



## Origins of the performance gaps in innovative cropping systems under experimental assessment.

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## Context and Objectives

To meet new agricultural issues and make agriculture more sustainable, innovative cropping systems (ICSs) targeting a multiplicity of purposes need to be designed. Four ICSs were designed by prototyping (Reau and Doré, 2008<sup>1</sup>) and assessed in a long-term field system experiment.

**Our objective was to analyze the results after the first complete rotation, particularly the bad performances compared to the targeted aims.**

## Materials and Methods

### Multiple goals of the four designed ICSs (Colnenne-David and Doré, 2014<sup>2</sup>)

#### The PHEP ICS goals:

##### 1. To satisfy multiple environmental criteria:

\*low pesticide use → high crop diversity, highly resistant varieties

\*low direct energy consumption → only 1 ploughing within the rotation

\*low indirect energy consumption → legumes in the rotation

\*low nitrogen leaching → catch crop (CC) before spring crops and no N fertilization during autumn and winter

\*stabilization and/or to enrich soil organic matter → burying residues of all crops

##### 2. To reach yield targets

matching the Ile-de-France yields

**Crop sequence:** winter faba bean, winter wheat, winter oilseed rape, winter wheat, mustard as CC and spring barley

#### The L-GHG ICS goals:

##### 1. 50% GHG emissions compared to the PHEP ICS

(i) increase soil C sequestration → many cereals, continuous soil cover, high yield targets, no ploughing

(ii) decrease N<sub>2</sub>O emissions → high number of legume crops in the rotation, improvement of N fertilization management, crops with taproots in order to reduce soil compaction

##### 2. To satisfy multiple environmental criteria: idem PHEP ICS

##### 3. To reach yield targets

matching the Ile-de-France yields  
**Crop sequence:** catch crop (CC), maize, triticale, CC, spring faba bean, winter oilseed rape, winter wheat, CC, winter barley

#### The L-EN ICS goals:

##### 1. 50% fossil energy consumption compared to the PHEP ICS

(i) Low direct energy consumption → no ploughing and using direct sowing machine

(ii) Low indirect energy consumption → high number of legume species in the rotation, species with high N efficiency use, decrease N fertilization by reducing yield objectives

##### 2. To satisfy multiple environmental criteria: idem PHEP ICS

##### 3. To reach yield targets: 20% lower than the Ile-de-France yields

**Crop sequence:** winter faba bean, winter wheat, winter flax, winter wheat–trifolium mixture, Trifolium as CC, spring oat

#### The No-Pest ICS goals:

##### 1. No pesticide is allowed

→ long rotation including a wide diversity of species (e.g. hemp), alternate sowing dates, different dates and densities of sowing, highly resistant varieties or mixtures, ploughing and mechanical weeding

