



## Aerial imagery for site specific weed management

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# Aerial imagery for site specific weed management

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- I. New technologies for weed detection : image acquisition by UAV
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- III. Spectral analysis to get more information
- IV. Practical application

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# Introduction

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- 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

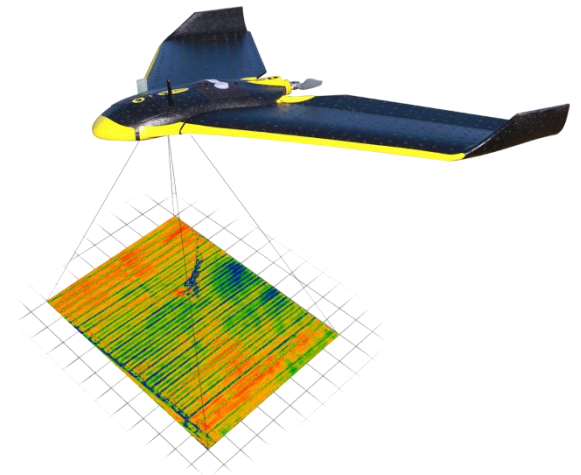
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A need to localize weeds in a field :

- 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

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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



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Workshop 26-28 May 2014

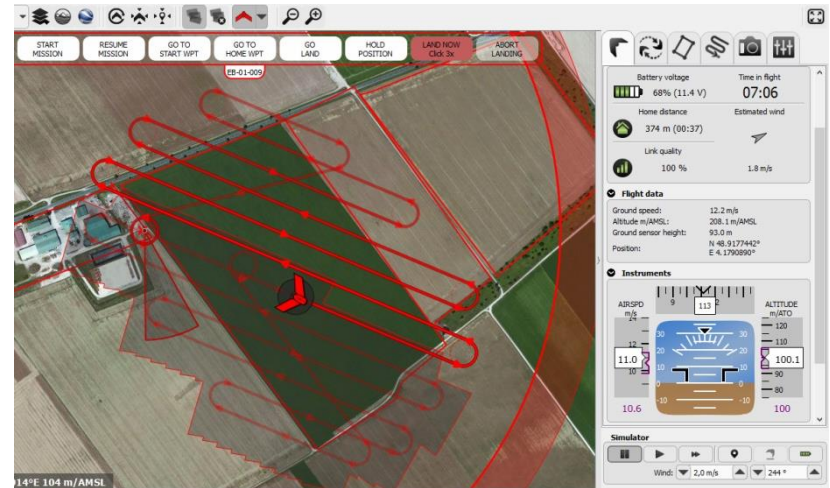
6



**L'IMAGERIE AÉRIENNE PAR DRONE**  
**AU SERVICE D'UNE AGRICULTURE DE PRÉCISION**

# 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

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- 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

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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)

