How can french agriculture contribute to reducing greenhouse gas emissions? Abatement potential and cost of technical measures

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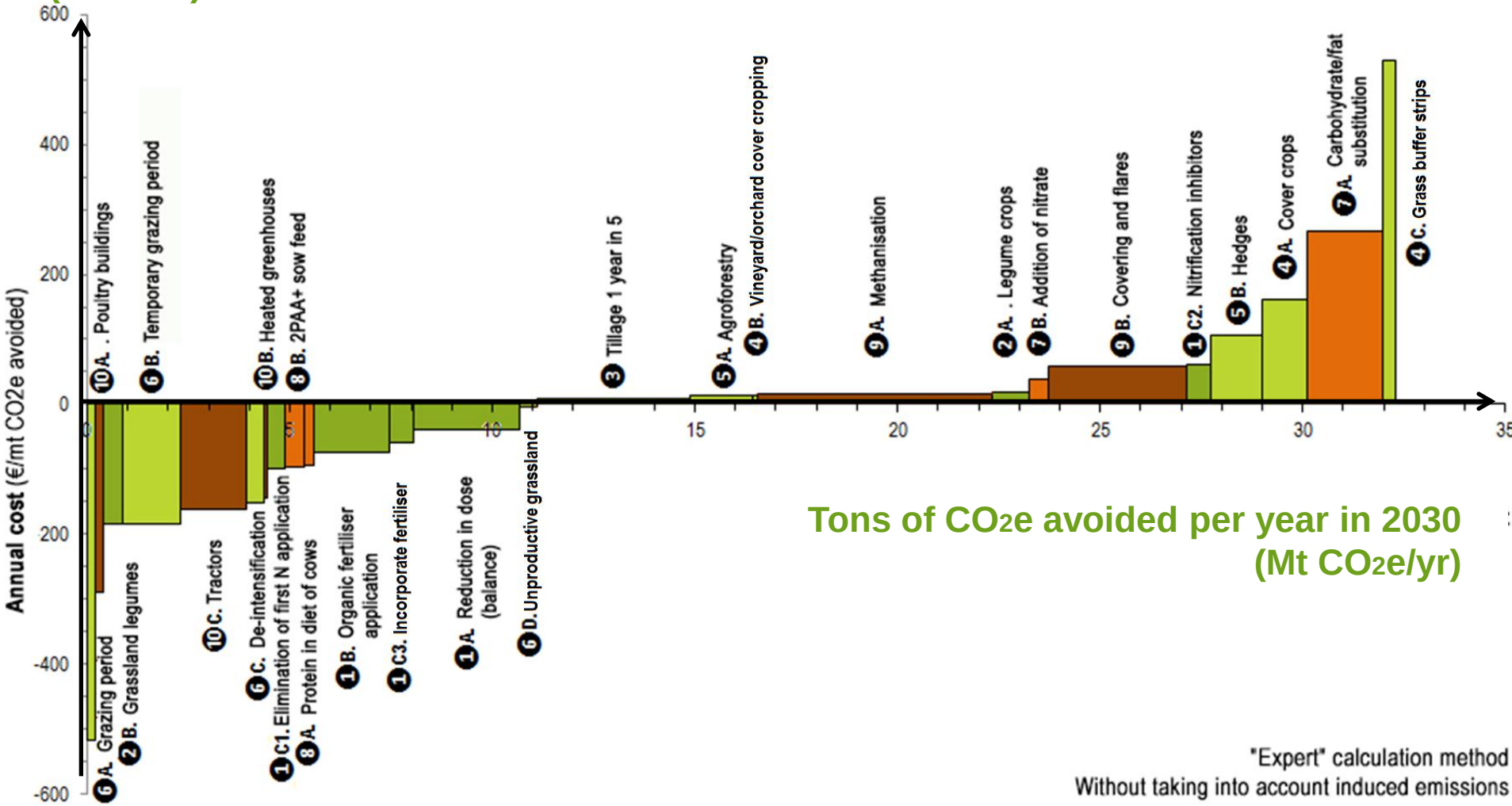
INRA SCIENCE & IMPACT

European Commission

Annual cost of the metric ton of CO_2e avoided (€/tCO_2e)



