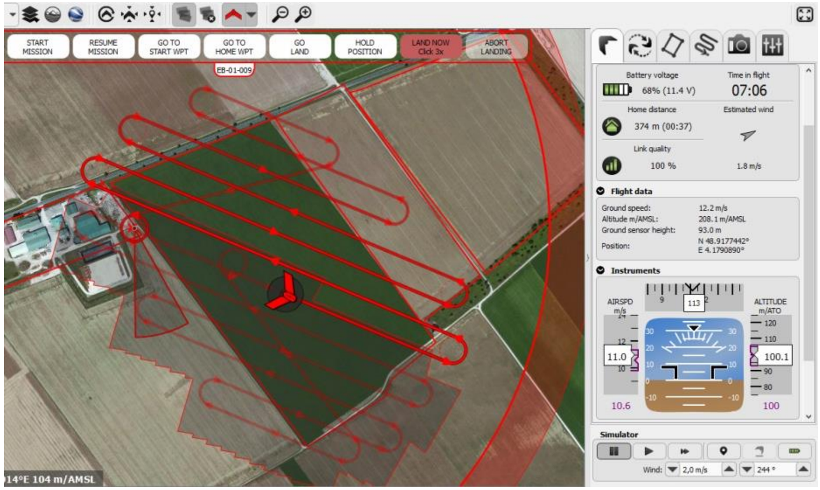
Contents

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



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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

