



Credits: Ferme Lammert

Soybean as a breakcrop for maize monoculture in Eastern France



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Objectives: find a more balanced crop rotation to manage pest and weeds

- Take advantage of the agronomic benefits of soybean
- Answer the problem of corn rootworm
- A solution for the crop rotation regulation

Haut Rhin, FRANCE

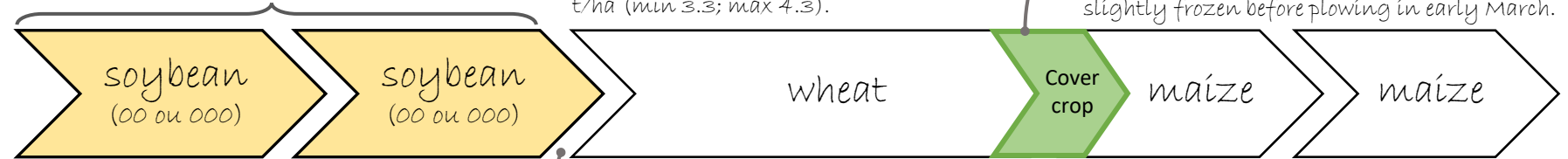
- 185 ha with 165 ha irrigable
- Silt, sandy silt, sensitive to crusting + limestone clay
- Semi-continental climate, 300 mm

- Sowing and tillage method:**
- Around April 25th in a well warmed soil (+12°C) for a quick emergence.
 - 65 gr/m², cereal drill, 15 cm spacing.
 - **Tillage at 25 cm** for soybean after maize to bury the canes, then a passage of **harrow or seedbed cultivator** before sowing with the **drill combination**. Possibly subsoiler between soybean and/or before cover crop.

2 years of soybean to take advantage of seed inoculation (seed inoculation is realized on-farm) : 2 doses the 1st year and 1 the 2nd

Soybean harvested on September 20-25, (more difficult beyond the end of Sept.) by a provider with a flex cut. On average 4 t/ha (min 3.3; max 4.3).

- Cover of vetch/clover/phacelia, **inexpensive** with an **optimal sowing after a 10-15 mm rain**.
- Destruction with discs in mid-feb. when the soil is slightly frozen before plowing in early March.



Fertilization strategy and irrigation:

- Plots that receive off-farm pig manure. The year before soybean no manure to enhance roots nodules.
- Before soybean, no manure to ensure a good nodulation.
- Molybdenum application in the 1st weeding.
- 7 applications of 35 mm, to be reduce to 30 mm.

Weed control:

- Depending on the weather, 1 herbicide after emergence with MERCANTOR GOLD.
- Adjustment when the soybean start to cover, in the inter-rows, in 1 or 2 passes of herbicide. (if bindweed, split in 2 passes).

wheat following to take advantage of the supplied N and on the good soil structure, due to soybean roots, facilitating the establishment without ploughing.

Few weeds in soybean, allowing no ploughing before wheat, thus limiting the impact on earthworms.

- Subsoiler to break up plow-sole and regenerate the horizons at greater depth.
- Then, Direct sowing with the combined drill.

Benefits for the rotation:

- Reduction of soil compaction, due to soybean and crop management improving soil structure.
- On maize, less bindweeds, because of the possibility to manage them after wheat and during the soybean crop: last year, on maize in rotation, no anti-bindweed was applied.

Evaluation by the farmer:

- ☺ Soybean provides a local outlet.
- ☺ Improved maize yield : 16 t/ha last year, compared to 14 t/ha on the rest of the farm, where it remained in monoculture.
- ☹ Harvesting problems related to weeds (goosefoot, bindweed) or lodging that delay drying and shift the dates.
- ☹ Inexplicable yield variability.

Success conditions and risks:

- Few diseases problems but when the first risks of Sclerotinia appears avoid to return soybean before 5 year.
- Weed control should be carried out rigorously for a clean and homogeneous soybean at harvest.
- Do not shift the sowing and harvesting dates too much to avoid threshing difficulties.
- Carefully manage the irrigation to secure yield

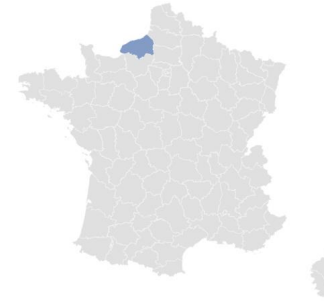


Credits: Terres Inovia

Take advantage of legumes in crop-livestock farming systems



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Objectives: develop the rapeseed-clover association for permanent cover and the use of faba bean for food autonomy.

- Solution to the difficulty of establishing cover crops in summer
- Nitrogen fixation for the following crop

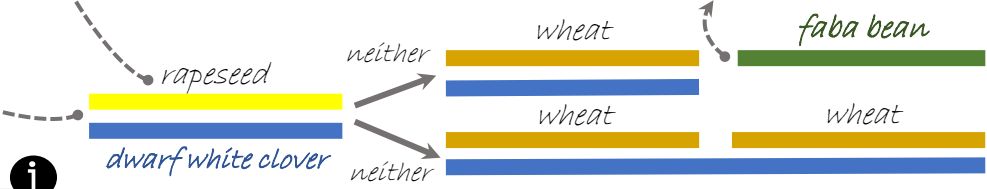
Seine Maritime, FRANCE

- 190 ha in reduced tillage
- Mostly medium to deep loam soils with some clay areas on some plots

Weed control:
2 NOVALL at 0.7L + one KERB FLO in the winter for grass control.

- Direct sowing in early August:
- Cereals precedents (wheat, barley).
 - 2 kg/ha of dwarf white clover which remains at soil level.
 - 22 units of phosphorus brought.

Example of a section of the rotation that can be implemented



Sowing behind a cereal, at the end of winter, beginning of spring, if possible as early as possible, at 4 cm, in a dry soil after a stubble ploughing to warm up the soil.

- 50 gr/m² of farm seed for a good soil cover, with certified seed rather 35 to 40 gr/m².
- 35 to 55 qtx depending on climate condition and pests.
- At harvest time, the grains are milled and stored.

This year, testing variants with lucerne and bird's foot trefoil as new companion plants, especially to explore other root systems and their impacts on water competition with wheat.

Clover that starts again at the harvest of the rapeseed (28 to 38 qtx/ha) with a light glyphosate application if necessary (DWC is relatively resistant to herbicides) to clean up the cover of clover before sowing the wheat.

Wheat sown under cover of clover, which is controlled (7g of ALLIE) to limit competition with the cereal. If the cover is well maintained, the objective is to grow several wheat crops under cover of clover to limit the wheat-on-wheat effect and help with N nutrition.

- Weed and pest management for faba bean:
- Weed control : NIVRANA + TOUTATIS
 - For pests, waits to see if the populations are controlled by beneficials before considering a treatment. Ex: last year, just a light insecticide against sitona at emergence and no weevil's damage.
 - Soil and sap analyses give an indication of the health of the plant.

Benefits for the rotation:

- Associated rapeseed which allows to reduce weeds before wheat with clover which smothers weeds and regrowth.
- Nitrogen saving on rapeseed and wheat.
- Faba bean are a solution to lengthen rotations and reduce the pressure of diseases and weeds

Evaluation by the farmer:

- ☺ "This year I had a plot of faba bean and barley next to each other, I did rapeseed on both, the rapeseed has more vigour after the faba bean than after the barley".
- ☺ Self-sufficient in protein on his farm, which leaves him a marketing possibility.
- ☹ Yield control in faba bean, where it depends on the weather and pest attacks.

