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Oilseed rape and pre-cropping effects from grain legumes – nitrogen fluxes and productivity

Anne Schneider, Francis Flénet, David Gouache

19/06/2019

International Rapeseed Congress 2019, Berlin

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Legumes for rapeseed – why should we care ?

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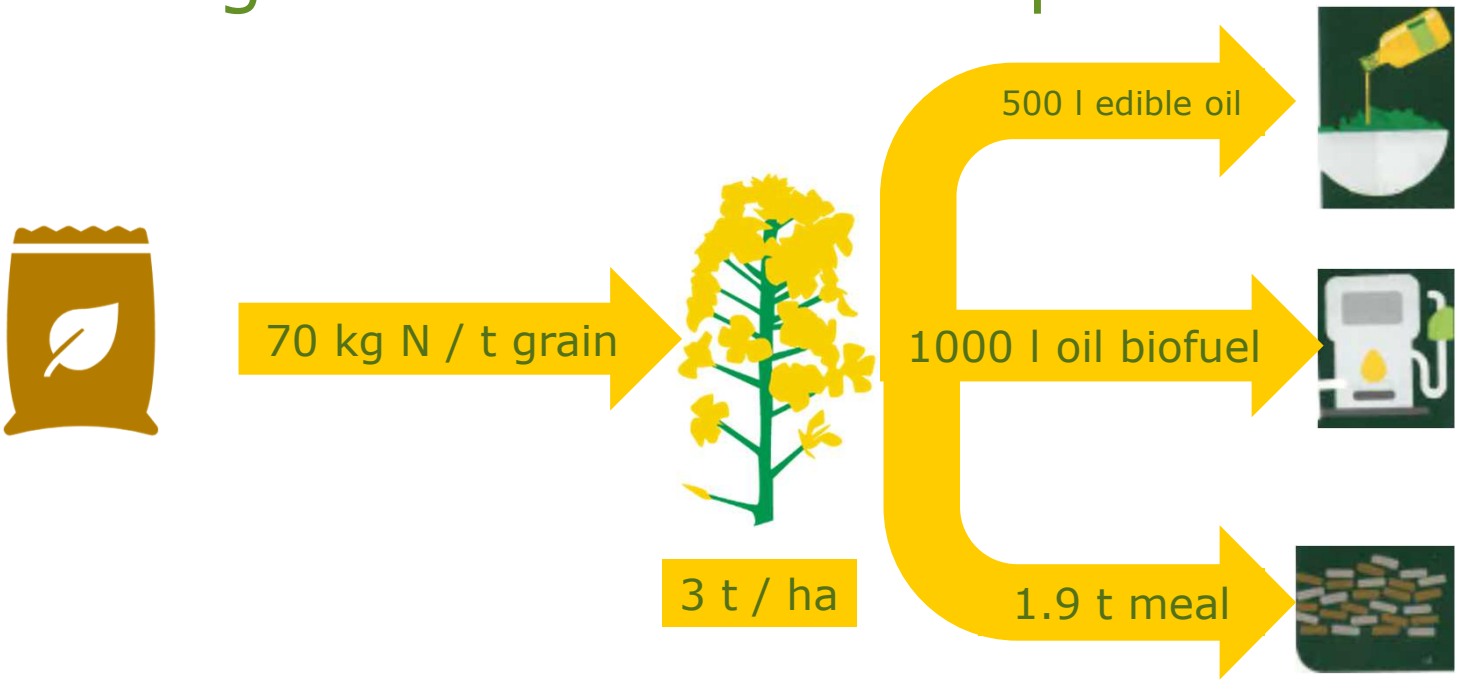
- Nitrogen : center of the rapeseed value chain



Low GHG emissions (=N) increasingly drive value

High Protein (=N) % increasingly drive value

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Legumes for rapeseed – why should we care ?

