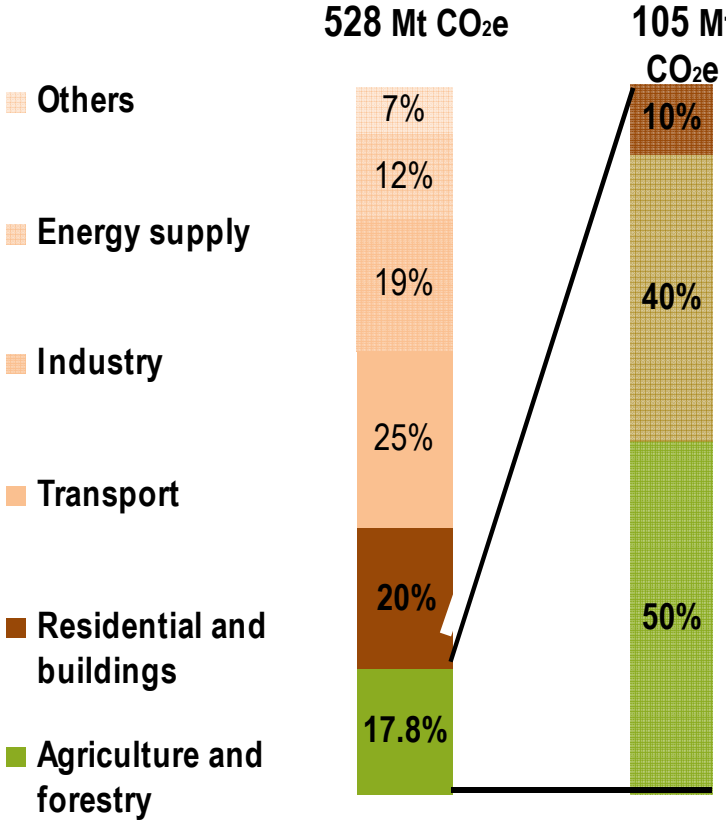
How can French agriculture contribute to reducing greenhouse gas emissions?