Success conditions and risks:

- Be careful in the dry spring regarding water competition between clover and wheat.
- Think about the choice of companion plant varieties so that they do not disturb the development of the rapeseed.
- Risk of beetle on rapeseed, do not wait too long before treating.



Credits: Terres Inovia

Winter Lupine, a water-saving solution for diversifying rotations



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Objectives: look for an alternative to irrigated maize to lengthen rotations

- Very good head of rotation
- Saves water for irrigation compared to maize

Vienne, FRANCE

- 175 ha in cereal production, in MAE IRRIG 04
- « Terres rouges à châtaigniers », rather heterogeneous and slightly stony
- Normal year, from 700 to 800 mm

Formerly in a short wheat-rapeseed rotation, which worked well but eventually showed its limits (development of sowing, diseases and pest pressure).



- Work with a cooperative that offers varieties, so the choice is limited, especially because it's a marginal crop with few new varieties. **Currently 2 varieties cultivated on the farm: AURUS (rises higher) and MAGNUS.**
- Fertilized (bottom manure) according to soil analysis, in August before planting in P and K
- BAROUD+CENTIUM at sowing then a KERBFLO in post emergence.
- The plant has little coverage for a large part of the crop and is therefore sensitive to soiling. It can then become very luxuriant and favour diseases at the end of the cycle.
- **Before each flowering, application of fongicides (AMISTAR and CARAMBA STAR) in 2 passages: before the flowering of the 1st floor and a 2nd at the flowering of the 2nd floor, the 3rd floor is more in the open air thus less sensitive.**



Sowing in between 10 and 30 Sept.:

- Minimize the presence of decaying straw at lupine emergence, which can attract seed flies.
- 27 to 33 gr/m², optimum to counter losses at emergence and avoid lodging and diseases due to a too dense cover.
- With a standard drill combination, with the possibility of using a single-seed drill for hoeing if there are few stones.

Harvest early August to mid-August:

- Standard combine harvester with a wheat cutter.
- **Harvesting at night** from 1 to 2 a.m. until 8 to 10 a.m. to slightly rewet the pods: in summer, on dry lupine, the pods burst very easily when they meet reels.
- Good yield = 3 to 3.5t; very good > 4t; average to bad < 2.5t.

Valorization:

- Contracts defined before the harvest with the coop (Terrena), around 350 €/t.
- Lupine used in animal feed (ovine) or for the cosmetic industry.
- To 3t/ha, equivalent margins to a rapeseed.

Benefits for the rotation:

- In lupine precedent, nitrogen saving (20 to 30 U N/ha) with visual effect on the following crop, compared to a rape or sunflower precedent.
- Beneficial effect on the soil structure thanks to their taproots.
- Few interventions on the crop except the application of fungicides that should not be missed.

Evaluation by the farmer:

- ☺ Allows to shift sowing and to harvest at a time when there is usually little harvest.
- ☺ Does not require any specialized equipment: "it is done like a rape or a wheat".
- ☹ Winter Lupine which tends to soil the plots for the following crop.

Success conditions and risks:

- Don't bring back lupine before 5 to 6 years min. to limit the pressure of seed flies and foliage diseases.
- Water-efficient crop but appreciates water at the right time.
- Avoid planting lupine in active limestone, in hydromorphic zones or dirty plots.

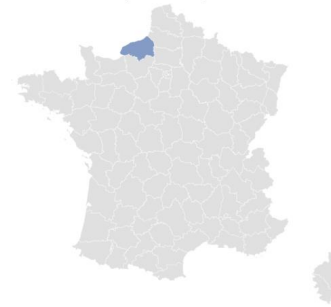


Credits: Terres Inovia

Spring field pea: an agronomically interesting crop between two cereals



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Objectives: wishes to lengthen its rotations with a high proportion of cereals

- Very good precedent for wheat
- Breaks the cycles of diseases/pests/weeds in its crop rotation

Seine Maritime, FRANCE

- 100 ha in in crop-livestock farming system
- Silty soils
- Proximity to the coast (sea at 15km)
- Annual precipitation around 650 to 800 mm

Post-harvest:

- The harvest is sent to the coop immediately after the harvest where the sorting and drying stages are carried out.
- Price between 200 and 230 e/t.



It is possible to plant an oilseed rape following the pea, but this is more complicated in his sector due to the harvesting dates of the pea.

Spring pea input application strategy:

- No fertilization on his spring pea crops.
- **Pre-emergence weed control** (NIRVANA + CHALLENGE + CENTIUM) then he decides according to the observations, often a grass killer or an adjustment dicots killer.

- Depending on the type of sector his pea are involved in, he may have to treat them against weevils.
- Pea behave well against diseases on his farm.
- He may need to apply 1 or 2 fungicide treatments, or even more if there is a lot of humidity at flowering.



Sowing 1st week of March:

- As soon as conditions permit.
- 60 plants/m², at least 3 cm deep.
- Stubble ploughing 3 days before sowing, then sowing directly afterwards with a combined rotary harrow and seed drill.
- variety BAGOO supplied by the coop.

Harvest:

- Depending on the moisture content of the grain, around 14%.
- Yields max at 66 qtx and min. at 26 qtx and on average 45 to 50 qtx.
- To limit lodging, it may be necessary to advance the harvesting dates a little, around 17 - 18% when the plant is still standing.
- Problems encountered: in wet conditions, plants that climb more difficultly in the cut of the combine harvester.

Benefits for the rotation:

- Restores a 20 U N/ha for the following wheat with a gain of about 5 qtx compared to a wheat with no crop rotation.
- Participates with other spring crops (fibre flax) in the control of soiling on the scale of the rotation: 1 weeding on wheat in the fall instead of 2
- Positive impact on soil structure.

Evaluation by the farmer:

- ☺ Culture that requires little input and no investment in specialized agricultural equipment.
- ☹ Pigeon problems in some places that can penalize the yields with losses that can go from 20 to 25% at emergence.

Success conditions and risks:

- Harvesting is a critical operation where one must be meticulous and not rush.
- Do not come back too quickly (8 to 10 years) with the pea on the plots to avoid diseases and especially aphanomyces.



Credits: Terres Inovia

Spring field pea: a crop with many agronomic benefits

Objectives: lengthen and diversify crop rotations with a spring crop

- Breaks the development cycle of weeds, especially black-grass
- Good precedent for wheat



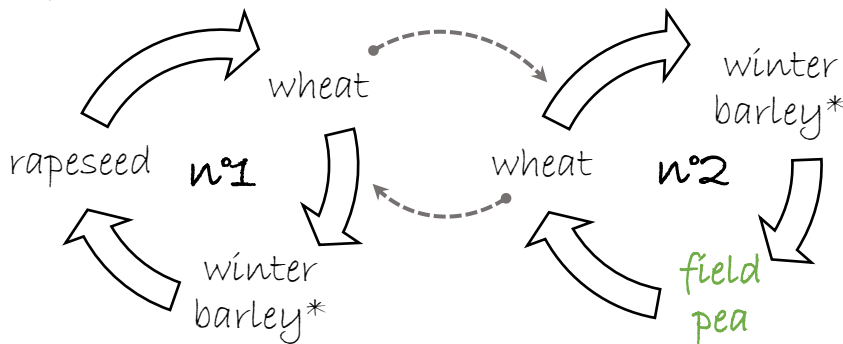
Authors:
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Eure-et-Loir, FRANCE

- 94 ha in cereal production
- Slightly rolling plots with stones at the bottom of the valley, mainly loam
- On average 700 to 750 mm

* or spring wheat



A 1st rotation cycle of wheat/barley/rapeseed followed by a 2nd cycle of wheat/barley/pea to take advantage of a wheat after a field pea and to avoid the too frequent return of rapeseed.

