Current use and potential of satellite imagery for crop production management

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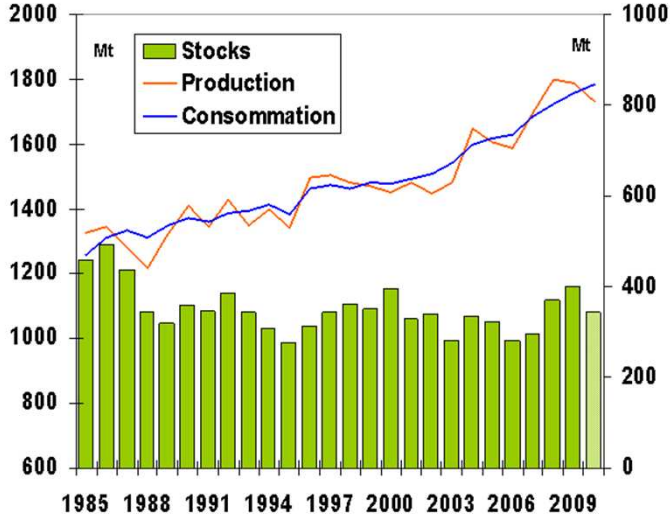
ARVALIS Institut du végétal

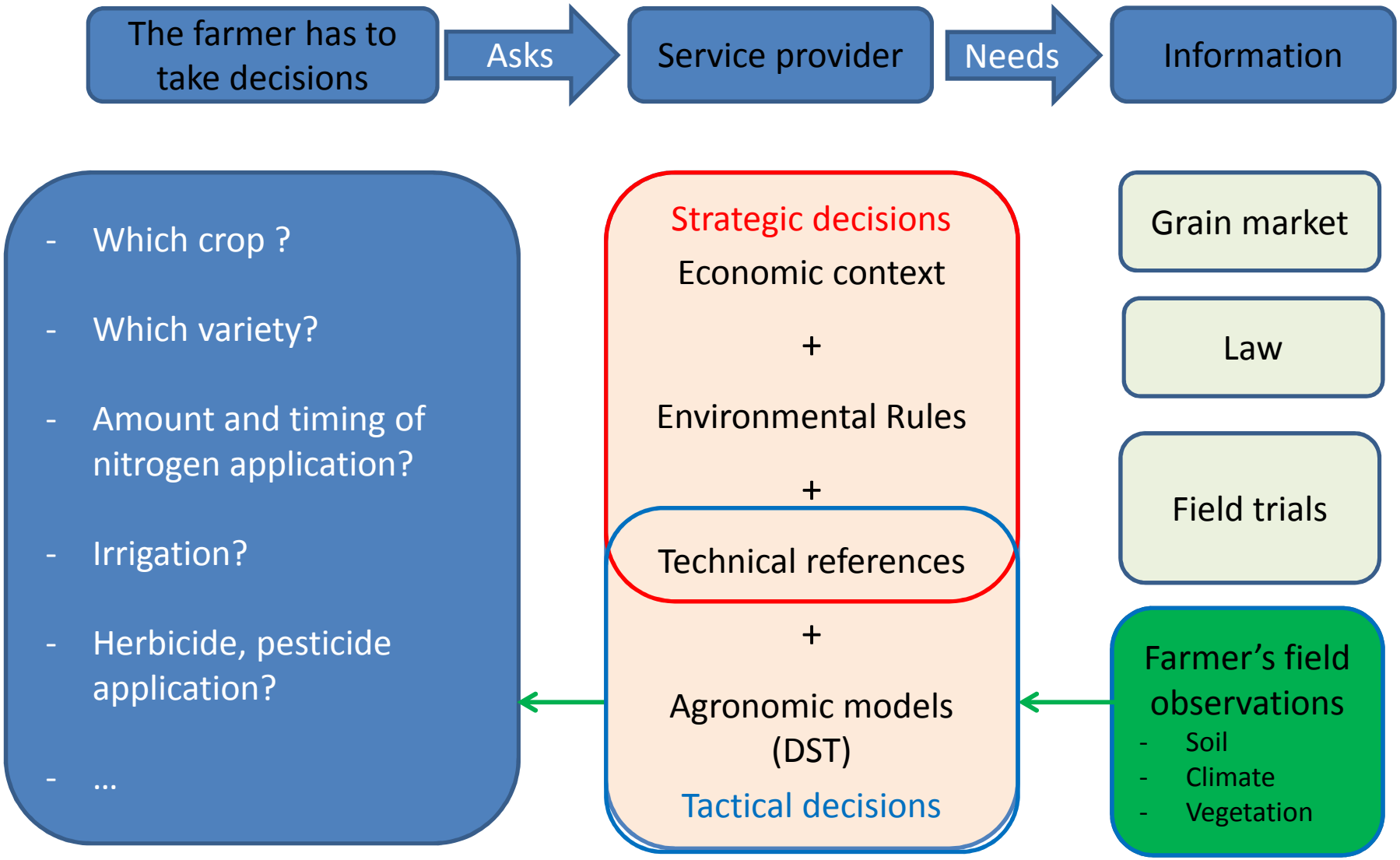
INRA

Increasing needs in observation data to optimize crop production

- Environmental constraints are increasing
  - Goal: a reduction of 50% of treatments within 2008 - 2018
  - A better water management
- A need to keep production at a high level of quantity and quality
  - Increasing needs for food
  - New uses of agro products (bio fuel, bio materials)
  - Strict rules on products' quality (mycotoxins)
- A fast evolution of agricultural products prices: requires a better harvest forecast



Decision support tools: requirements



ARVALIS – Institut du végétal

- ARVALIS:
  - a French applied research institute funded and run by farmers
  - on cereals, maize, pulses, potatoes and forage crops
  - in the field of: production, storage, preservation, first process (food and non food uses)

- Provide advices for cropping practices
  - Evaluate new varieties
  - Test new cropping practices
  - Develop decision support tools

- Objective: to maintain a high level of production in a better way
  - Services to farmers, agricultural organizations and firms

Existing DST in France
The case of nitrogen management

- 3 kinds of vegetation based tools are used:
  - Leaf scale tools (HNTester ® = SPAD)
  - Tractor borne sensors (Yara Nsensor®, GreenSeeker®, CropCircle®, …)
  - Satellite imagery (Farmstar, …)

- 15 - 20 % of crop lands are managed with a DST for nitrogen applications

Too low !

- Due to lack and cost of observations availability (spatially and temporally)

- Use of satellite observation has strong interests for a large development of DST:

  - No investment / tractor borne sensors
  - Control possible on calculation process (centralized processing)
  - Monitoring interesting at different scales (farmer but also cooperatives, traders)
  - The spatial resolution fits well application requirements (10 m)

From satellite to the farmer : a long way!

Satellite products processing :

LAI

Chlorophyll content

Building semi empirical relationships:

- Biomass = f(LAI, phenology, cultivar)
- Total nitrogen uptake = f(Chlorophyll, cultivar)

Typical nitrogen recommendation based on:

- Yield potential
- Total biomass at given development stages
- Total nitrogen uptake at given development stages