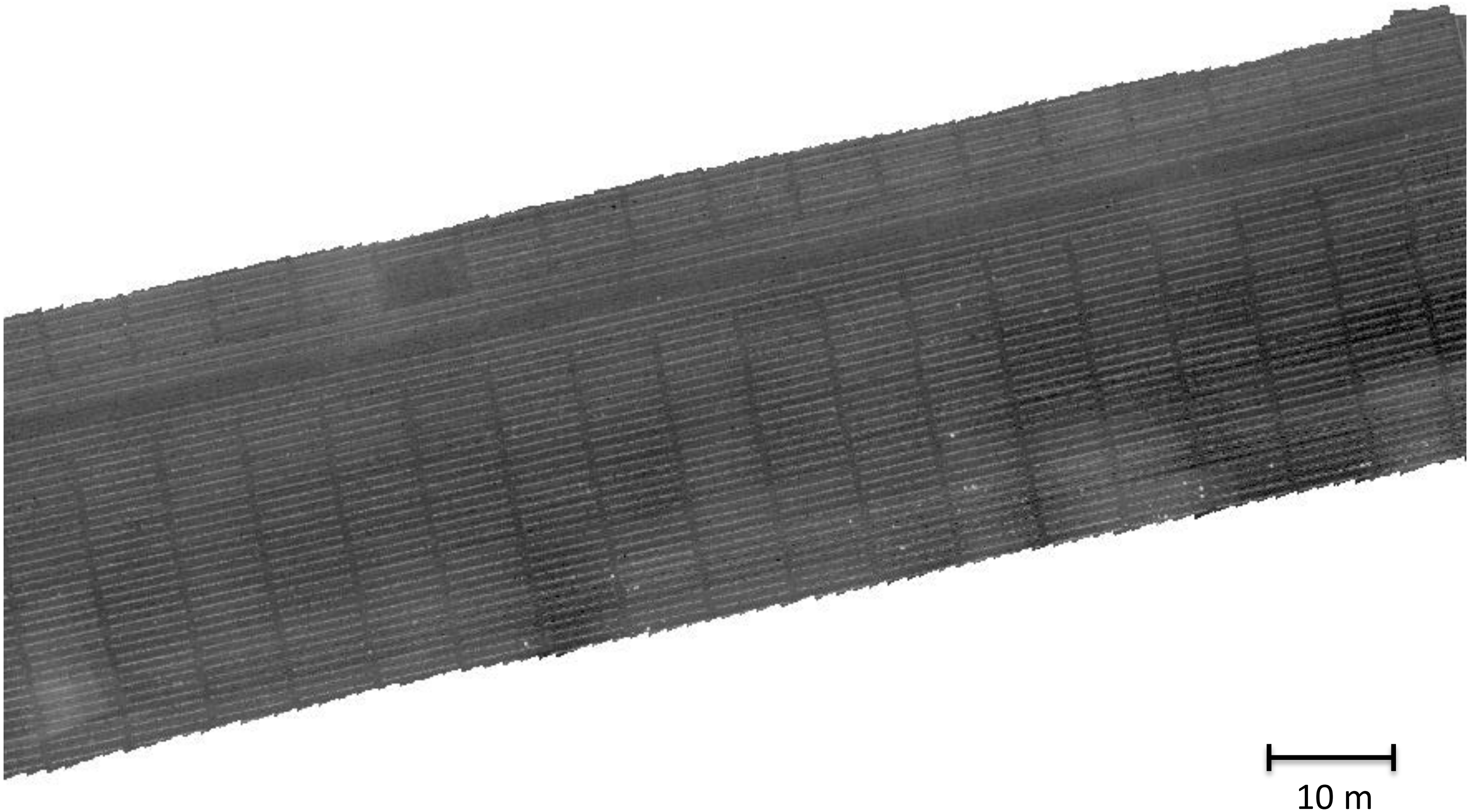
Weeds encountered on these crops

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

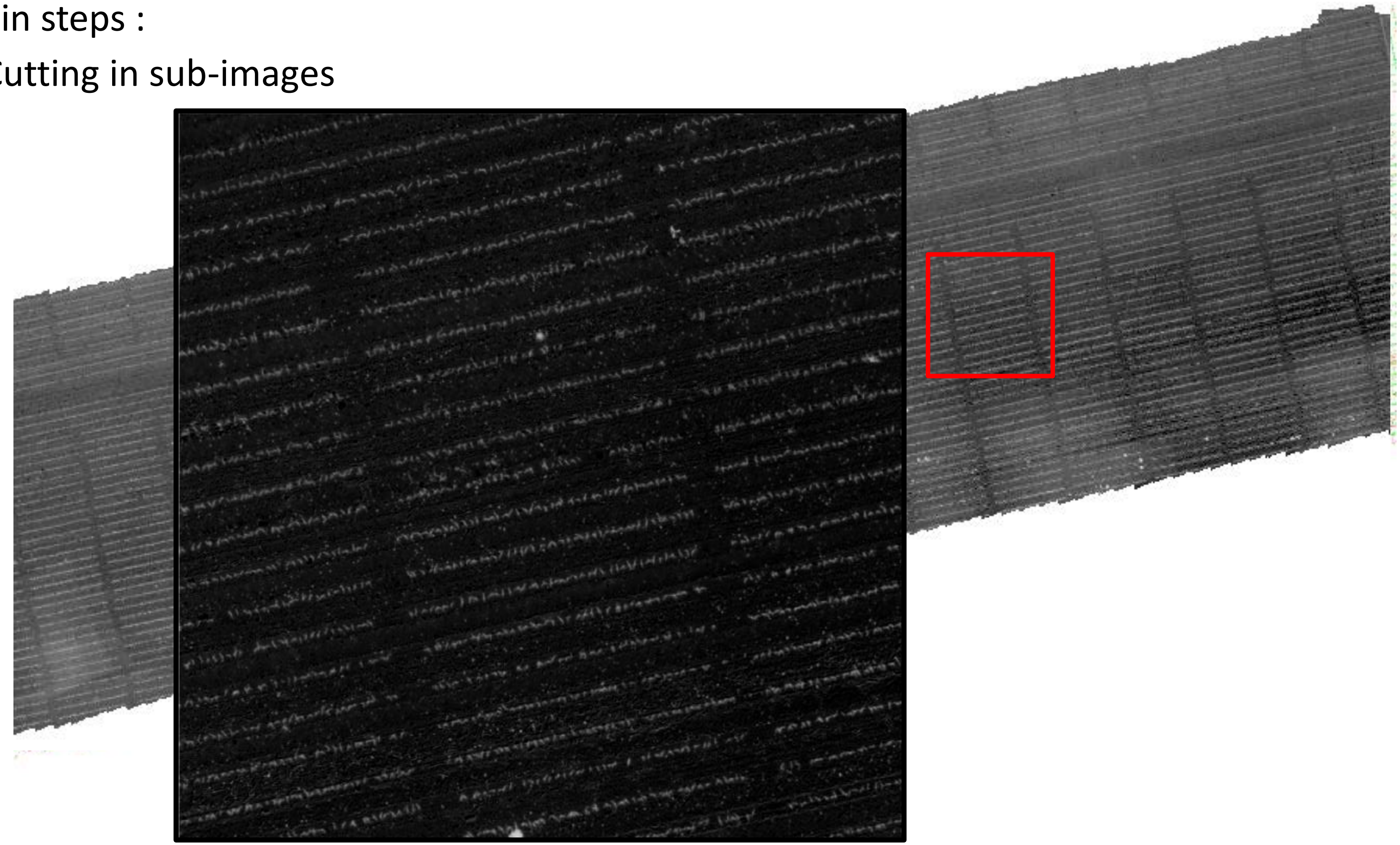
A method based on row crop detection



A method based on row crop detection

Main steps :