Abatement potential and cost of 10 technical measures

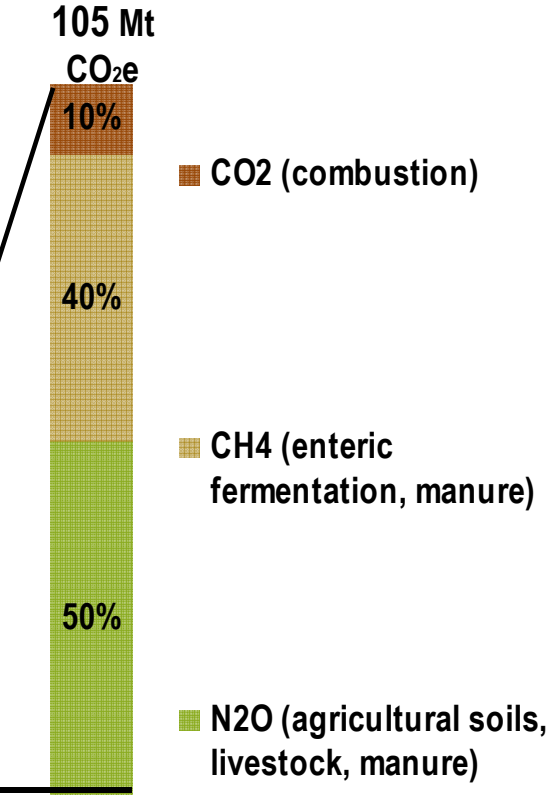
Sylvain Pellerin

In France, agriculture accounts for ≈ 18% of GHG emissions

Share of different sectors in GHG emissions in France

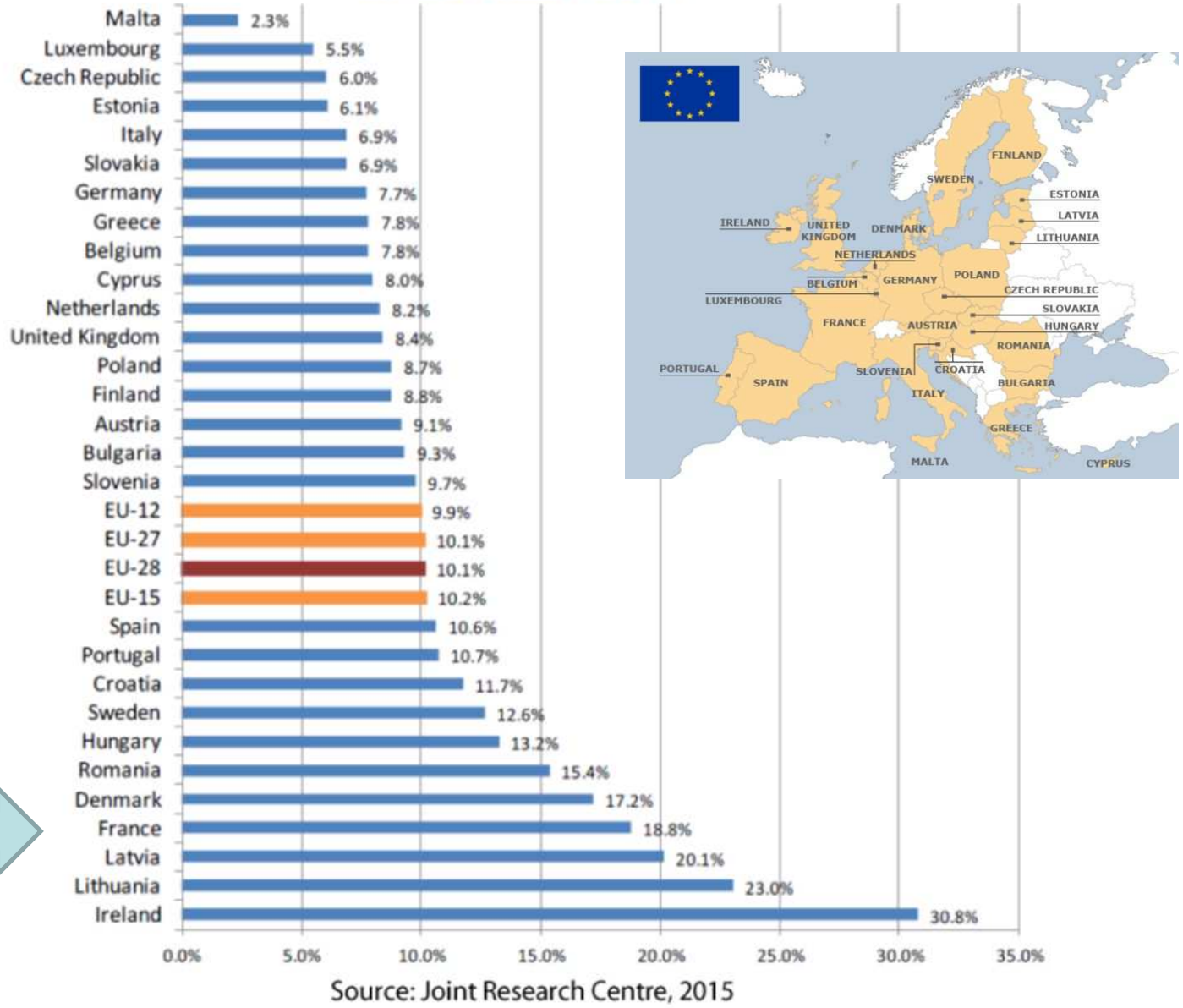


Share of different GHGs in agricultural emissions



CITEPA, 2012

Figure 2: Share of agricultural greenhouse gas emissions in total national emissions in EU Member States (2011)



Source: Joint Research Centre, 2015

France

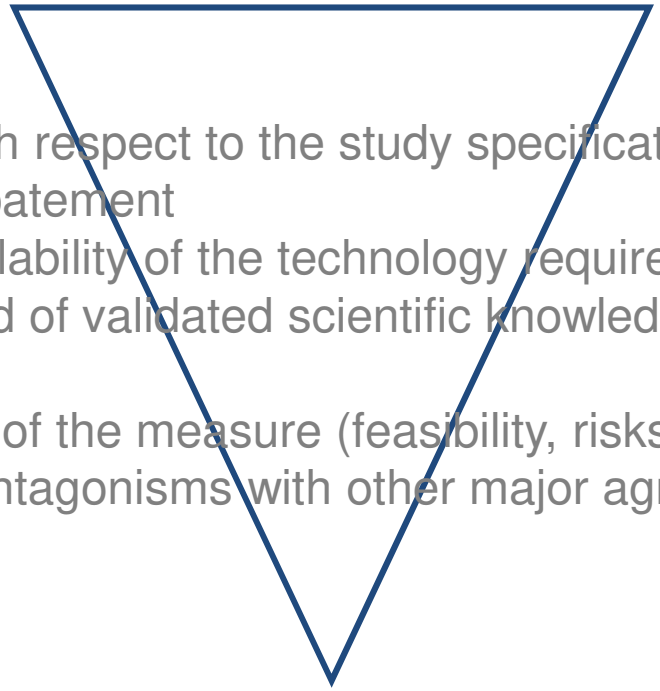
Aims

- Select 10 technical measures
  - that could reduce net GHG emissions from the agricultural sector or increase C storage in soils or biomass,
  - related to agricultural practices (e.g. fertilisation, tillage, animal feeding,…),
  - Targeting on-farm emissions,
  - involving no major change to the production systems, and no major yield reductions (<10%)
- Quantify their mitigation potential and estimate their cost over the 2010-2030 period

Selection process

± 100 measures from international literature

Five Criteria



- Eligibility with respect to the study specifications
- Expected abatement
- Current availability of the technology required to implement the measure and of validated scientific knowledge establishing its efficacy
- Applicability of the measure (feasibility, risks, social acceptability)
- Synergies/antagonisms with other major agricultural objectives