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- Legumes : major modifiers of the N cycle in arable cropping
  - Yield

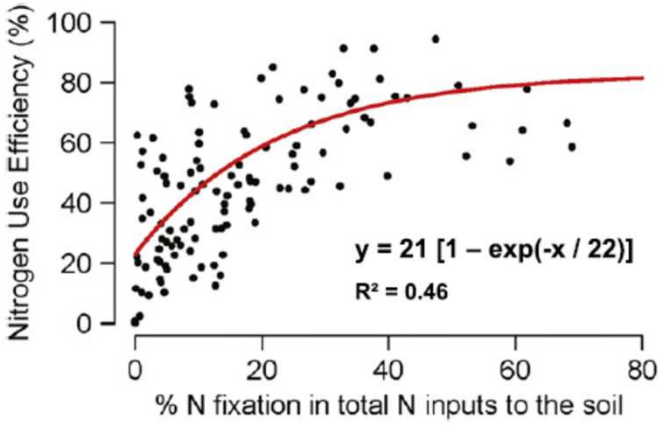
Preceding cultivation of grain legumes increases cereal yields under low nitrogen input conditions

Charles Cernay[1] · David Makowski[1] · Elise Pelzer[1]

  - Overall NUE

50 year trends in nitrogen use efficiency of world cropping systems: the relationship between yield and nitrogen input to cropland

Luis Lassaletta[1], Gilles Billen[1,2], Bruna Grizzetti[3], Juliette Anglade[1] and Josette Garnier[1,2]



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Legumes for rapeseed – why should we care ?

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- Nitrogen : center of the rapeseed value chain
- Legumes : major modifiers of the N cycle in arable cropping

→Can we make better use of legumes to improve rapeseed value (yield, margin, GHG, protein) ?

→What are legume effects (as preceding crops) on the multiple N fluxes in arable systems that impact rapeseed value ?

→What variabilities exist in legume effects on rapeseed ?

