Syppre Lauragais technical day

June 6, 2024

In partnership with

Chambre Régionale d'Agriculture Occitanie,
Chambres d'Agriculture de l'Aude & de la Haute-Garonne,
Conseil Départemental de la Haute-Garonne,
Agro d'Oc, Arterris, Val de Gascogne,
Lycée d'Enseignement Général et Technologique Toulouse-Auzeville, LIA

Construire ensemble les systèmes de culture de demain

10am to noon Visit of the platform in rotating workshops

- **Improving my soil**
  Matthieu KILLMAYER (Arvalis)
  Clémence DE SAINTIGNON (Terres Inovia)
- **Weed management**
  Sylvie NICOLIER (Arvalis)
  Jean-Luc VERGE (Chambre Agriculture de l'Aude)
- **Improving the sustainability of my system under climate change conditions**
  Eva DESCHAMPS (Arvalis)
  Vincent LECOMTE (Terres Inovia)
- **Background and lessons learned from the innovative system**
  Antony CAZABAN (Arvalis)
  Marie ESTIENNE (Arvalis)

1:30pm to 5:30pm Equipment demonstrations

How to manage the cover crop destruction in an efficient way, which settings and methods for which results? Come and see different types of cover crop destruction equipment in action on a dedicated cover crop platform and stay to hear feedback from farmers.

Anthony CAZABAN, Eva DESCHAMPS (Arvalis)
Clémence DE SAINTIGNON (Terres Inovia)
Maurice DE GUEBRIANT, Sébastien DELMAS, Yannick JEAN, Damien MAZIERES,
Eric ZAMBON (agriculteurs)

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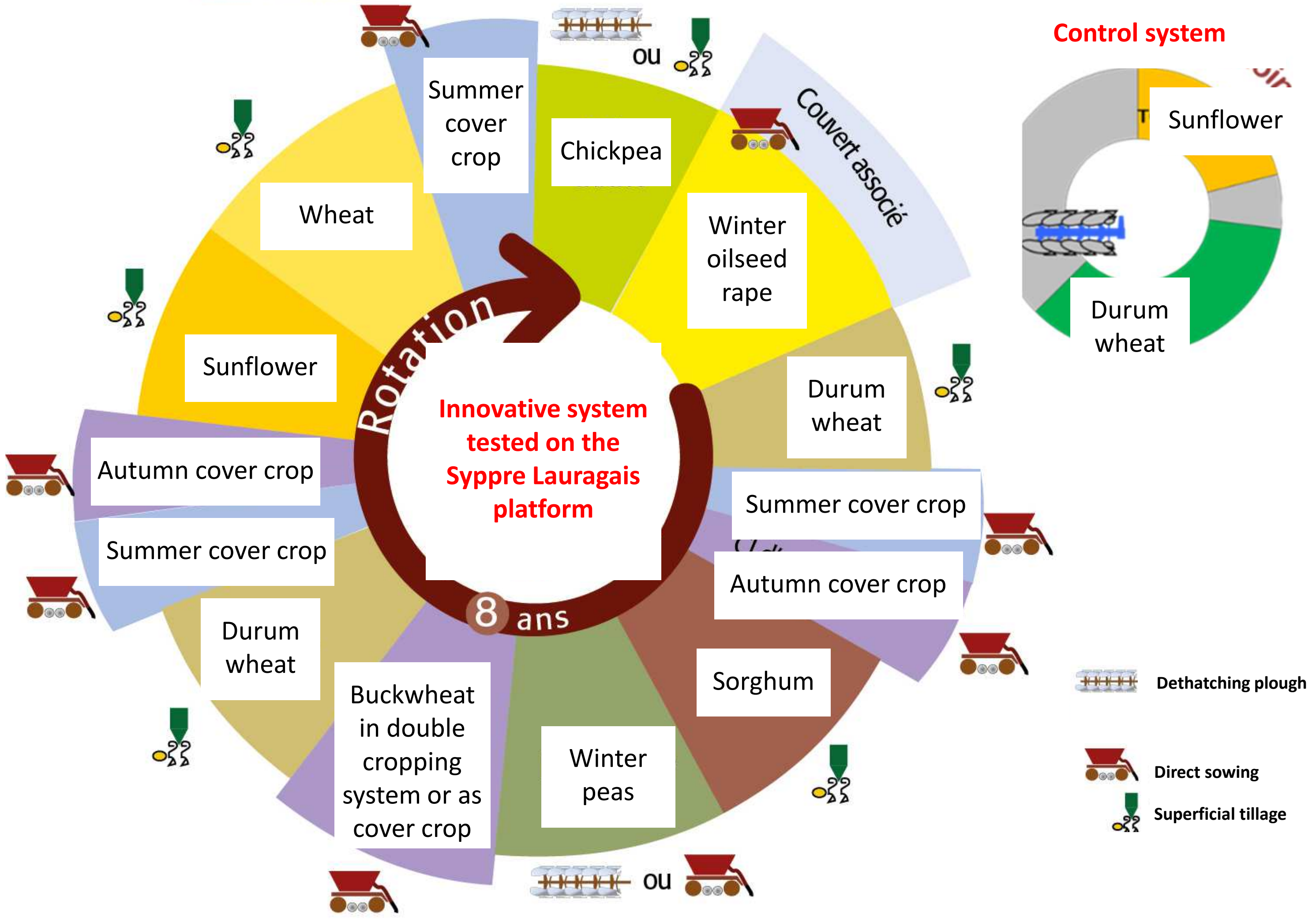
Site identity card



Control system

Sunflower

Durum wheat

Innovative system tested on the Syppre Lauragais platform

Rotation 8 ans

Summer cover crop

Chickpea

Couvert associé

Winter oilseed rape

Durum wheat

Summer cover crop

Autumn cover crop

Sorghum

Winter peas

Buckwheat in double cropping system or as cover crop

Durum wheat

Summer cover crop

Autumn cover crop

Sunflower

Wheat

ou

ou

Dethatching plough

Direct sowing

Superficial tillage

Experimental system:

Start of the trial in 2015-2016 with a winter oilseed rape as previous crop.

Clay-limestone slope

Slopes from 5 to 14%

Clay content: 23 to 33%

Water pH: 8.4

Non-irrigable plot

Available water capacity : 70 mm to 122 mm between the top and bottom of the field

North exposure

Organic matter content in 2015: 1.3%

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Site identity card

The innovative system objectives :

Improve economic performance and robustness

Improve soil fertility and limit the risk of erosion

Reduce dependence on inputs (glyphosate as a last resort and 0 S-metolachlor)

Improve energy balance and reduce greenhouse gas emissions

Erosive phenomena observed on the system :

Rainfall measured on the Syppre Lauragais platform at the time of the erosive phenomena

Date	Measured rainfall (mm/day)	Maximum hourly rainfall
26/04/2015	45	21.8
31/03/2017	30	11
11/05/2017	20	7.8
08/04/2018	40	8.6
28/05/2018	35	22.4
24/05/2019	22	2.6
21/06/2021	25	4.4
09/09/2021	47	13

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ARVALIS ITB Institut Technique de la Betterave Terres Inovia l'agronomie en mouvement

Some key figures

Present and past climate

Average annual rainfall: 600 mm
Average annual temperature: 13.6°C

Temperature

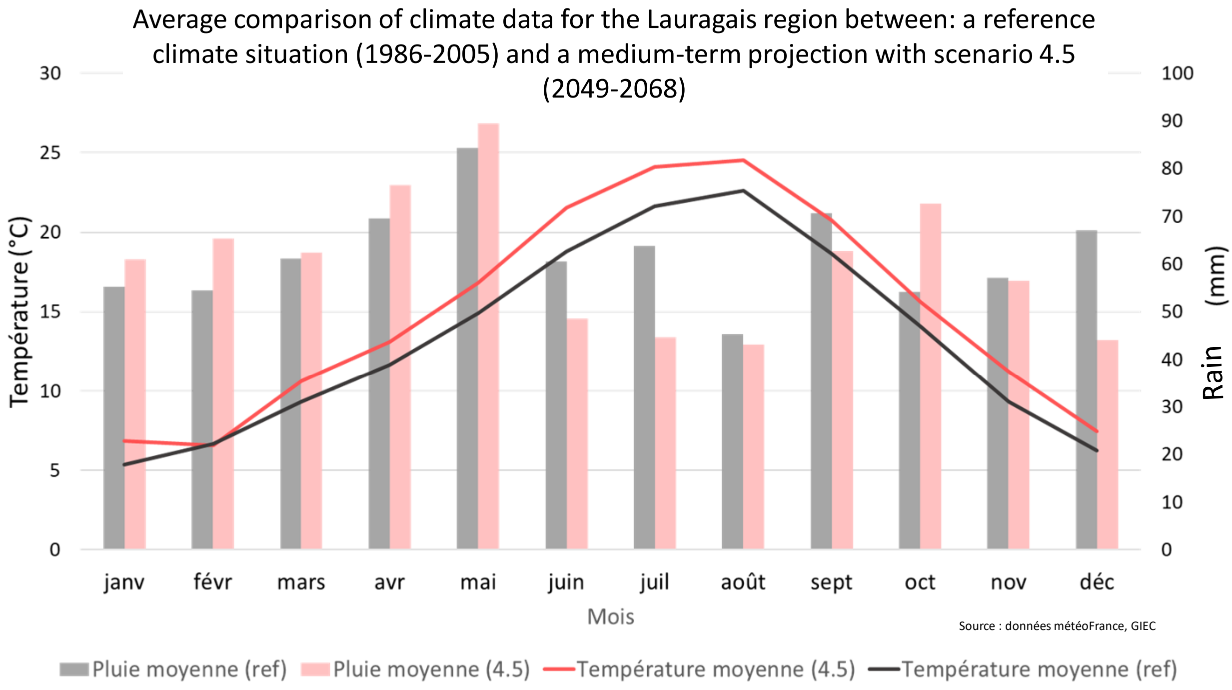
Average temperature (°C)	octobre	novembre	décembre	janvier	février	mars	avril	mai	juin	juillet	août	septembre	Moyenne (octobre-mai)
2023-2024	17.8	10.6	8.0	7.1	8.9	11.3	12.7	15.3					11.4
20-year median	14.9	10.5	7.0	5.3	6.8	9.7	12.2	16.0	18.2	21.9	21.7	19.4	10.3
Degree difference	2.9	0.0	0.9	1.7	2.1	1.6	0.5	-0.7					1.1

Pluviometry

Rainfall (mm)	octobre	novembre	décembre	janvier	février	mars	avril	mai	juin	juillet			Somme (octobre-mai)
2023-2024	33	89	54	38	83	58	46	80					482
20-year median	43	55	50	64	38	51	65	67	11	33	32	47	433
Degree difference	-11	35	4	-26	46	7	-19	13					49

While autumn and winter rainfall is generally moderate in intensity, spring and summer rainfall can be heavy, as a result of thunderstorms, leading to soil erosion.

How will the climate evolve in the context of climate change?



Average comparison of climate data for the Lauragais region between: a reference climate situation (1986-2005) and a medium-term projection with scenario 4.5 (2049-2068)

Source : données météoFrance, GIEC

- **Increase of the average temperature throughout the year**
- **June to September: less rain, warmer temperatures**
- **More rain in October and April-May**
- **Overall, climate more variable from May to July**

ClieNFarms Climate Neutral Farms

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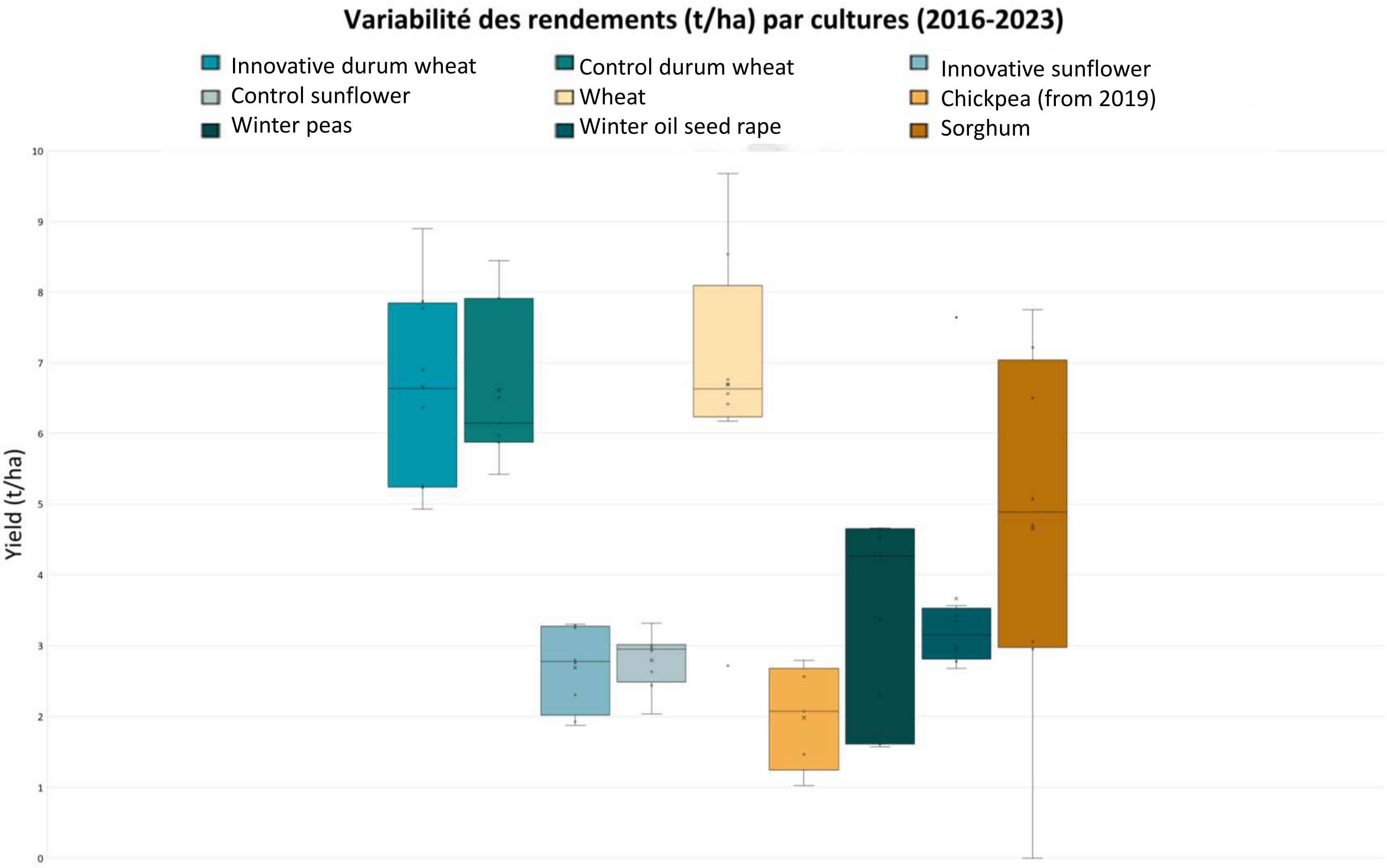
Liberté Égalité Fraternité