4 main levers, 10 measures, 26 sub-measures

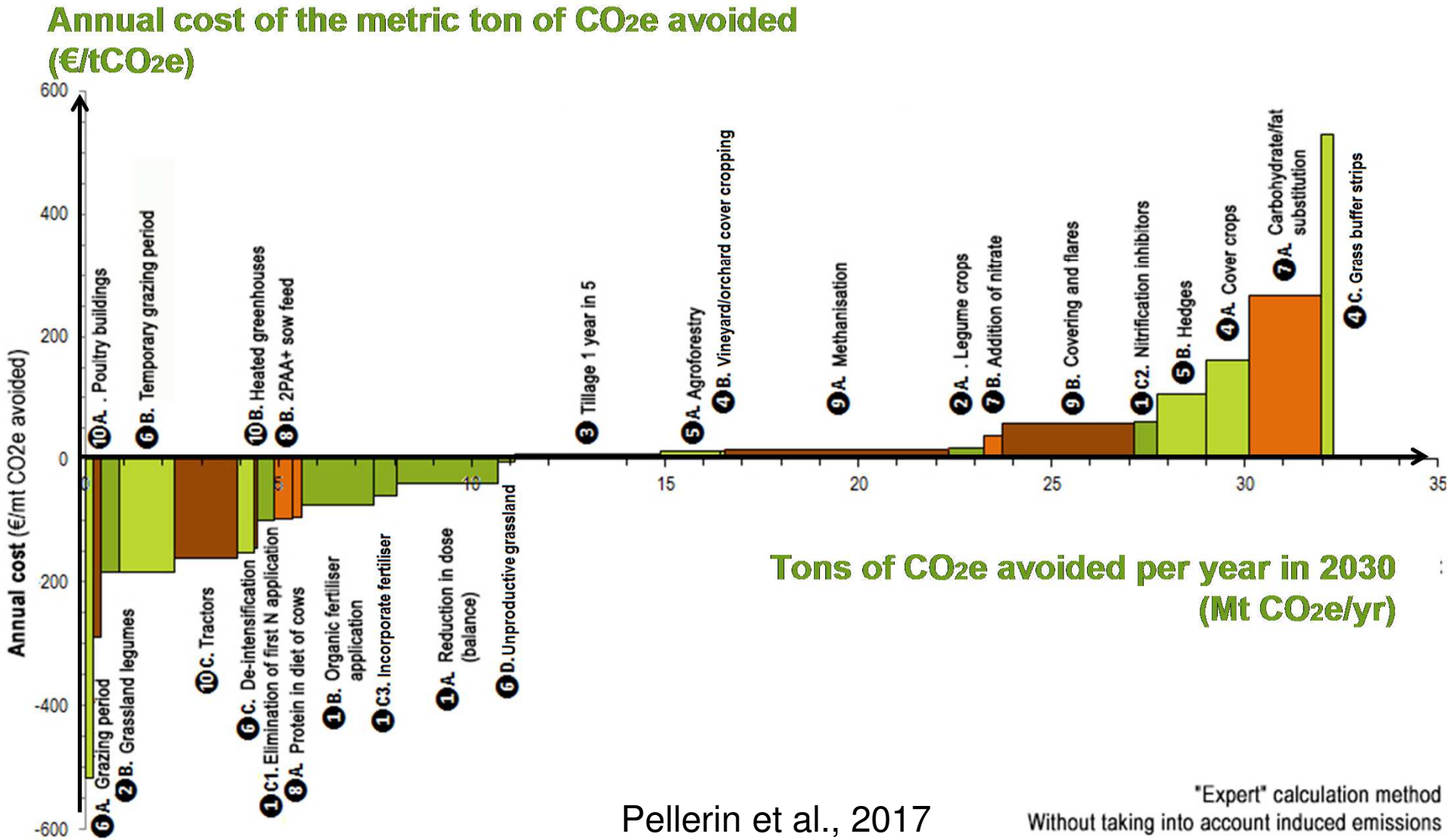
	List of selected measures	Effect(s)
Reduce the application of mineral nitrogen fertilisers in order to reduce the associated N_2O emissions		
❶	Reduce the use of synthetic mineral fertilisers, through their more effective use and making greater use of organic resources	↓ N_2O
❷	Increase the use of legumes to reduce the use of synthetic nitrogen fertilisers	↓ N_2O
Store carbon in soil and biomass		
❸	Develop no-till cropping systems to store carbon in soils	↓ CO_2
❹	Introduce more cover crops, intercropping and green cover strips in cropping systems	↓ CO_2 ↓ N_2O
❺	Develop agroforestry and hedges to promote carbon storage in soil and plant biomass	↓ CO_2
❻	Optimise grassland management to promote carbon storage	↓ CO_2 ↓ N_2O
Modify the animal diet to reduce enteric CH_4 emissions and N_2O emissions related to manure		
❼	Replace carbohydrates with unsaturated fats and use additives in the diet of ruminants to reduce enteric CH_4 emissions	↓ CH_4
❽	Reduce the amount of protein in the livestock diet to limit the quantity of nitrogen excreted in manure and the associated N_2O emissions	↓ N_2O
Recycle manure to produce energy and reduce fossil fuel consumption to reduce CH_4 and CO_2 emissions		
❾	Develop methanisation and install flares to reduce CH_4 emissions related to livestock manure storage	↓ CH_4
❿	Reduce fossil fuel consumption of agricultural buildings and machinery on the farm to limit CO_2 emissions	↓ CO_2