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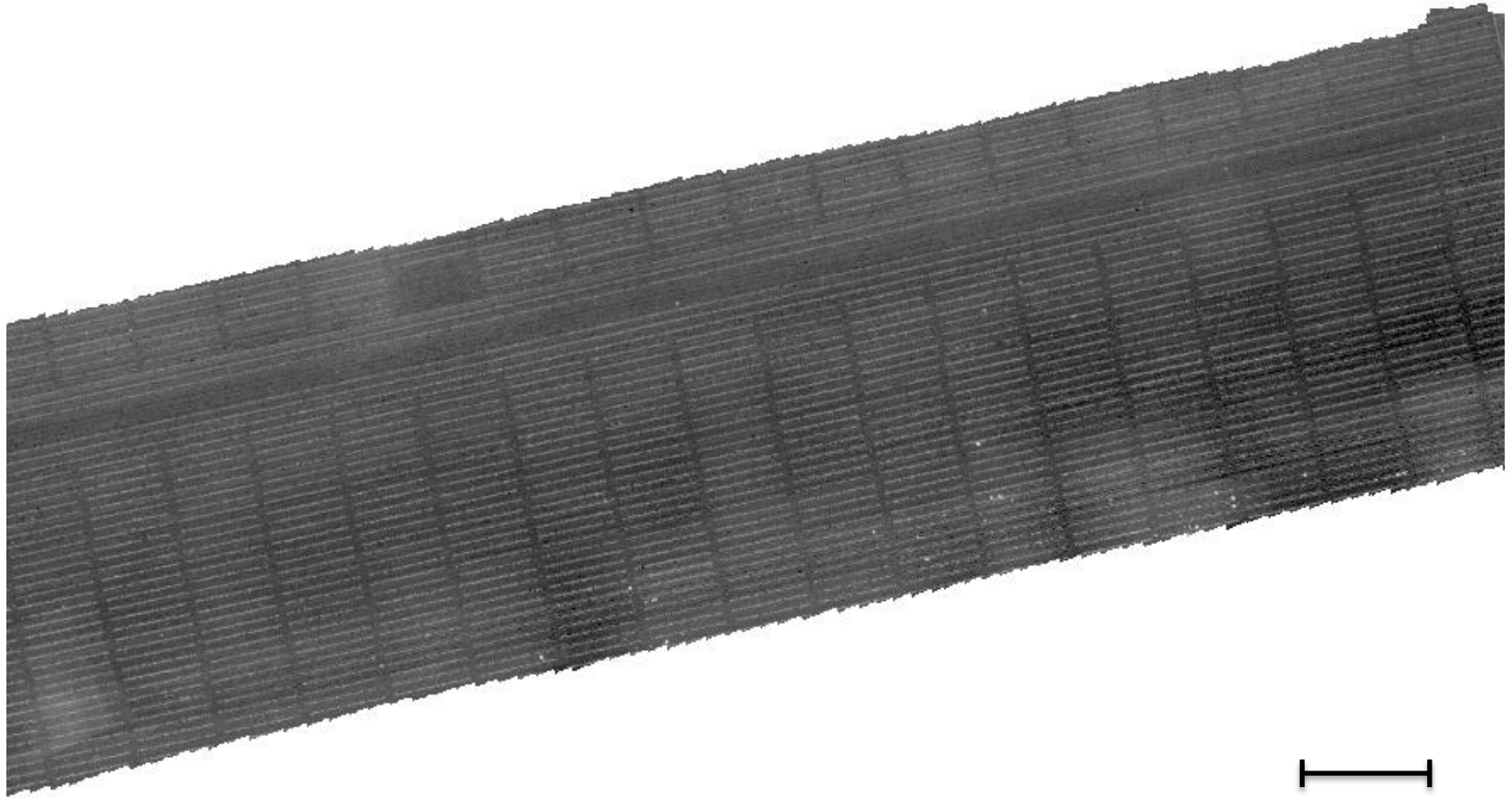
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# A method based on row crop detection