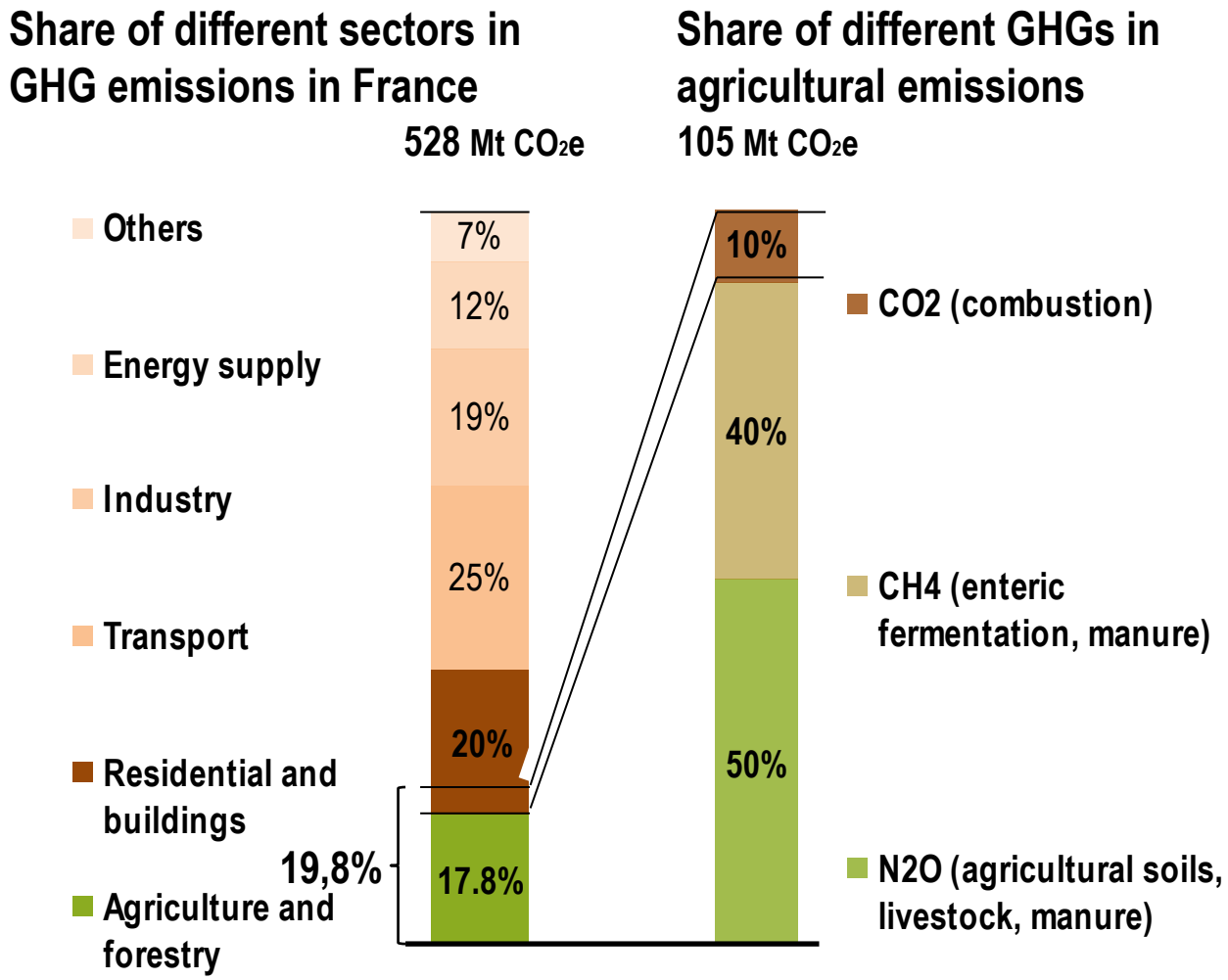
Tons of CO_2e avoided per year in 2030 (Mt CO_2e/yr)

"Expert" calculation method
Without taking into account induced emissions

Outline

- Greenhouse gases emissions from the agricultural sector in France
- Aims of the study
- Methods
    - Selection criteria
    - Proposed measures and sub-measures
    - Calculations of abatement potential and cost
- Results
    - Compared abatement potential and costs of the proposed measures
- Conclusion

GHG emissions in France



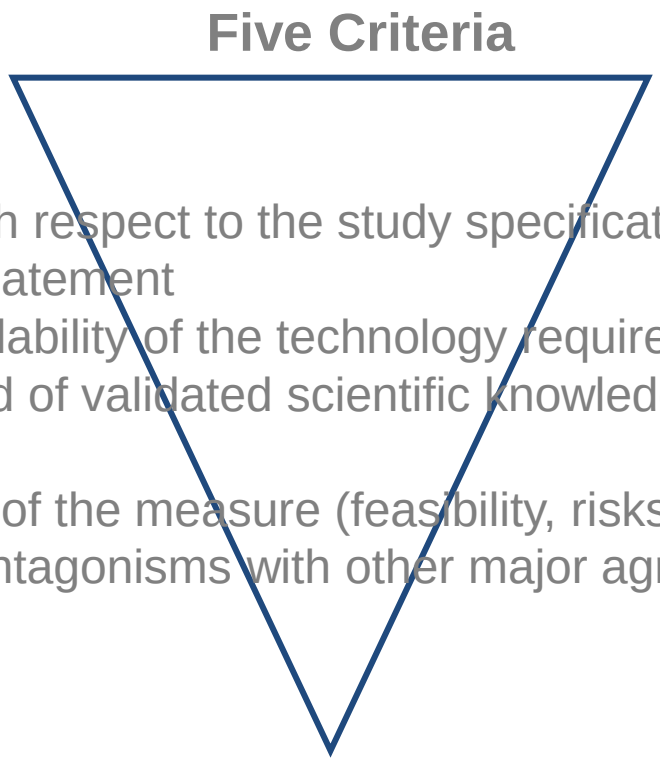
CITEPA, 2012

Aims

- Select 10 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,…),
  - 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