Some key figures

Yield variability on the experimental platform (t/ha)



Details of yields (t/ha) by year and by crop, and yield targets

Système	Innovant							Témoin	
Cultures	Innovative durum wheat	Innovative sunflower	Wheat	Chickpea	Winter peas (spring peas in 2020)	Winter oilseed rape	Sorghum	Control durum wheat	Control sunflower
Yield objective t	**7**	**3**	**6**	**2**	**4.5**	**3.5**	**6**	**7**	**3**
2016	7.8	2.8	9.7		4.3	3	4.7	7.9	3
2017	7.9	3.3	8.5		4.7	3	6.5	8.4	2.9
2018	5.3	2	6.2		1.6	3.3	0	5.4	2.6
2019	8.9	2	6.7	1.5	4.5		3	7.6	2
2020	5.2	2.8	2.7	2.6	2.8	2.7	5.1	5.9	3
2021	4.9	3.3	6.8	2.8	4.7	3.6	7.8	6.1	3.3
2022	6.4	2.3	6.6	1	2.3	2.8	3.1	6.5	2.4
2023	6.9	3.2	6.4	2.1	1.6	3.4	7.2	6.0	3
Moyenne	**7**	**3**	**7**	**2**	**3**	**3**	**5**	**7**	**3**
Ecart-type	1.5	0.6	2	0.7	1.4	0.3	2.6	1.1	0.4

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Strategies implemented on the innovative system: background and lessons learned

Strategies implemented on the innovative system: background and lessons learned

2014

Combining agronomic levers to meet high ambitions

Objectives and constraints

Objectives

- Improve the economic performance
- Improve soil fertility and limit the erosion risk
- Reduce dependence on inputs
- Improve the energy balance and reduce greenhouse gas emissions

Levers

- Diversification and lengthening of the rotation, choice of suitable varieties to reduce the use of plant protection products by 50% and limit risks
- Near-permanent cover crops to improve soil C stock, combined with reduced tillage to reduce erosion
- Growing legumes as crops or cover crops to limit the use of mineral nitrogen and reduce greenhouse gases

Co conception

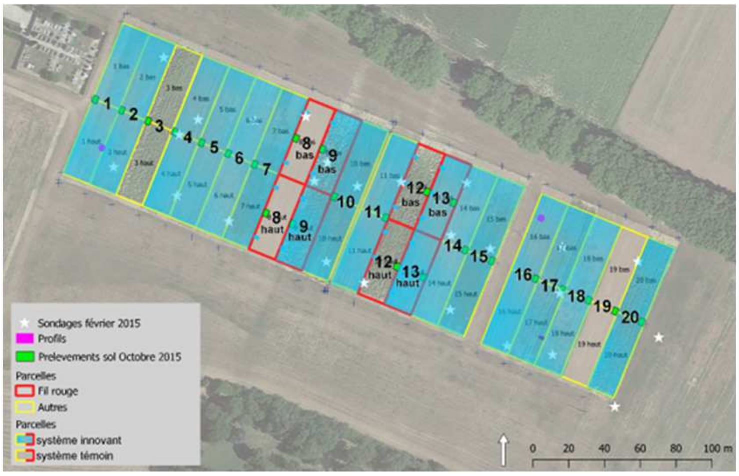
Capitalising on the collective expertise of farmers, economic partners and technical institutes to build an innovative system that outperforms the control system (economic, social and environmental).
Composition of the COPIL

A complex system on a dedicated plot for a long period (>10 years)

Initial state

North-facing slope, clay-limestone, sensitive to erosion
Characterisation of the initial fertility of the plot: chemical, physical and biological.
Average % OM=1.3
Rotation history: 5 years, fairly diversified
Weed history: no significant pressure

Plot before the trial implementation



Design of the experimental system

- ✓ 20 plots of 16*100 metres, 2 replications, randomisation
- ✓ All the crops of the rotation are grown every year
- ✓ Upper and lower slopes analysed separately to assess the system's performance on different potential soils, representative of the farmers' production areas
- ✓ Crop management according to the recommendations of the French Technical Institutes

➡ Decision-making rules set by COPIL, taking account of soil and climate constraints.

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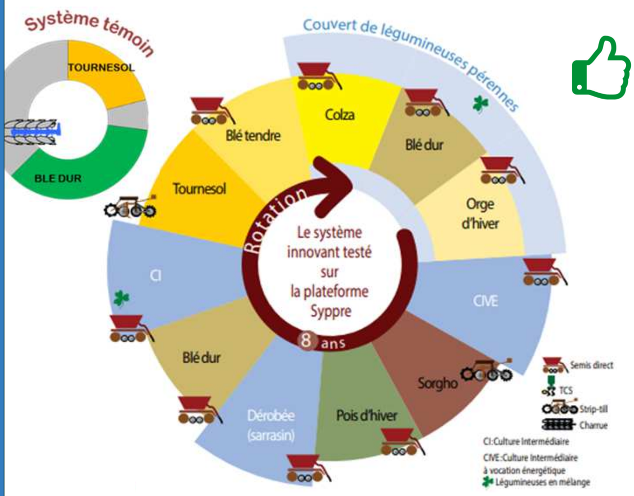
Strategies implemented on the innovative system: background and lessons learned

2015 Implementation of the first system



- Crops compatible with local markets
- Direct sowing + cover crops
- Lowering the treatment frequency index by managing the intercrops
- Successful direct sowing of peas behind sorghum and wheat

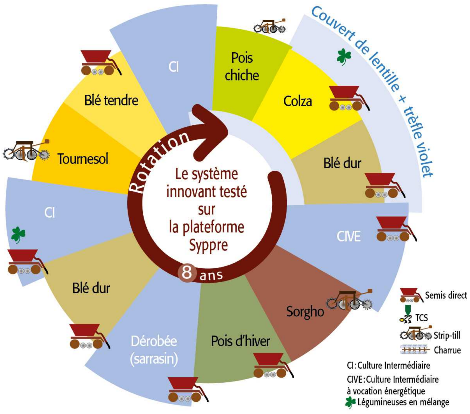
- 5 successive winter crops + weed control failures on ryegrass (RG) drift
- Difficulties to implant sunflowers with strip-till
- Difficulty to move on from the energy catch crop to the sorghum

2017 Suspicion of resistance in ryegrass, confirmed by laboratory analysis

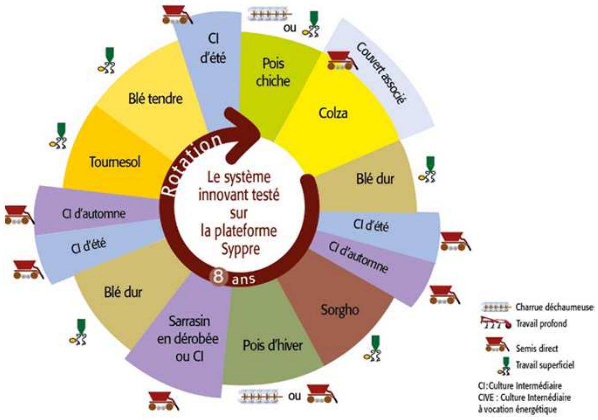
2018 Objective of using glyphosate as a last resort on the platform Necessity to review the system to manage weeds

- Rotation modification
- Adaptation of weed management strategies
- Destruction of cover crops before they set seed
- Competitive effect of buckwheat on ryegrass

- Reintroduction of tillage but with permanent cover
- Difficulty of implementing permanent clover cover



2020 Replacement of the winter energy catch crop by an opportunistic summer energy catch crop



- Winter energy catch crop replaced by summer energy catch crop, which can be harvested depending on its biomass
- Improved weed management
- Soil covered for the entire intercropping period

- Negative impact of winter energy catch crop on the following spring crop
- RG set seed in the energy catch crop
- Difficulties in managing the energy catch crop/Sorghum sequence without glyphosate

2024 Conclusion: a system adapted without reconsidering its initial objectives

- Maintained soil fertility
- Significant reduction of the nitrogen inputs throughout the system
- Weed pressure contained
- Cover crops before sunflower and sorghum destroyed without glyphosate

- Significant diversification, which has an impact on economic performance and the use of cover crops

Compromise between performances according to the context of the year: Flexibility, Observation & Reactivity. Towards new objectives and a new system?

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Strategies implemented on the innovative system: background and lessons learned

What is our trajectory in managing this innovative system?

	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Intercropping and tillage management	🟩	🟧	🟧	🟧	🟧	🟧	🟩
Implantation control	🟧	🟧	🟩	🟧	🟧	🟧	🟧
Weed control	🟧 RG set seed in cereals and sunflowers	🟥 Alfalfa and RG volunteers in cereals	🟥 RG in wheat, sorghum and peas/buckwheat	🟥 RG transplanting in winter oilseed rape, durum wheat, wheat and energy catch crop	🟧 RG in sorghum and durum wheat	🟧 weeding controlled throughout the year but weeding satisfaction note behind the objective	🟥 phytosanitary accident on peas. Climatic conditions perturbed treatments and their effectiveness.
Pest control	🟩	🟩	🟩	🟩	🟩	🟩	🟧
Diseases and lodging control	🟩						
Nitrogen and other elements nutrition control	🟩						
Yields yields are always at the same level as regional yields	🟩	🟥 Unsatisafctory yields except for wheat and winter oilseed rape (good)	🟩 winter crops 🟥 summer crops	🟧 yields quite good except for sunflowers and chickpeas (good)	🟩 good yields except for durum wheat (quite good)	🟥 all crops yields below the objective except sunflower, wheat and durum wheat (top of the field)	🟩 Good yield except for peas
Quality			🟩	🟩	🟩	🟩	🟩

Level of satisfaction regarding the platform's objectives : 🟩 Good 🟧 Quite good 🟥 Unsatisfactory

What we control :

Pests, diseases, fertilisation

- ✓ Effective pest and disease control, management
- ✓ Good nitrogen efficiency thanks to CHN management
- ✓ Yields still in line with regional benchmarks

What we are learning to control: intercropping, cover crops, implantation of the crops and weed management in this context.

Using innovative levers, taking risks.

- ✓ Sowing cover crops and winter oilseed rape: dependent on summer weather conditions
- ✓ Clay-limestone soils: reactivity required for intervention possibilities
- ✓ Cover crop management + destruction to sow on clean soil
- ✓ Ryegrass emergence throughout the year, transplanting with tillage: very low tolerance threshold <5 feet/m² to avoid drift.

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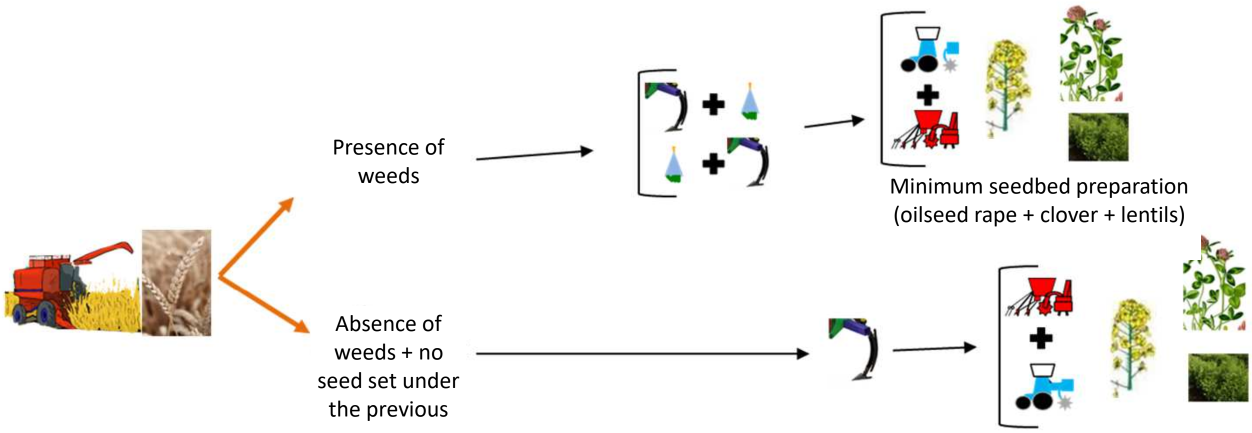
How have the decision-making rules evolved in line with the platform's objectives?

The Decision Rules have been revised in line with the changing context on the platform. They allow for a degree of flexibility and successful implementation according to the set criteria.

Winter oilseed rape example

Before 2018, simplified sowing with glyphosate depending on the presence of weeds and access to direct sowing or strip-till equipment.

