



Legumes in France: obstacles and opportunities

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LEGumes for the
Agriculture of TOmorrow



Outline

1. Why legumes have “disappeared” from french arable areas ?
2. Why legumes are considered good candidates for a necessary agroecological transition ?
3. Which levers to increase legumes in agrosystems ?
4. To conclude

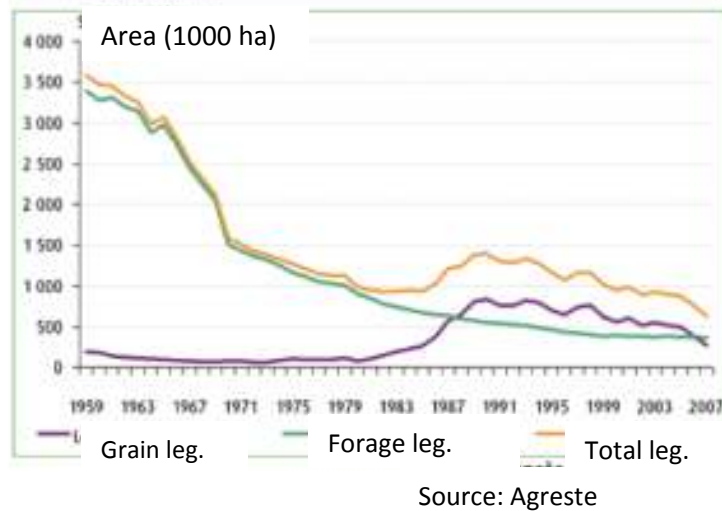


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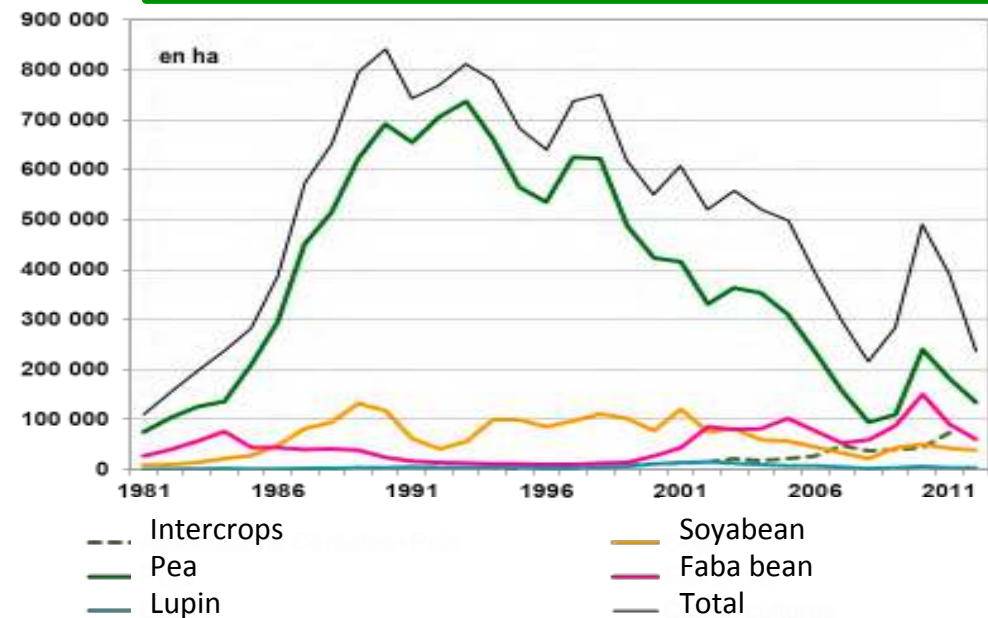


1. Why legumes have disappeared from french arable areas ?

Legume areas in France, 1960-2007



Grain legume areas in France, 1980-2013



While areas strongly increased in America, during the same period,
with detrimental environmental and social impacts (*Botta et al., 2011*)
and for an european (and asian) use,
thus leading to negative consequences on the nutrient cycles at planet scale !



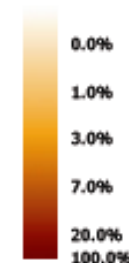
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1. Why legumes have disappeared from french arable areas ?