	Measures	Effect(s)
	Reduce the application of mineral nitrogen fertilisers in order to reduce the associated N_2O emissions	
❶	**Reduce the use of synthetic mineral fertilisers, through their more effective use and making greater use of organic resources**	↓ N_2O

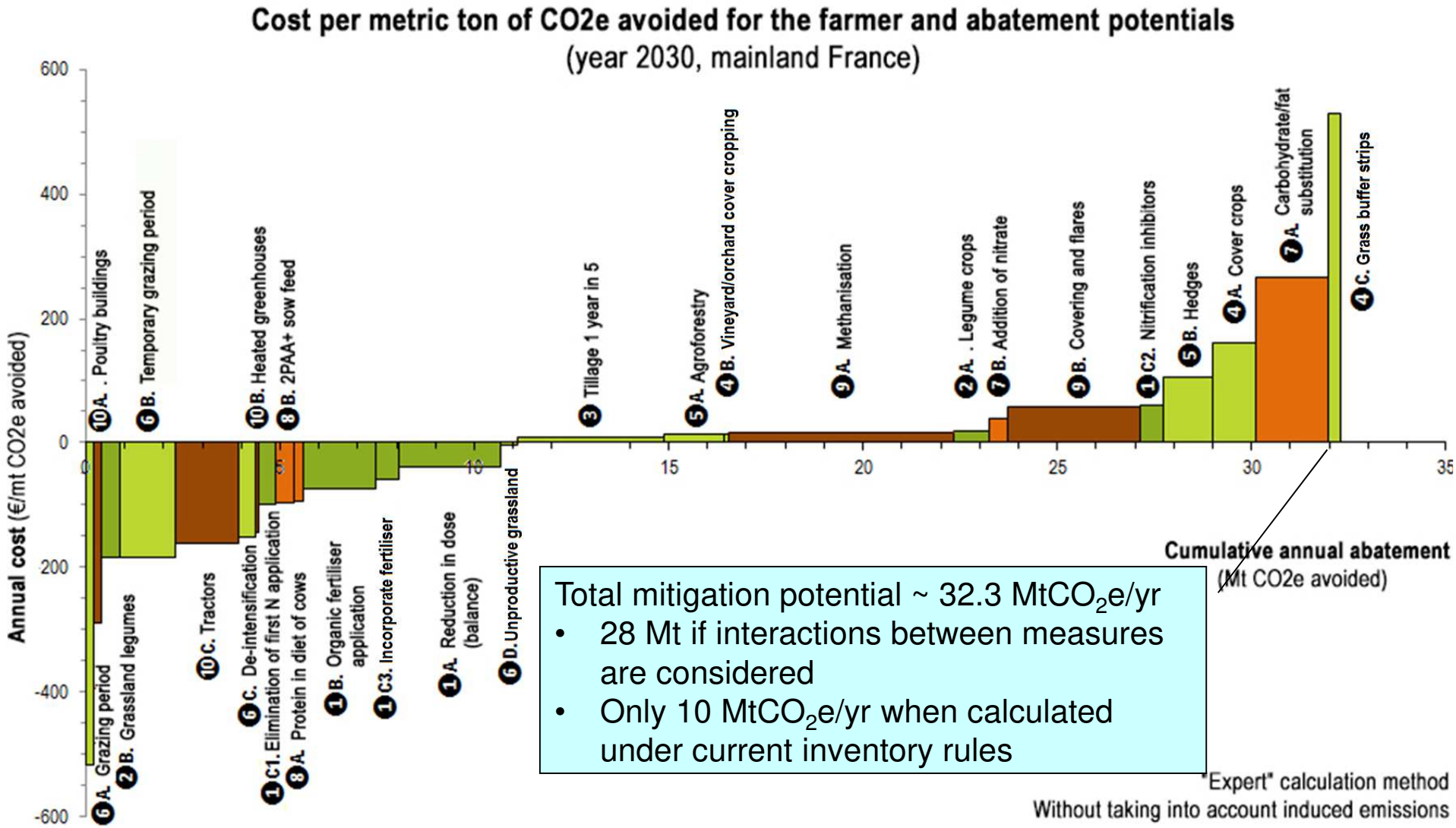
Measures and sub-measures

		Effect(s)
	Reduce the application of mineral nitrogen fertilisers in order to reduce the associated N_2O emissions	
❶	**Reduce the use of synthetic mineral fertilisers, through their more effective use and making greater use of organic resources:** **1A.** Adjust fertiliser application rates to more realistic yield targets **1B.** Make better use of organic fertiliser **1C.** Adjust application dates to crop requirements **1D.** Add a nitrification inhibitor **1E.** Incorporate fertiliser	↓ N_2O