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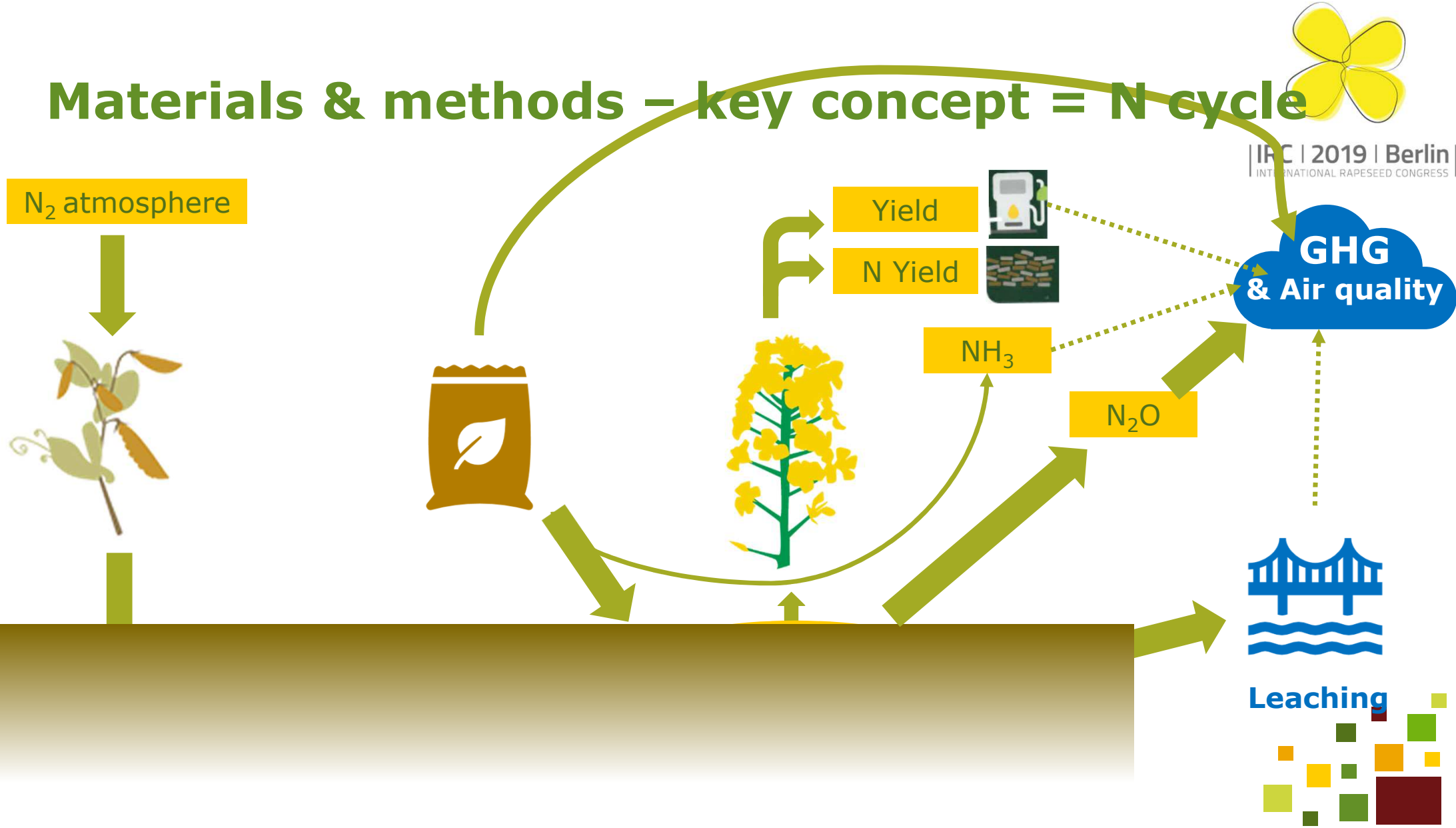
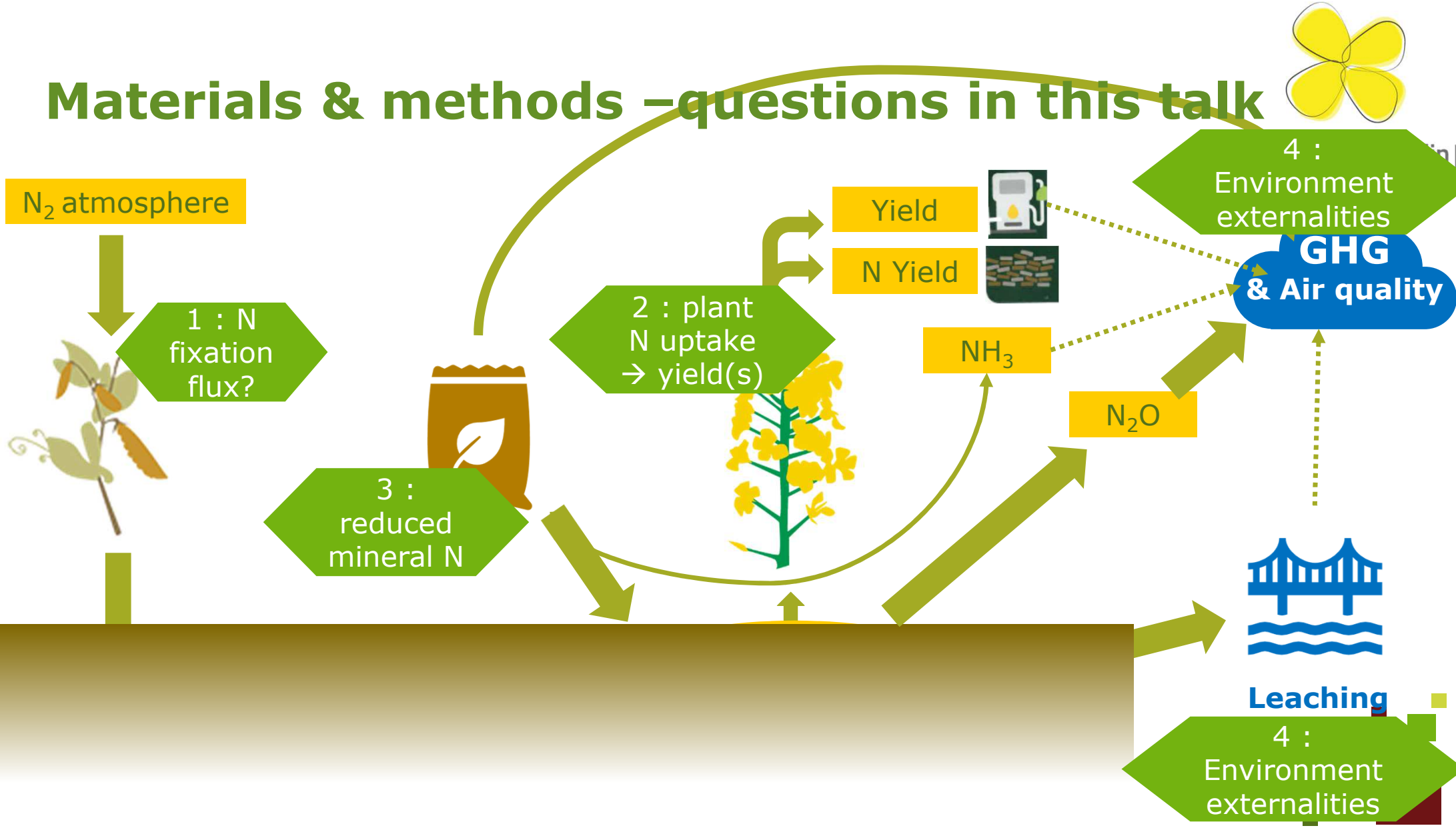
Materials & methods – key concept = N cycle