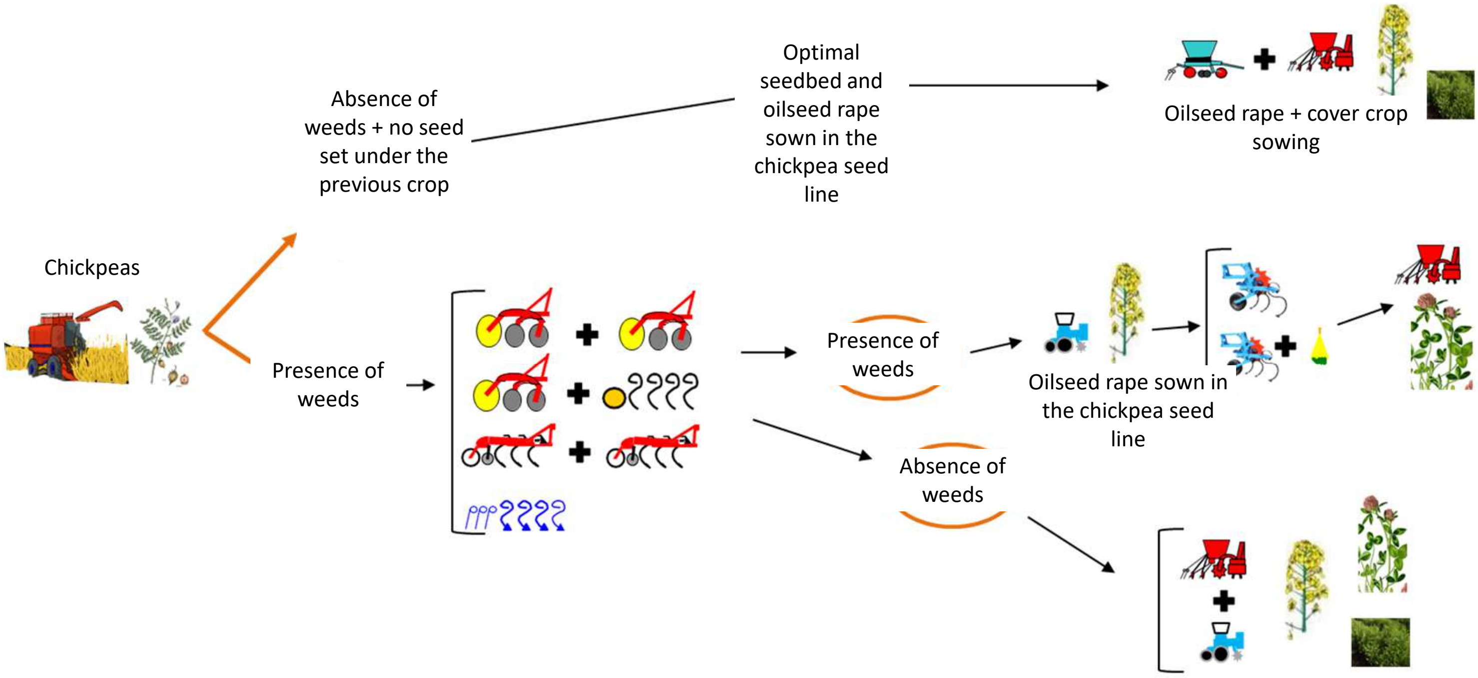

Presence of weeds

Minimum seedbed preparation (oilseed rape + clover + lentils)

Absence of weeds + no seed set under the previous crop

Minimum seedbed preparation (oilseed rape + clover + lentils)

After 2018, introduction of chickpea. Aim for a short intercrop and vigorous oilseed rape thanks to the nitrogen provided by chickpeas. Always sow on clean soil.


Absence of weeds + no seed set under the previous crop

Optimal seedbed and oilseed rape sown in the chickpea seed line

Oilseed rape + cover crop sowing

Chickpeas

Presence of weeds

Presence of weeds

Oilseed rape sown in the chickpea seed line

Absence of weeds

Oilseed rape + cover crop sowing

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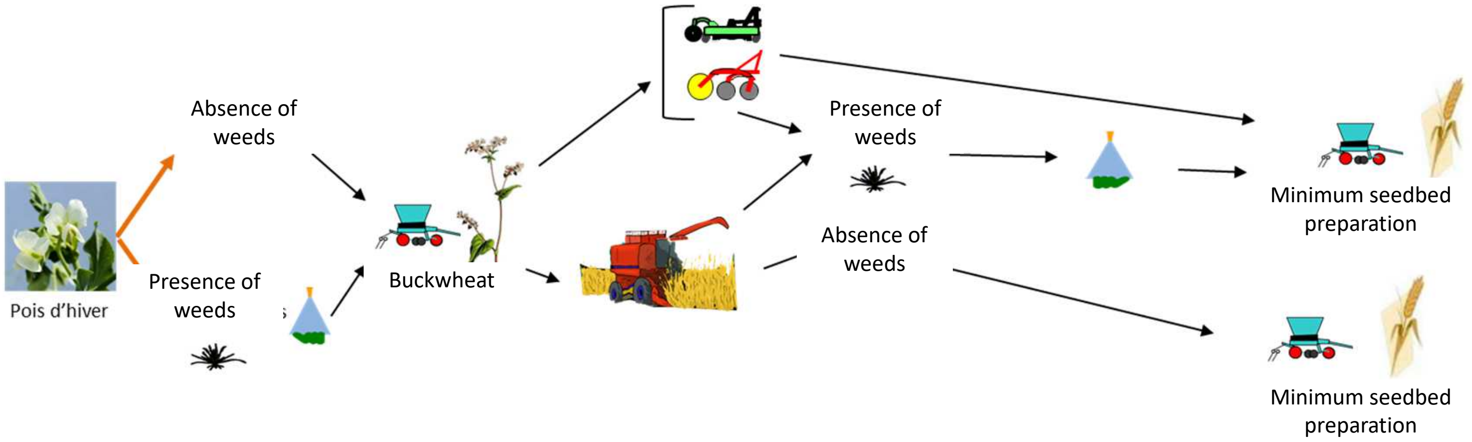
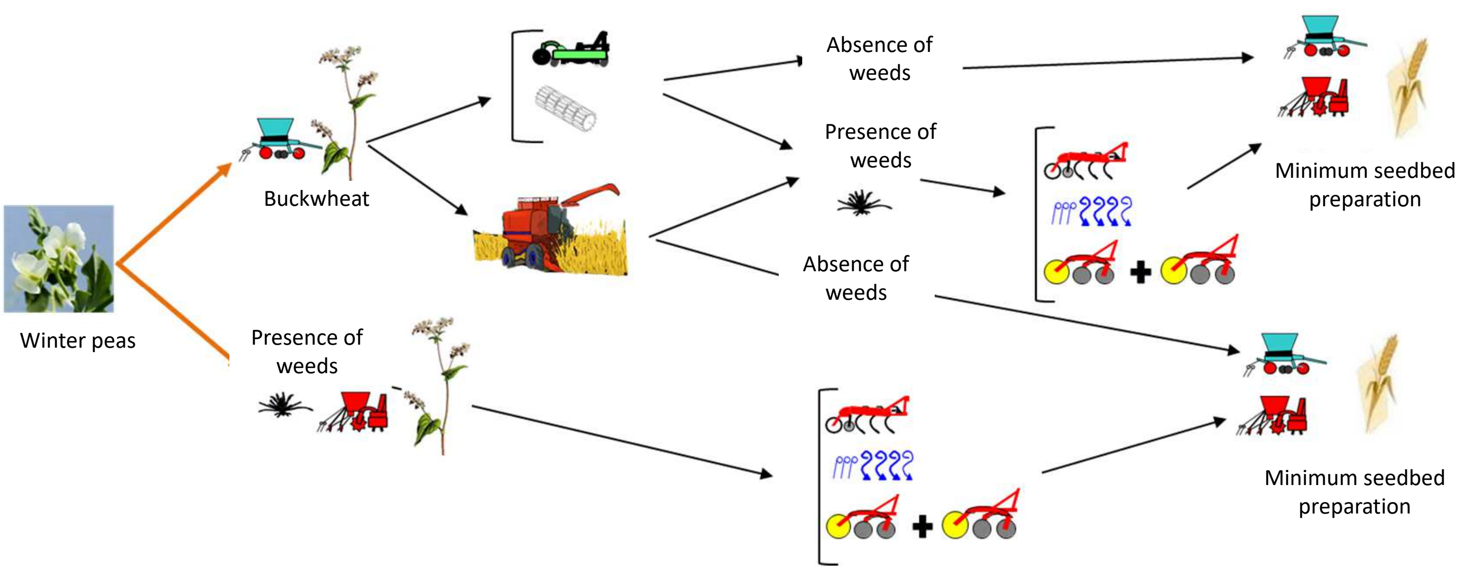
How have the decision-making rules evolved in line with the platform's objectives?

Durum wheat sowing after buckwheat/winter peas example

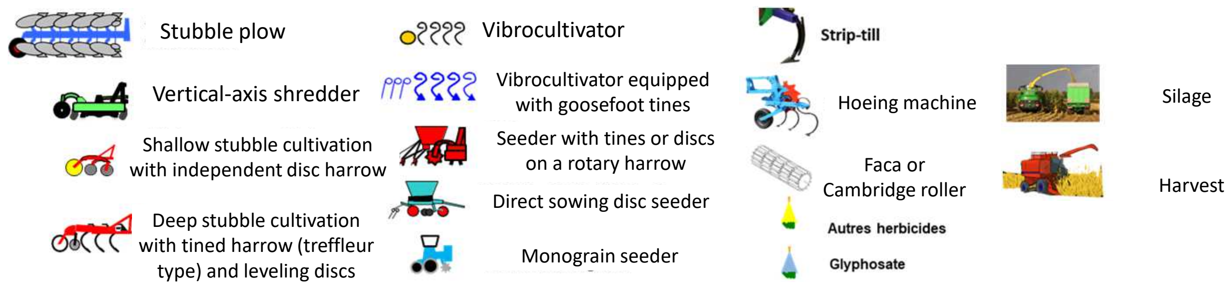
Before 2018, simplified sowing with glyphosate depending on the presence of weeds and access to direct sowing or strip-till equipment.



After 2018, in the majority of cases, buckwheat and durum wheat were sown by direct sowing just after the winter pea harvest. The success of the buckwheat (homogeneity) is decisive for the success of direct sowing of the following durum wheat (limiting the emergence of ryegrass and the competitive effect of buckwheat).



Caption:


Stubble plow
Vertical-axis shredder
Shallow stubble cultivation with independent disc harrow
Deep stubble cultivation with tined harrow (treffleur type) and leveling discs
Vibrocultivator
Vibrocultivator equipped with goosefoot tines
Seeder with tines or discs on a rotary harrow
Direct sowing disc seeder
Monograin seeder
Strip-till
Hoeing machine
Faca or Cambridge roller
Autres herbicides
Glyphosate
Silage
Harvest

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Improving the sustainability of my system in a context of climate change

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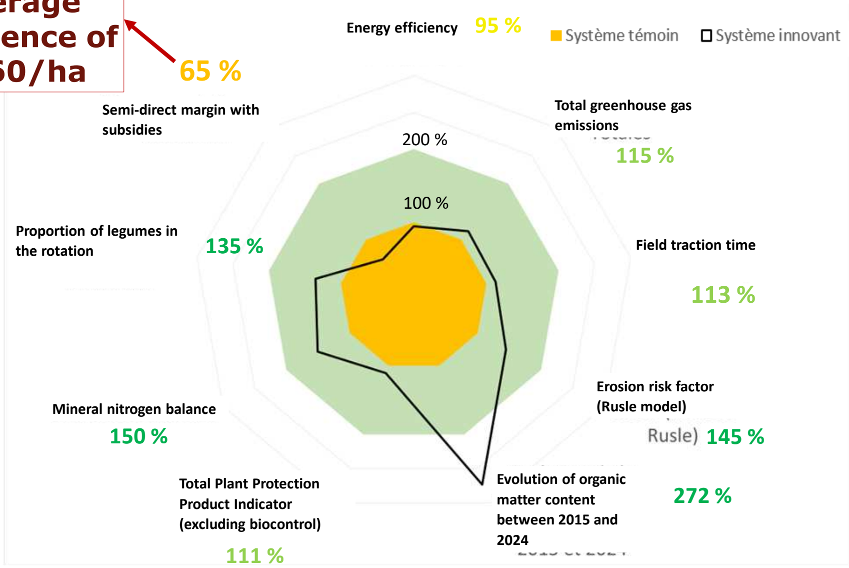
*I*mproving the sustainability of my system in a context of climate change

5 years/8: average difference of €260/ha

Multi-performance of the innovative system compared with the control - On average over the period 2016-2023, as a % of the control –



A high level of risk-taking to meet these multiple objectives

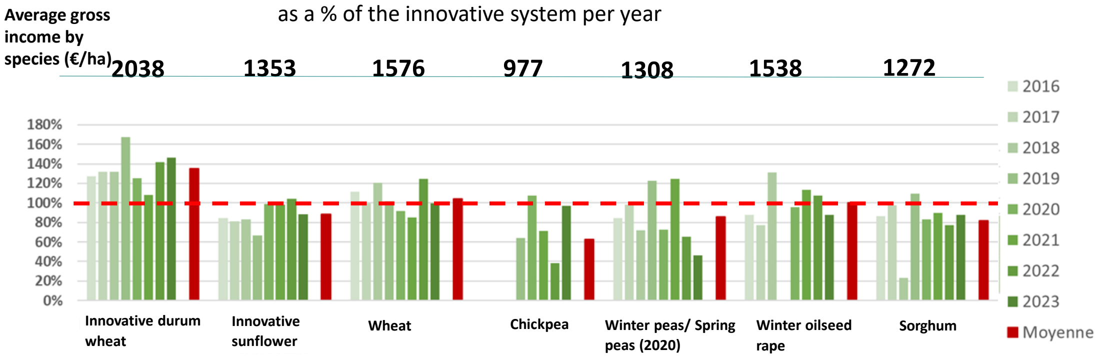
An innovative system that needs fewer inputs but performs less well economically*.