- On his farm, the soil is loamy with sensitivity to crusting and fairly cold, so he waits for it to dry and warm up before a 3 cm sowing around mid-March in general. Systematically rolling to flatten the soil and facilitate harvesting.
- 80 to 90 gr/m² with ploughing 24 to 48 hours before sowing.
- Variety ASTRONAUTE, supplied by the cooperative, sometimes prone to lodging depending on the weather and the number of pea in the pods.
- P and K fertilization with a dose modulation tool (BIAPI)

- No more pre-emergence weed control (he systematically re-passed afterwards), from now on, he treats once the broadleaf weeds have all emerged with PROWL 400 (1L) + BASAGRAN (0.6 kg) = cheaper and very effective.
- The main weed problems in his rotation concern grass management, especially foxtail grass.
- Treatment against pests according to the level of infestation observed in the field. Ex: this year no treatment against thrips and one treatment against pea leaf weevil which were attacking his field pea.
- PRO SARD fungicides against leaf diseases.

- Harvested with a combine harvester when the plant reaches about 15% moisture content.
- Field peas are then transported to the cooperative once they have been harvested.
- Outlets: animal feed or seed when he was growing garden pea.
- Last year field pea sold for around 230 €/t and garden pea were sold for around 470 €/t (but lower yields).
- varies between 20 and 45 qtx/ha.

Benefits for the rotation:

- Less nitrogen on the following wheat, savings of about 30 U N/ha compared to rapeseed and better yields with a gain of between 5 and 8 qtx/ha.
- Allows to clean up these plots: less foxtail grass due to the introduction of a spring crop in the rotation.

Evaluation by the farmer:

- ☹ Aphanomyces pathogen on some plots (PI > 2.5) which prevents a return of spring field pea but is still a problem...
- 😊 ... de-stoning equipment that allows him to continue growing spring field pea on plots with high initial stone.
- 😊 The economic results of the field pea are a little lower and are compensated by the following wheat.

Success conditions and risks:

- Respect the frequency of field pea return (5-6 years minimum).
- If possible, do not delay sowing field pea too much to limit the risk of heat stroke at flowering in June.



Credits: Terres Inovia

Growing legumes in association with cereals to replace the use of chemical inputs after transition to OF

Objectives: look for agronomic levers about pest/disease pressure and N nutrition for organic cereal production

- Fulfill part of the system's N needs
- Reduce disease/pest/weed pressure



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Aude, FRANCE

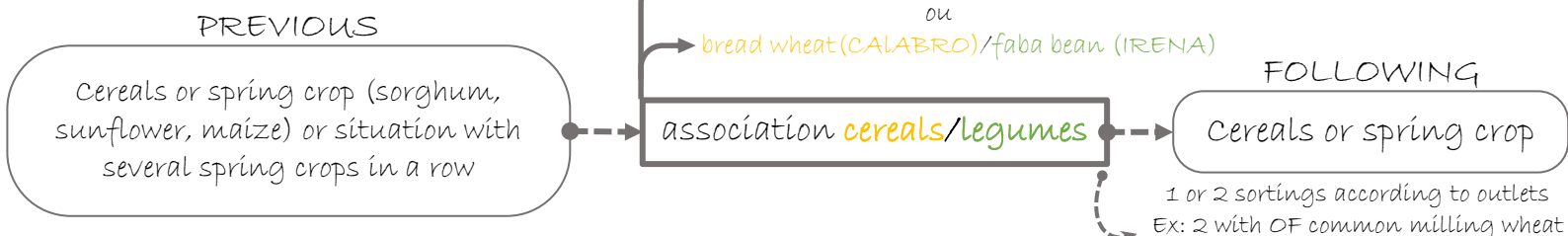


- Mediterranean climate
- 300 ha in total on several farms
- Clay-limestone soils with a part on the hillside + another more clayey part on the plain or plateau

i Will to transpose the crop-livestock farming systems practices of harvesting meslin with immature cereals into dry grain harvesting.

- Animal feed: barley, field pea, faba bean
- Milling: bread wheat (except for quality problems)

- Sown with a drill combination from 10 Nov. at:
 - 30 gr/m² of faba bean and 320 gr/m² of wheat.
 - 60 gr/m² of field pea and 220 gr/m² of barley.
- 1 to 2 disc passes before planting followed by 1 to 2 tine passes. Targets well-structured soil for easy crop establishment, especially of legumes.
- varieties equivalent to those used previously when he was in conventional farming, chosen according to their hardiness and productivity.
- Less sensitivity to lodging with the presence of stakes + situation without N input.
- Weed control is mainly achieved by working the soil before sowing.
- On winter barley/field pea he sometimes uses the harrow, which is less common on the other mixture because faba bean are more sensitive.
- For diseases and pests, he observes lower levels of infestation than with pure crops, thanks to a modification of the micro-climate and a barrier effect of the associated crop.
- Harvested at the beginning of July, around 2 to 3 t/ha of mixture with a legume share of 5 to 40%.
- Separates its mixture with a rotary sorter with 3 grids: either a 1st coarse sorting before putting in the bin and then a 2nd sorting afterwards, or flat storage and sorting afterwards when there is more time.



Benefits for the rotation:

- Association with complementarities between the species which allows to smooth out the heterogeneities of the plot and to secure the yields.
- The bread wheat/ faba bean allows to have faba bean regrowth as soil cover until the next crop.
- A previous crop that is easy to take up with a structuring effect.

Evaluation by the farmer:

- ☺ The legumes used in these mixtures contribute nitrogen to the system and zero input crop.
- ☹ Protein content of bread wheat difficult to match with the demands of the organic market (11%)... even if the mixture seems to help a bit compared to a single crop.
- ☹ Low faba bean yields in 2020.

Success conditions and risks:

- Consider the establishment of the mixtures according to the plot history (pest pressure, level of N residue, delay between legumes).
- Avoid situations where the two mixtures follow each other with too frequent a return of legumes, so the cereal can be grown pure.
- Excess water at sowing which can penalize faba bean.

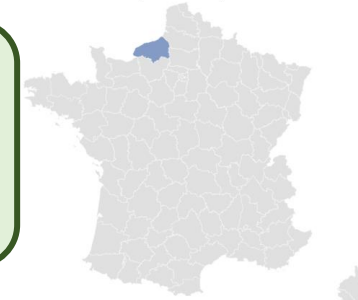


Credits: web agri

The lucerne, a multi-service crop to diversify the crop rotation



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Objectifs: bring back protein and fibre in the ration of dairy cattle and fight the development of certain weeds in no tillage

- Lever for controlling foxtail grass
- Of interest for the calculation of EFA for the CAP

Seine Maritime, FRANCE

- 240 ha, 180 ha of crops and 60 ha of permanent grassland with a herd of dairy cattle and suckler cows
- Clay-limestone + limestone on the slopes

Lucerne (7 ha)

wheat

winter barley

rapeseed

wheat

winter barley

Lucerne which is reserved for clay-limestone soils

Dry soils, which do not impact the growth of lucerne thanks to its particularly deep taproot system, which explains its good resistance to drought.