Materials & methods –questions in this talk



Materials & methods – multiple questions → multiple sources

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- Sources for more information :

Comparative effect of inorganic N on plant growth and N_2 fixation of ten legume crops: towards a better understanding of the differential response among species

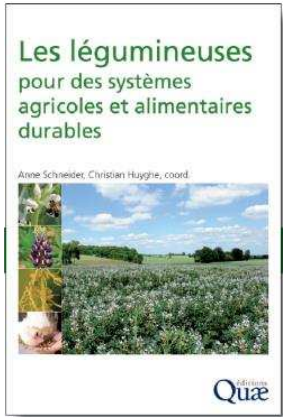
Maé Guinet · Bernard Nicolardot · Cécile Revellin · Vincent Durey · Georg Carlsson · Anne-Sophie Voisin

Congrès GEMAS-COMIFER, Lyon 18 et 19 novembre 2015

Impact de l'introduction des légumineuses dans les systèmes de culture sur les émissions de N_2O

Premiers résultats marquants du projet CASDAR LEG-N-GES

Cohan J.P.[1*], Cadillon A.[2], Dubois S.[1], Duval R.[3], Flenet F.[4], Justes E.[5], Mary B.[6], Massad R.S.[7], Plaza-Bonilla D.[5], Schneider A.[4]



Chapitre 3

Performances agronomiques et gestion des légumineuses dans les systèmes de productions végétales

Marie-Hélène Jeuffroy, Véronique Biarnès, Jean-Pierre Cohan, Guénaëlle Corre-Hellou, François Gastal, Pierre Jouffret, Eric Justes, Nathalie Landé, Gaëtan Louarn, Sylvain Plantureux, Anne Schneider, Pascal Thiébeau, Muriel Valantin-Morison, Françoise Vertès

- Specific trials : (4 reps)

Year n	**4 legume preceding crops**		**2 non-leg**	
Berry (2016, 2017)	*W Pea, W Faba, Pea+Wheat, Lentil*		*Rapeseed, Wheat*	
Grignon (2017, 2018)	*W Pea, Pea+Wheat, S Faba, W Pea*		*Rapeseed, Wheat*	
Year n+1	**Wheat**	**Rapeseed**	**Wheat**	**Rapeseed**
Berry (2017, 2018)	**0N | N1**	**0N | N2**	**0N | N1**	**0N | N2**
Grignon (2018, 2019)				

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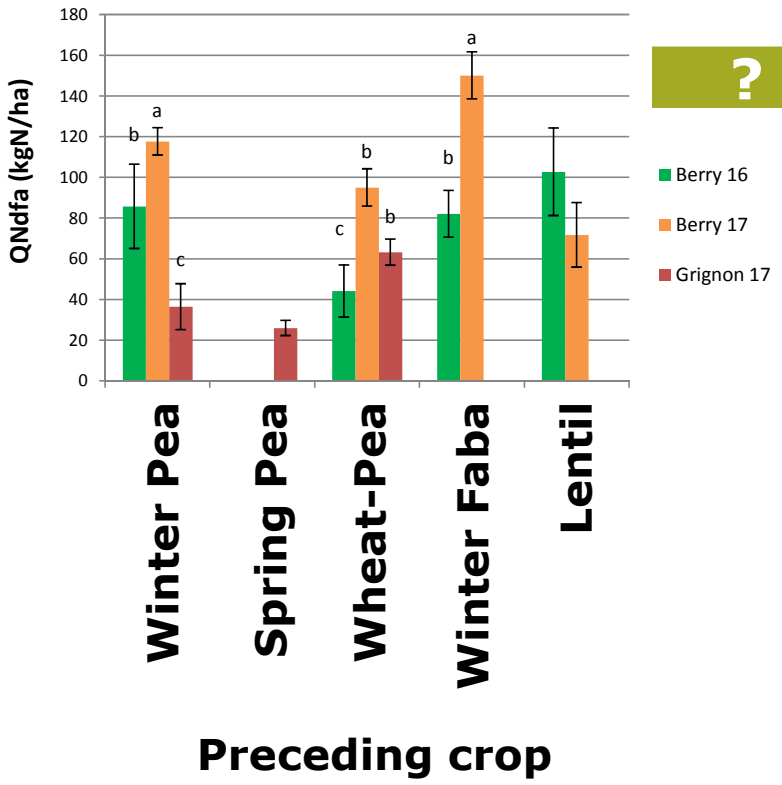
1 : N fixation variability drivers