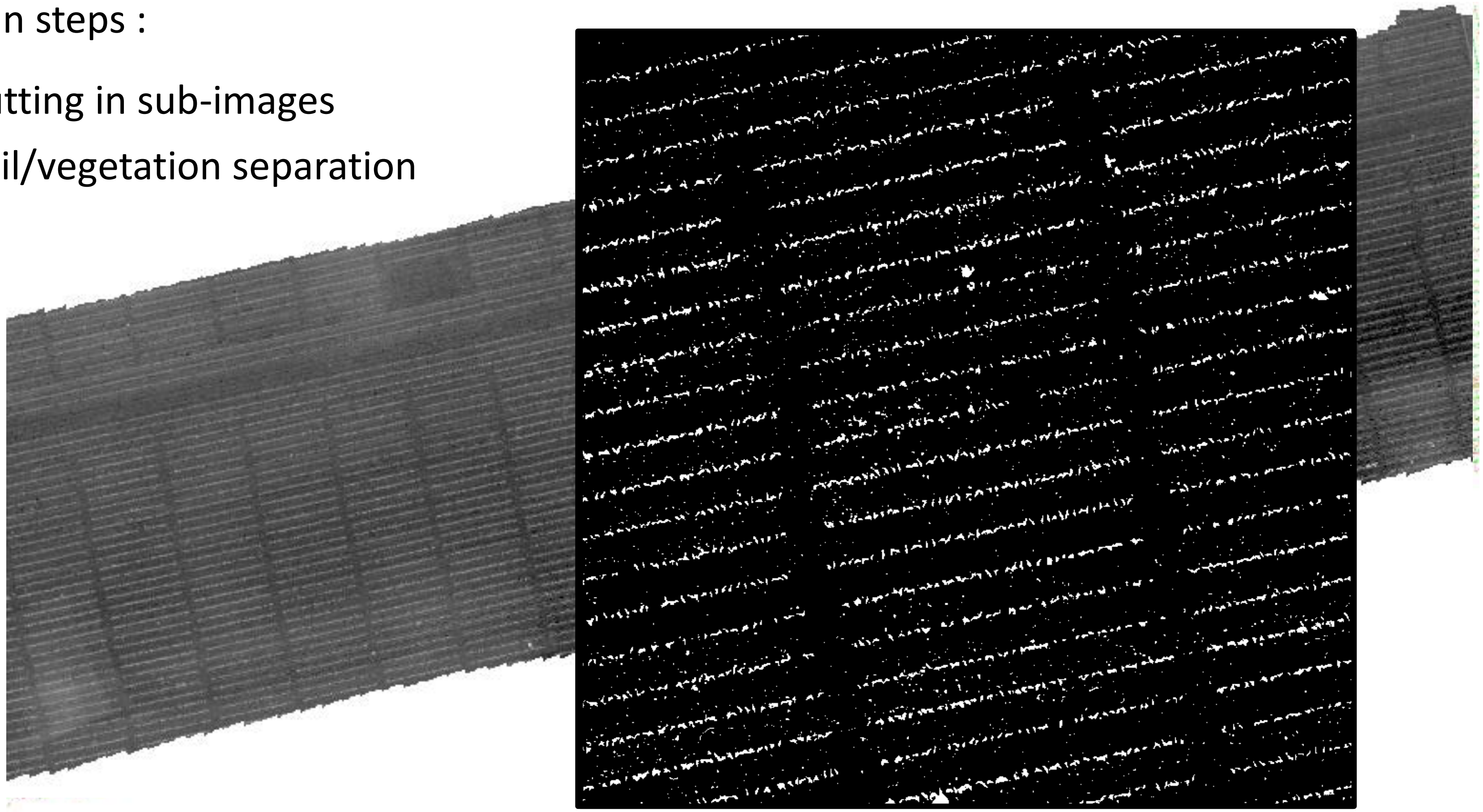
- Cutting in sub-images



A method based on row crop detection

Main steps :