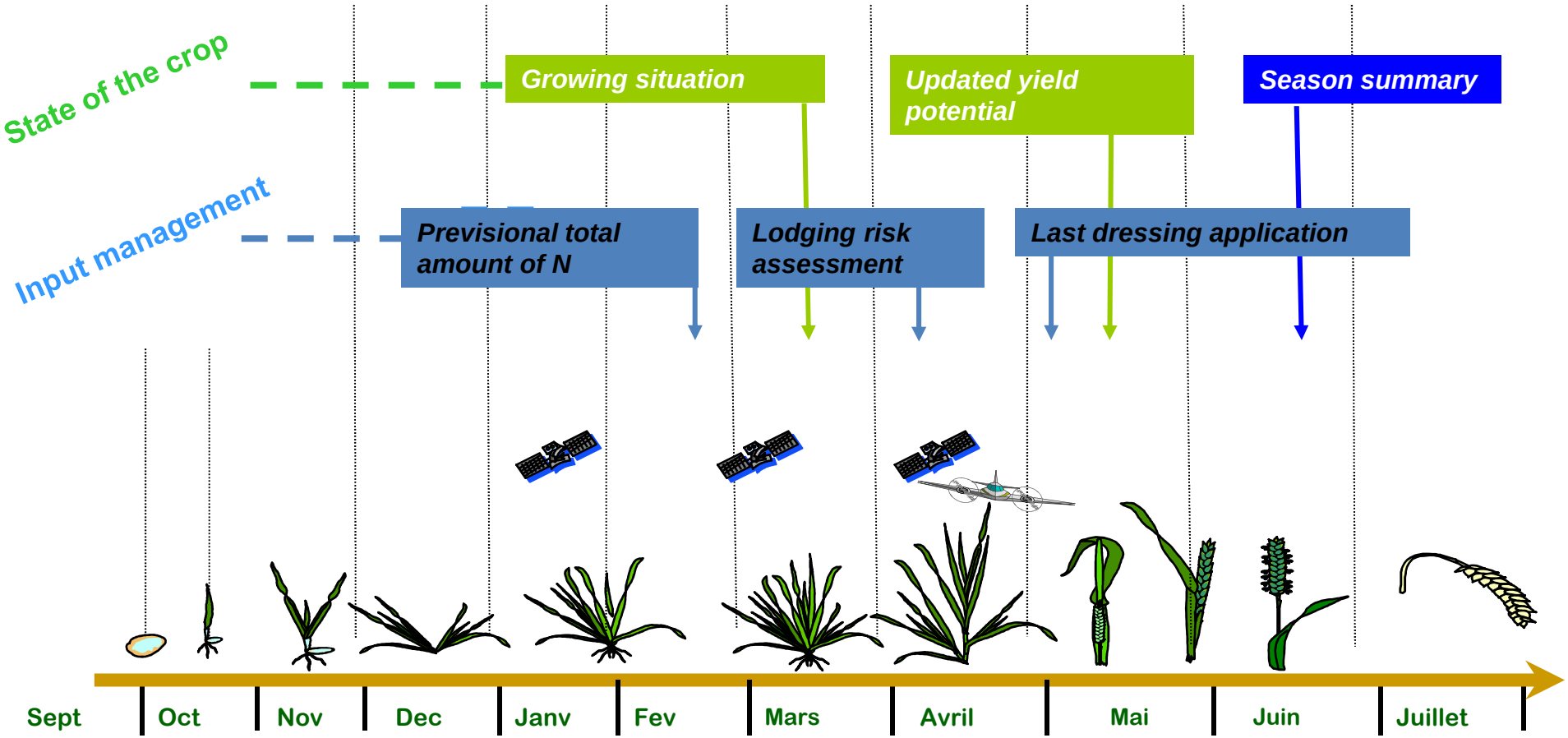
Farmer wants application maps:

Time of application (phenology) <- Meteorological data

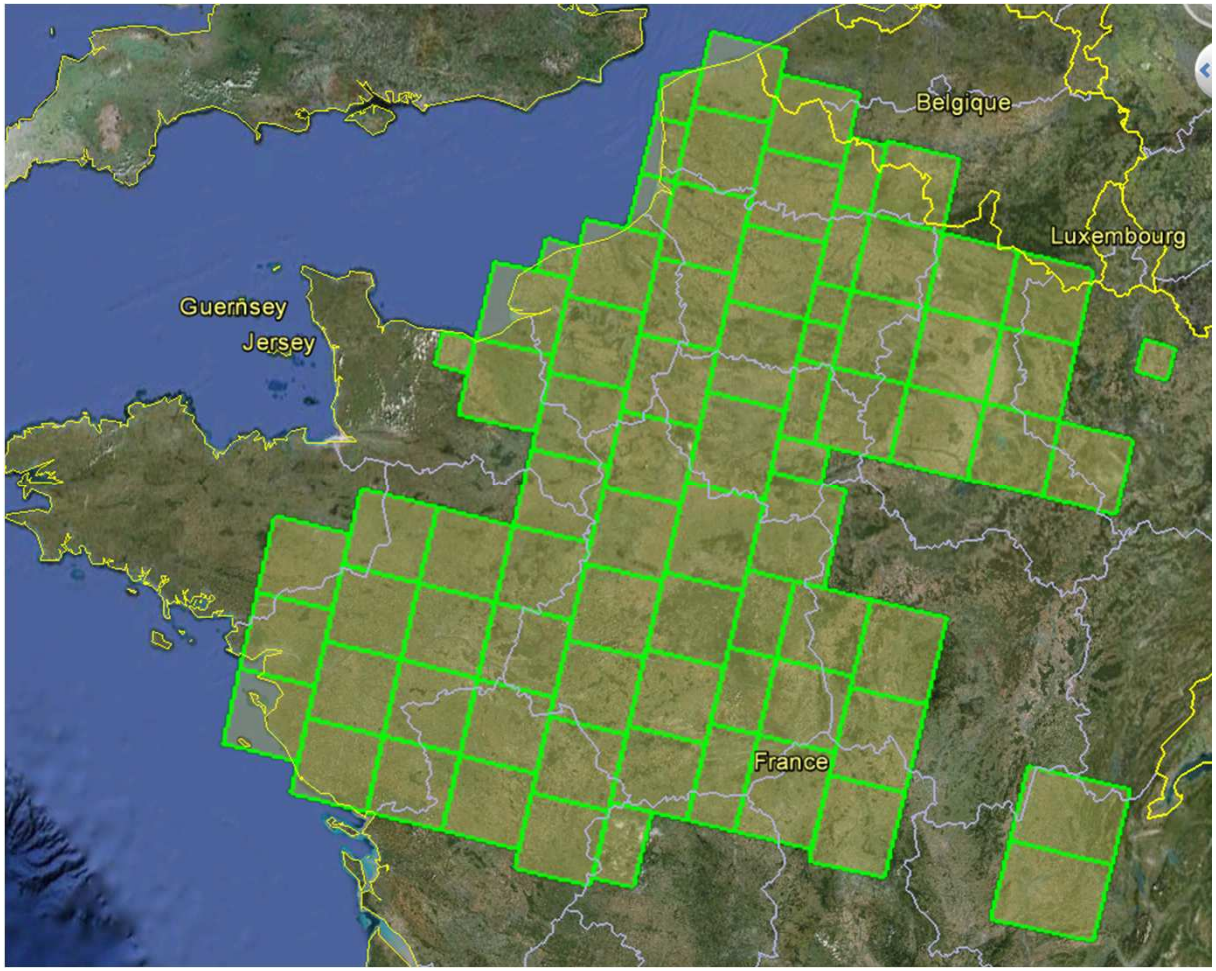
Nitrogen amount <- vegetation observation data