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10 m

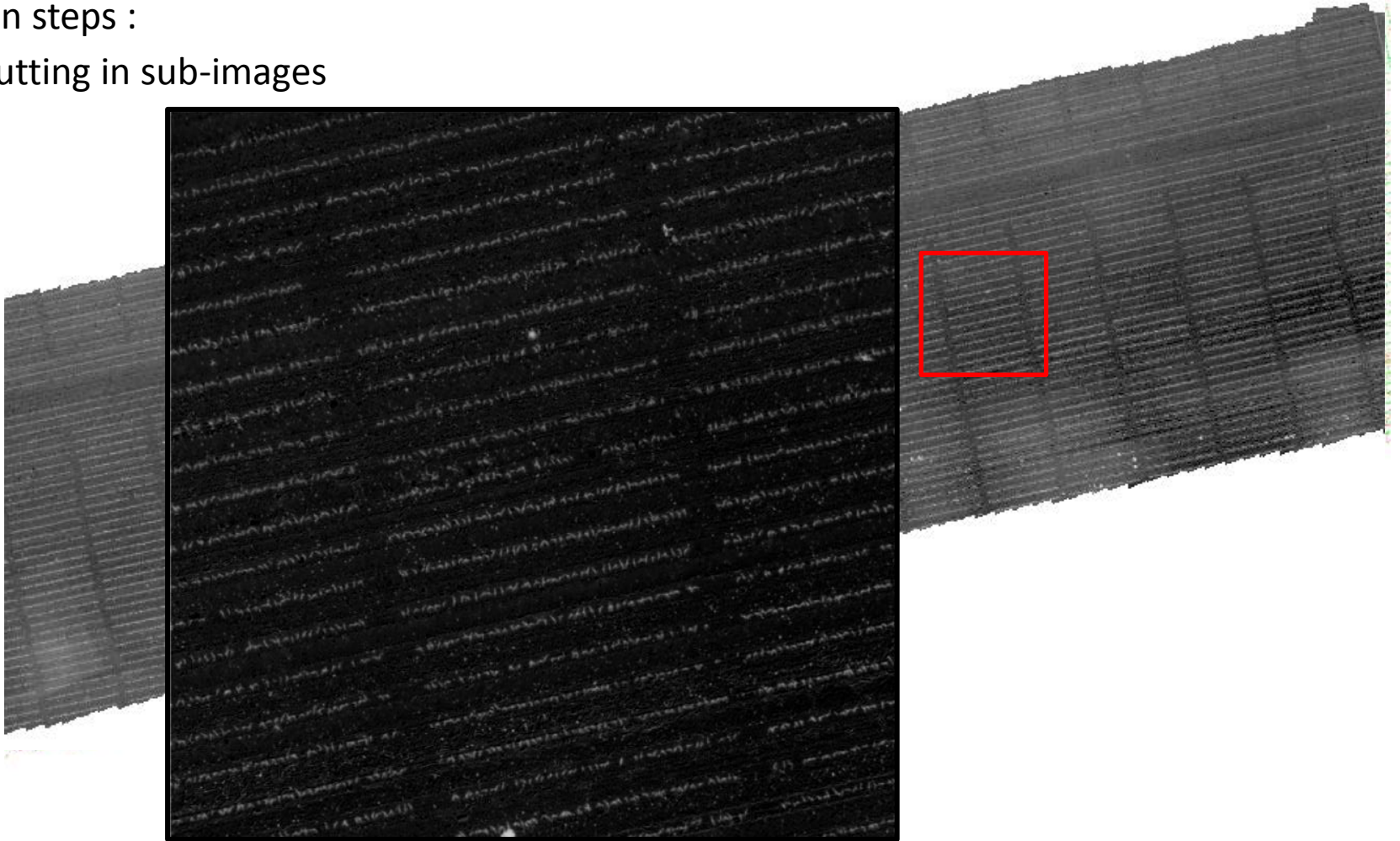


# A method based on row crop detection

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Main steps :

- Cutting in sub-images

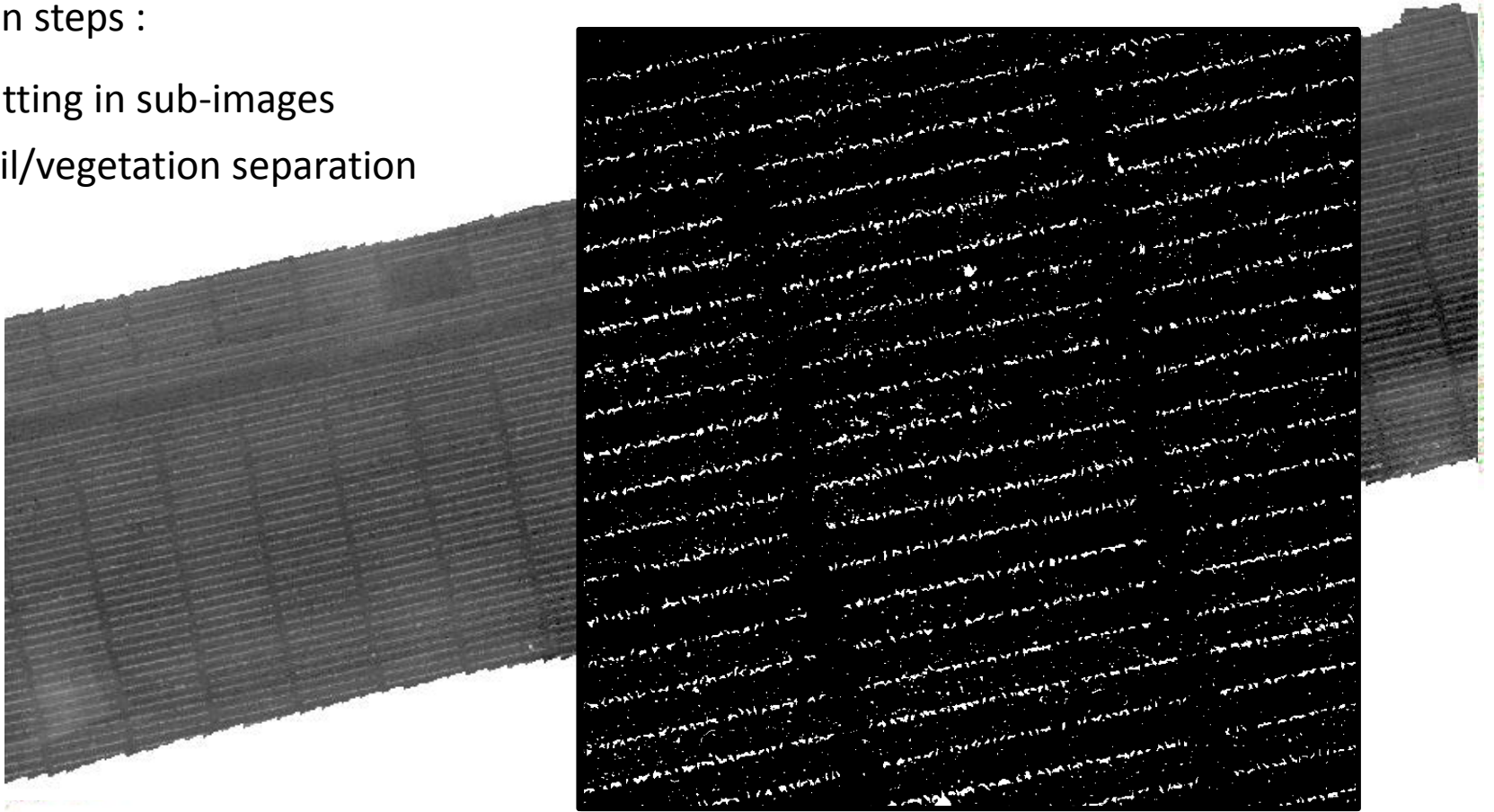




# A method based on row crop detection

Main steps :