- **Sowing in late August**, immediately after winter barley. In the future, is considering sowing lucerne under spring barley to promote good starting and the plant's vigour.
- lucerne left in cultivation for 3 years, beyond that, loss of yield.
- **Between 3 and 4 cuts per year**, theoretically 1 cut every 5 weeks.

- Every year in February/March, 400 kg/ha of 60% potassium chloride => 240 units of potassium.
- Only in the 1st year (prohibited after declaration of EFA surfaces) a **KERB FLO** for grass management in winter.
- No disease/pest problems.

- Sowing combination, between 1 and 2 cm, spacing 12 cm.
- 25 kg/ha of lucerne + 3 kg/ha of red clover for a larger harvest volume in the first year, then the clover disappears.
- 1 or 2 stubble ploughings + rolling + sowing + rolling.
- Certified lucerne seed, inoculated

- First cut around 20 May, then after the second cut, let the lucerne to flower for longer to help replenish the plant's reserves.
- Harvesting in baler-wrapper: mow and windrow the next day (leave to dry for 24 to 38 hours), then press the following evening or morning.
- Information: sun or belt type windrower ideal for preserving the integrity of the leaves.
- Yields in one year around 9 to 11 t DM, with the best production performances obtained in the 2nd year around 12 t DM.
- Lucerne introduced into the ration at a rate of 2 kg DM.

Benefits for the rotation:

- Saves about 30 U N/ha on the following wheat.
- Wheat following easier to weed thanks to the "cleaning" effect of the lucerne crop.
- Improved soil structure for easier establishment of the following wheat: 3rd cut at the end of September, then October, sowing in DS in the lucerne with a disc drill and destruction with glyphosate + ALLIE.

Evaluation by the farmer:

- ☺ Mowing that helps to manage the developing weeds on the plots.
- ☹ Lucerne establishment sometimes difficult to control with poor emergence and irregular cover.
- ☹ Time of work due to regular mowing operations.

Success conditions and risks:

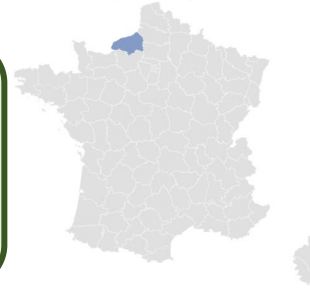
- Sowing and emergence which influence the good management of lucerne: ⚠ to pests such as flea beetles.



Spring field pea to diversify a no-till rotation



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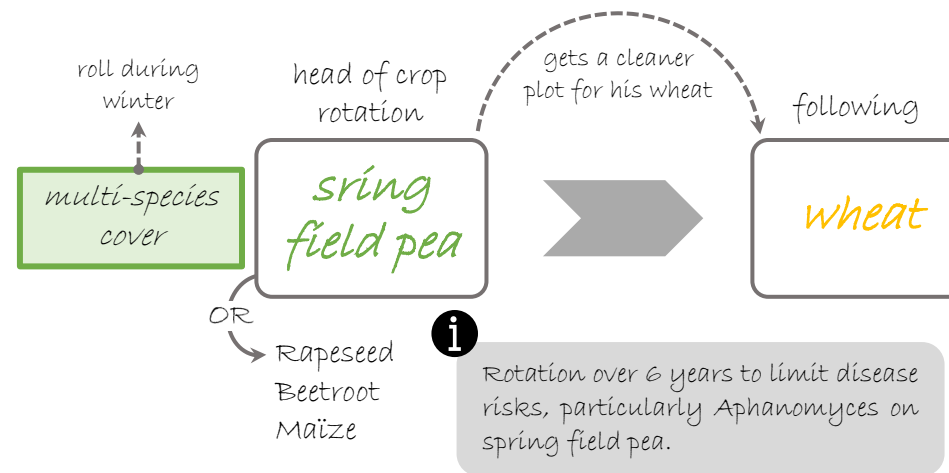
Objectives: insert a good head of the crop rotation

- Easier to manage than faba bean in calcareous, shallow soils, regarding drought phenomena and less susceptible to weevils
- Lever for controlling resistant grasses

Seine Maritime, FRANCE

- 280 ha crop-livestock farming system in SD
- Geographically fragmented plots with very heterogeneous land and steep slopes
- On average 900 mm per year

- **Sowing window:** end of February to end of March, if conditions allow, he considers to sow earlier to avoid hot days in summer.
- In chalky soil, he favours dense densities, between 80 and 90 gr/m² with the aim of covering the soil quickly.
- 2 passes of a stubble cultivator at 5 cm in a criss-cross pattern to warm up the soil, then direct sowing with rolling afterwards in plots with stones to flatten the soil.
- Farm seeds with good stem strength.
- **Fertilization:** 40 units of P + 60 of K + 20 of S.
- Insecticide treatments which depend on infestation levels.
- Main pests: pea leaf weevils, thrips and pigeons.
- Grouped weed raising, therefore possibility of treatment by early morning application of an anti-grass product coupled with adjuvants on very young weeds (2 leaves), especially vulpine.



- **Yields objective:** 50 to 55 qtx/ha.
- Yields generally around 45 to 55 qtx with minima at 30 qtx in bad years, which can be explained by sowing a little too early with limited conditions and too low densities.
- On his farm he uses a maximum of grass, so there is no additional need for protein for his livestock activity. Thus, the field pea is sold to cooperatives.
- The selling price is between 200 and 230 €/t, for gross margins that can reach 1200 to 1250 €/ha. However, they are still lower than the economic results obtained for wheat and rapeseed on his farm.
- Part of the harvest is kept and sorted to renew the farm seeds.

Benefits for the rotation:

- Alternating spring and winter crops helps to control the weed flora in his rotation and allows him to limit the pressure just before his wheat by sowing a crop of spring field pea that he can easily clean up.

Evaluation by the farmer:

- ☺ Offers a treatment window to lower the weed pressure in the rotation.
- ☺ Additional crop to limit dependence on rapeseed at the head of the crop rotation.
- ☹ Effectiveness of treatment solutions against pests.
- ☹ Yields are rather uncertain and greatly affect the economic results.

Success conditions and risks:

- Avoid overworking the soil as much as possible to prevent weeds from germinating and bring out the stones.
- Sow as early as possible but in well-dried soil and at least 3 cm deep.
- Avoid very clayey plots with stones.



Credits: Terres Inovia

Take advantage of the agronomic benefits of winter field pea and faba bean as a previous crop to wheat

Objectives: look for an alternative to wheat succession to find a balanced rotation

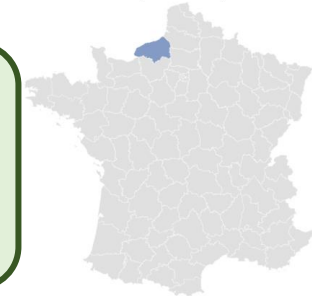
- Increased yields on wheat
- Beneficial effect on soil quality
- Allows to regulate the pressure of weeds

Seine Maritime, FRANCE

- 194 ha spread over 2 farms
- Clay with flint, very hard soils, therefore no tillage strategy with collection of stones and marling operations to raise the pH



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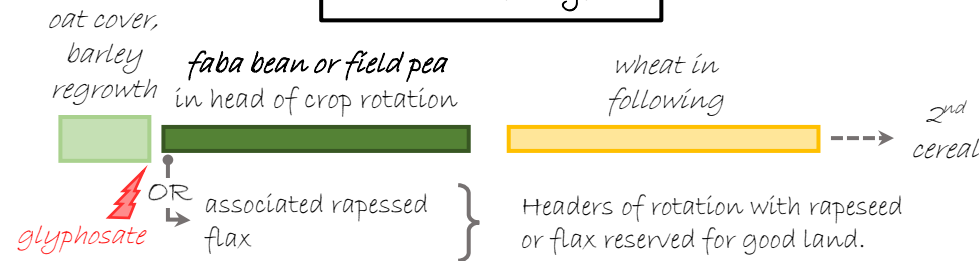
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sowing according to the nature of the soil: winter faba bean can be grown in stony soils, such as flinty clay, and winter field pea in marly plots.