***Extrapolation of the technical and economic results of the platform to a farm of 170 ha entirely on northern slopes.**

Semi-direct margin = (Revenue + CAP subsidies) – Operating costs – Mechanical costs

A gross income* based on a few major species, with diversification crops providing flexibility

Gross income performance of the crops - as a % of the innovative system per year



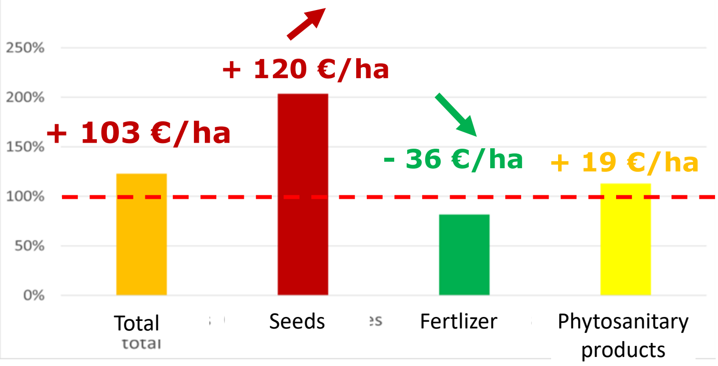
**Price after harvest*

- ✓ **Greater variability: risk-taking**
- ✓ **Significant improvement in yields of summer crops after cover crops over time**
- **√The innovative system still lags behind economically, even though diversification crops help to buffer against climatic hazards 6 years out of 8.**

Gross income at system level extrapolated to a farm of 170 ha
5 années / 8 : average difference of **136 €/ha**
3 années / 8 : average difference of **344 €/ha**

Higher input costs (€103/ha) despite lower fertiliser costs, mainly linked to seed costs

Costs performance of the innovative system compared with the control system - on average from 2016 to 2023 - as a % of the control system per year)



How to maximise your chances of success in this climate change context?

Observation of your fields

Combination of levers

Flexibility and opportunities

Preservation of the functioning and sustainability of your soils

Performance trade-off

Technical mastery time

Improving the sustainability of my system in a context of climate change

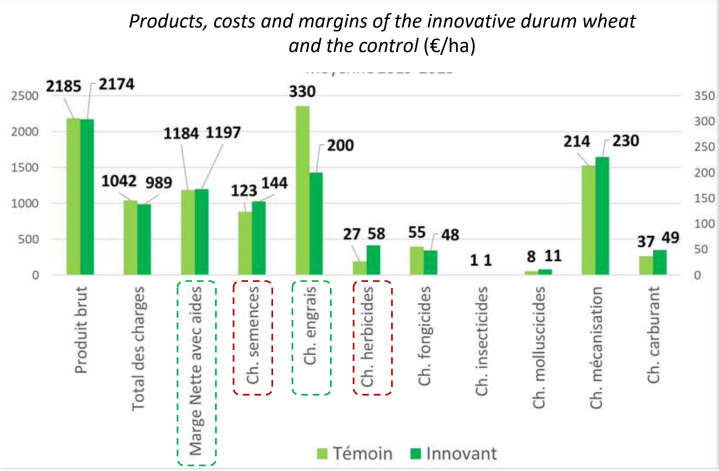
Durum wheat, the economic pillar of the Lauragais systems

Innovative durum wheat performs very well thanks to controlled fertilisation costs

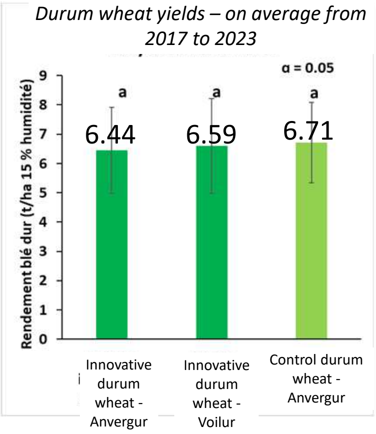
An equivalent gross income
An average reduction in costs of €53/ha

Substantial drop in fertiliser costs despite slightly higher herbicide and seed costs

Differences widen over the last 3 years: fertilisation and fungicides down

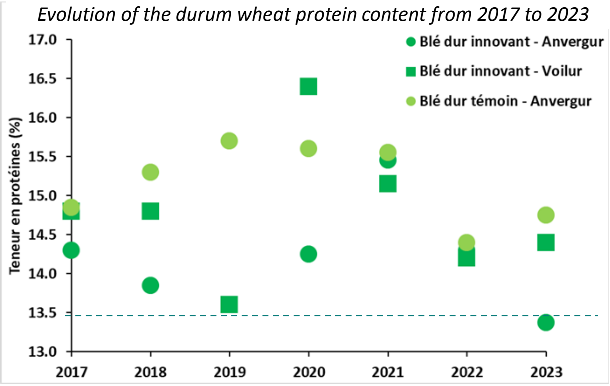

Products, costs and margins of the innovative durum wheat and the control (€/ha)

What are the yield and protein results for different years?


Durum wheat yields – on average from 2017 to 2023

- 2 q/ha difference on average not significant
Depending on the year, differences may vary more significantly

Differences vary according to the soil depth :
Superficial: + 2 q/ha
Medium : -4 q/ha


Evolution of the durum wheat protein content from 2017 to 2023

-0.3 to +0.5 % protein on average, slightly better for the control

Threshold of 13.5 % almost always reached whatever the method

- Years with high nitrogen residues at the end of winter
- Less effective use of mineral nitrogen in spring
- Innovative durum wheat performs better on shallow soils

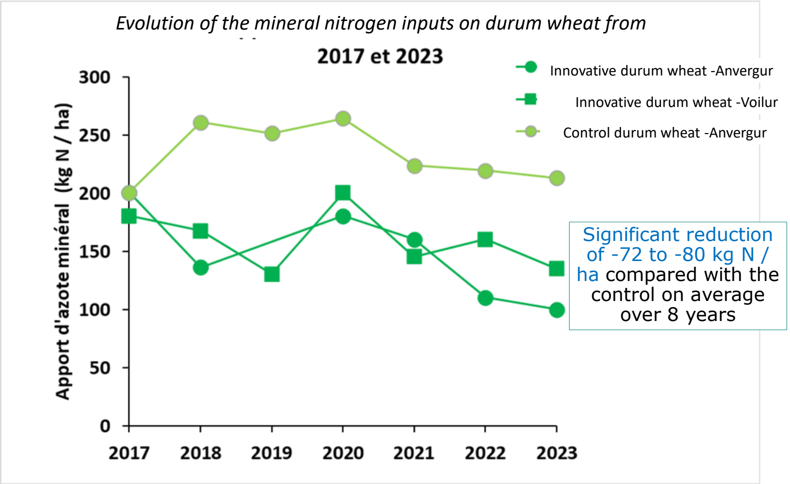
- Wet autumn years with sowing difficulties
- Years with complex fusarium problems on ears of corn

Which strategy pays off?

✓ **Reducing the use of mineral nitrogen in innovative durum wheat varieties**

✓ **Varietal choice and control of fungicide treatments: for the past 3 years, T1 or even T2 deadlocks have been possible depending on the variety and climatic conditions.**

✓ **Ryegrass control using a combination of levers**


Evolution of the mineral nitrogen inputs on durum wheat from

Significant reduction of -72 to -80 kg N / ha compared with the control on average over 8 years

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*I*mproving the sustainability of my system in a context of climate change

An innovative sunflower with contrasting performances

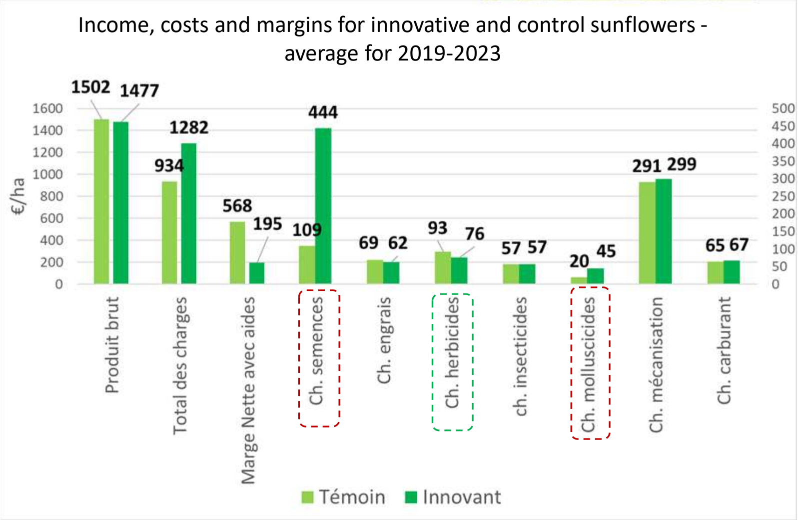
Equivalent gross income
An increase in costs

Similar mechanisation costs

A slight increase in slug control costs

A high level of protection against wireworm larvae (high risk) with the 2 methods.

The costs of double cover crops before sunflower are allocated to the crop. However, the benefits are assessed on the scale of the crop succession and over the long term.



Agronomy and environment

(1)Reduced risk of erosion
(2) Effect of cover crops which needs to be better exploited by optimising the fertilisation of the following sunflower.

Profitability

Deterioration linked to the 'cover crop seeds' item (100% purchased with double cover in summer and winter): + €335/ha in costs allocated entirely to sunflower.

Equivalent yields (2019-23)

Average yield for the control system = 27.6 q/ha
Average yield of the innovative system = 27.0 q/ha

Social

Equivalent traction time

innovative Vs control sunflower
Example of two contrasting seasons: 2022 (very hot and dry) and 2023 (wet then hot and dry at the end of the cycle)

❑ Benefits :

- Yields and quality maintained
- Reduced erosion
- Interesting crop in rotation (diversification)
- Prolonged maintenance of leaf area over the summer period, a key period in yield development

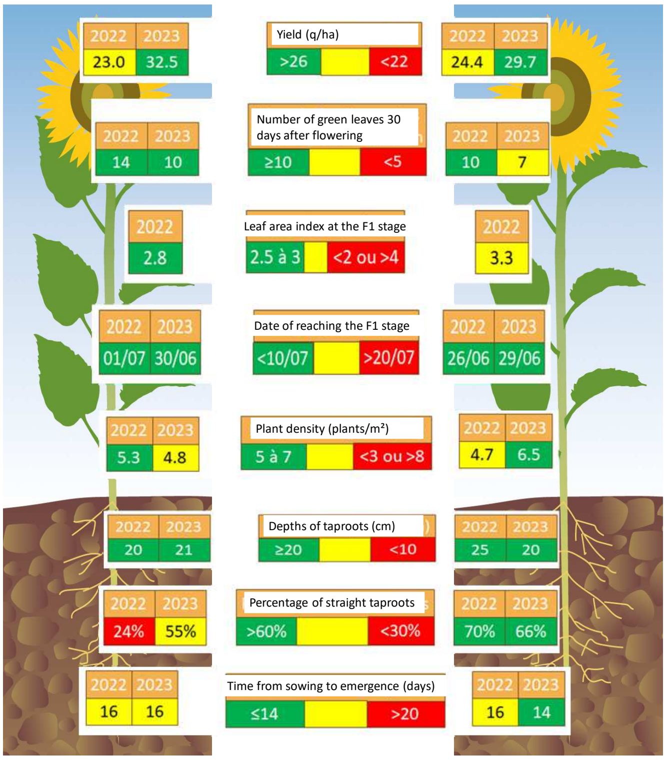
❑ Progress possibilities:

- Managing cover crop destruction without glyphosate on a northern clay-limestone slope
- Seedbed preparation
- Slug control
- Vigour at start-up
- Rationalisation/optimisation of nitrogen fertilisation in the presence of big cover crops

Towards a more robust sunflower

Key indicators - 2022 et 2023

innovative Vs control sunflower



2022	2023					2022	2023
23.0	32.5	Yield (q/ha)	>26	🟨	<22	24.4	29.7
14	10	Number of green leaves 30 days after flowering	≥10	🟨	<5	10	7
2.8		Leaf area index at the F1 stage	2.5 à 3	🟨	<2 ou >4	3.3	
01/07	30/06	Date of reaching the F1 stage	<10/07	🟨	>20/07	26/06	29/06
5.3	4.8	Plant density (plants/m²)	5 à 7	🟨	<3 ou >8	4.7	6.5
20	21	Depths of taproots (cm)	≥20	🟨	<10	25	20
24%	55%	Percentage of straight taproots	>60%	🟨	<30%	70%	66%
16	16	Time from sowing to emergence (days)	≤14	🟨	>20	16	14