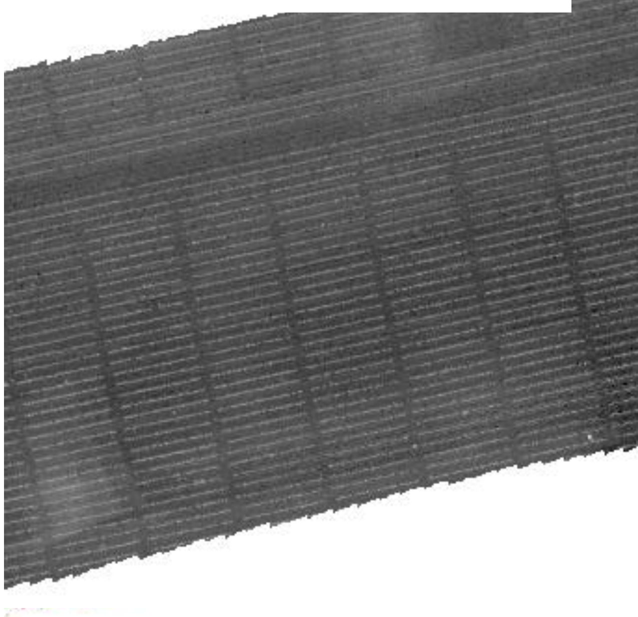
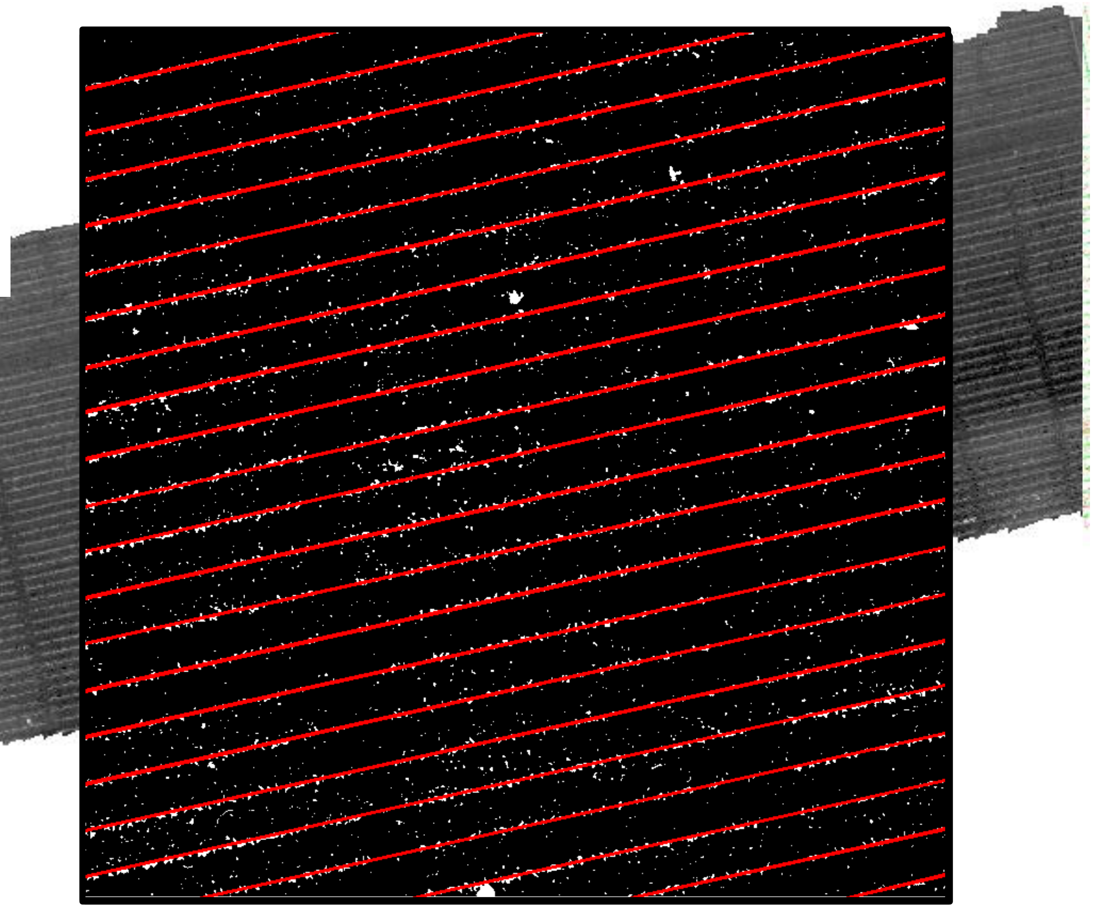
- Cutting in sub-images
- Soil/vegetation separation



A method based on row crop detection

Main steps :