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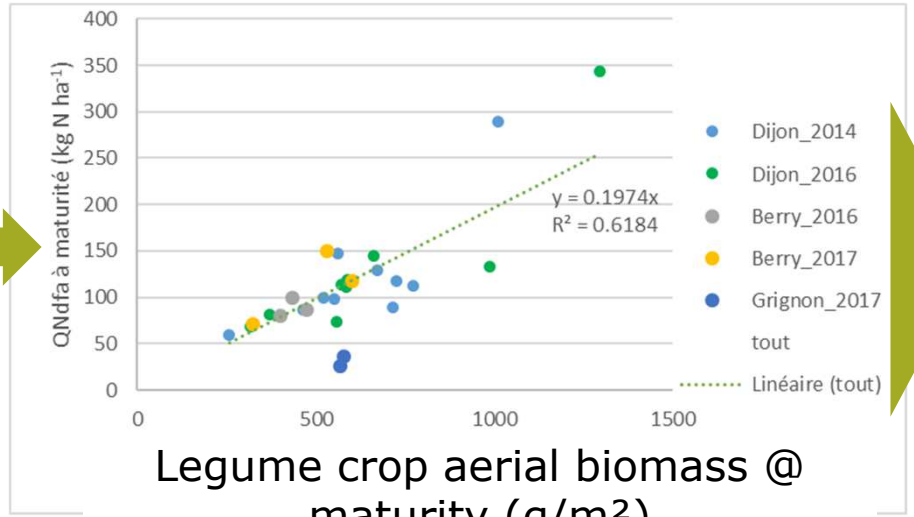
Comparative effect of inorganic N on plant growth and N_2 fixation of ten legume crops: towards a better understanding of the differential response among species

Maé Guinet · Bernard Nicolardot · Cécile Revellin · Vincent Durey · Georg Carlsson · Anne-Sophie Voisin

- ↗ Soil available N diminishes N fixation
- Interaction w/ species specific ability for N uptake (root width expansion)
- Favorable conditions for nodulation/fixation