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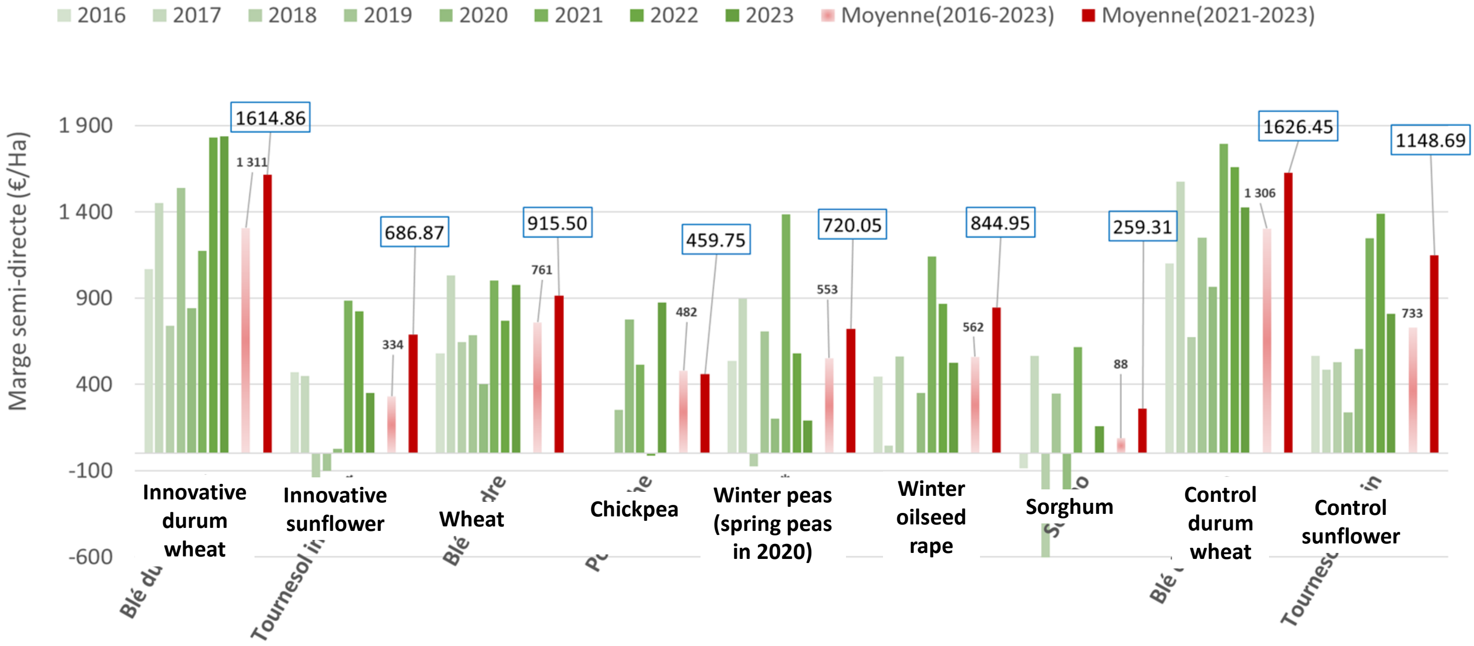
Details of semi-direct margins by crop

Semi-direct margins have improved overall over the last 3 years, thanks to a fairly favourable price environment, but also to a change in rotation and technical itineraries that have improved technical control of certain species (particularly spring crops before cover crops).

Semi-direct margins by crop between 2016 and 2023

Marge semi-directe *= (Chiffre d'Affaires + Aides PAC) – Charges opérationnelles – Charges mécanisation*

Semi-direct margins with subsidies for the crops in the control and innovative systems (cost of cover crop seed allocated to the following species)



Détail des charges par cultures

Innovative durum wheat	Innovative sunflower	Wheat	Chickpea	Winter peas (spring peas in 2020)	Winter oilseed rape	Sorghum	Control durum wheat	Control sunflower
Inputs costs: 539 €/ha Buckwheat ≈ 150 €/ha Mechanical costs : 225 €/ha	Inputs costs: 649 €/ha Sorghum/moha ≈ 80 €/ha Fababean/phacélia ≈ 280 €/ha soit≈ 360 €/ha Mechanical costs: 313 €/ha	Inputs costs: 484 €/ha Mechanical costs: 209 €/ha	Inputs costs: 369 €/ha Sorghum/moha ≈ 60 €/ha Mechanical costs: 323 €/ha	Inputs costs: 462 €/ha Mechanical costs: 305 €/ha	Inputs costs: 723 €/ha Fababean/lentils/clover ≈ 150 €/ha Mechanical costs: 253 €/ha	Inputs costs: 849 €/ha Sorghum/moha ≈ 80 €/ha Puis Fababean/phacélia ≈ 280 €/ha soit≈ 360 €/ha Mechanical costs: 430 €/ha	Inputs costs: 553 €/ha Mechanical costs: 210 €/ha	Inputs costs: 375 €/ha Mechanical costs: 284 €/ha

Average cost of cover crop seeds for the innovative system ≈ 144 €/ha
Increase in mechanisation costs: + €37/ha on the innovative system compared with the control.

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Weed management

Weed management

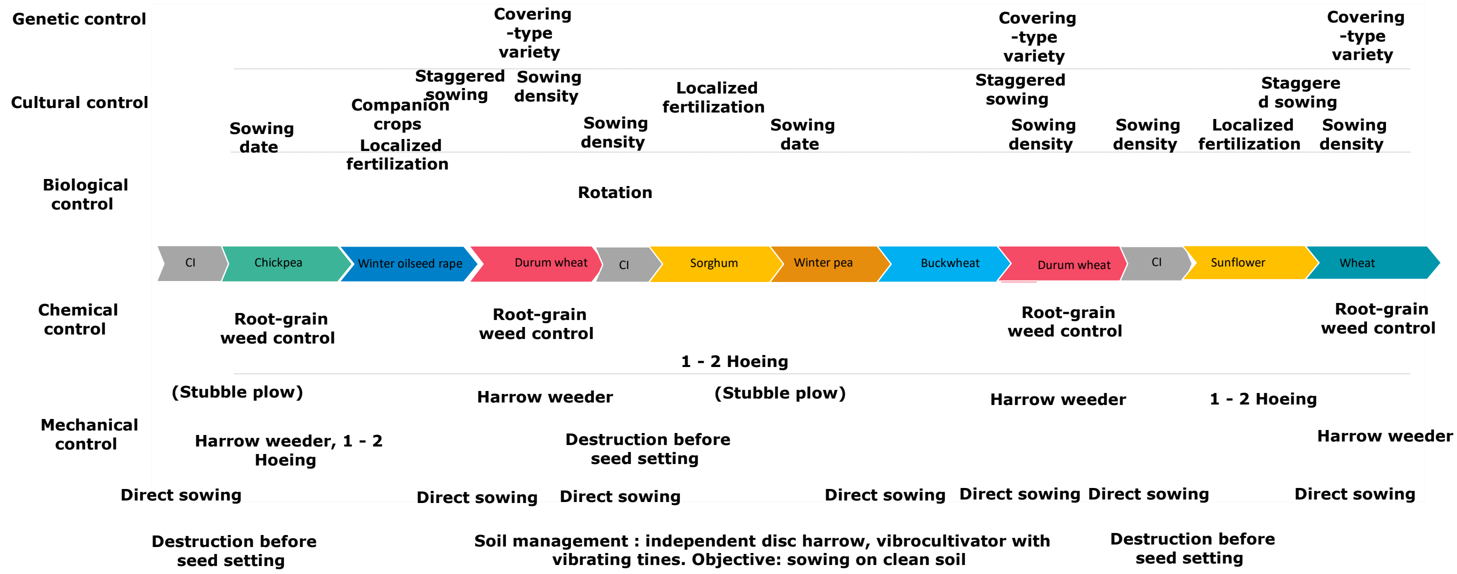
A context encouraging change, multiple objectives

The objectives of the **innovative system** :

- ✓ Reduce dependence on inputs by combining all available levers
- ✓ Use of glyphosate as a last resort since 2018
- ✓ Stop using S-metolachlor

2018 - Comportement de la population de Ray grass à Archipel Duo sur Syppre Lauragais (à gauche : dose N = 1 l/ha, à droite : dose 4 N = 4 l/ha)

Which control strategies have been implemented?



Genetic control

Covering -type variety

Covering -type variety

Covering -type variety

Cultural control

Sowing date

Companion crops

Localized fertilization

Staggered sowing

Sowing density

Sowing density

Localized fertilization

Sowing date

Staggered sowing

Sowing density

Sowing density

Staggered sowing

Localized fertilization

Sowing density

Biological control

Rotation

CI → Chickpea → Winter oilseed rape → Durum wheat → CI → Sorghum → Winter pea → Buckwheat → Durum wheat → CI → Sunflower → Wheat

Chemical control

Root-grain weed control

Root-grain weed control

Root-grain weed control

Root-grain weed control

Mechanical control

1 - 2 Hoeing

(Stubble plow)

Harrow weeder

(Stubble plow)

Harrow weeder

1 - 2 Hoeing

Harrow weeder, 1 - 2 Hoeing

Destruction before seed setting

Harrow weeder

Direct sowing

Direct sowing

Direct sowing

Direct sowing

Direct sowing

Direct sowing

Direct sowing

Destruction before seed setting

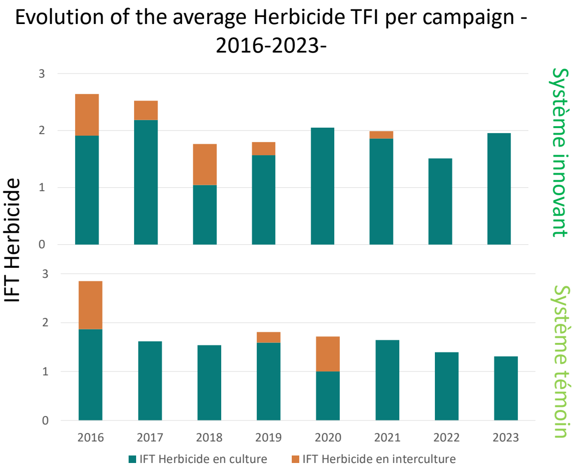
Soil management : independent disc harrow, vibrocultivator with vibrating tines. Objective: sowing on clean soil

Destruction before seed setting

A multi-lever strategy that can be applied throughout the rotation

- ✓ A multitude of levers to combine
- ✓ Crop rotation remains one of the keys
- ✓ Field observation is essential to the success levers

Herbicide Treatment Frequency Indices for the systems

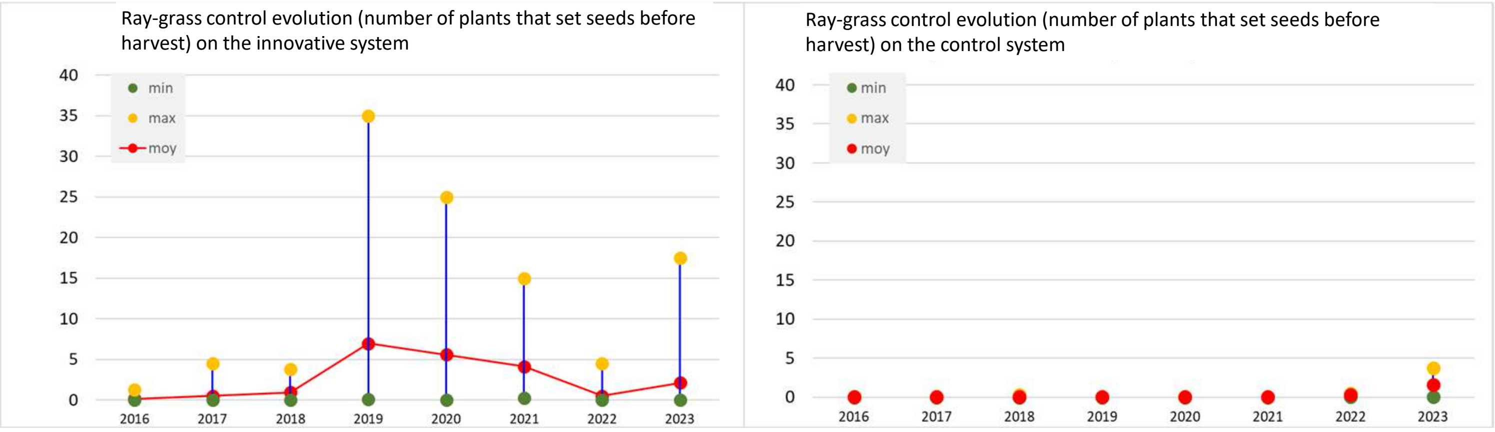


Weed management

What are the successes and difficulties in implementing the levers?

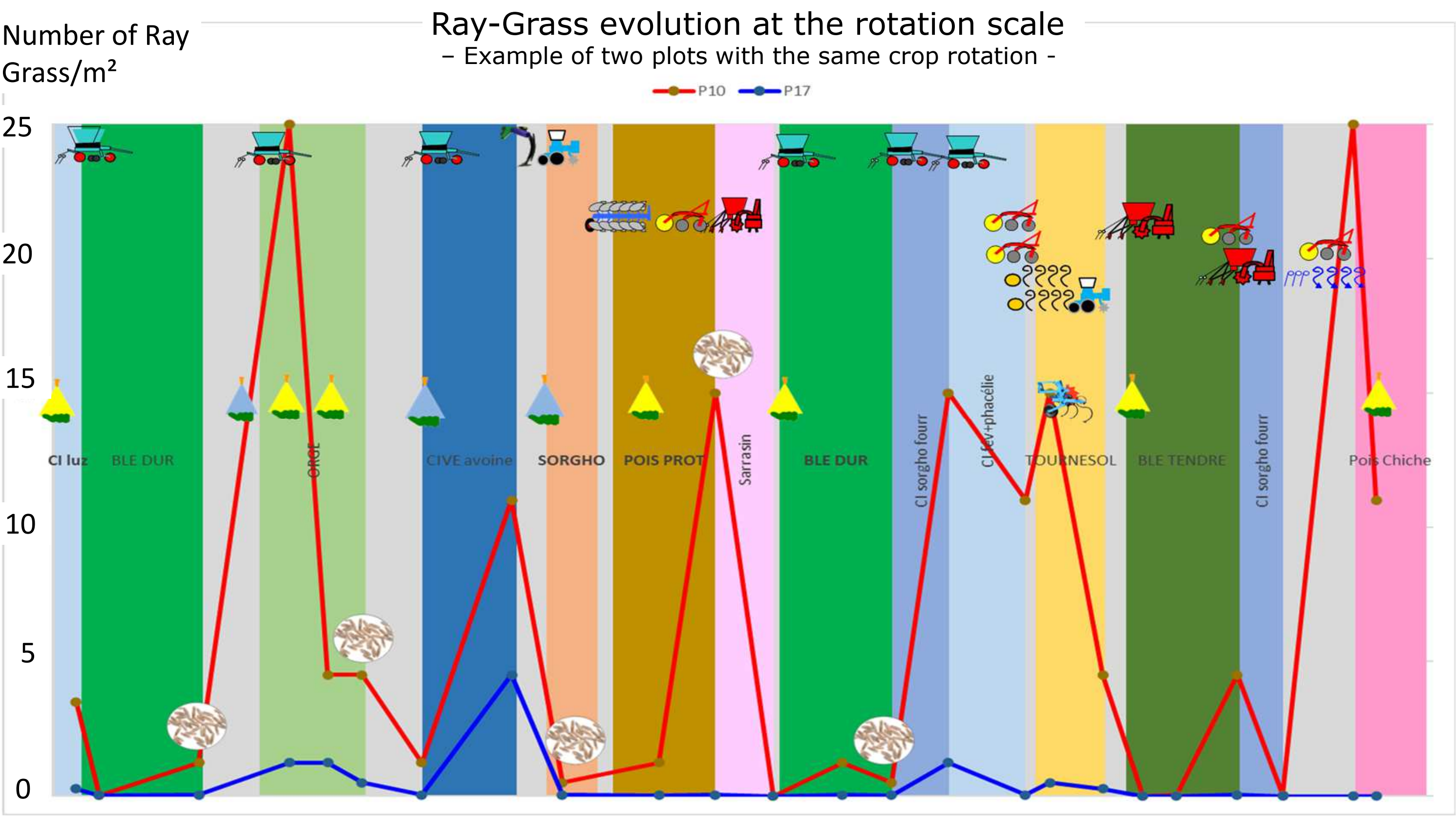
Ray-Grass control

Pre-harvest ryegrass density (pl/m2) in the innovative and control systems (2016-2023)