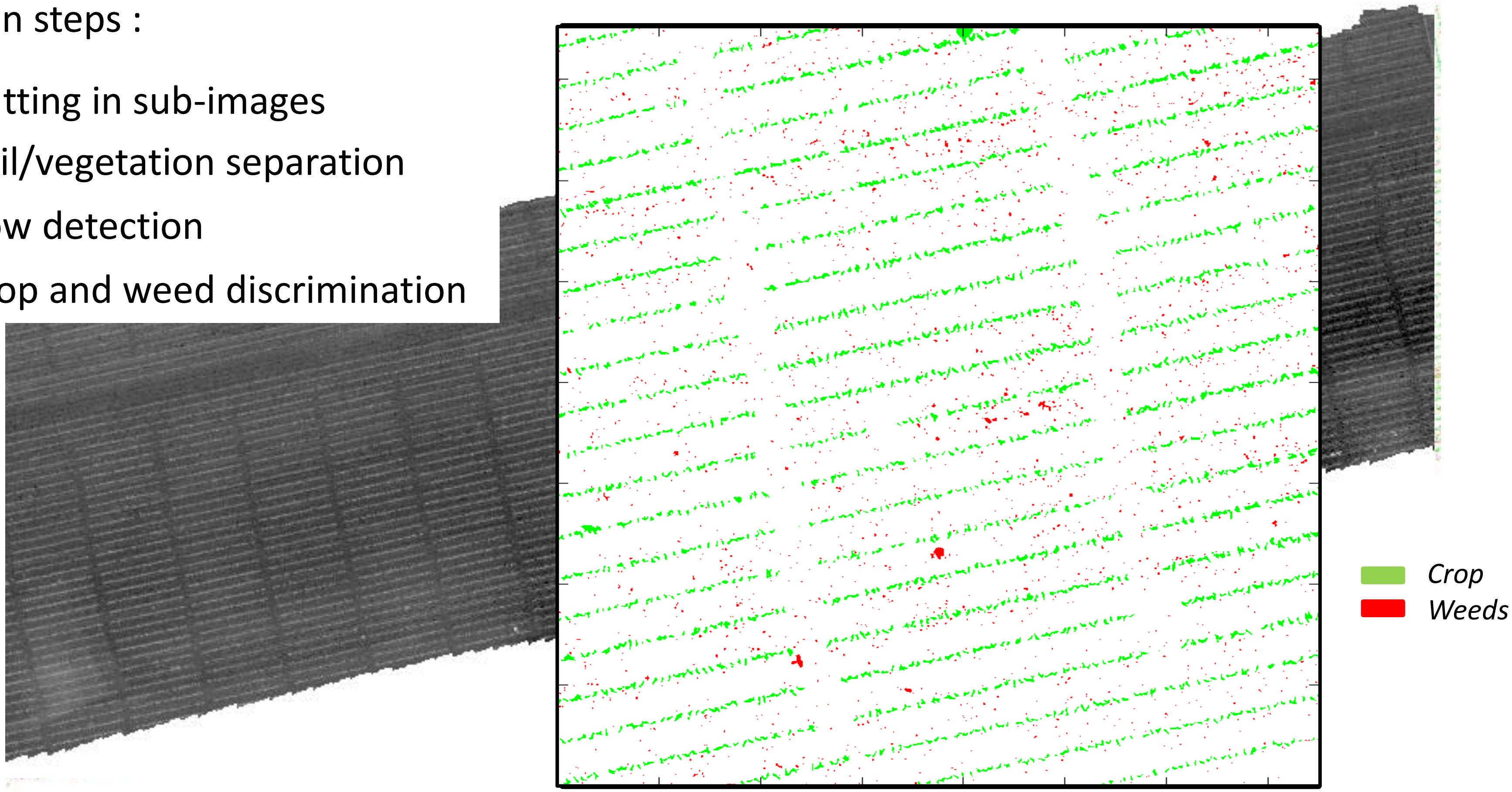
- Cutting in sub-images
- Soil/vegetation separation
- Row detection

A method based on row crop detection

Main steps :