Increased legume growth correlates to increased N fixation flux into the system

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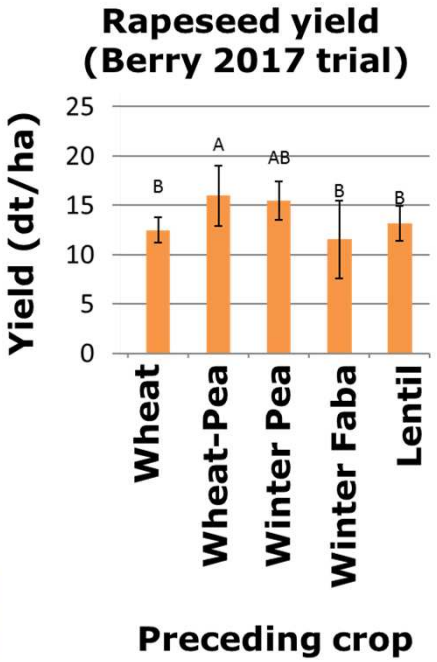
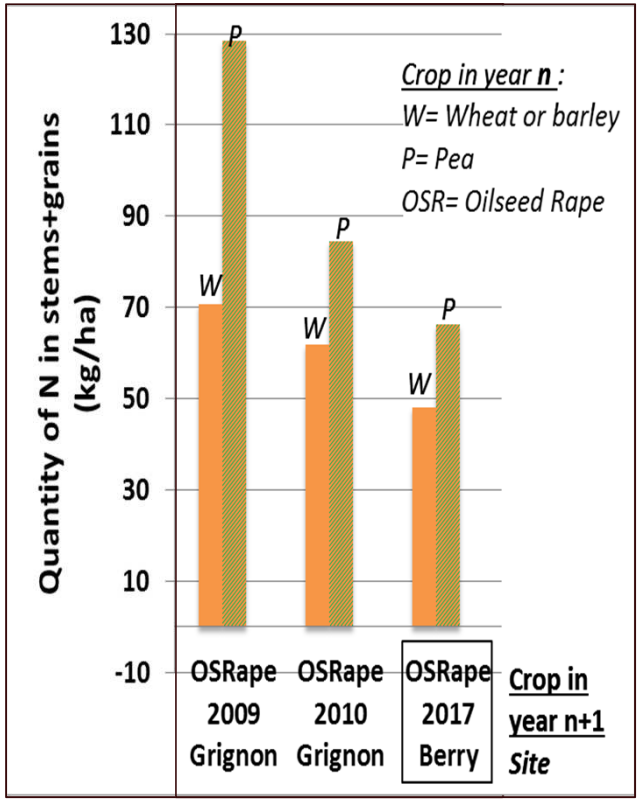
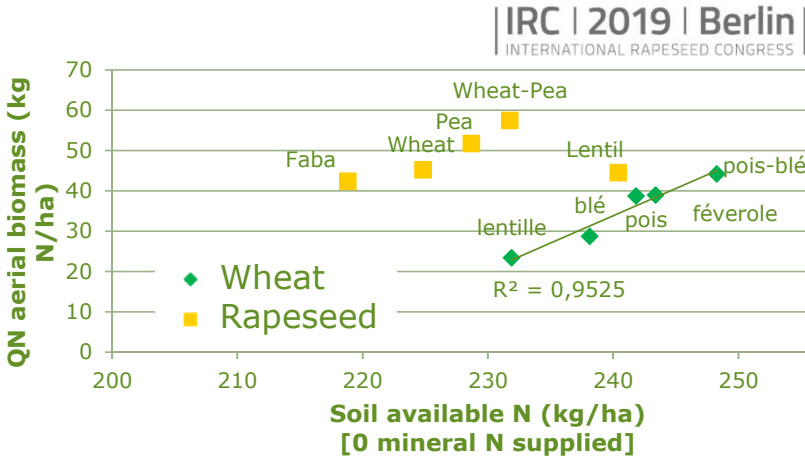
2 : Yield effects ← Rapeseed N uptake ← Soil available N

Average yield effect – pea vs cereal as preceding crop		
N0	0,41 t/ha	12 trials
Nmax	0,0 t/ha	7 trials