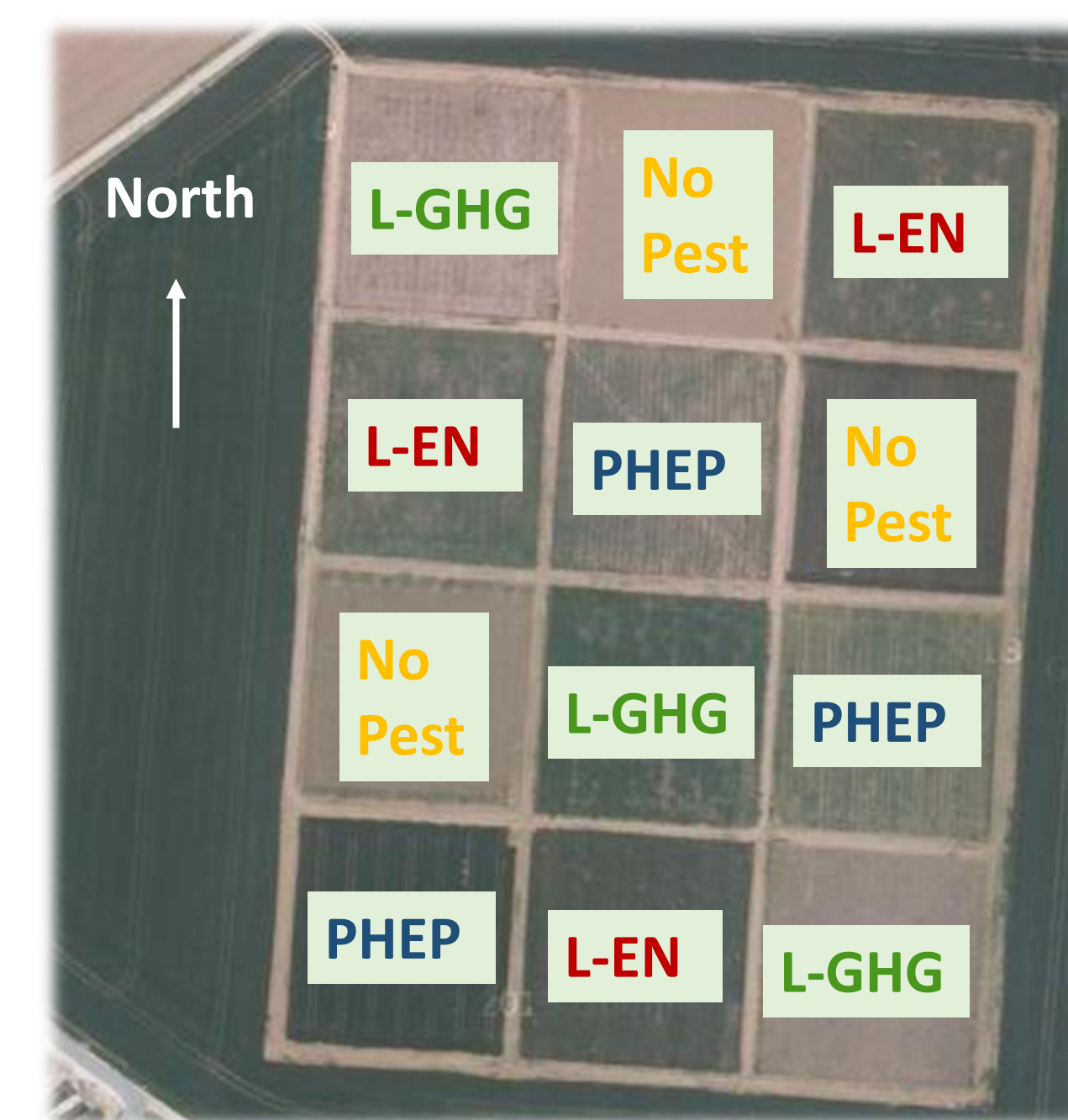
##### 2. To satisfy multiple environmental criteria: idem PHEP ICS

##### 3. To reach yield targets: higher than organic systems in the Ile-de-France

**Crop sequence:** triticale, CC, maize, winter wheat, CC, spring faba bean, winter wheat, CC, hemp

### Main characteristics of the field trial

- ✓ located in Grignon (78, France)
- ✓ 6.2 ha (surface plot: ≈ 4000 m<sup>2</sup>)
- ✓ 3 blocks
- ✓ deep loamy soil
- ✓ Beginning of field assessment: 2008



## Results: Classification of the major disparities

Classification	Examples collected in the ICSs
Some agronomical strategies were no suitable to reach the goals	In the L-GHG ICS: No ploughing → No increase of C sequestration as expected C sequestration evolution = -149kgCO <sub>2</sub> ha <sup>-1</sup> year <sup>-1</sup> (+87kgCO <sub>2</sub> ha <sup>-1</sup> year <sup>-1</sup> expected)
Some practices were not adapted to satisfy a multiplicity of objectives	In the No-Pest ICS: No possible to satisfy both the pesticide constraint and the S.O.M. criteria. Restitution of small organic matter amounts + regular ploughings → Few weeds but adverse effect on C sequestration (C sequestration evolution = -560kgCO <sub>2</sub> ha <sup>-1</sup> year <sup>-1</sup> )
Some practices were not appropriate in the context of the field-trial conditions	In the L-GHG ICS: Very dry conditions in summer 3 years / 6 → Low amount of aerial biomass of cover crops
An unpredicted evolution of the agrosystem occurred	In both the L-EN and the L-GHG ICSs: High weed development → to mow oilseed rape plots in 2014

## Discussions – Conclusion

- After the first complete rotation the major sources of disparities were classified
- Nevertheless, a more complete agronomic diagnosis is necessary to identify and to rank all the causes of bad performances
- This knowledge allowed us to improve the innovative cropping systems through a new design step
- This experiment contributes to the learning design processes and cropping system management

### REFERENCES

<sup>1</sup> Reau R. and Doré T. (2008). "Systèmes de culture innovants et durables : quelles méthodes pour les mettre au point et les évaluer ?" *Educagri Editions, Dijon, France*, pp 175

<sup>2</sup> Colnenne-David C. and Doré T., 2014. Designing innovative productive cropping systems with quantified and ambitious environmental goals. "Renewable Agriculture and Food Systems".

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