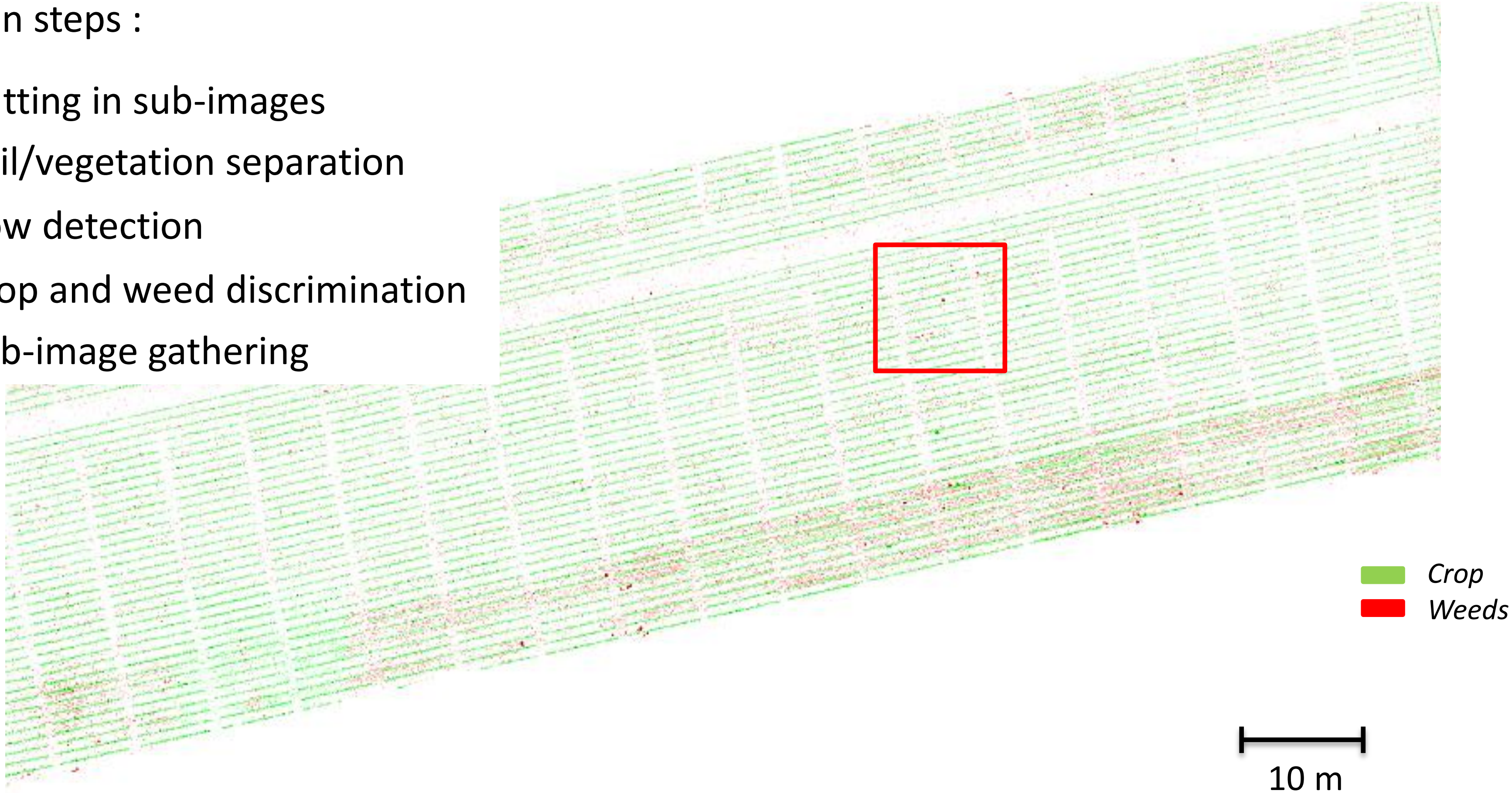
- Cutting in sub-images
- Soil/vegetation separation
- Row detection
- Crop and weed discrimination



