# Syppre, a unique experimental network to meet the sustainability objectives of agricultural systems

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# Syppre, an unique research & development methodology

## Synergy between the 3 technical institutes on arables crops in France

## An original methodology based on

- An **observatory** of algricultural practices
- 5 experimental **platform**
- Farmers **network**

# Syppre, an original experimental network

- 5 sites representative of major arable farming areas in France;
- **On each site:**
  - Experimentations starts in 2016, **data acquisition from 2017 to 2023**;
  - An experimental platform from 3 to 10 ha;
  - Locally adapted innovative and reference systems;
    - Reference system representative of main local farming practices (crops and crop management).
    - Innovative system co-built with local farming partners and farmers.
  - All crops present every year;
  - 2 to 3 spatial repetitions.

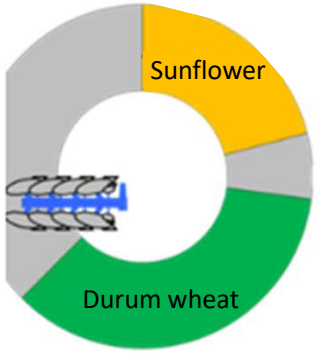
# Which levers in the innovative systems ?

## Main levers :

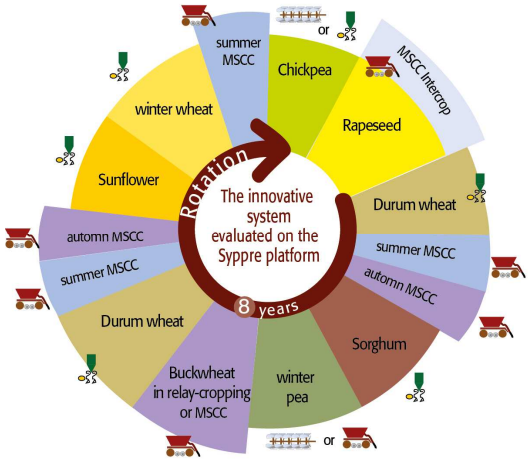
- Increased cultivated biodiversity:
  - More crops (major and minor), including legumes;
  - Multiple cropping, mostly through relay-cropping;
  - Multi-Services Cover Crops (MSCC), including legumes.
- Reduction of inversion and deep tillage;
- Use of decision tools and technical institute recommendations for crop management;
- Use of cultivar diversification.

## Example from the Lauragais site :

**Reference system**
**2-year rotation**




**Innovative system**
**8-year rotation**



# What objectives and criteria to assess the systems?

| Dimension | Criteria | Objective innovative vs. reference |
|---|---|---|
| Technical | **TFI** | **-50%** |
| | **Mineral nitrogen application** (kg $ha^{-1}$) | **-20%** |
| Environment | **Primary energy consumption** (MJ $ha^{-1}$) | **-20%** |
| | **Greenhouse Gases emissions** (t eq.$CO_2$ $ha^{-1}$) | **-20%** |
| Productivity | **Gross energy production** (MJ $ha^{-1}$) | **≥** |
| Profitability | **Direct margins with aids** (€ $ha^{-1}$) | **≥** |

Research questions:

- Do innovative systems achieve their objectives (**system effect**)?
- What is the impact of annual variations (**year effect**)?
- Do innovative systems improve over time (**system:year**)?

# Do our innovative systems achieve multi-performance?

***Average of the 5 sites over 7 years**

| Dimension | Criteria | Objective (Innovative vs. Reference ) | Results* (Innovative vs. Reference) | System effect (p-value) | Year effect (p-value) | System:year effect (p-value) |
|---|---|---|---|---|---|---|
| Technical | TFI | -20 % | -10 ± 25 % | 0.14 | 0.00 | 0.98 |
| | Mineral nitrogen application (kg $ha^{-1}$) | -20 % | -24 ± 15 % | 0.01 | 0.06 | 0.85 |
| Environment | Primary energy consumption (MJ $ha^{-1}$) | -20 % | -15 ± 10 % | 0.03 | 0.00 | 0.91 |
| | Greenhouse Gases emissions (t eq.$CO_2$ $ha^{-1}$) | -20 % | -22 ± 10 % | 0.00 | 0.02 | 0.78 |
| Productivity | Gross energy production (MJ $ha^{-1}$) | ≥ | -11 ± 13 % | 0.03 | 0.00 | 0.97 |
| Profitability | Direct margins with aids (€ $ha^{-1}$) | ≥ | -20 ± 33 % | 0.01 | 0.00 | 0.94 |

Main results:

- Technical and environmental performances → **innovative > reference ;**
- Productivity and profitability performances → **innovative < reference ;**

} **Ø Multiperformance → unsatisfactory**

- Strong variations of performances according to the year (***significant year effect***);
- No suggestions for relative improvement of innovative systems over time (***nonsignificant system:year interaction***).