While increase of short rotations :

- frequency of the rotation oilseed rape – wheat - barley in arable land (figure)
- Increase of the rotation oilseed rape – wheat – wheat
- Increase of the rotation maize – wheat
- Increase of monocultures of wheat or maize



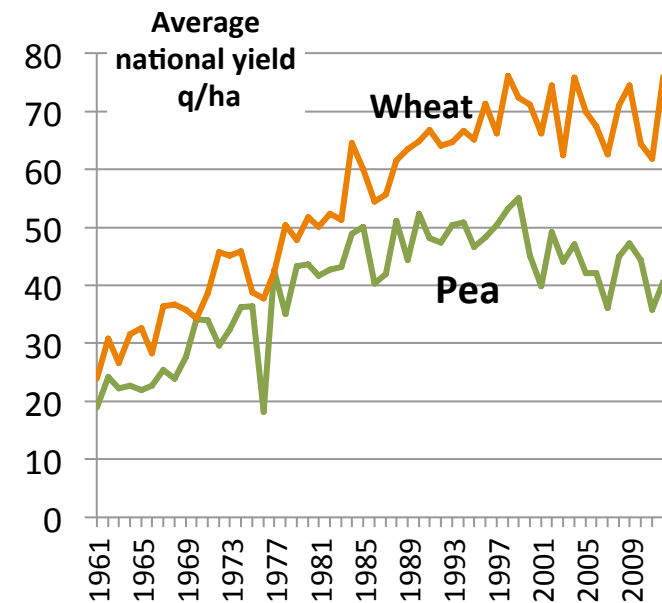
source : Ministry of
Agriculture and INRA
Mirecourt

1. Why legumes have disappeared from french arable areas ?

Lower productivity of GL compared to main arable crops

At the field scale

- low yield due to the **cost of protein synthesis** in the protein-rich grains (*Munier-Jolain & Salon, 2005*)
- Increasing gap between pea and wheat yields due to the higher **sensitivity of grain legumes to climatic stress** (heat, water, frost) more frequent in the recent years
- Development of a **soil-borne disease**, *Aphanomyces euteiches*, which affects many fields in France
- **Yield more variable** than other main arable crops (*Cernay et al., 2015*)



Source: data FAOSTAT



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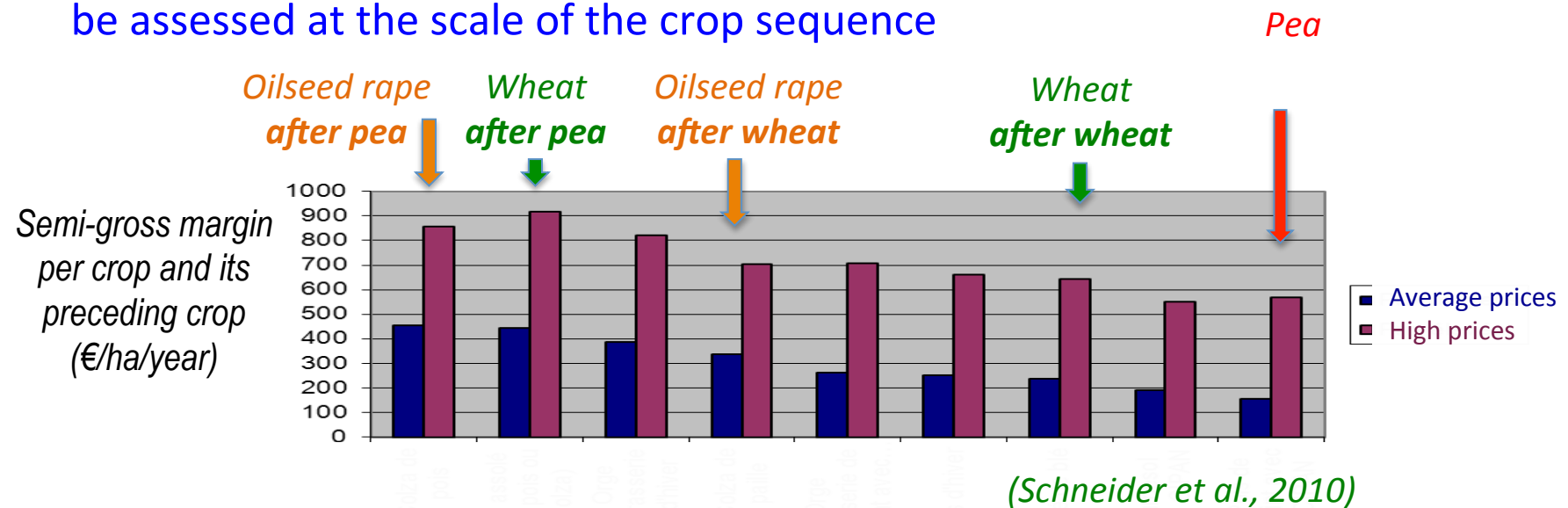