Ray-grass control evolution (number of plants that set seeds before harvest) on the innovative system

Ray-grass control evolution (number of plants that set seeds before harvest) on the control system



Ray-Grass evolution at the rotation scale

– Example of two plots with the same crop rotation -

- ✓ **Multiple control methods sometimes involve tillage, especially in a glyphosate-free context.**
- ✓ **No room for error: grain potential**
- ✓ **Vigilance is still required to avoid slippage**

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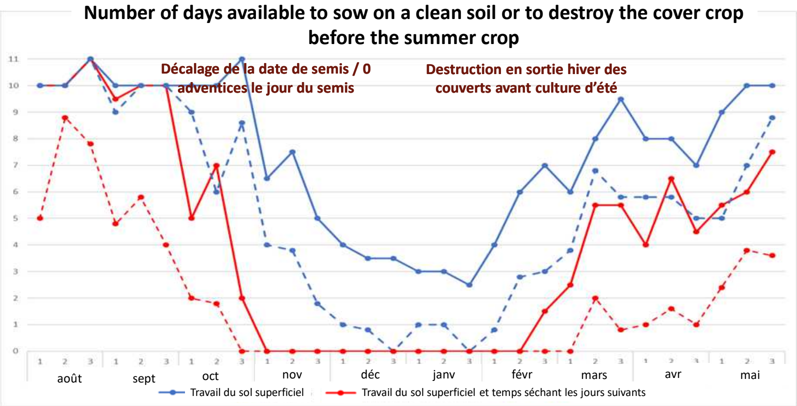
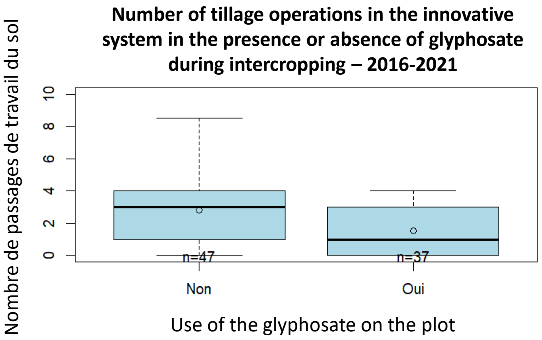
Weed management



Number of days available to sow on a clean soil or to destroy the cover crop before the summer crop

Limited opportunities to superficially prepare the soil and take advantage of the dry weather at the end of the pass: management of ryegrass compromised.

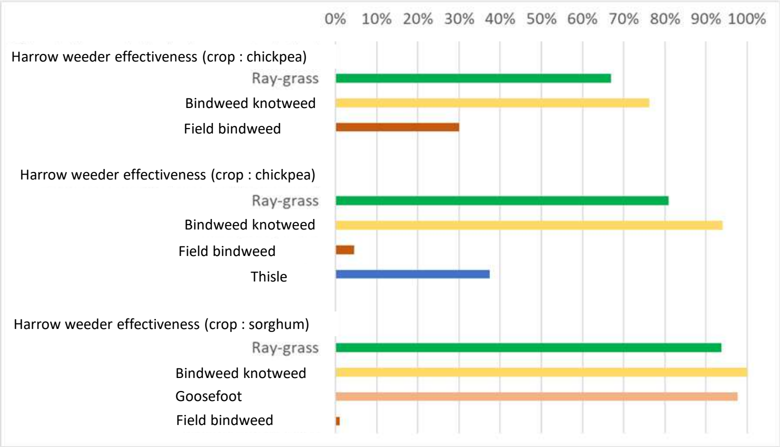


Number of tillage operations in the innovative system in the presence or absence of glyphosate during intercropping – 2016-2021

On average 1 more tillage operation on plots not treated with glyphosate

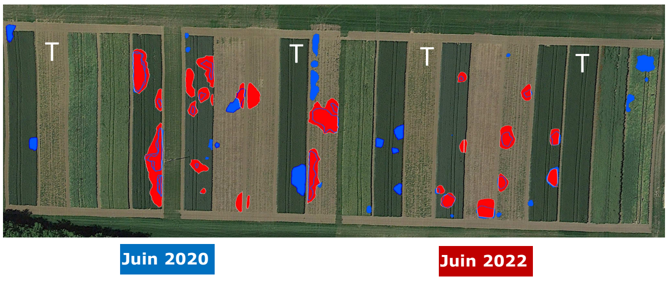
Controlling broadleaf weeds and perennials

Effectiveness of mechanical weeding tools



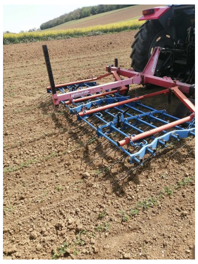
Percentage effectiveness of mechanical weeding carried out on the platform - Quadrat counts before and after mechanical weed control in 2020

Mapping outbreaks of thistle



The technical management set with the soil covered make thistle management more complex by eliminating an effective mechanical control solution between crops.

What should we remember?



A slightly higher number of operations on the innovative plots, particularly for intercropping tillage

Mechanisation costs increased by around €37/ha

Weed control satisfaction scores are more random, averaging 5.5 compared with 7.5/10 for the control

Increased monitoring in the innovative system

Solutions exist, but not necessarily on a campaign scale

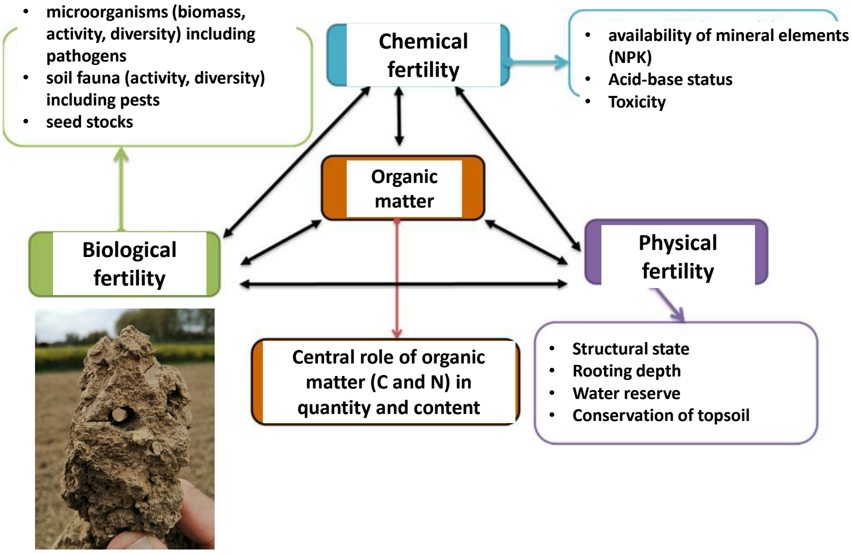
Adjustments and adaptations right through to rotation: compromises have to be found

A combination of levers is essential in a changing context

Enhancing my soil

Enhancing my soil

What is fertile soil? What does it mean?



- microorganisms (biomass, activity, diversity) including pathogens
- soil fauna (activity, diversity) including pests
- seed stocks

Chemical fertility

- availability of mineral elements (NPK)
- Acid-base status
- Toxicity

Organic matter

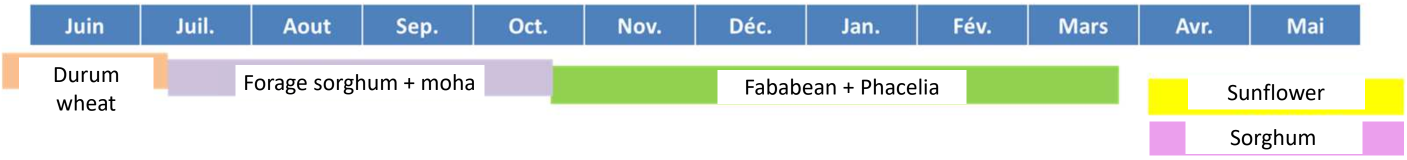
Biological fertility

Physical fertility

Central role of organic matter (C and N) in quantity and content

- Structural state
- Rooting depth
- Water reserve
- Conservation of topsoil

Cover crops: a lever to improve soil fertility



Objectives :

✓ Cover the soil to limit erosion

✓ Produce biomass and supply nitrogen

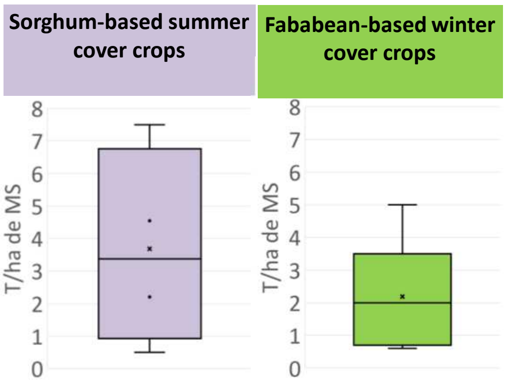
✓ Provide an optimum seedbed for the following crop: ensure rapid and regular implementation

✓ Secure income

✓ Use glyphosate as a last resort

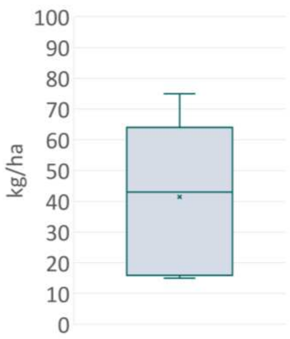
✓ Control weeds

Cover crop biomass measured between 2017 and 2022 (tonnes of dry matter (TDM) per hectare)



Nitrogen potentially returned by faba beans-based winter cover

– MERCI method -



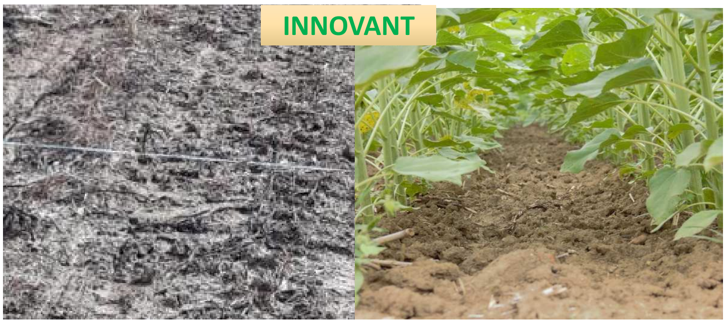
3.5 TDM/ha

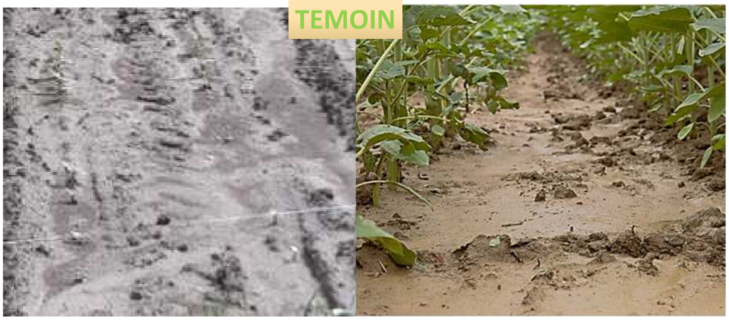
5 TDM/ha

Enhancing my soil

Which results can we expect?