26 proposed technical sub-measures



Pellerin et al., 2017

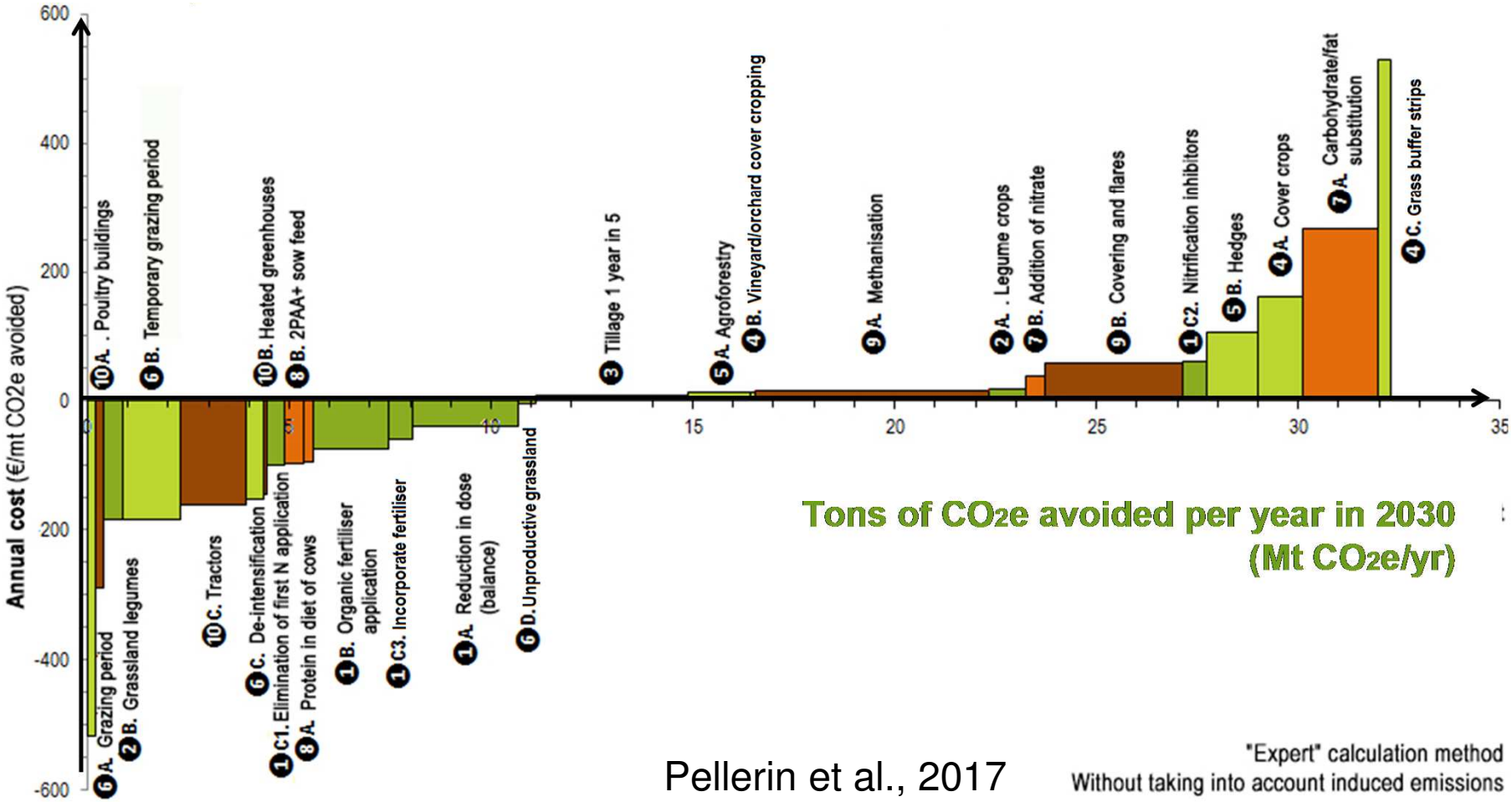


Pellerin et al., 2017

Increase in input-use efficiency (N, energy)
►negative cost, win-win measures

Require investments and/or changes in practices
Possible additional income
►moderate cost (<€25/MtCO$_2$e)

Require investments and/or changes in practices
No additional income
►high cost (>€25/MtCO$_2$e)