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

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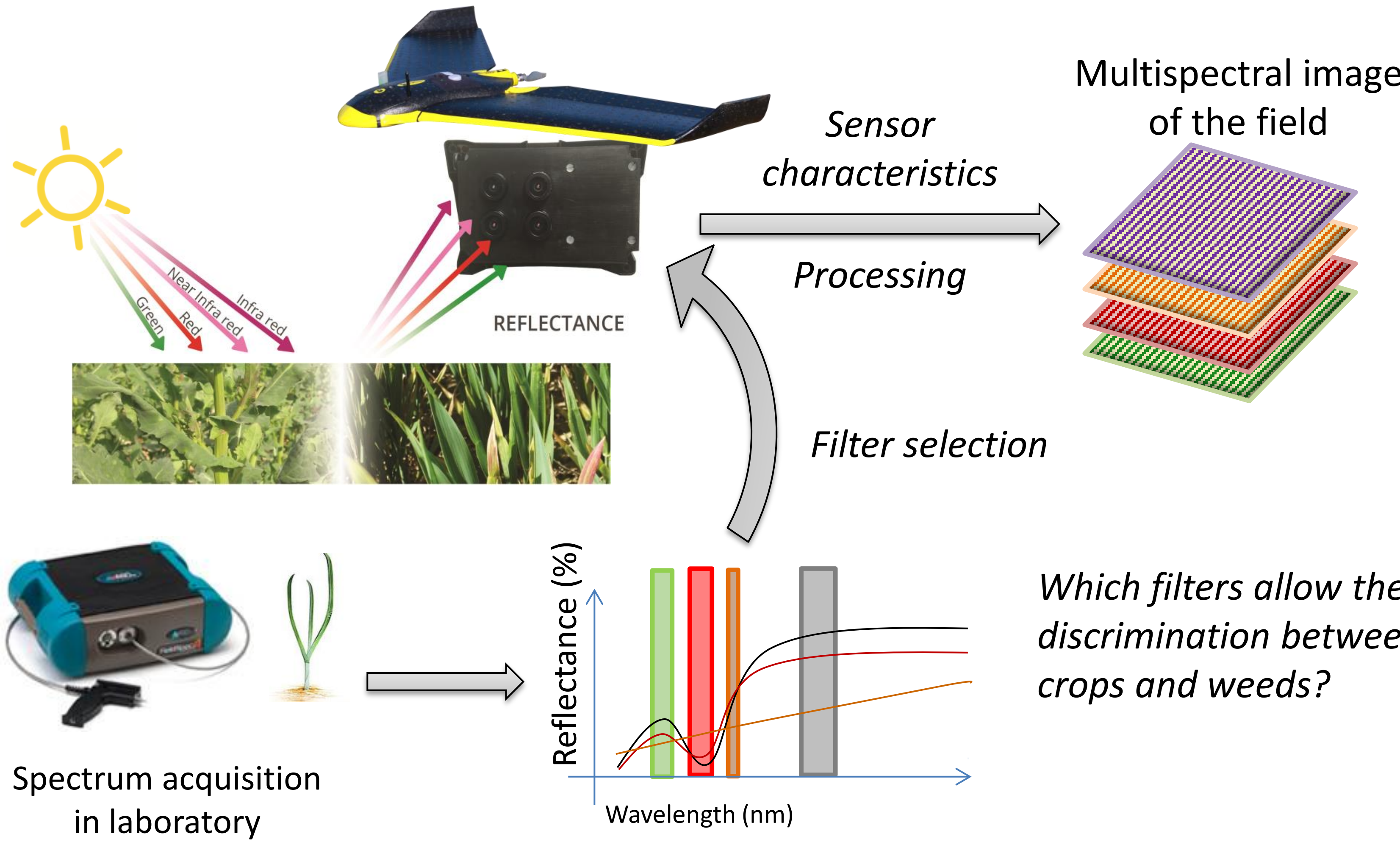
Spectral analysis

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



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

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	

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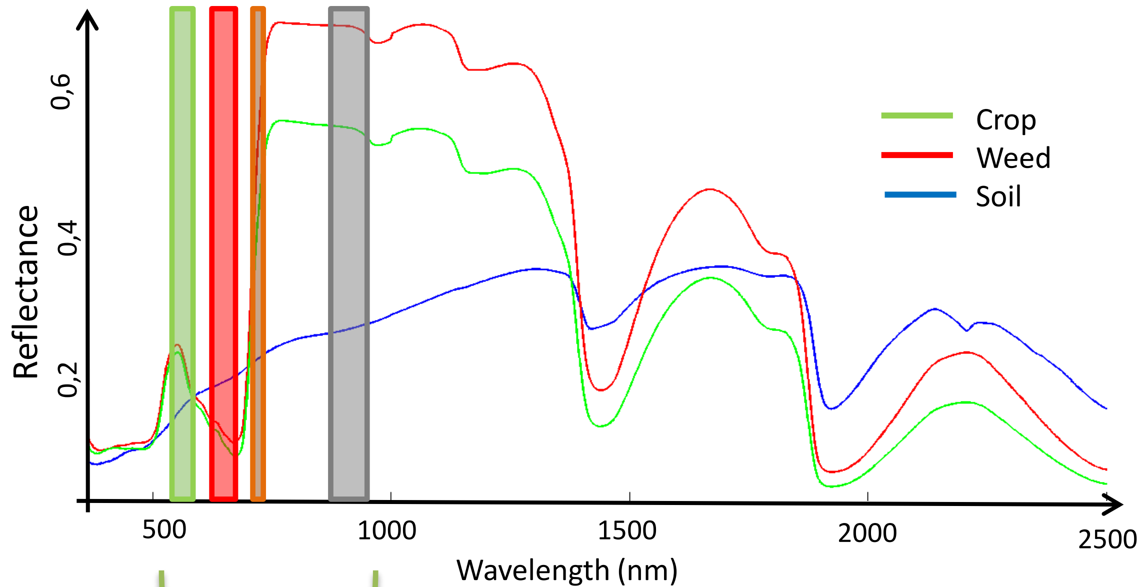
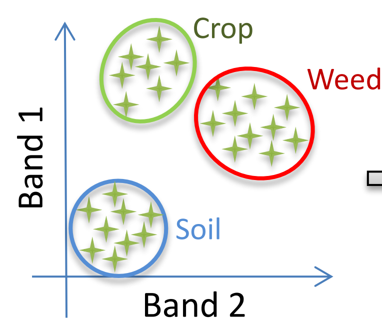
Wavelength selection