Changes in soil responses





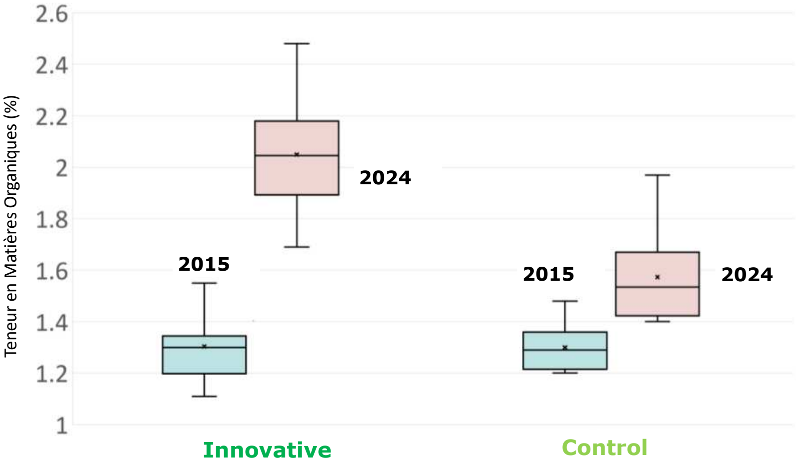
Aggregate stability test, spring 2020

- ✓ **A significant improvement in soil responses during erosive events and at the time of recovery (bearing capacity)**

Changes in organic matter content

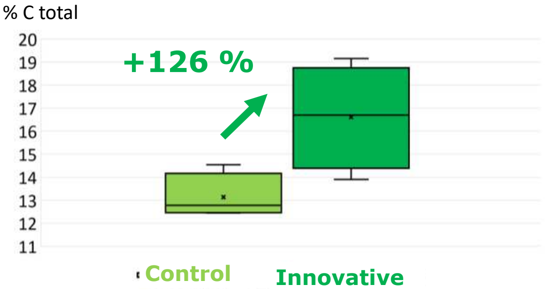
- ✓ **Significant system effect: levels have risen by an average of +0.74 points of OM in 8 years on the innovative system.**

Change in organic matter content (%) between 2015 and 2024 on all plots (0-20 cm)



Green light indicators for physical and biological fertility, particularly for structural stability

Measurement of the 50-2000 µm fraction of total carbon - As a % of total carbon fraction



Point mi-rotation de 2021 sur les parcelles fil rouge

Structural stability improved (battance, erosion): **Confirmed by the fraction 50-2000 µm in % of total C and quantity of labile Carbon with potassium permanganate (Microbioterre Project)**

Earthworm biomass increased (endogeous and anecitic) but no increase in the number of worms/m²

≈ **Some indicators have not changed or are difficult to interpret: infiltration rate, microbial biomass, evaluation of structure using the spade test, etc.**

Increasing organic matter in clay-limestone hillside soils is an achievable goal. Against erosion, there are solutions.

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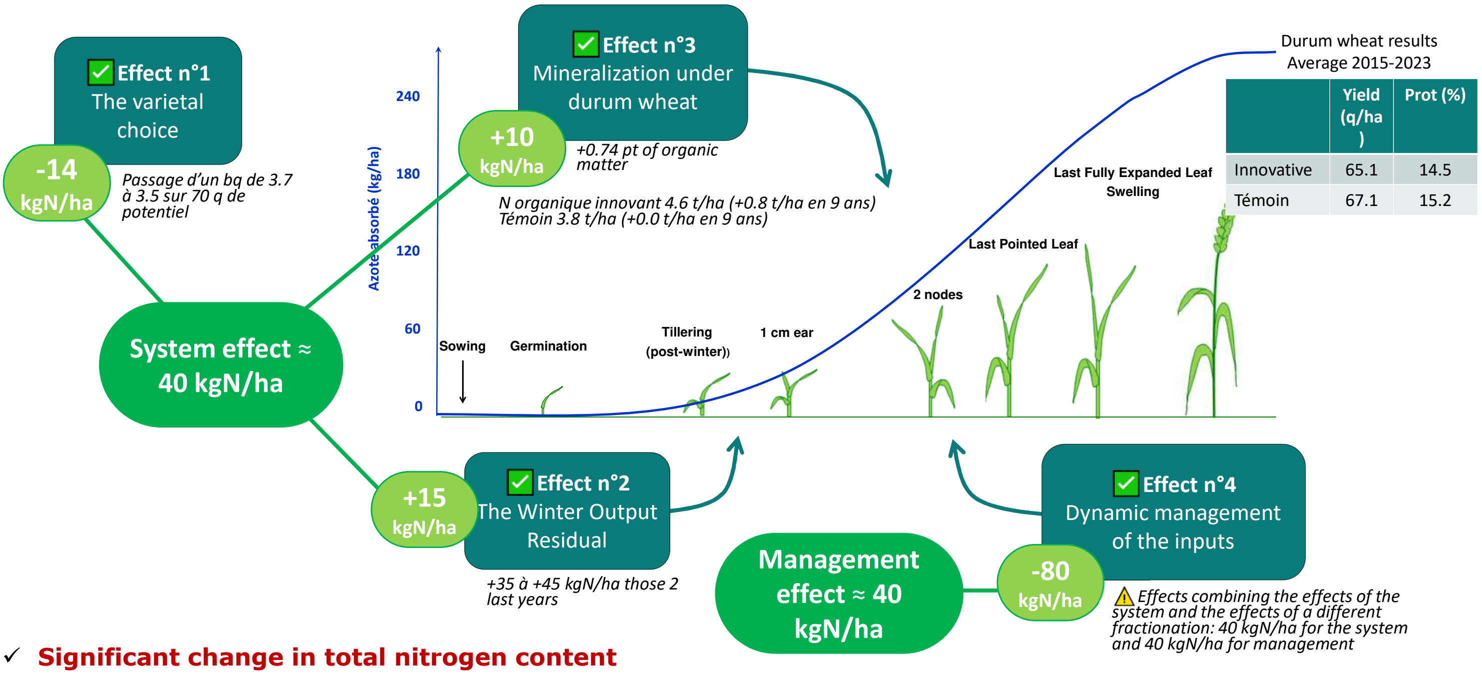
Enhancing my soil

Chemical fertility evolution

Example of the effects of the SYPPRE Lauragais system on nitrogen fertilisation of durum wheat



✓ **Effect n°1**
The varietal choice

-14 kgN/ha

Passage d'un bq de 3.7 à 3.5 sur 70 q de potentiel

✓ **Effect n°3**
Mineralization under durum wheat

+10 kgN/ha

+0.74 pt of organic matter

N organique innovant 4.6 t/ha (+0.8 t/ha en 9 ans)
Témoin 3.8 t/ha (+0.0 t/ha en 9 ans)

System effect ≈ 40 kgN/ha

✓ **Effect n°2**
The Winter Output Residual

+15 kgN/ha

+35 à +45 kgN/ha those 2 last years

Management effect ≈ 40 kgN/ha

✓ **Effect n°4**
Dynamic management of the inputs

-80 kgN/ha

⚠ *Effects combining the effects of the system and the effects of a different fractionation: 40 kgN/ha for the system and 40 kgN/ha for management*

Durum wheat results
Average 2015-2023

	Yield (q/ha)	Prot (%)
Innovative	65.1	14.5
Témoin	67.1	15.2

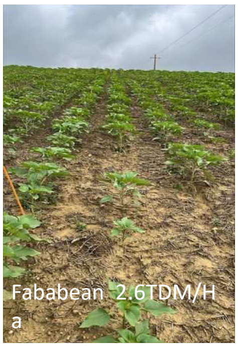
- ✓ **Significant change in total nitrogen content**
- ✓ **The C/N ratio has become satisfactory: 7 to 9 in median**
- ✓ **Olsen phosphorus levels are low and have improved little: 2/3 of plots have values below 20 ppm: below the threshold for strengthening crops with low requirements.**

Work carried out with the Syppre Lauragais network of farmers

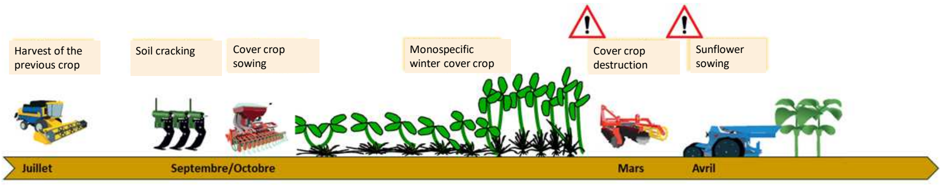
Objective: Limit soil erosion

✓ **Growing cover crops as the first lever used by farmers**

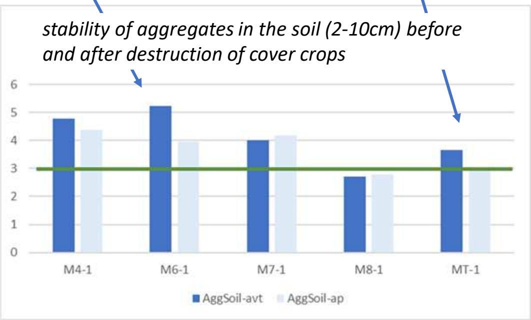
Photos of erosion marks on 14 June 2023 after a 70 mm storm


Fababean 2.6TDM/Ha


Bare soil



Work carried out by the network to remove obstacles:
-Plot monitoring
-Demonstration of tools, comparative strips (mixtures of cover crops, types of sowing, destruction)
-Monitoring soil fertility
-Improving technical itineraries (positioning of cover crops in the rotation, cover period, quality of sunflower sowing, etc.)


stability of aggregates in the soil (2-10cm) before and after destruction of cover crops

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Crop management plan to sow and destroy cover crops in long intercropping period

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Cover crop choice and adaptation to the pedoclimatic context

Choices and adaptation to different contexts

- **The farm: available equipment, economic cost, time and work organisation**
- **The plot: rotation, following crop, soil and climate, weeds - diseases - pests**
- **Type of cover crop: summer - intermediate - winter**
- **Choice of species and density: linked to the context of the plot and the farmer's strategic choices**

✦ ***Reduced dependence on inputs***

✦ ***Improved soil structural stability and drainage***

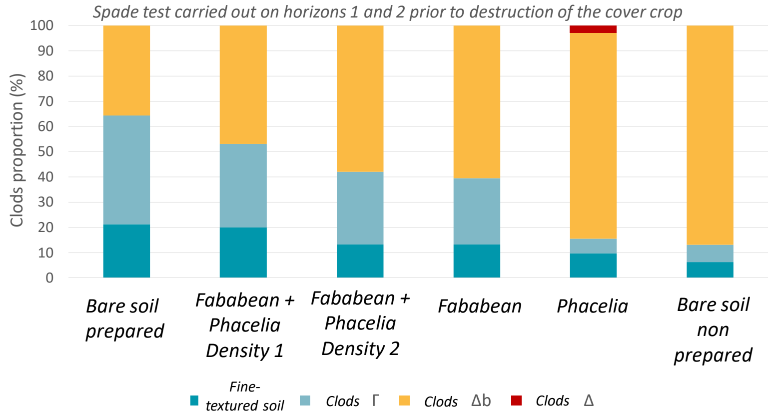
✦ ***Destruction method strategy***

✦ ***Valorisation of the intercrops***

✦ ***Management of climatic hazards and erosion control***

Soil preparation and cover crop sowing

Moisture conditions and maintenance of soil structure



Spade test 12/03/2021

- Sowing cover crops in wet conditions can damage the soil structure, **do not sow if conditions are not optimal**
- The presence of a cover crop can partially improve a degraded structure **only if it is well developed ≥ 2TMS/ha**
- Unlike bare soil, cover crops help maintain **structural stability after destruction.**

Maximising chances of germination: choice of sowing method

Seed drill:
Better density and spatial regularity of the cover crop. Weed control. Easier destruction and preparation.

Broadcast:
Overall lower germination rate: more random. To be avoided in dry conditions and without significant early rainfall.

Opportunity sowing if conditions are favourable. For mixed species, difficulties with seed distribution/depth.

Climatic sequence	**Sowing**	**Germination**		
		Start (h after sowing)	End (h after sowing)	Rate (%)
Rainfall	Seed drill	48	50	100
	Broadcast	48	56	100
Rainfall/drying out /rainfall (1)	Seed drill	52	529	100
	Broadcast	52	529	80
Rainfall/drying out (2)	Seed drill	51	58	84
	Broadcast	51	58	68

(1) 20 mm within two days of sowing - drying out for 20 days - 20 mm
(2) 20 mm after sowing then continuous drying out

Bruckler et Bouaziz, 1991 cinétique de germination du blé

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Choice and effectiveness of mechanical destruction and soil preparation tools in clay soil

Destruction and preparation of the seed bed

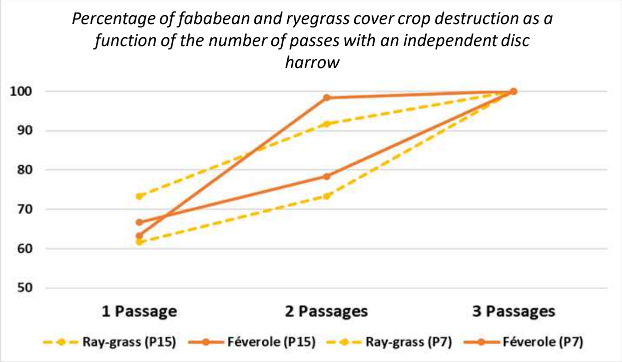
1. Time between destruction and sowing

- ✓ Depending on the equipment available on the farm
- ✓ Adaptation to the pedoclimatic conditions
- ✓ Depending on the type of cover crop, its stage and the biomass produced

Observe your soils !

2. Cover crop residue management

- ✓ Size of residue (finely chopped, coarse, whole)
- ✓ Impact on the seedbed
- ✓ Nitrogen recovery (C/N)
- ✓ Impact on the time between destruction and sowing


Percentage of fababean and ryegrass cover crop destruction as a function of the number of passes with an independent disc harrow

quadrat monitoring on Syppre Lauragais in 2021

3. Weed management

- ✓ Grasses and perennials: not the same battle
- ✓ Combining chemical and tillage levers
- ✓ The choice of the tool will determine whether the weeds will be on the surface or at depth
- ✓ Number of passes (ryegrass)

Soil = a giant fridge

⚠ Transplanting risk for grasses !