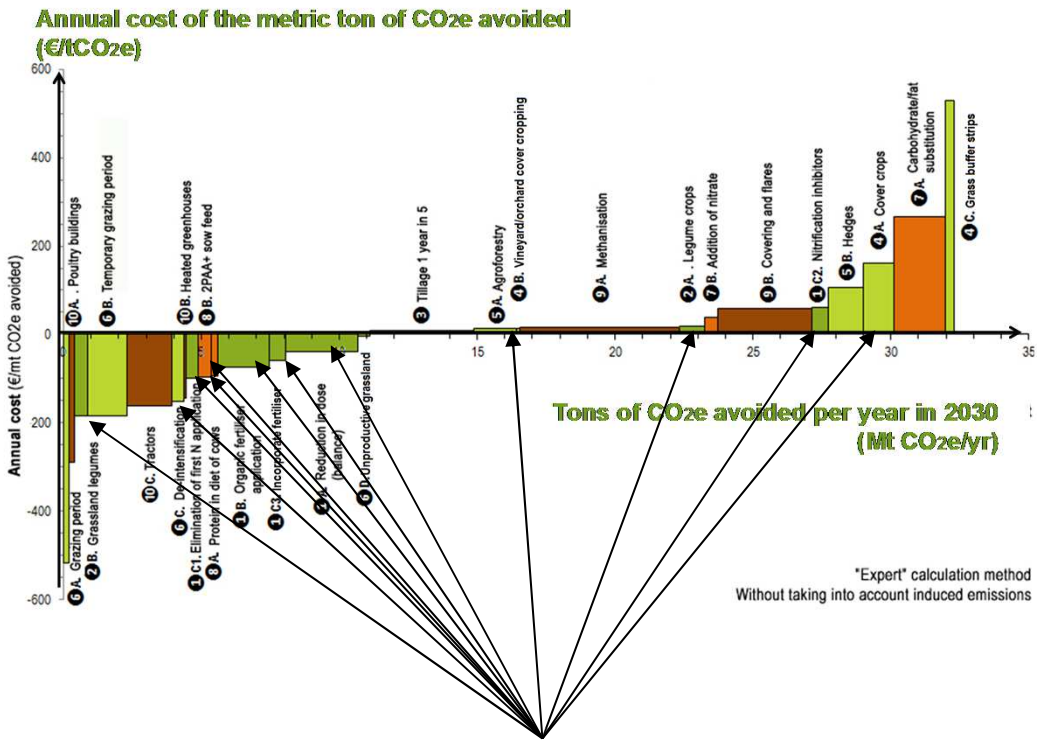


Pellerin et al., 2017

"Expert" calculation method
Without taking into account induced emissions

Among the 26 sub-measures, 12 are related to N management → N fertilisation, legumes, N content in animal diets,…

- They represent 28% of the total abatement potential
- Eight of these 12 sub-measures belong to the "win-win" group
- The weighted average cost is
  - -54.5€/tCO_2e for N-related sub-measures
  - +5.1 €/tCO_2e for all measures
- Most of the abatement is accounted for in inventories
- A better N management has positive co-effects (water quality, air quality,…)

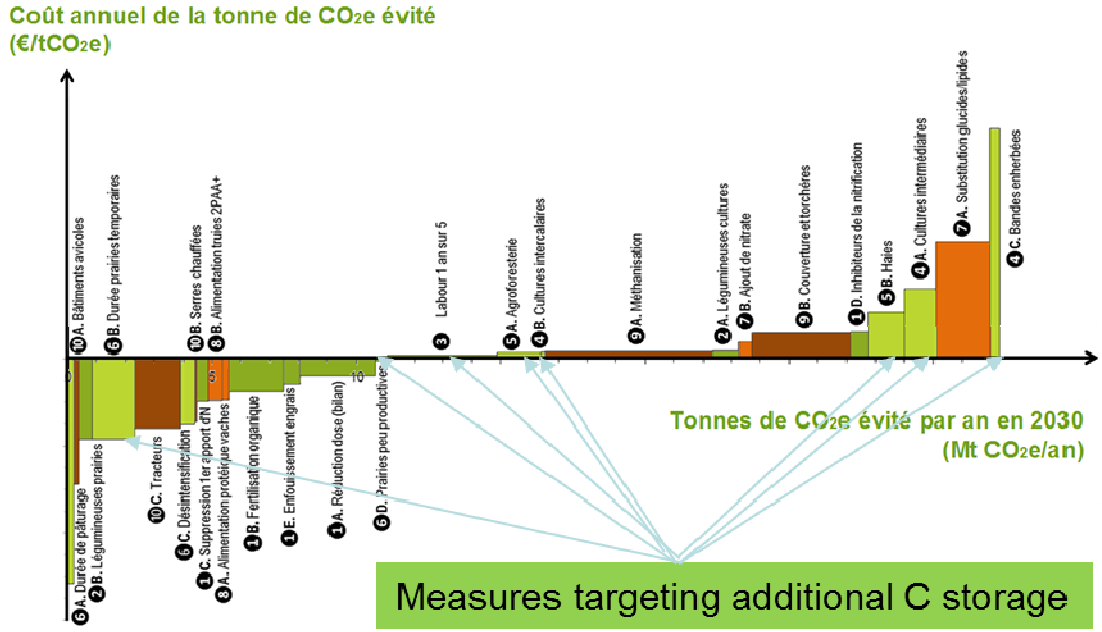


Measures targeting a reduction of N_2O emissions

What are the barriers (risk aversion, knowledge gap,...)? Which incentives?