1. Why legumes have disappeared from french arable areas ?

Economic return on following crops is rarely considered

At the farm scale

- Pea has generally the lowest gross margin among arable crops
- But the crops following a pea have the highest gross margin
- ➔ the economic interest of the legume crop should be assessed at the scale of the crop sequence





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1. Why legumes have disappeared from french arable areas ?

A lack of advice on legumes

At the scale of advisors

- References on a pluri-annual period are not available
- The environmental benefits of legumes (and the determinants of their variability) are rarely known and thus taken into account by farmers, advisors, and users.
- Crop management on legume crops might be improved if technical advice was more performant (compared to wheat or oilseed rape)

« Crop diversification: obstacles and levers » (Meynard et al., 2013)



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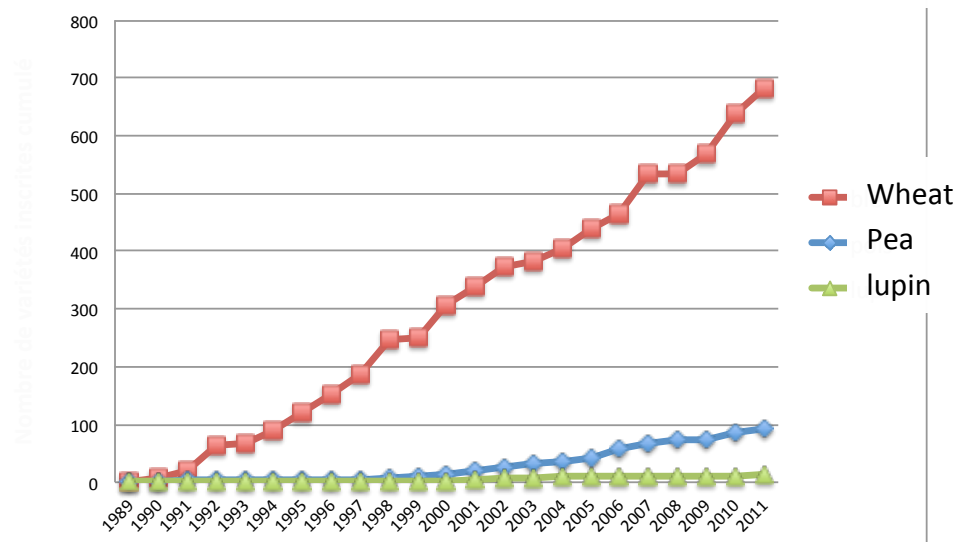


1. Why legumes have disappeared from french arable areas ?

Genetic progress is lower and less rapid than on main arable crops

At the scale of breeding industry

Cumulated number of cultivars registered in France



Yield increase in breeding trials :