- Cutting in sub-images
- Soil/vegetation separation

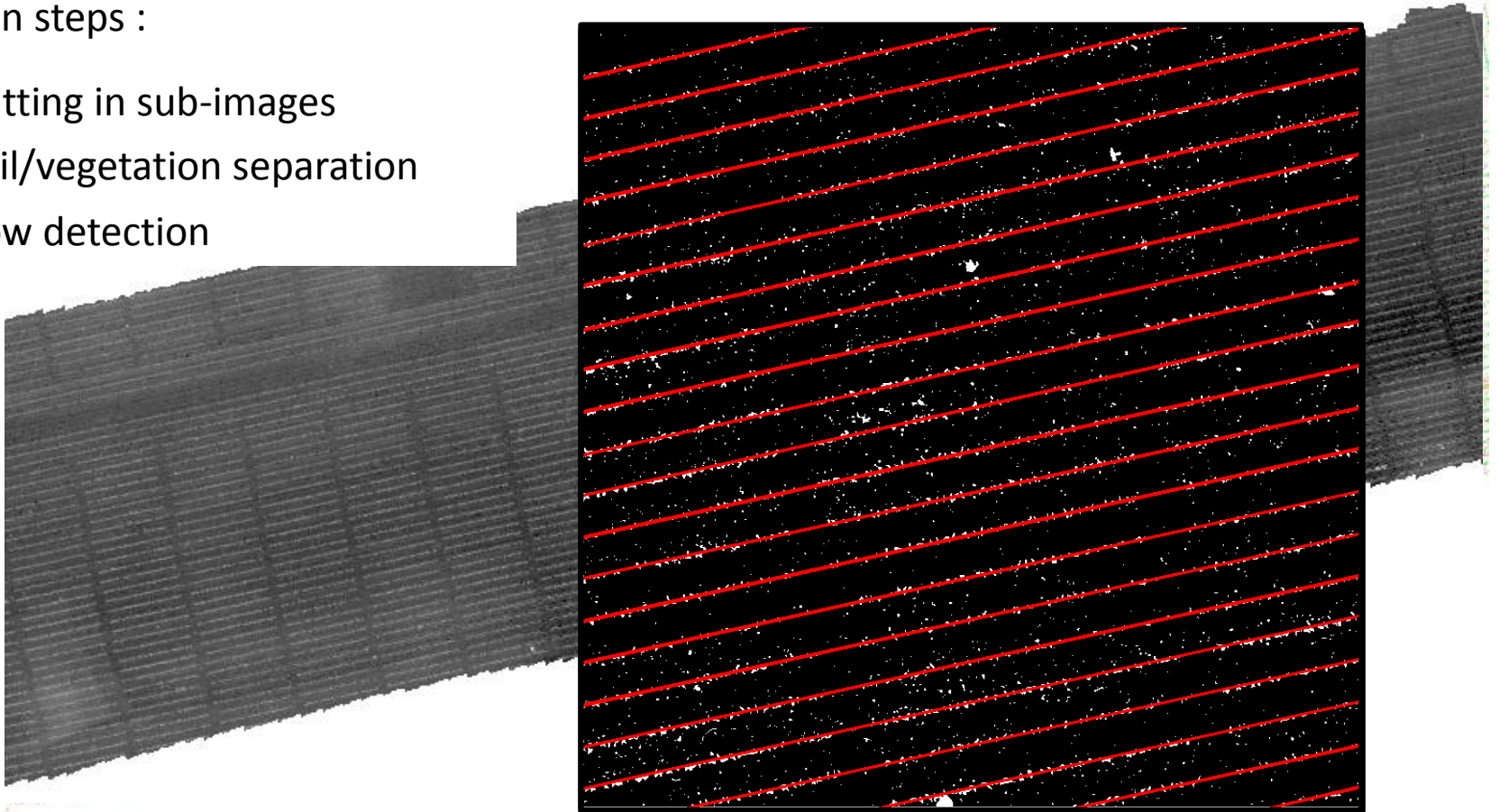


# A method based on row crop detection

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Main steps :