Support tools provided by FARMSTAR

ARVALIS & Astrium



Geographic cover of Farmstar 2012



Contracted areas

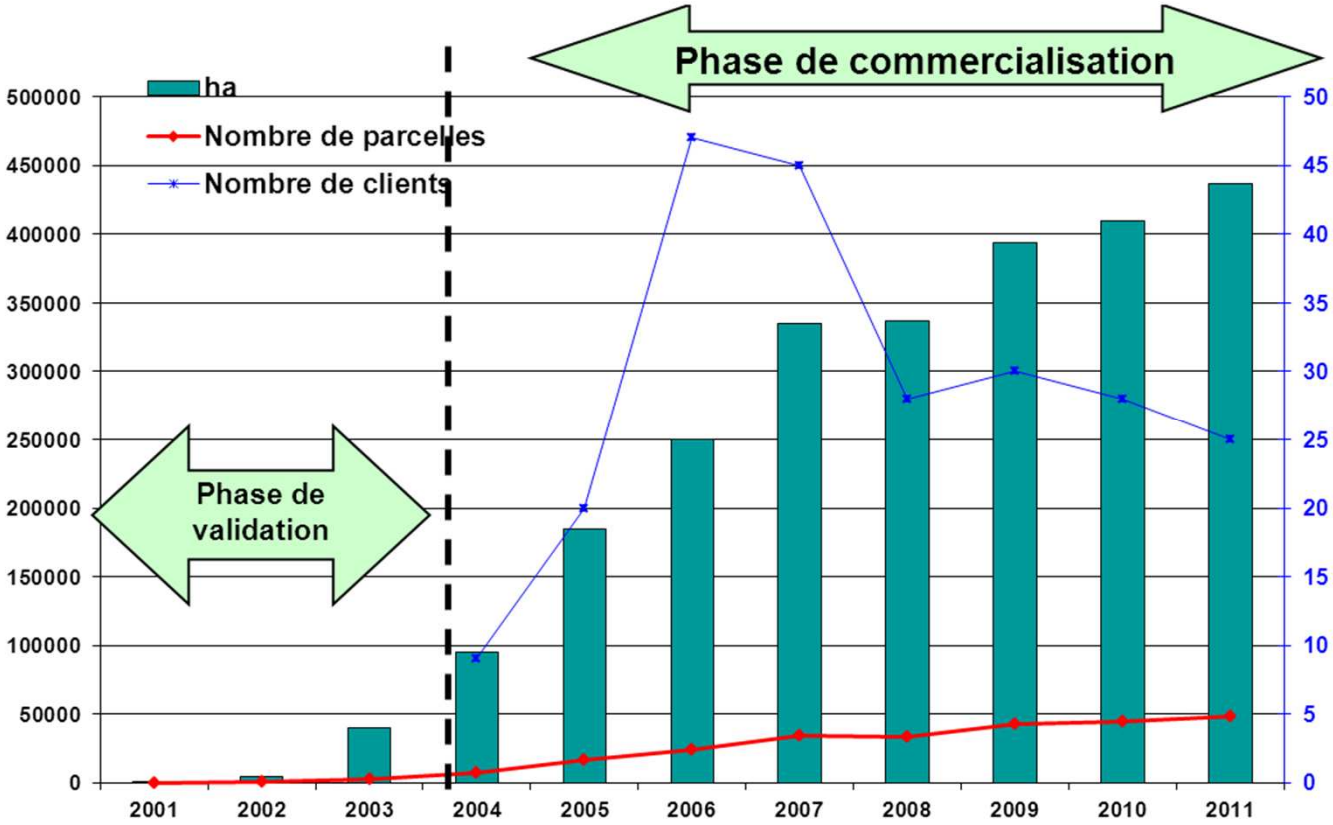
620.000 ha

Satellite acquisitons :