- Sowing in November, without tillage with a conventional Horsch tine seed drill (no disc seed drill in his flinty soils).
- Sowing slightly thicker than recommendations, to compensate for losses at emergence in hard soil (avoids going too high in number of grains/m² regarding disease risks).
- Farm seeds renewed each year with certified seeds: NEBRASKA for faba bean and FRESNEL for field pea.

- Fertilization: green compost.
- Few weed control problems on his crops.
- Problem of weevils on winter faba bean, although it is less sensitive than the spring faba bean that he cultivated before and on which the damage caused by weevils forced him to use it for animal feed. Carries out a treatment but it is not very effective.

Rotation over 6 years



- Harvest carried out by a service provider using a CLAAS LEXION harvester with relatively clean threshing.
- varietal choice that has solved many lodging problems. Field pea that can be harvested a little before maturity, at 20% humidity to avoid the risk of rain, with costs relating to drying at the cooperative.
- On average, 40 qtx/ha for faba bean and 45 qtx/ha for field pea with maxima of 64 qtx for faba bean and 50 qtx for field pea.
- Winter faba bean temporarily stored and then sold in short circuit (at market prices: 250 €/t in 2019) to a neighbour, a pig farmer.
- Wheat yields over the last 4 years, respectively at: 75, 90, 85 and 80 qtx/ha, compared to 65 to 70 qtx before introducing legumes in his rotation.

Benefits for the rotation:

- Legume crops that have allowed diversification of the rotation and solved the problems related to vulpine weeds with a reduction of at least 20% of the weeding costs on the following crop.
- Yield gain on the following wheat of about 10 qtx/ha, resulting in an increase in the farm's turnover.
- Increased OM levels in his soils.

Evaluation by the farmer:

- ☹ **Weather dependent: at sowing + during flowering** (but winter variety with delayed flowering, less sensitive) **hot days that aborts flowers + excess water in winter.**
- ☺ Intercrops that allow water to be pumped out to limit excess water + helps to soil preparation before sowing legumes.
- ☺ Less dirty than a rapeseed in head of the crop rotation.

Success conditions and risks:

- Be careful with threshing for field pea, which fall quickly; harvest a little earlier can help preserve the seeds' resistance to mechanical shocks.
- Good soil preparation with a Cruiser or Terrano type stubble cultivator, less aggressive on soil life than disc tools.

Combining yellow spring lupine with bread wheat on the south coast of Brittany



Authors:
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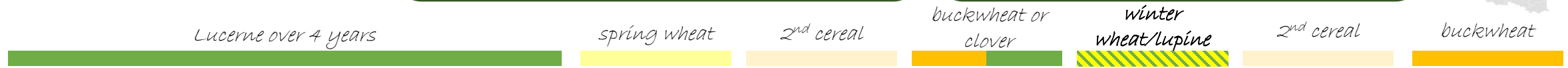
Credits: Terres Inovia & Arvalis

Objectives: insert a legume to benefit from its advantages in a rotation with a high proportion of cereals

- Local protein production
- Provides good soil cover

Morbihan, FRANCE

- Bakers-farmers who cultivate 25 ha + plot exchanges with a dairy farmer
- Acid soils, sandy soil with little depth, some hydromorphic plots



Good precedent, crop that particularly appreciates acid soils and that is valued by the organic dairy farmer.

Clover that works well in his farm.
Buckwheat, which cleans up the plots.

Rye or spring wheat

- **Soil preparation:** tillage or rather deep no-till methods with rolling.
- **Sowing window:** sown as a mixture between 15 November and 15 December with a conventional seed drill, for a winter wheat harvest around 15 July which coincides well with the maturity of the yellow spring lupine.
- Sowing densities established thanks to the advice of another farmer, used to lupine cultivation: 30 kg/ha of lupine and 190 kg/ha of wheat.
- ⚠ system with spring lupine which works on the coast, with a milder climate and land that warms up quickly, but which may be more difficult to transfer inland.

- Old milling varieties in wheat, more rustic.
- Farm varieties of lupine, without inoculant.
- Addition of cattle manure compost + this year testing the addition of poultry manure.
- Weed harrow as the main weeding tool with a first pass one month after sowing, then 1 or 2 more aggressive passes afterwards + hoeing in March.
- on some plots that need to be very clean (where he wants to do his seed).

- Harvested wheat at the last moment to ensure a successful lupine harvest.
- Harvest carried out by a service provider with a flex cutter harvester.
- He targets wheat yields of 25, 35 quintals sorted, but currently results vary between 20 and 30 quintals (land that is not well suited to wheat + old varieties), in lupine last year around 300 kg/ha and he aims for a production of 150 kg/ha.
- The crop is sent to the separator sorter and then to a cell with ventilation + regular passes to the alveolar sorter to eliminate the remains of the lupine.
- 100% of the wheat is used on the farm with a mill (Astrié type) for milling, the lupine is used by the farmer + this year, a new outlet with 2 tons sent to a mill to process the lupine into flour for human consumption.

Benefits for the rotation:

- Self-sufficient in seed.
- Lever that helps to break in the rotation, the cycles of diseases/pests/weeds.
- Local outlets.

Evaluation by the farmer:

- ☺ Association with wheat which limits weed and pest pressure on the yellow lupin crop.
- ☺ Good protein content of bread wheat.
- ☺ A lot of CUMA work, so low mechanisation costs.
- ☹ Poorly stacked lupine which forces harvesting at a very low level with undesirable plants rising in the cutterbar.

Success conditions and risks:

- Be vigilant about the weed pressure concerning the lupine, which are likely to be smothered by weeds: do not hesitate to use harrows when there is a development.
- Sow lupine in areas that are not very sensitive to frost in the spring.



Lucerne: a crop that adapts well to dry conditions



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Objectives: reduce the costs of feeding and remain productive in a context of water stress

- Plant with an interesting DM tonnage/ha
- Breaks weed cycles in its rotation

Indre, FRANCE

- 220 ha crop-livestock farming system
- Clayey sandy-loam with low AWC, very dry soils that warm up quickly with some wetlands
- Between 650 and 700 mm per year

Credits: Arvalis

spring sowing complicated in its soils

barley or spelt

Previous

Lucerne over 5 years

wheat

Following

Harvest with

- Disc mowers 4m20
- Rotor tedder 13 m
- Twin Rotor Rakes 9 m
- Baler-Wrapper Combinations
- Square baler 120 x 90

- Best lucerne variety on his farm: SORAYA (southern type).
- Targets southern type varieties with low dormancy because it allows him to gain a cut on his lucerne in his land.
- Fertilization with 15 t/ha of manure every year in November. On the plots close to habitations, instead of manure, he brings only the first year 30 U N/ha (ammonitrate) in spring as boost, then 80 kg of PK and 80 kg of S.
- In winter when the soil is not too moist, a pass of the meadow harrow to finish crumbling the manure and for a light effect on the weeds.
- No chemical weed control on his lucerne.