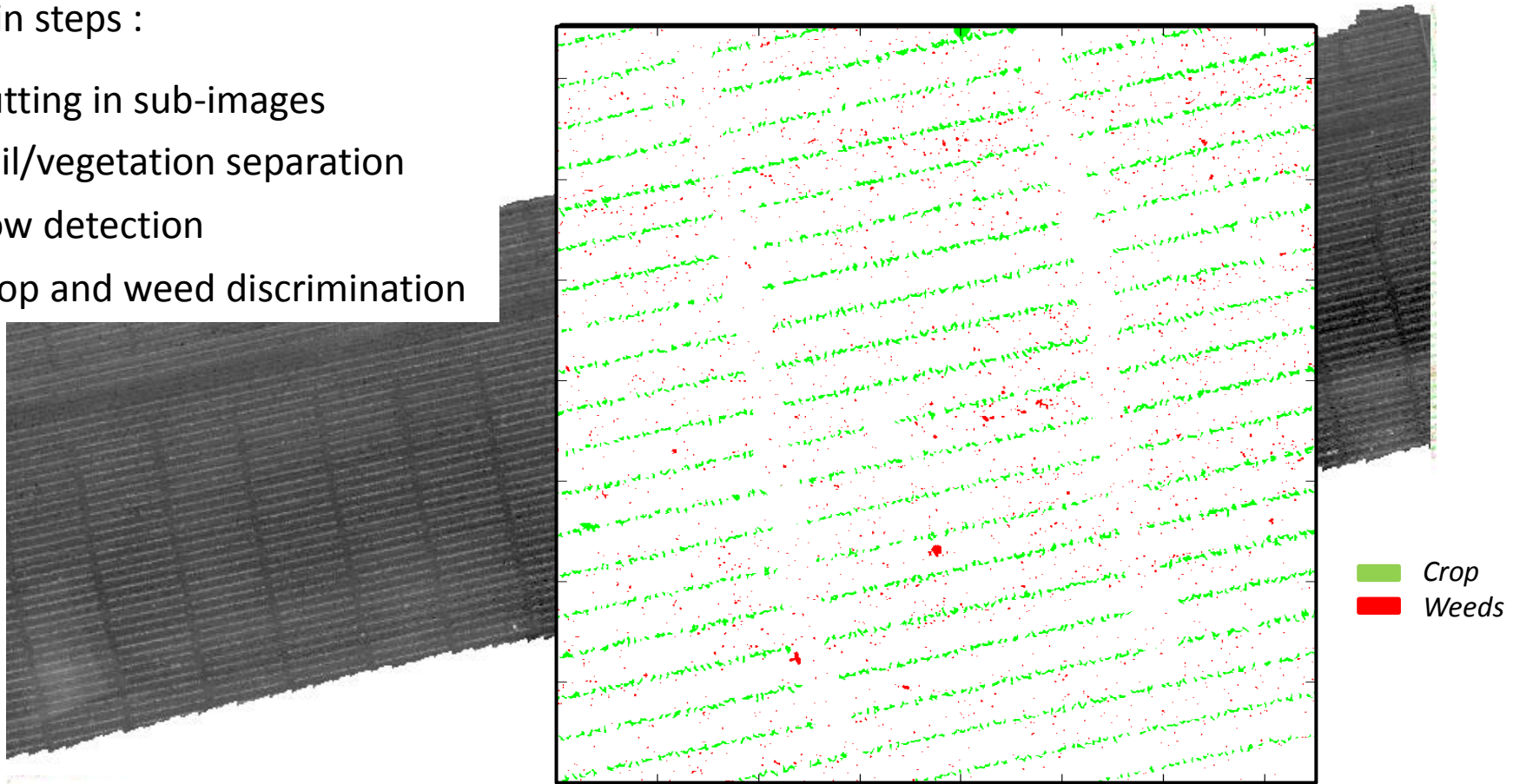
- Cutting in sub-images
- Soil/vegetation separation
- Row detection



# A method based on row crop detection

Main steps :