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	? %	? %	? %

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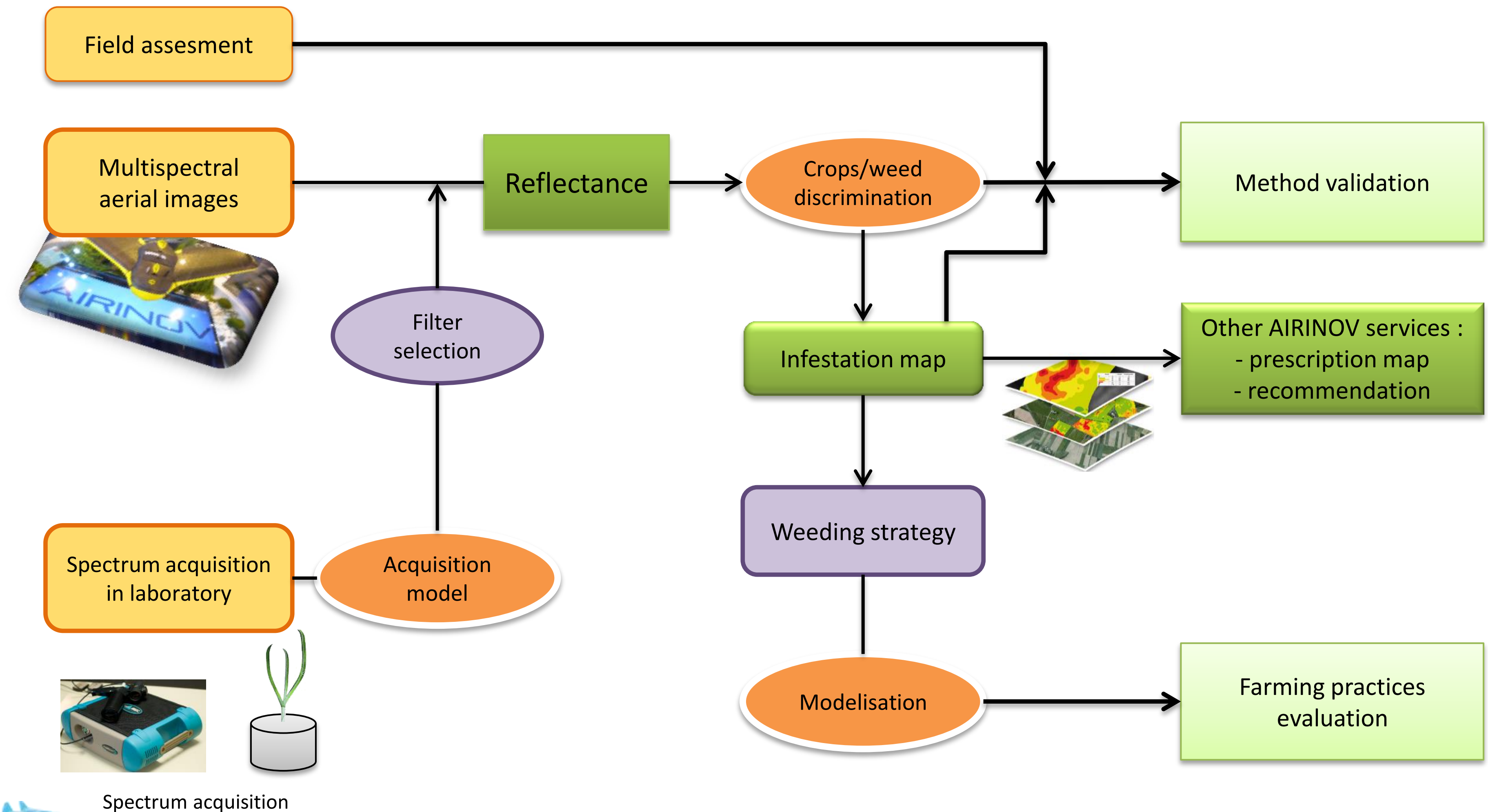
Practical application



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)

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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