- 1st mowing, the most productive, around 8 May with an interval of 6 weeks between each mowing. 3 cuts per year systematically, or even 4 or 5 in good years, with a target of 9 t DM/year.
- He lets the lucerne bloom a little after the third cut so that the plant has time to build up its reserves.
- In autumn, before the crop is destroyed, the lucerne is grazed to mow it before a pass of stubble disc cultivators with a slant in relation to the direction of the plot, followed by a tillage.
- Often, the 3rd cut is produced in hay, the other cuts are harvested as wraps: in lucerne hay it is difficult to keep all the leaves + very rich fodder, between 15 and 17% of MAT, so it is rationed and for this he uses a round bale unwinder.

Benefits for the rotation:

- Good precedent for wheat
- Savings on nitrogen fertilisation behind the lucerne with about 50 euros/ha less nitrogen inputs and therefore higher margins on following wheat.
- Lucerne has a structuring effect on the soil.

Evaluation by the farmer:

- ☺ Reduction of the pressure of thistles, Ray Grass and curly dock in the rotation by successive mowing of the lucerne which prevents these weeds from going to seed.
- ☹ Working time: crop that requires numerous technical operations at harvest time and they need to be carried out correctly so as not to lose leaves.

Success conditions and risks:

- Successful sowing by sowing early.
- Fertilize sufficiently and correctly for good lucerne productivity.
- Sow lucerne in the least sandy plots possible and check the pH, favouring soils with a pH > 6.



Credits: Terre Inovia

Using legumes for poultry feed



Authors:
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Objectives: use alternative crops to soybean for poultry feed with a soil fertilization function

- Ideal to compensate for the lack of manure on an expanding farm

Finistère, FRANCE

- 110 ha of crops
- Specialized in organic farm poultry with direct sales
- Heterogeneous soils with heavy to light soils and pH ranging from 5.5 to about 7

- Since last year he has been growing blue lupine with barley at a rate of 170 kg/ha of lupin for 40 kg/ha of barley. Good first results that need to be confirmed over time: 40 qtx/ha in lupin and about 5 qtx/ha in barley.
- Faba bean is the only protein crop grown pure. In a mixture it is grown with triticale: 120 kg/ha of triticale and 80 kg/ha of faba bean. Previously he has tested 50/50 densities but the faba bean took over from the triticale.
- Areas of pure faba bean reduced in favour of triticale/faba bean
- Previous: Winter mixtures generally inserted after rapeseed or maize with sowing in late November/early December. For the spring barley/pea precedent often a cereal. Next: after triticale/faba bean, spring barley/pea; after wheat/pea, the same or maize; after spring barley/pea or pure faba bean, rapeseed.
- In wheat/pea, possible use of alternative varieties with sowing in January until 15 February, which offers more security against soiling.
- Sowing with a combination seed drill after a tillage and, as soon as the soil is dry, using a rotary hoe followed by 1 or 2 pass of the harrows.

Protein crops grown in mixtures or pure:

- wheat/field pea
- barley/blue lupine
- triticale/faba bean
- winter barley/field pea
- pure faba bean

- Poultry manure (only for mixtures, for pure protein crops no fertilization) at a rate of 5 t/ha, applied as close as possible to tillering, or even before, depending on soil humidity. For lupine/barley, he inoculates his seeds with a mixer the day before or the day of sowing.
- 80% of farm-seed, completed with certified seed.
- Weed control with rotary hoe and harrows. A few years ago, a hoeing was used in pure faba bean and in the triticale/faba bean mixture with a 37.5 cm spacing: worked well but required more working time.
- Pigeon problem on peas.
- Harvest carried out by a contractor, with a sorting operation immediately after harvesting or later with a MAROT rotary sorter with 4 grids (sorting rate at about 10-15 t/h): For seeds 4 to 5 passes, for feed 1 pass is enough. Storage in compartment.

Benefits for the rotation:

- With a rapeseed following, the faba bean regrowth act as companion plants.
- Good precedent with good vigour of the following cereals.
- Recovers a cleaner plot after a faba bean.
- Stake effect in the mixture so little lodging.

Evaluation by the farmer:

- ☺ Secure yields.
- ☺ Mixed faba bean crop less affected than pure crop by diseases and pests.
- ☺ He has supplanted soybean thanks to its protein crop and rapeseed crops
- ☹ Irregularities in yields, mainly on the faba bean crop. E.g.: last year faba bean to 10 qtx and the year before 30 qtx.

Success conditions and risks:

- Pay attention to sowing to ensure good soil cover.
- Between two pure faba beans, aim for a return period of 5 or 6 years to limit the risk of disease.



Credits: Terre Inovia

Blue lupine, a “rapeseed equivalent” to bring protein back into the ration



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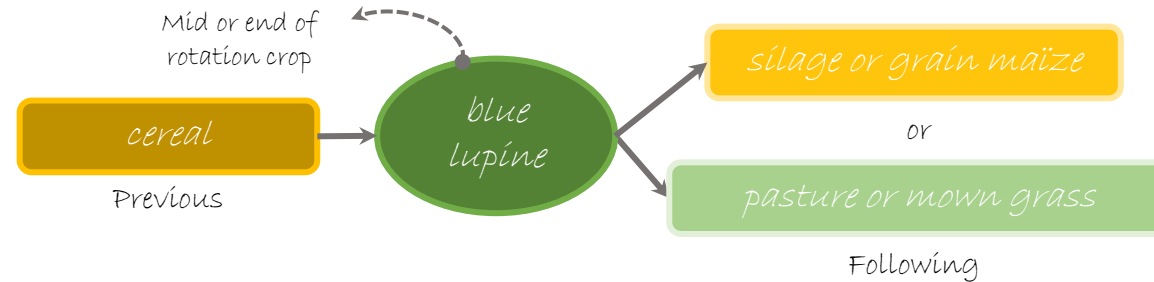
Objectives: cover its protein needs

- Offers a more economical protein source than soybean OF with good agronomic qualities for soil

Finistère, FRANCE

- 160 ha with 130 ha accessible to cows
- Clay soils with a lot of stones, dry soil
- 1000 to 1100 mm per year

- Spring blue lupine sown between 150 and 170 kg/ha combined with 25 to 30 kg/ha of barley. The main purpose of barley is to cover the soil very quickly at the beginning of the cycle to compete with weeds and to act as stake for the lupine at the end of the cycle.
- Choice of blue lupine because it adapts better to lower pH (5.5 < pH < 6.5), better start in spring, less risk of disease at the end of the cycle.
- Targets yields around 30 to 35 qtx/ha on average with total nitrogen content rates of the same order at 30, 35% of DM.
- Sowing between 15 March and 15 April, at the latest.
- BOREGINE variety which works well on his farm.



- Before sowing, destruction of the cover crop (this year fodder rapessed and the year before, daikow/phacelia) followed by tillage and 2 false seed beds. Sometimes not even a false seed beds.
- Blue lupine is less demanding than white lupin, so no fertilization of the crop.
- For weed control at least 1 pass of harrows (often 2) at the arrival of 3-4 true leaves.
- ⚠ be careful with the multiplication of tools, the plants are quite fragile.