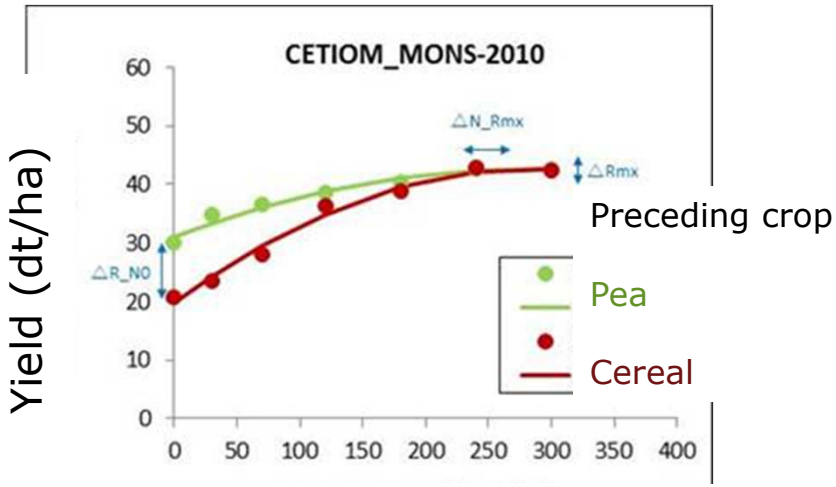
Jeuffroy et al. 2015



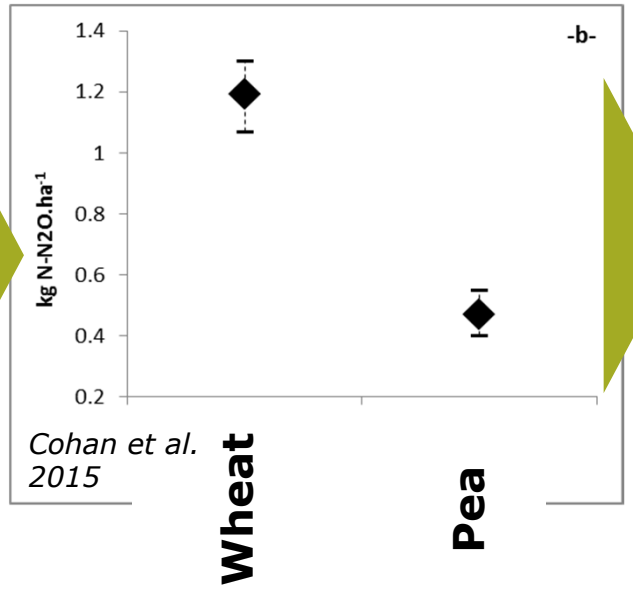
Succesful legume crop → Strong soil available N → Improved rapeseed N uptake

Question : improved N uptake > improved N availability in some cases – how ? why ? Yet to be elucidated

3 : mineral N requirements



Preceding crop



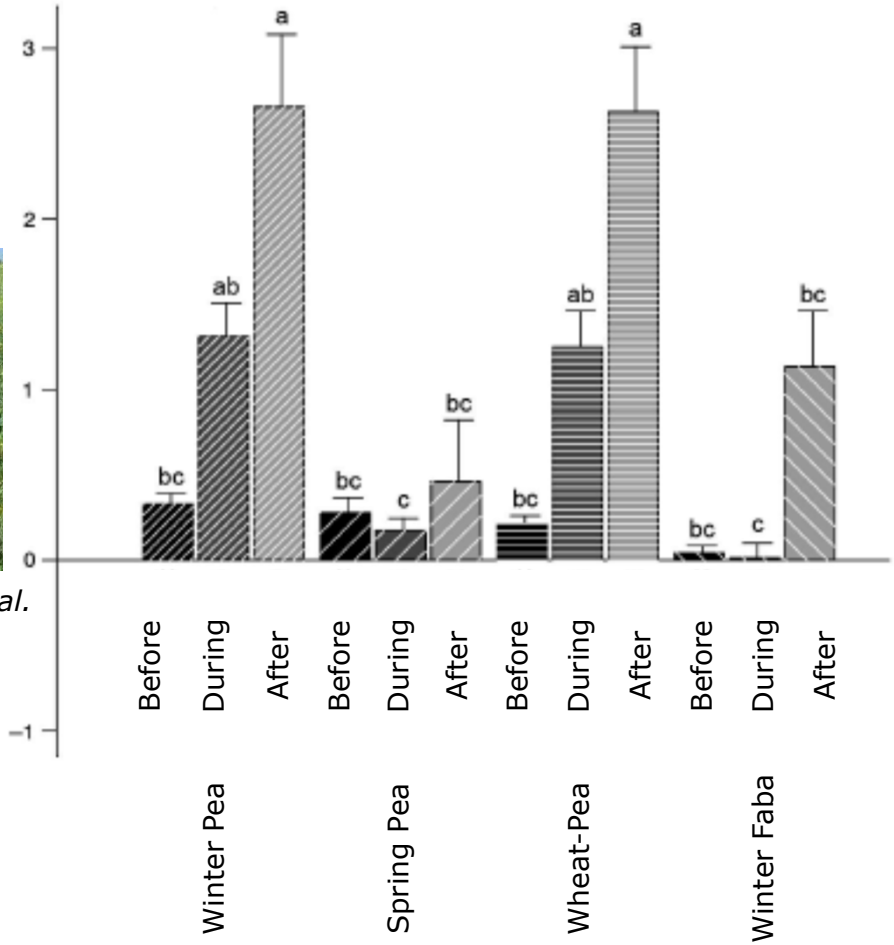
GHG (g eq. CO2 / MJ) of rapeseed biodisel vs. diesel	
Average rapeseed	- 52 %
Rapeseed following pea	- 60 %

7 trials / 3 years :
- 30 - -60 kg N/ha required

13 trials: Tier 1 IPCC calculations for N_2O effects
Lower mineral N requirement
→ lower N_2O emissions

4 : N losses & externalities of legume cultivation

Jeuffroy et al. 2015



Pea = unfertilized wheat in terms of N_2O emissions

2017 & 2018 (Berry) : direct N_2O emissions of rapeseed not influenced by preceding crop (data not shown)