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

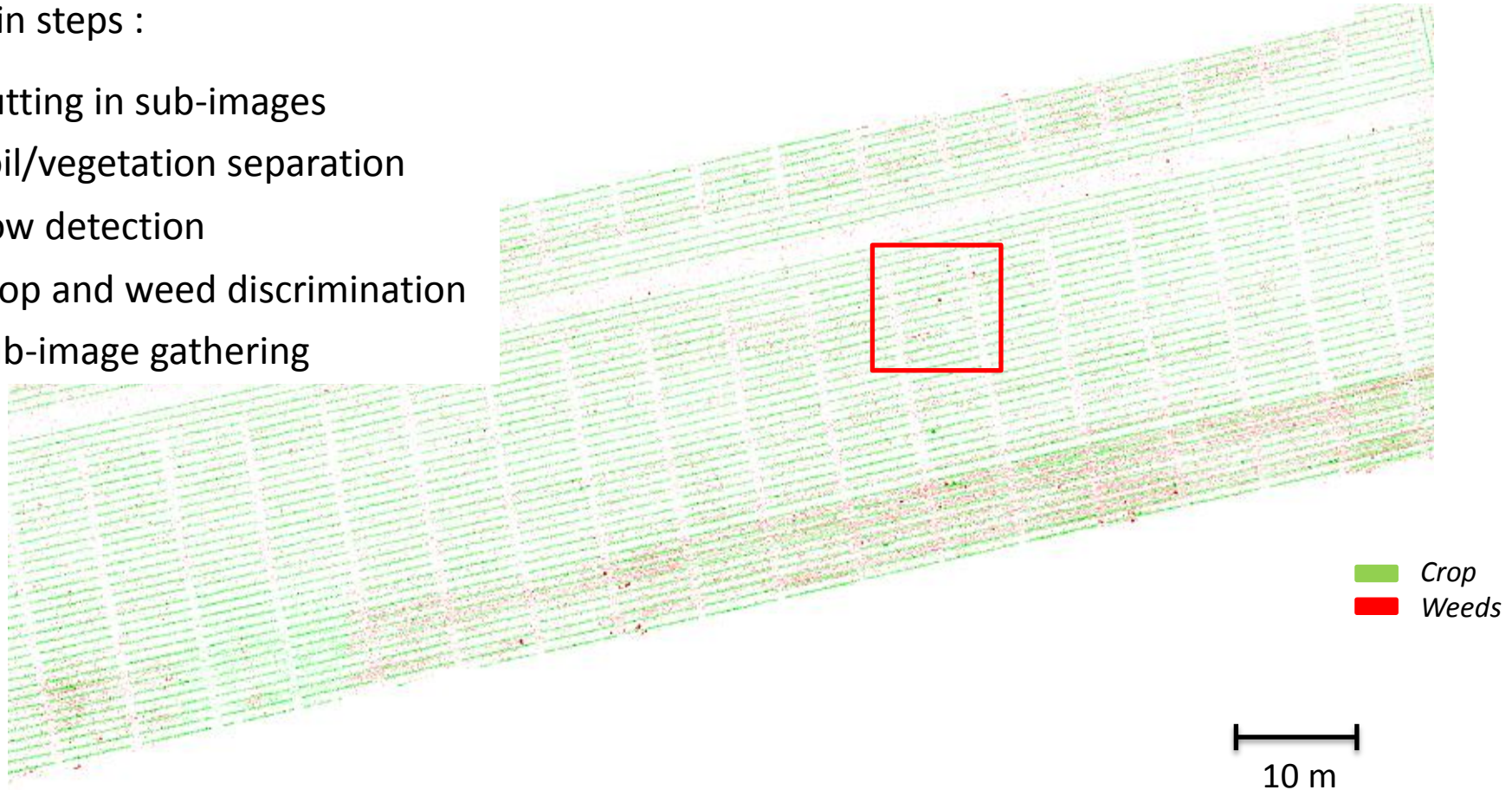




# A method based on row crop detection

Main steps :

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





# Results

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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