- Harvest with a classic cut, between August 20 and September 5: Try to harvest after several days of good weather to thresh below 15% moisture.
- very little barley in the lupin as the harvest is realized later in the season.
- Blue lupin stored flat and coarsely ground as the winter progresses to incorporate into the ration at a rate of 1.5 kg to 2 kg per cow.
- In 2020 lupin at 45 qtx/ha for 29% total nitrogen content.
- Does not keep any seed because his priority is to correct the cows' ration

Benefits for the rotation:

- Lupin that does not lodge thanks to the barley, so less susceptible to diseases.
- No disease and pest problems on his blue lupine so far.
- Good maize following behind a blue lupine.
- The root system of the blue lupine “tills” the soil well.

Evaluation by the farmer:

- ☹ Supply and availability of seed.
- ☹ Less yield than a white lupine...
- ☺ ...but more stable in total nitrogen content.
- ☺ For the past 3 years it has been self-sufficient in protein, which even allows it to sell wraps.

Success conditions and risks:

- The blue lupin does not appreciate toasting: the year in which it was toasted corresponds to the year in which it had the lowest rate of maturation and the lowest milk production.
- Barley plays an important role in supporting the blue lupine.
- Do not sow too early, nor too late + crop that appreciates the slight cold spells at the end of April and beginning of May.



Credits: Cultivar

Associated rapeseed with legumes to limit inputs to the crop

Objectives: use companion plants and manage rapeseed with 0 weed control at sowing

- Only a catch-up weed control against grasses
- Saving nitrogen for rapeseed



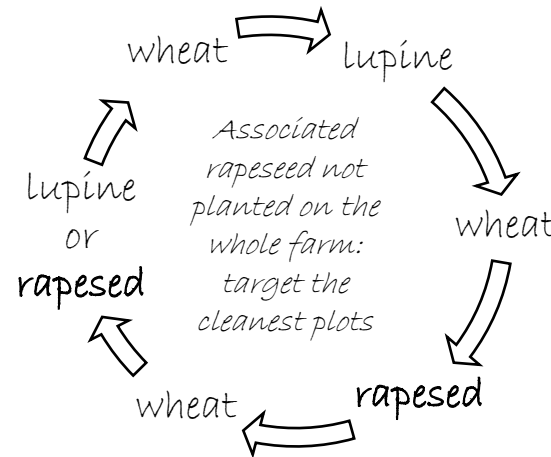
Authors:
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Vienne, FRANCE

- Farm of 190 ha, almost no tillage
- Very heterogeneous red chestnut soil, quite dry
- About 700 mm per year

- Rapeseed associated with frost-sensitive companion plants supplied by the cooperative: before, a mixture of Bengal vetch with Alexandria clover and in the last 2 years a mixture of clover and fenugreek. Preference for the first mixture, with a better initial vigour.
- Tillage: no-till, 2 passes with a stubble cultivator.
- Sows early, on 5 August, all in mixture to limit operations by adding together the doses of rape and the doses of companion plants: Has a seeder with two sides of descent in which he adds 2 ha on each side.
- Seeding rate: 10 to 12 kg/ha of companion plants, for rape, about 1,8 kg/ha.



- If frost is not enough to destroy the cover, consider 1 pass of LUMEO or BELKAR (in December) when there is a geranium infestation.
- Rape yields around 3.5 to 3.8 t/ha, like non-associated rape. No difference in moisture content, Dry Weight compared to unassociated rapeseed on the rest of the farm.
- Rapeseed valued by the cooperative: last year, around 380 euros/t, this year, prices will be around 430 euros/t on average.

Benefits for the rotation:

- When the companion plants are well established, there are 30 to 40 U N/ha returned for the rapeseed crop.
- Improvement of soil structure through the diversity of root systems of companion plants and rapeseed.

Evaluation by the farmer:

- ☺ Companion plants seem to act as a decoy on flea beetle populations.
- ☺ No depreciating effect of companion plants on rapeseed yields.
- ☹ If there is little rain, emergence difficulties for companion plants.

Success conditions and risks:

- Choose relatively clean plots to plant the associated oilseed rape and in particular free of geranium.

Lucerne to reduce weed pressure in rapeseed-wheat-barley successions and to feed the herd



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- Objectives:** reduce the use of oil cake in the cows' ration while controlling the development of weeds in the rotation
- Crop that does not require herbicide treatment

Seine Maritime, FRANCE

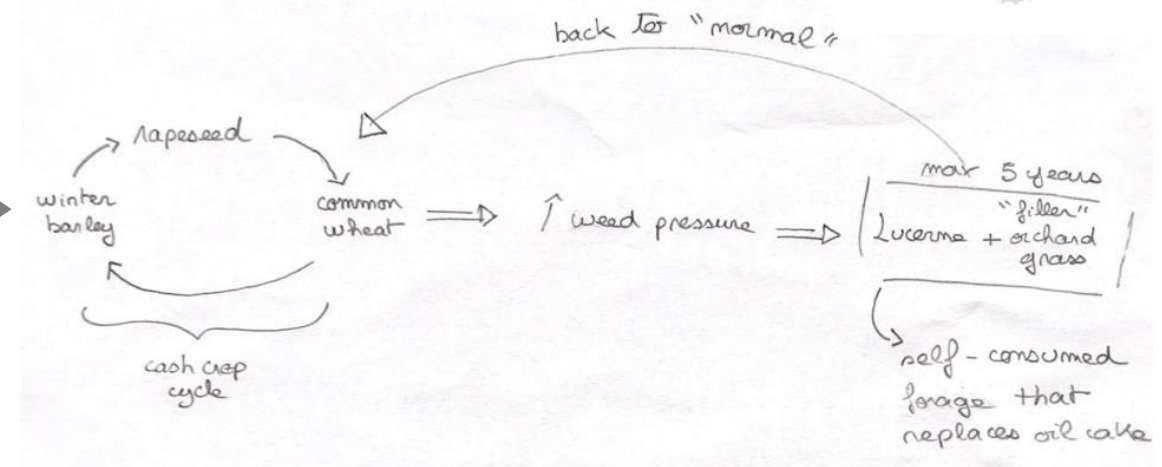
- Dairy farm in crop-livestock farming system
- Soil 30-40% clay
- Temperate climate 900 to 1000 mm of rainfall on average per year + hot summer



Credits: Terres-net



When foxtail grass pressure becomes too high in the winter wheat - winter barley - rapeseed cycle, he sows a mixture composed of 90% lucerne and 10% orchard grass. This mixture remains in place for a maximum of 5 years and is used for hay or silage, before returning to the initial rotation.



Benefits for the rotation:

- Weed pressure in the rotation is better controlled thanks to lucerne.

Evaluation by the farmer:

- ☺ 1 ha of lucerne replaces 6 t of oil cake.

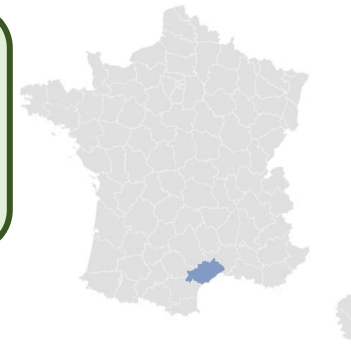
Success conditions and risks:

- Plant the lucerne in a calcareous and draining soil.
- Ensure that the lucerne does not lack calcium (supplementation with carbonate and quarry sand).
- Weather conditions for hay harvesting (when 10-15% of the plot is in flower), a delicate and crucial stage: 4-5 days of good weather with a temperature between 25 and 30°C.