Benefits of lower mineral N requirements following pea fully translate into GHG reductions at the crop scale

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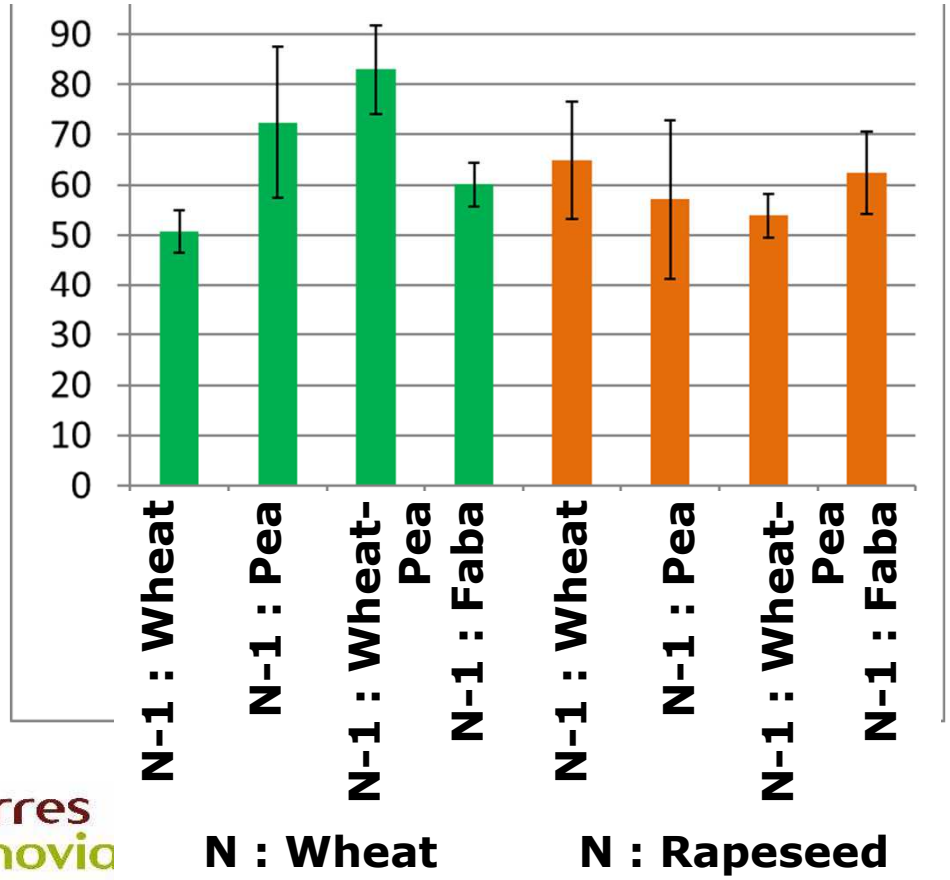
4 : N losses & externalities of legume cultivation

Berry N=2017 :
Residual soil N (kg N/ha) @ entry of winter N = leaching risk



Rapeseed high & early N uptake ability → no increase in nitrate leaching risk following legume

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Discussion – legumes & rapeseed, from knowledge to action

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- Legumes : benefits all around !
- Are we benefiting from them ? … Not like we should
  - Terres Inovia grower survey : 2% legumes as preceding crop
    - Legume performance is the key for benefits to rapeseed, and to the grower
      - Theoretically OK for high yield potential areas

      → still much to be done for yield potential & protection
    - Legume as companion crop (12% of French rapeseed) offers another option (https://www.terresinovia.fr/p/colza-associe-a-un-couvert-de-legumineuses-gelives-point-technique), especially in low legume yield potential regions
  - Terres Inovia grower survey : adapting N dose to crop conditions via balance sheet still under-utilized → 30 kg N/ha not saved as could be
    - Incorporate better knowledge of legume preceding effects on N supply to rapeseed in DSS
      - Multiple sources of information from French & international trials : from cherry-picking to meta-analysis
    - Improve actual use of DSS
      - 27% use via remote sensing / image analysis
      - 38 % manual biomass

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Réglette azote colza

Thanks… for your attention, & to :

- Terres Inovia colleagues

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  Maé Guinet, Anne-Sophie Voisin (INRA Agroécologie)
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LEG'TIMES
LEGume Insertion in Territories to Induce Main Ecosystem Services

ALTER'N

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