4. Finely prepare the seedbed for the next crop

- ✓ Choice of the tool
- ✓ Number of passes and intervals between tractor passes
- ✓ Working depth: in clay, there's no room for error
- ✓ Operation timing : structural stability, risk of erosion, risk of compaction

Destruction: tools to be combined according to objectives and soil type, varying effectiveness according to species and biomass

	Shredder, disc mower, chopper roller	Plow	Stubble cultivator	**Glyphosate**	**Glyphosate + 2,4D**
White and brown mustard	+++++	+++	++++	+++	+++++
Abyssinie mustard	+++	+++++	++	+++	+++++
Forage radish	+	+++	+	+	+++
Chinese radish	+	++++	+++	+++	+++++
Winter oilseed rape	+	+++++	+	+	+++
Camelina	+++	+++++	++++	+++	+++++
Niger	++++	+++++	++++	+++	+++++
Sunflower	+++++	+++++	+++++	+++	+++++
Buckwheat	++++	+++++	++++	+++	+++++
Spring flax	+++	+++++	++++	+++	+++++
Phacelia	++++	+++++	++++	+++	+++++
Moha	+++	+++++	+++	+++++	+++++
Forage sorghum	++++	+++	+++	+++++	+++++
Rye, wild rye, italian ray-grass	+	++++	+	+++	+++
Winter oat, triticale	+	+++++	+	+++++	+++++
Winter oat, rough oat	++	+++++	++	+++++	+++++
Spring vetch	++	+++++	++	+	+++++
Blackish lentils	+	+++++	+++	+++	+++++
Fenugreek, vetch	++	+++++	+++	+++	+++++
Fababean, spring peas	+++	+++++	+++	+	+++++
Alexandria clover	++	+++++	+++	+++	+++++
Crimson clover	+	+++++	++	+	+++

Très sensible	+++++
Sensible	++++
Moyennement sensible	+++

Assez peu sensible	++
Peu sensible	+

Cover crops, the keystone of the cropping system, its sustainability and its resilience

- ✓ Compromise to be found, necessities/constraints
- ✓ Requires technical skills and observations (cover crop/soil)
- ✓ Beneficial effects of cover crops: release of nitrogen into the system, soil erosion and compaction, fertility, structural stability, weed, disease and pest control, stimulation of the biological activity in the soil.
- ✓ A cover crop is successful when it has no impact on the productivity of the following crop

ClieNFarms
Climate Neutral Farms

UNISSON

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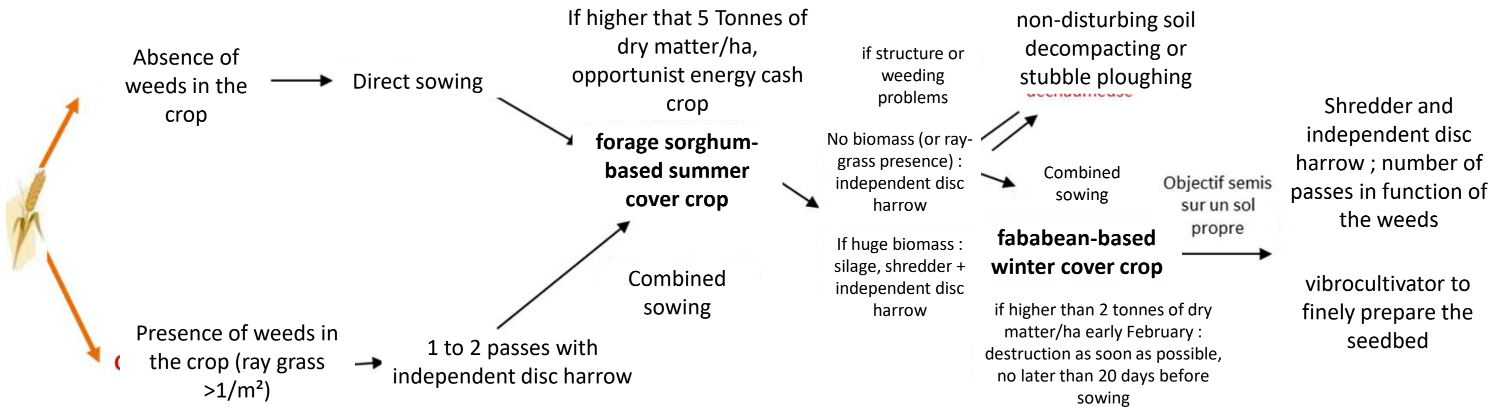
Crop management plan to sow and destroy cover crops in long intercropping period

How can cover crops be sown and destroyed without glyphosate? Example of the Syppre Lauragais platform

On the Syppre Lauragais platform, without glyphosate, tillage is reintroduced and direct sowing is still possible depending on weediness. In clay soils, deep tillage is preferentially positioned between the summer and winter cover crops (soil-disturbing decompactor, stubble plough). The cover crop is mainly destroyed in 2 close passes to obtain a good seedbed and because of the presence of ryegrass and the risk of transplanting.



Absence of weeds in the crop

Direct sowing

If higher that 5 Tonnes of dry matter/ha, opportunist energy cash crop

forage sorghum-based summer cover crop

Presence of weeds in the crop (ray grass >1/m²)

1 to 2 passes with independent disc harrow

Combined sowing

if structure or weeding problems

non-disturbing soil decompacting or stubble ploughing

No biomass (or ray-grass presence) : independent disc harrow

Combined sowing

If huge biomass : silage, shredder + independent disc harrow

fababean-based winter cover crop

if higher than 2 tonnes of dry matter/ha early February : destruction as soon as possible, no later than 20 days before sowing

Objectif semis sur un sol propre

Shredder and independent disc harrow ; number of passes in function of the weeds

vibrocultivator to finely prepare the seedbed

Most common strategy: shredding followed by 1 to 2 passes with an independent disc harrow.

Summer cover crop :

Forage sorghum

- Piper variety
- 20 to 30 kg/ha adjustab weediness

Moha - 10 kg/ha

2 cm deep

Sowing :

Direct drill 1 to 2 days maximum after harvesting ≈22/06

Destruction :

Shredder + independent disc harrow ≈15/10

Winter cover crop :

Black spring fababean

- Vesuvio or Scuro di torre lama varie
- 110-150 kg/ha depending on weigh

Phacelia

- Variety Stala
- - 5 kg/ha

2-3 cm deep

Sowing :

Combined drill ≈20/10 ;

If no summer cover crop, direct sowing on clean soil.

Destruction : from flowering stage

Shredding + independent disc harrow ≈01/04

Sowing the following crop:

Sunflower: from 10/04 → 20/04

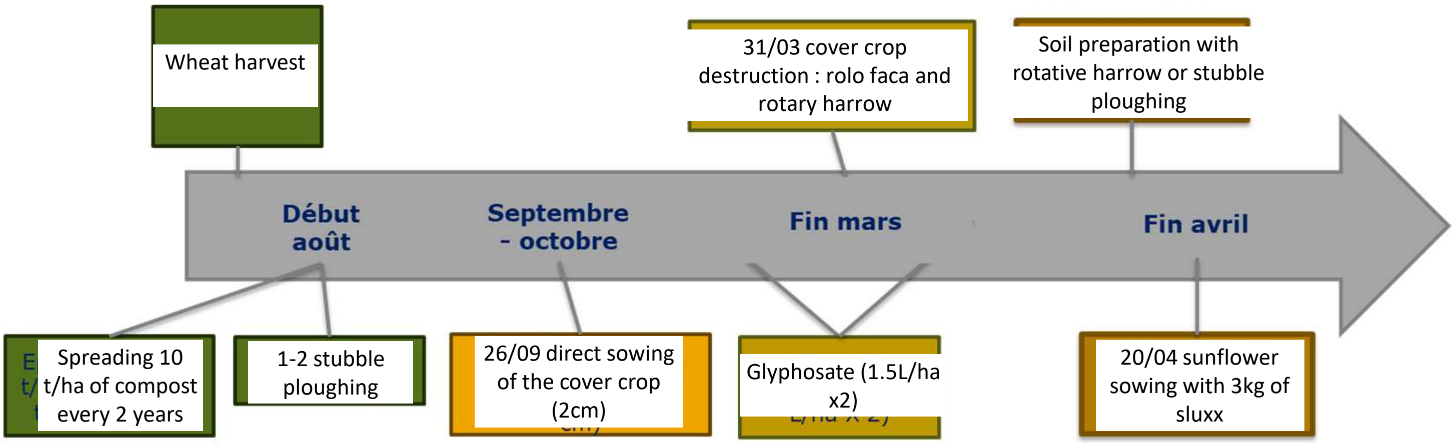
Sorghum: from 15/04 → 10/05

Crop management plan to sow and destroy cover crops in long intercropping period

Examples of crop management plans practised by farmers of the Syppre Lauragais network (Department 31)

- Clay-limestone on hillsides
- Minimum tillage
- No deep tillage since 2017
- Objective: to improve soil structure

140 kg/ha fababean
2.5 kg/ha of phacelia
5 kg/ha common vetch
2.5 kg/ha chinese radish



Wheat harvest

31/03 cover crop destruction : rolo faca and rotary harrow

Soil preparation with rotative harrow or stubble ploughing

Début août

Septembre - octobre

Fin mars

Fin avril

Spreading 10 t/ha of compost every 2 years

1-2 stubble ploughing

26/09 direct sowing of the cover crop (2cm)

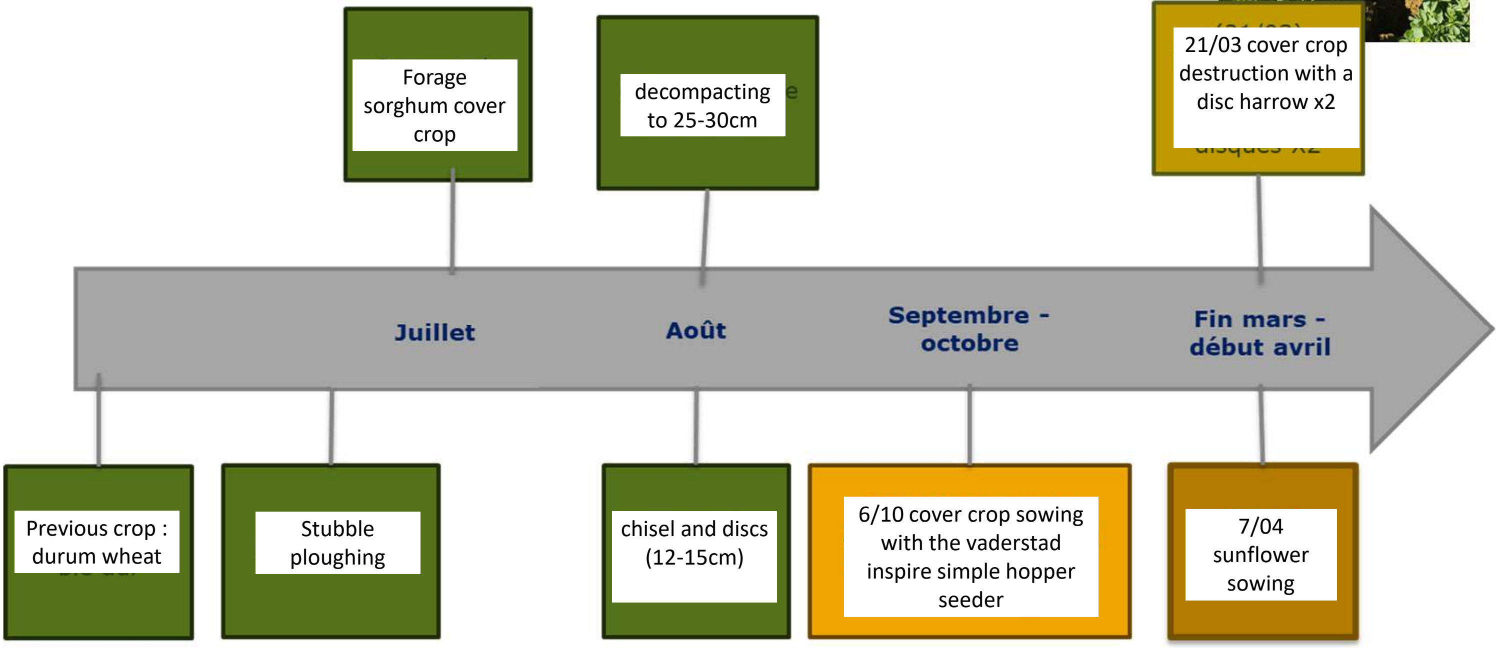
Glyphosate (1.5L/ha x2)

20/04 sunflower sowing with 3kg of sluxx

- Clay-limestone on hillsides
- Objective: weed management and destruction without glyphosate

20-25 kg/ha of forage sorghum

190 kg/ha fababean
9 kg/ha of vetch
2 kg/ha mustard



Forage sorghum cover crop

decompacting to 25-30cm

21/03 cover crop destruction with a disc harrow x2

Juillet

Août

Septembre - octobre

Fin mars - début avril

Previous crop : durum wheat

Stubble ploughing

chisel and discs (12-15cm)

6/10 cover crop sowing with the vaderstad inspire simple hopper seeder

7/04 sunflower sowing

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What to remember ?

A trial that provides an insight into regional issues from a cropping system perspective:

- Indispensable combinations of levers: avenues and building blocks of interest provided by the system
- Flexibility/opportunity in the choice of species depending on the economic/climatic context
- Performance compromise has to be found: ambitious objectives, where should the cursor be placed?
- A time for observation and technical management that should not be overlooked: training, support, farmer groups, steering, etc.
- Observing your plots
- In a context of climate change, we need to think about crop management plan to preserve the way the soil functions: the example of Syppre provides food for thought on how to achieve achievable results.

Many thanks to

Partners :

Funders :

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 101036822

Journée UNISSON
Les voies de l'agroécologie
organisée dans le cadre du
Plan de transfert Occitanie

Yannick JEAN, ***agriculteur qui accueille la plateforme Syppre Lauragais***

Les agriculteurs du réseau, pour leur participation active au projet Syppre **:**
Maxime BAUCE, Romain BASSO, Sébastien DELMAS, Maurice DE GUÉBRIANT, Valentin MILLET, François PARAYRE, David VINCENT, Eric ZAMBON

Where to find information on the Syppre project ?

On the Syppre website :

https://syppre.fr/coteaux-argilo-calcaires-du-lauragais/

On the technical institutes website :

Arvalis : https://www.arvalis.fr/
Terres Inovia : https://www.terresinovia.fr/

On the En Crambade facebook :

Arvalis Baziège - En Crambade

Do you need more information ?

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