Eight sub-measures target additional C storage in soils and biomass→ reduced tillage, cover crops, agroforestry, hedges,…

- 31% of the total abatement potential
- Low or high cost
- Many co-benefits (soil fertility, biodiversity, reduction of erosion risk,…)
- Very poorly accounted for in national inventories

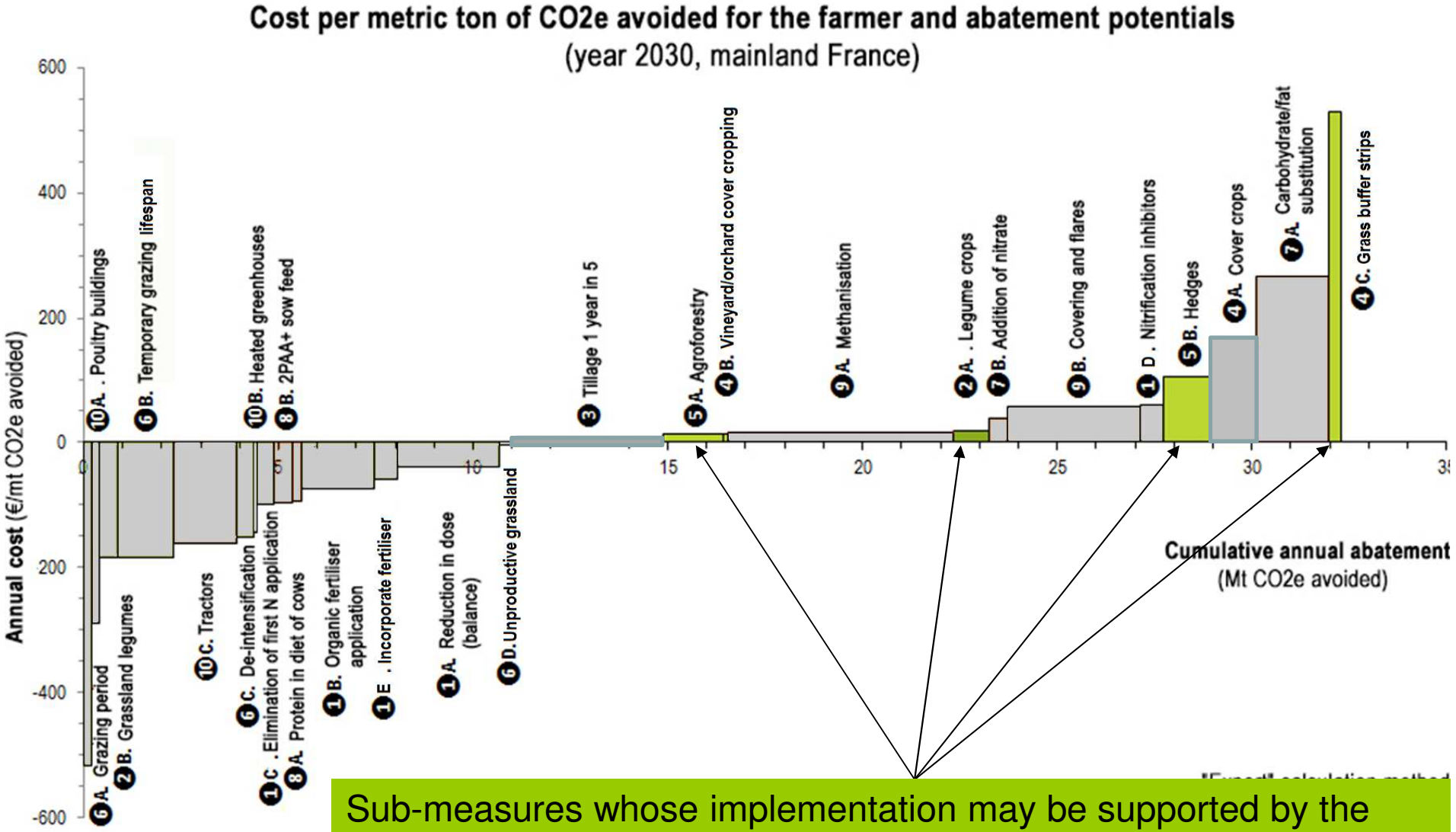


→ **4 per mille initiative**
→ **A urgent need for upgrading the national emission inventory system**