Chickpea as an alternative to durum wheat monoculture (farm 1)



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- Objectives: increase rotation possibilities for main durum wheat and control take-all**
- Durum wheat yields are more consistent and have increased

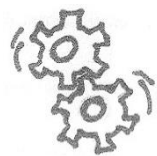
Hérault, FRANCE

- Large-scale farming, COP crops + seeds + market gardening + vines
- Clay-limestone soils on plains and hillsides
- Mediterranean climate: 650 mm per year

Credits: Terres Inovia

Example of a rotation and associated technical itinerary

<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>	<u>Year 4</u>	<u>Year 5</u>	<u>Year 6</u>
Tillage	Direct seed	Direct seed	Direct seed	Direct seed	Tillage
Chickpea	Durum wheat	Durum wheat	Durum wheat	Durum wheat	return Chickpea



use of chickpea as a "head of rotation" with a good capacity to fix atmospheric nitrogen in order to produce quality durum wheat afterwards (protein rate improving) and which offers the possibility of reducing nitrogen inputs in the rotation.

Benefits for the rotation:

- Important benefit on the limitation and the regression of the take-all for the following cereal crops.
- The introduction of legumes contributes to a better management of nitrogenous inputs

Evaluation by the farmer:

- ☺ The introduction of chickpea makes it possible to extend the period for sowing field crops from the beginning of October to the end of February: better optimization of the climatic windows for sowing and distribution of work.

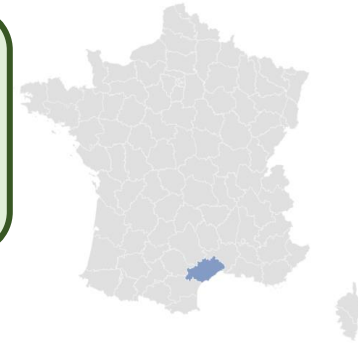
Success conditions and risks:

- Do not return the chickpea too quickly (minimum 4 years).
- Take care when planting chickpea.
- Avoid poorly drained and hydromorphic soils.

Chickpea, an additional asset against Ray Grass problems (farm 2)



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Objectives: reduce the pressure of Ray Grass in the crop rotation

- Disruption of the Rays Grass cycle

Hérault, FRANCE

- Large-scale farming, COP crops + seeds + market gardening + vines
- Clay-limestone soils on plains and hillsides
- Mediterranean climate: 650 mm per year

Example of a rotation and itinerary negative to Ray Grass

<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>	<u>Year 4</u>	<u>Year 5</u>	<u>Year 6</u>
Tillage	Direct seed	Direct seed	Direct seed	Direct seed	Tillage
Chickpea *	Durum wheat	Durum wheat	Durum wheat	Durum wheat	return Chickpea *



Introducing chickpea in cereal rotations allows to lengthen rotations, thus giving the possibility, with late sowings on chickpea crops (*), to hinder the proliferation of Ray Grass, the tillage practiced for the establishment of chickpea acts in the same way. The use of herbicides from different families than those used in cereals contributes to limit resistance problems.

Benefits for the rotation:

- Lengthen of the sowing period with chickpea planting up to the end of February (period when the ryegrass has finished to emerge), which leaves time to carry out false sowing and to disrupt the ryegrass cycle.
- Better management of nitrogenous inputs on the crops that follow the chickpea.

Evaluation by the farmer:

- ☺ The set of management methods implemented in his rotation allows him to control the proliferation of Ray Grass.

Success conditions and risks:

- Do not return the chickpea too quickly (minimum 4 years).
- Take care when planting chickpeas.
- Avoid poorly drained and hydromorphic soils.

Credits: Terres Inovia

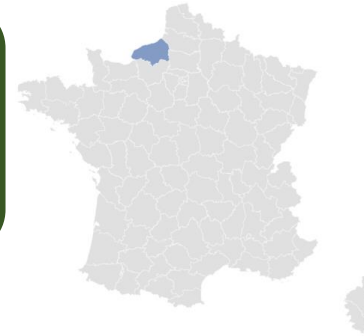


Crédits photo: Terres Inovia

Winter pea as an opportunity in the weed control strategy of cereal farms



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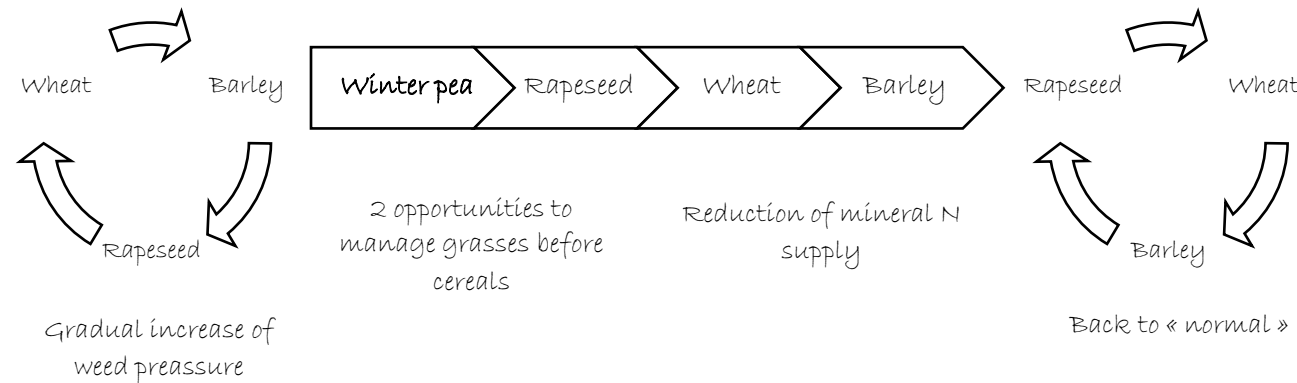
Objectives: Reduce the pressure of Ryegrass and Vulpine in rape/wheat/barley rotations

- Limits costs on low-potential plots of land, in particular by making use of neighbouring livestock farmers and by saving N

Seine Maritime, FRANCE

- Cereal farm with some neighbours in corp-livestock farming system (pigs)
- Low potential soils with either very chalky and shallow slopes or very clayey soils

Introduce a winter pea forage crop before rapeseed between two rapeseed/wheat/barley cycles, when herbicides can no longer control weed pressure and ploughing is not an option: The pea/rapeseed succession allows the use of a weed control product that is not subject to resistance in weeds over two successive seasons



Even if the winter pea cannot be valued for a human food outlet with the local storage organizations and cannot be self-consumed, it can find an outlet with neighbouring farmers.

Benefits for the rotation:

- Nitrogen savings are possible on rapeseed or cereal crops following the pea.
- A system that allows grass pressure to be managed for several years.

Evaluation by the farmer:

- ☺ The sale of the pea to neighbouring farmers helps to cover the costs incurred.

Success conditions and risks:

- Limit as much as possible the expenses linked to winter peas, especially if you are not sure of their value in the same way as spring peas or in contract with seed companies.
- Good vegetative development before winter is essential: adapt the depth and date of planting to the state of the structure, to allow a rapid start. If possible, ask for advice from those who have historically grown peas.