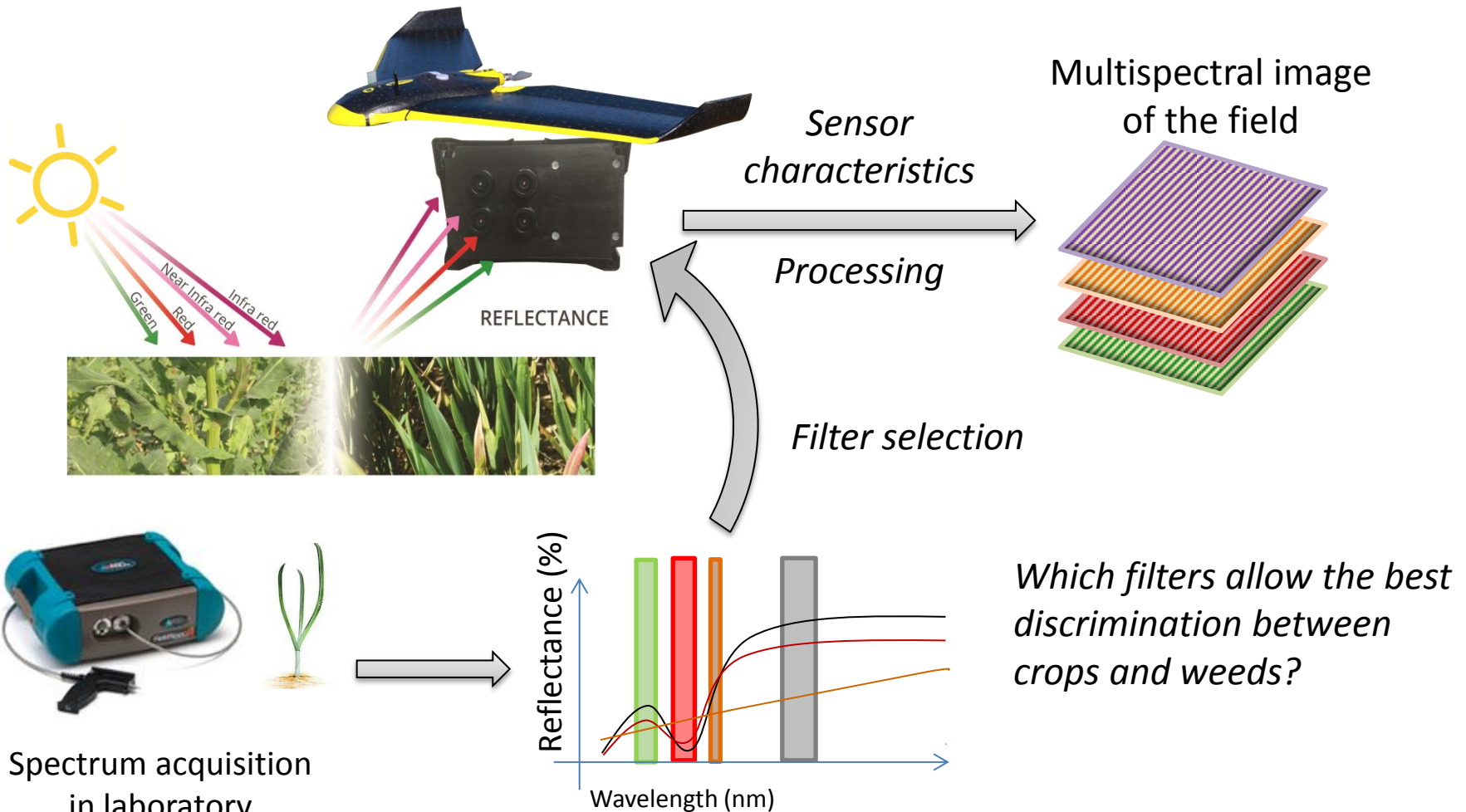
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How to complete this spatial method with spectral analysis?

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





# Spectrum acquisition

Spectrometer :

- Full spectrum from 350nm to 2500 nm
- Reflectance spectrum

Spectrum acquisition of soil, crop and weed

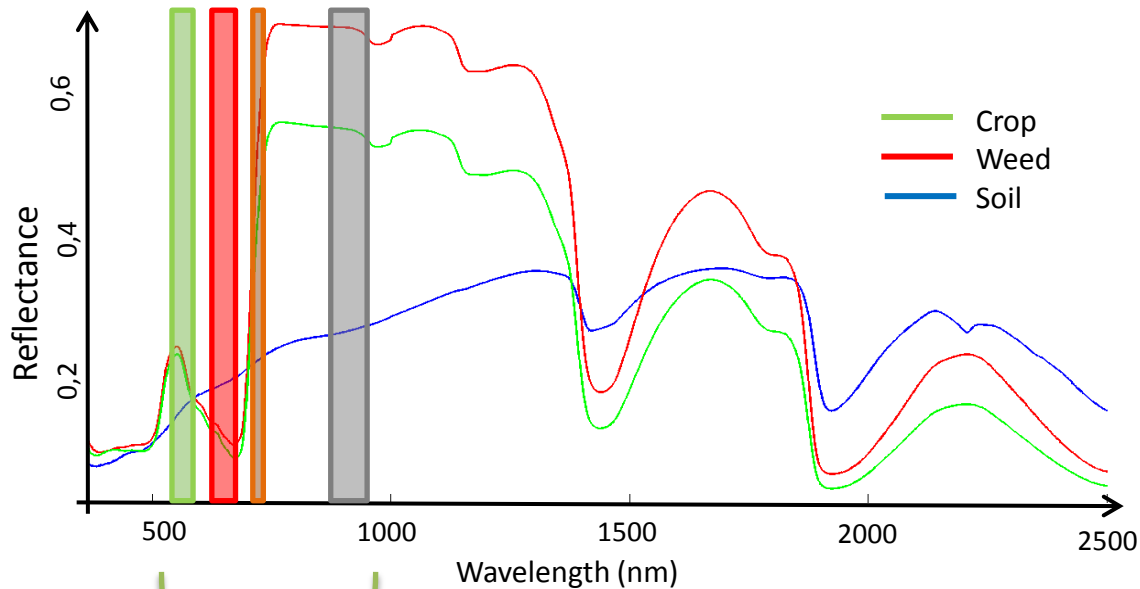
- At different stages
- Pure spectrum of the whole plant
  - Spectrum unmixing process
- Spectrum in the field