*Stastistics → Mixed-effects model with « site » as a random effect – Longis et al. 2024*

# Are there any differences in trends between sites ?

| Dimension | Criteria | Objective (Innovative vs. Reference ) | Results* (Innovative vs. Reference) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Béarn | Berry | Champagne | Lauragais | Picardie |
| Technical | TFI | -20 % | -26 ± 29 % | -21 ± 20 % | -6 ± 13 % | 22 ± 14 % | -21 ± 9 % |
| | Mineral nitrogen application (kg $ha^{-1}$) | -20 % | -34 ± 6 % | -30 ± 15 % | -25 ± 12 % | -25 ± 15 % | -9 ± 11 % |
| Environmental | Primary energy consumption (MJ $ha^{-1}$) | -20 % | -23 ± 6 % | -19 ± 11 % | -11 ± 6 % | -1 ± 6 % | -20 ± 4 % |
| | Greenhouse Gases emissions (t eq.$CO_2$ $ha^{-1}$) | -20 % | -28 ± 5 % | -25 ± 12 % | -19 ± 9 % | -19 ± 10 % | -18 ± 8 % |
| Productivity | Gross energy production (MJ $ha^{-1}$) | ≥ | 1 ± 14 % | -20 ± 7 % | -7 ± 4 % | -8 ± 10 % | -23 ± 7 % |
| Profitability | Direct margins with aids (€ $ha^{-1}$) | ≥ | 23 ± 33 % | -11 ± 27 % | -32 ± 25 % | -38 ± 12 % | -40 ± 21 % |

***Average per site over 7 years**

- TFI : most systems reach the objective ;
  - Increased in Lauragais → addition of relatively high TFI crops (e.g., rapeseed) and MSCC chemical destruction in relation to reduced tillage strategy.
- Other technical and environmental dimensions results are detailed in ***Marie Estienne's presentation Syppre: innovative systems to meet the challenges of improving agriculture's carbon footprint.***
- Productivity and profitability: only Béarn stands out (extensive use of multiple cropping, relatively low addition of minor crops).
- *Why do our innovative systems tend to be less productive ?*

# Why do our innovative systems tend to be less productive ?

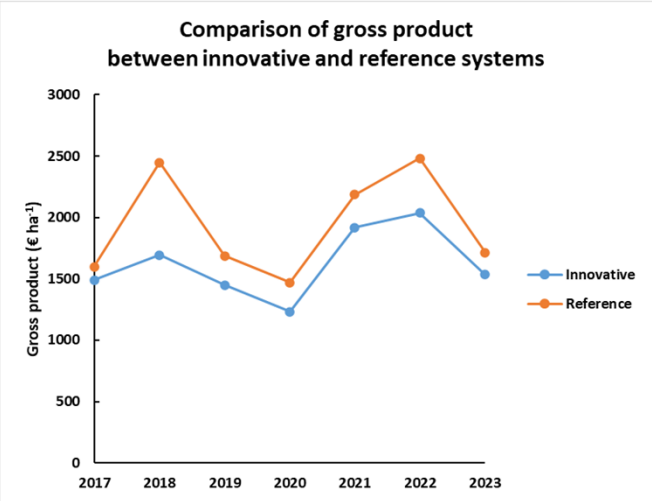
| | Crop | Yield (t . ha$^{-1}$) | | p-value | Energy content (kcal.kg$^{-1}$) | Crop area at farm level (ha) | |
|---|---|---|---|---|---|---|---|
| | | Innovative | Reference | | | Innovative | Reference |
| Major crops (site) | Maize + *oat as energy crop* (Béarn) | 10.9 ± 2.4 + 7.2 ± 1.9 | 11.9 ± 2 | 0.1095 | 4450 | 31.5 | 63 |
| | Soft wheat (Berry) | 6.6 ± 1 | 6.9 ± 1 | 0.441 | 4350 | 34 | 50 |
| | Beetroot (Champagne) | 79 ± 26.2 | 84.9 ± 24.1 | 0.944 | 3870 | 36 | 36 |
| | Durum wheat (Lauragais) | 6.2 ± 1.5 | 6.6 ± 1.5 | 0.221 | 4420 | 43 | 85 |
| | Beetroot (Picardie) | 80.1 ± 17.4 | 94.3 ± 13.9 | **0.00642** | 3870 | 18 | 27 |
| Exemple of added minor crops in Berry | Millet | 3.4 ± 0.8 | / | | 4610 | | |
| | Lentil | 1.8 ± 0.9 | / | | 4410 | | |