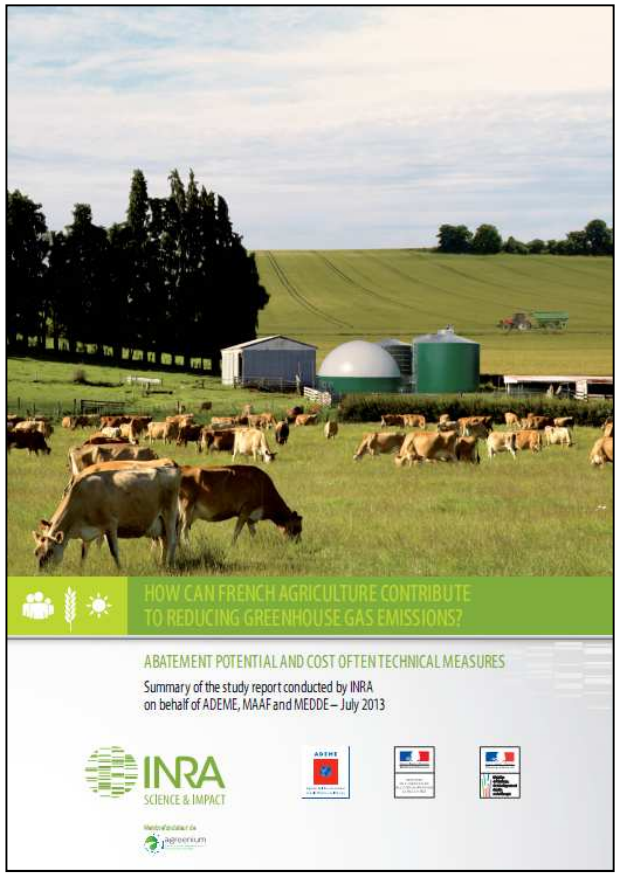
Correpondance between the green payment measures of the CAP and the selected measures to mitigate GHG emissions in the French study

MEASURES	Permanent grassland	Crop diversif.	Ecological focus area
Reduce the use of synthetic mineral fertilisers			
Increase the proportion of leguminous crops on arable land and temporary grassland		**X** (croplands)	**X** (croplands)
Develop no-till cropping systems			
Introduce more cover crops, vineyard/orchard cover cropping and grass buffer strips in cropping systems			**X** (grass buffer strips)
Develop agroforestry and hedges			**X**
Optimise grassland management	**(X)**		
Replace carbohydrates with unsaturated fats and use an additive in the diet of ruminants			
Reduce the amount of protein in the diet of livestock			
Develop methanisation and install flares			
Reduce the fossil fuel consumption of agricultural buildings and machinery			

Correpondance between the green payment measures of the CAP and the selected measures to mitigate GHG emissions in the French study



Sub-measures whose implementation may be supported by the greening measures → about 12% of the total abatement potential



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Identifying cost-competitive greenhouse gas mitigation potential of French agriculture

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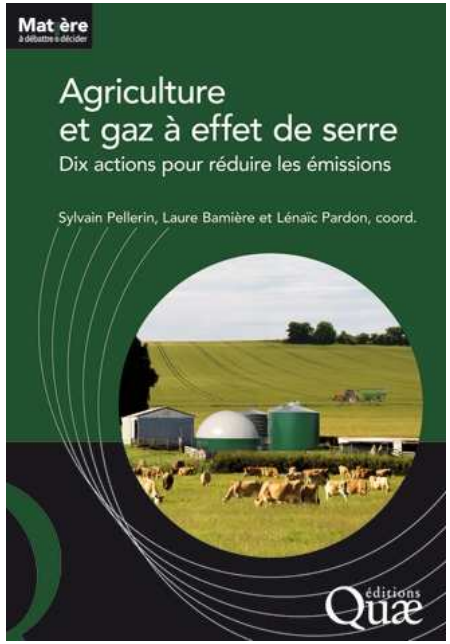

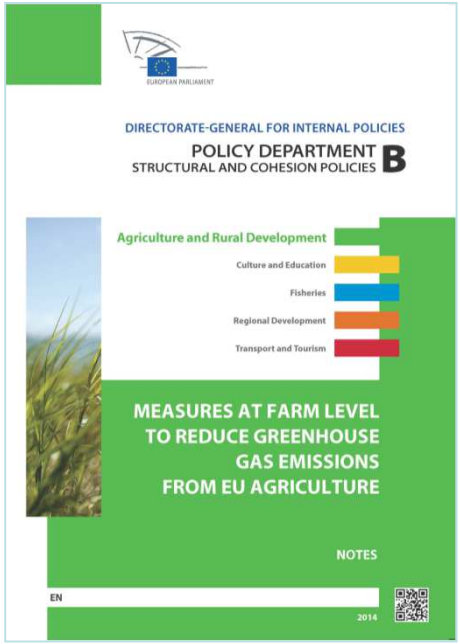

Thank you for your attention!

Pellerin S., Bamière L., Angers D., Béline F., Benoit M., Butault J.P., Chenu C., Colnenne-david C., De Cara S., Delame N., Doreau M., Dupraz P., Faverdin P., Garcia-launay F., Hassouna M., Hénault C., Jeuffroy M.H., Klumpp K., Metay A., Moran D., Recous S., Samson E., Savini I., Pardon L., Chemineau P., 2017. Identifying cost-competitive greenhouse gas mitigation potential of french agriculture. Environmental Science And Policy 77, 130-139.