# Spectrum acquisition – Studied species

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

# Wavelength selection

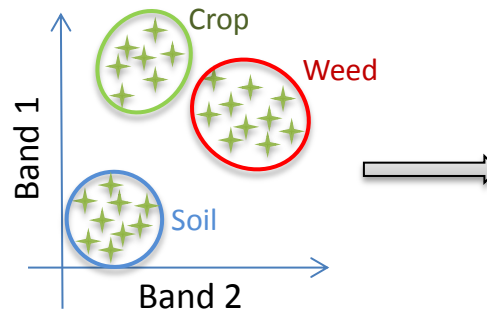


Assessment of each combination of bands  
→ classification

Combination of 4 spectral bands  
( $\approx$  pixel)

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

*Classification of each pixel*



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

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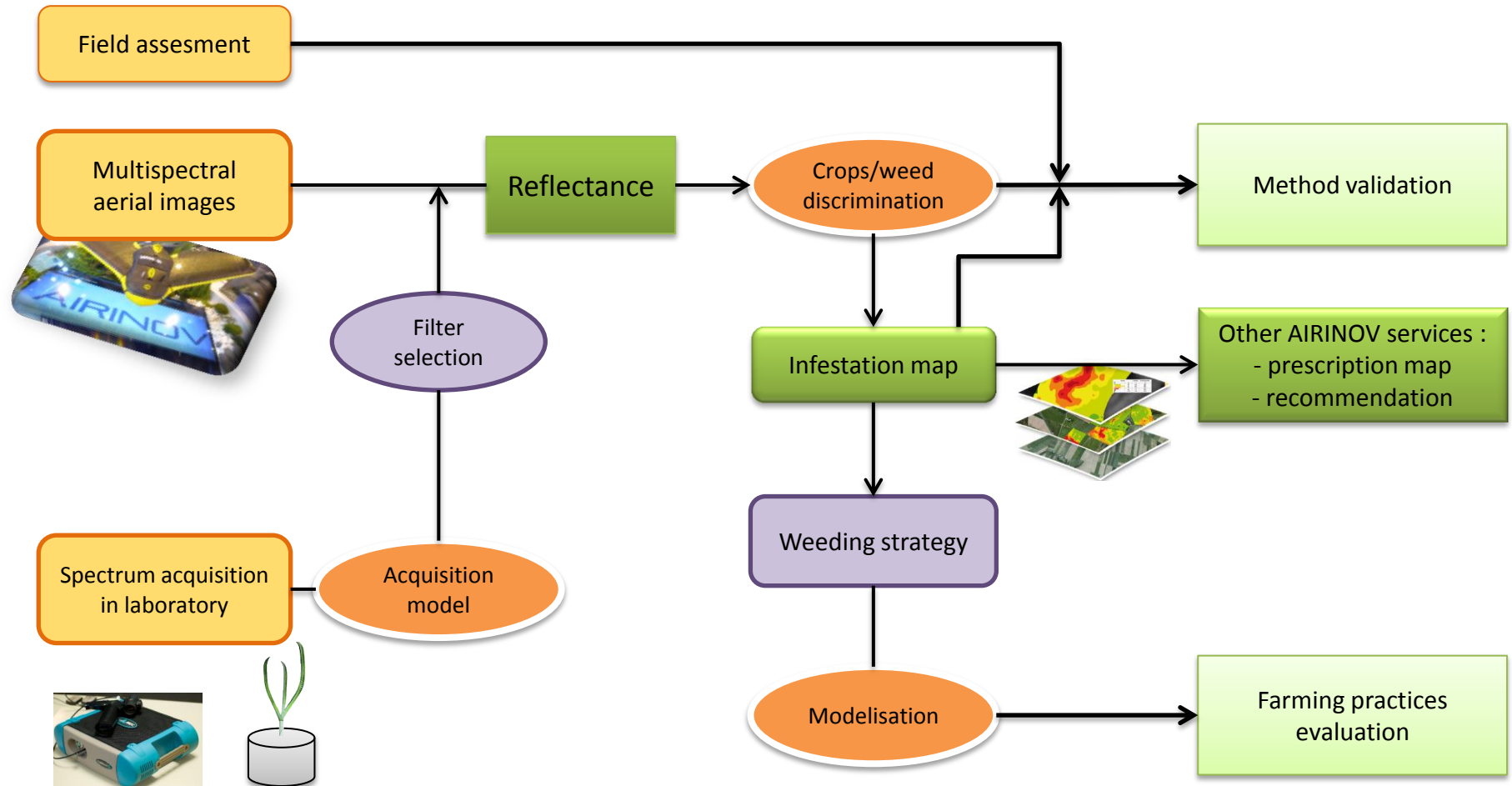
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# Practical application



# Practical application

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- 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

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- 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