Wheat: + 134 kg/ha/year

Spring Pea: + 50 kg/ha/year

Winter pea: + 90 kg/ha/year

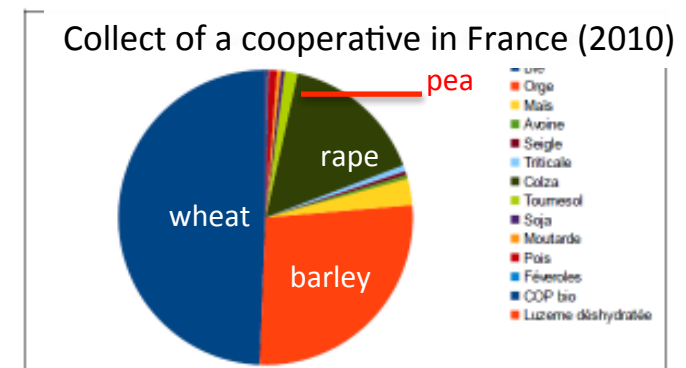
- *Less cultivars (thus lower choice, and lower adaptation to various environmental conditions)*
- *and lower increase of potential yield (but improvment on other criteria : frost sensitivity, lodging sensitivity)*

1. Why legumes have disappeared from french arable areas ?

Strategies of collecting firms and industry reinforce the dominant crops

At the scale of collecting firms

- Collecting firms concentrate their activity on a small number of products showing the highest volumes and the lowest logistical costs
- Competition among available raw materials → legumes are often replaced by other products in feed industry
- Difficulty to change dietary habits



At the scale of food and feed industry

At the scale of consumers

« Crop diversification: obstacles and levers » (Meynard et al., 2013)



Outline

1. Why legumes have “disappeared” from french arable areas ?
- 2. Why legumes are considered good candidates for a necessary agroecological transition ?**
3. Which levers to increase legumes in agrosystems ?
4. To conclude



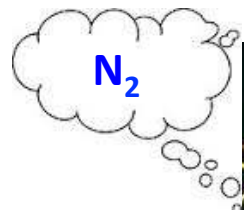
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2. Why legumes are considered good candidates for a necessary agroecological transition ?

They supply numerous agronomic benefits ...

- ◆ Strong **reduction of N fertilizer requirements** on the legume and on the following crop



0 kgN.ha⁻¹ on the legume crop

-20 to -50 kgN.ha⁻¹ on the following wheat crop;

-30 to -60 kgN.ha⁻¹ on the following oilseed rape crop

(Schneider et al., 2010)

- ◆ **Yield increase of the following crop**

Wheat crop
following a wheat



+ 0.84 t.ha⁻¹



Wheat crop
following a pea

*Average from farmers' fields
in Northern France
(Schneider et al., 2010)*



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2. Why legumes are considered good candidates for a necessary agroecological transition ?

They supply numerous agronomic benefits ...
and environmental benefits in agro-ecosystems ...

- ◆ Decrease of **greenhouse gazes** (N_2O et CO_2) compared to fertilized crops, **at field scale and at crop sequence scale** (*Jensen et al., 2012; Jeuffroy et al., 2013; Nemecek et al., 2015*),
- ◆ Decrease of **fossil energy consumption** : -50% **compared to a fertilized crop**, -11% **compared to a 5-year rotation** without legume (*Nemecek et al., 2008*)
- ◆ Decrease of **weeds and soil-borne pathogens in a crop sequence** including a legume crop compared to cereal- and oilseed rape-based crop sequences, **at field scale**, allowing a **reduction in pesticide use** (*Colbach et al., 1996 ; Deytieux et al., 2012; Bennett et al., 2012; Petit et al., 2012*)
- ◆ Contribution to increase of the **grown biodiversity in the landscape** → decrease of **insect pest population** with aerial dispersal on main arable crops (*Tscharntke et al., 2005 ; Mulumba et al., 2012*)
- ◆ Key role in the **associated biodiversity** whether in the air (pollinators on faba beans, alfalfa, clovers; *Tasei 1978, 1984*) or in the soil microflora (*Zancarini et al., 2013*)



2. Why legumes are considered good candidates for a necessary agroecological transition ?

They supply numerous agronomic benefits ...
and environmental benefits in agro-ecosystems ...
and economical interest at crop sequence scale ! *Carrouée et al., 2012*

Difference of semi-net margin between a crop sequence with/without pea (%) for 2 price levels and 4 regions in France