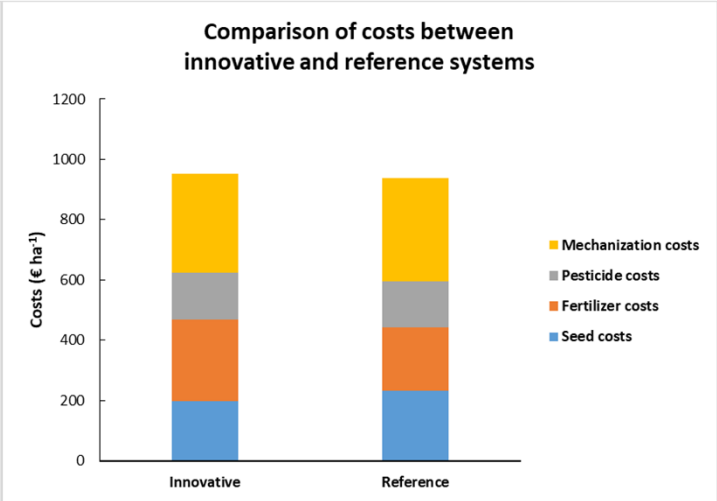
| Site | Innovative system | | Reference system | |
|---|---|---|---|---|
| | Crop failure | Crop partial failure | Crop failure | Crop partial failure |
| Béarn | 0 | 3 | 0 | 0 |
| Berry | 1 | 0 | 0 | 1 |
| Champagne | 5 | 3 | 0 | 0 |
| Lauragais | 3 | 9 | 0 | 0 |
| Picardie | 2 | 2 | 1 | 0 |
| **Total** | **11** | **17** | **1** | **1** |

- **Major crop yields:**
  - No statistical difference between systems at each site (except beetroot in Picardie);
  - Nevertheless, on trend, industrial crops such as beet and potatoes tend to have lower yields in innovative systems since they are more sensitive to changes in crop management.
  - We can also note yield differences between same crops at a different place in the rotation wich benefit or not from the previous crop effect
- **Minor crop yields:**
  - Tend to have **low yields** and contribute to **more failure and partial failures;**
    - Learnings, fewer plant improvements, less phytosanitary options, less adapted farm equipment, predation problem (birds).
  - No compensation through higher energy content of crops (**gross energy production**).

# Why do our innovative systems tend to be less profitable?

***Average of the 5 sites***




***Average of the 5 sites over 7 years***

- Gross product of innovative systems are lower:
  - Dilution of profitable major crops in farm utilized area, low minor crop yields and unprofitable prices for minor crops.
- Innovative and reference systems costs are similar:
  - Innovative systems tend to have lower fertilizers and similar pesticides costs;
  - Innovative systems tend to have higher mechanization (weeding) and seed (MSCC) costs.
- Direct aids including eco-schemes from the 2023-2027 CAP are not enough to reverse economic trends.

# Main conclusions

- Diversification is a way to improve environmental performances of agricultural systems.
  - Antagonisms may occur depending on the starting point (e.g. TFI in Lauragais site).

- The economic performance of more diversified systems is often not achieved:
  - Need to increase agronomic knowledge to improve yields of minor crop and reduce failures and adapt crops to experimental constraints like bird predation;
  - Need synchronized contribution of other actors of agri-food system (genetic, value-chain, consumers) to collectively improve the agronomic and economic performances;
  - Need for greater financial support from the CAP for agricultural systems with fewer negative externalities for the environment.

- Adaptation of crops and crop management to local environmental and economical contexts is decisive to achieve multiperformance.

- Syppre is a unique network of collaboration between French technical institutes and generates many technical learnings (see → syppre.fr)

# Thank you for you attention

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