61 SPOT HRV images

15 Formosat images

A strong field technical support

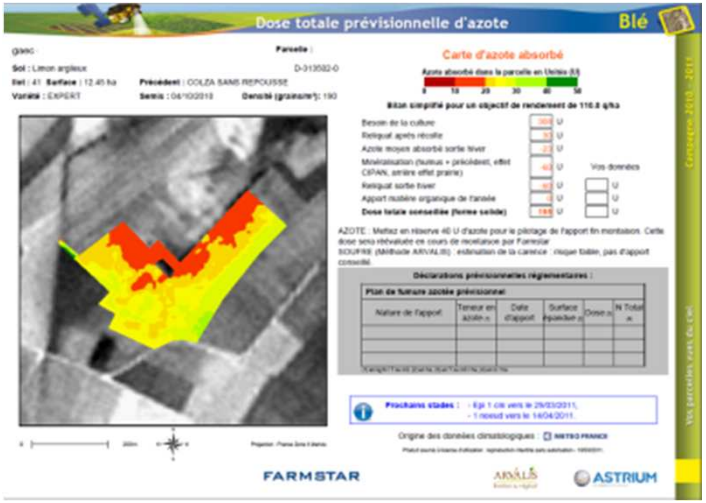


2012

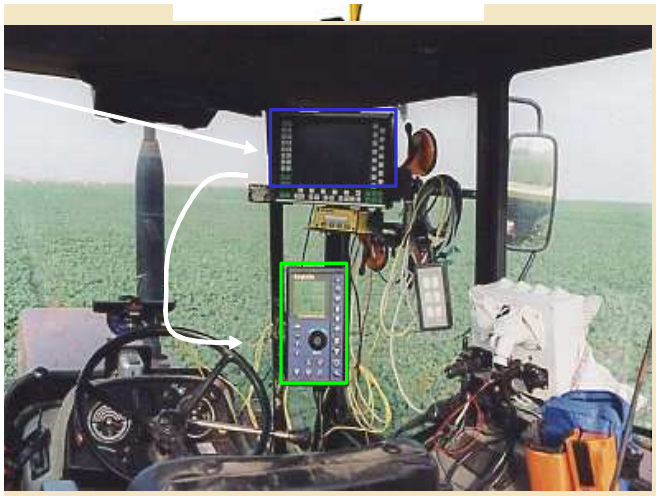
- 11540 Farmers
- 25 Coops
- 620 000 ha contracted
  - ➔ Wheat : 340 000 ha
  - ➔ Barley : 60 000 ha
  - ➔ Colza : 220 000 ha
- 730 technicians
- 13 Engineers

Delivered information

- Application map + phenology



- Compatible with sprayers for VRA



Present limitations

- Only proposed on major crops and producing regions because of the cost of images
- Lack of dynamic data, mandatory for summer crops
- Need of airborne flights for Chl content estimation
- Need of an important parameterization to match satellite information and agronomic variables

New opportunities – At the sky level

Agriculture requirements for new satellites

- Resolution: 10 m ok for major annual crops (wheat, maize, …)
- 1-2 acquisitions / week during fast growing periods
- Spectral configuration : Red edge bands for chlorophyll estimation
- High quality of pre processing:
  - Geometric correction (ortho rectified)
  - Atmospheric corrections -> Reflectance TOC is important !
- Service continuity insurance for services development
- Fast delivery: 2-3 days between acquisition and delivery to the customer
  - 1 day for raw data access
- Free access to images for a larger diffusion and new services development

New opportunities – At the ground level

A better integration of sensors data in DST

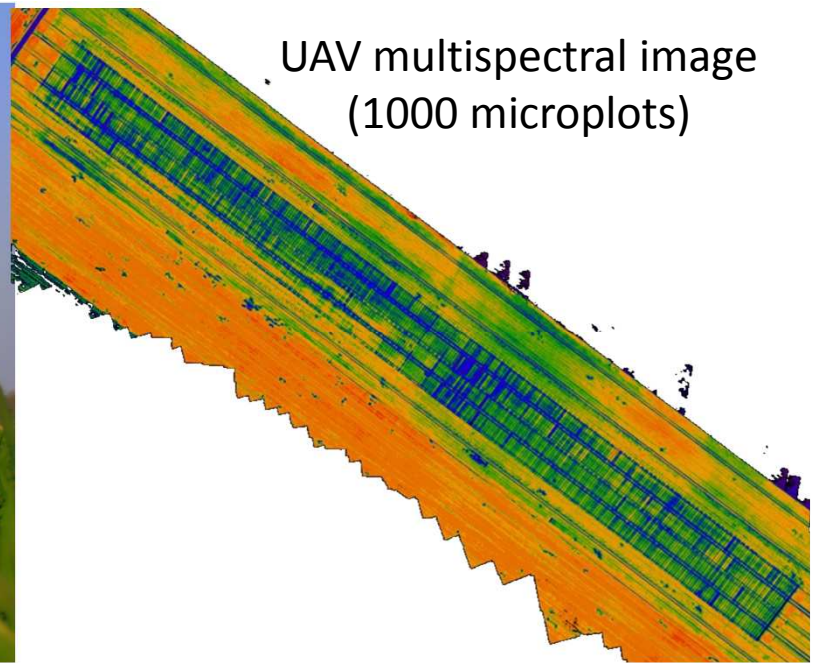
- Need for a better match between sensors observations and agronomic references and tools:

- More ground based acquisition to develop new DST based on reflectances or Vegetation indices
- High quality of satellite data to match these ground measurements

- Possible through phenotyping applications:

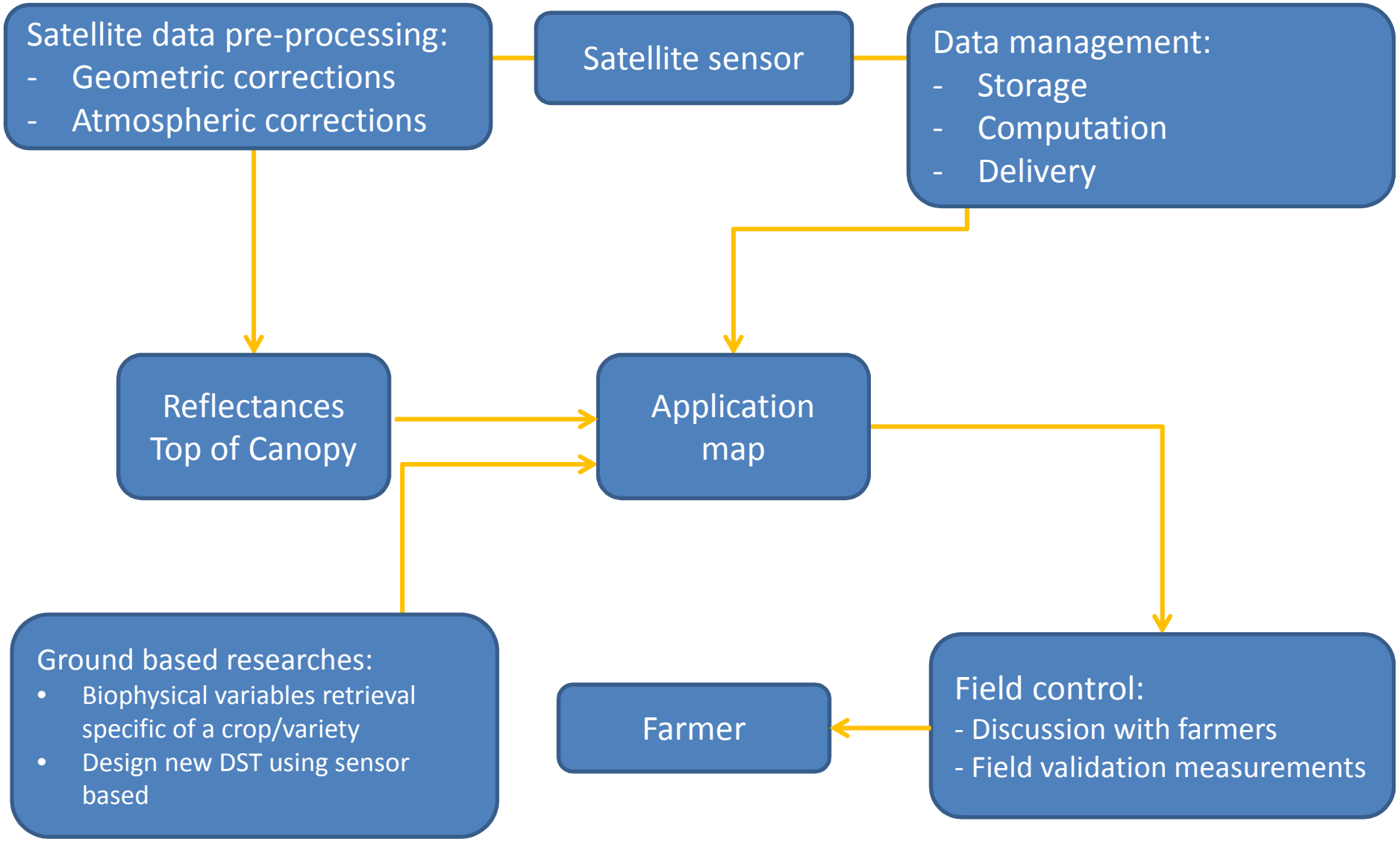
- Used for cultivar selection
- Usable to bridge the gap between satellite images and application

High throughput automated system combining Hyperspectral spectroradiometers + cameras + Lidars



UAV multispectral image (1000 microplots)

Use of RS data for agricultural monitoring



A strong potential for new applications

- Better yield and quality forecast: images at the end of the growing season
- Irrigation management: more images in spring and summer
- New services for crops with smaller extent (potatoes, sunflower, linen, …)
- Intermediate crops nitrogen uptake
- Forages monitoring

Satellite imagery has the potential to become the reference data source for farmer's crop management in Europe