€/ha/year % without P	A pea between to wheats: rape-wheat-(Pea)-wheat- barley (1/5)		A pea before 1 rape : Rape-wheat-barley-(Pea)-rape- wheat-barley (1/7)		A pea instead of 1 barley: Rape-wheat-barley(or Pea)-rape- wheat-barley (1/6)	
	Low prices (W=126; P=150)	High prices (W=200; P=225)	Low prices (W=126; P=150)	High prices (W=200; P=225)	Low prices (W=126; P=150)	High prices (W=200; P=225)
Beauce with spring B, winter P,	+ 14 (+2,9 %)	+ 35 (+3,7 %)	-1 (-0,3 %)	+5 (+0,5 %)	+2 (+0,4 %)	-9 (-1 %)
Thymerais with spring P, winter Barley	0	+ 14 (+ 1,5 %)	-16 (-3,3 %)	-3 (-0,3 %)	-11 (-2,4 %)	+4 (+0,4 %)
Bourgogne with winter B, winter Pea	+21 (+6 %)	+ 32 (+ 4,2 %)	- 2 (-0,6 %)	0	-3 (-0,6 %)	-1 (-0,1 %)
Plateau lorrain with winter B, spring P	+ 22 (+6 %)	+ 44 (+ 5,6 %)	+ 9 (+2,3 %)	+ 21 (+ 2,6 %)	+12 (+3 %)	+29 (+3,6 %)

Second annual meeting, Cordoba, Spain 1-2th December 2015



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3. Which levers to increase legumes in agrosystems ?

The reasons for the low development of legumes are strongly linked each others: the strategies and actions of all the actors are strongly interconnected

→ To increase legumes in agrosystems, it is necessary to act simultaneously at the different scales

→ And to act on the uses of legumes (food) !

At the field scale

At the farm scale

At the scale of advisors

At the scale of breeding
industry

At the scale of collecting firms

At the scale of food and feed
industry

At the scale of consumers

« Crop diversification: obstacles and levers » (Meynard et al., 2013)



3. Which levers to increase legumes in agrosystems ?

There are numerous favorable factors for increasing grain legumes consumption

- **Increasing need of plant proteins**
 - 40% increase of protein needs (animal and plant) until 2030 at global scale (*Prospective Sofiproteol, 2014*)
 - Obligation to decrease consumption of animal products in order to satisfy world food needs in 2050 (*AgriMonde 2009*)
 - Food transitions: according to the countries, increase in plant proteins demand, or replacement of animal proteins by plant proteins (*BIPE from FAO*)
- **Nutritional quality**
 - Complementarity with animal proteins
 - Plant proteins more interesting for some ages of the human population
- **Innovations in agri-food processes**

ready-to-eat products, food products based on cereal-legumes mixtures, fractioning to extract ingredients
- **Development of quality signs and origin**



3. Which levers to increase legumes in agrosystems ?

Examples of farmers' cropping systems including GL with high performances

- Among the 1000 cropping systems surveyed in the Ecophyto network, which are the low-cost and multi-performant ones :
 - 31% of cropping systems with lucerne
 - 31% of cropping systems with grain legumes
 - 14% of cropping systems without legumes
- Comparaison of 27 cropping systems with/without legumes in the Burgundy region (PSDR Profile):
 - Reduction of fossile energy use (due to N fertilisation reduction)
 - Similar economic performances whatever the price level
 - No increase in pesticide use
 - Small increase of work load (5.3 h/ha instead of 5.0)
- Other examples in France that can help to convince other farmers to grow GL

From Schneider & Huyghe, 2015 ; Duc et al., 2010)



To conclude : guidelines for a research and development agenda

- **Increase the value of legumes in the upstream agri-food chain**
 - Work on a diversity of legume species (diversity of inclusion in the cropping systems)
 - Identify and develop new breeding criteria
 - Improve the environmental assessment and diffuse it
 - Improve agronomical practices (intercrops ...) to improve legume performances
- **Increase the value of legumes in the downstream agri-food chain**
 - Increase knowledge in nutritional and technological qualities
 - Increase innovations in products and industrial processes
 - Increase the information for consumers
- **Increase the coordination between the stakeholders from the upstream and the downstream agri-food chain**

ready-to-eat products, food products based on cereal-legumes mixtures, fractioning to extract ingredients
- **And eat more legumes !**



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