Methodology : Selection process

± 100 measures from international literature



- 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

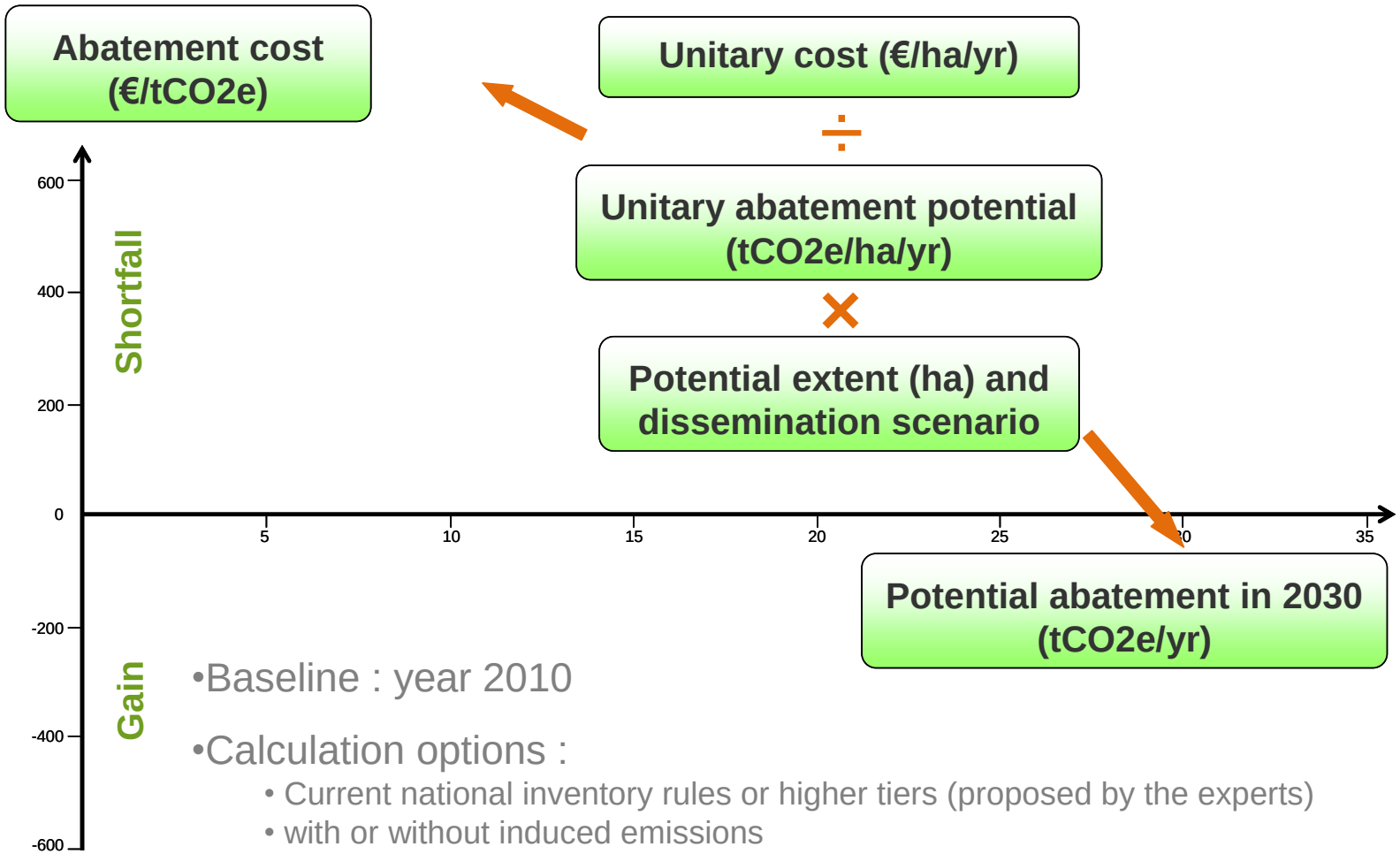
	List of selected measures	Effect(s)
Reduce the application of mineral nitrogen fertilisers in order to reduce the associated N_2O emissions		
❶	Reduce the use of synthetic mineral fertilisers, through their more effective use and making greater use of organic resources	↓ N_2O
❷	Increase the use of legumes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

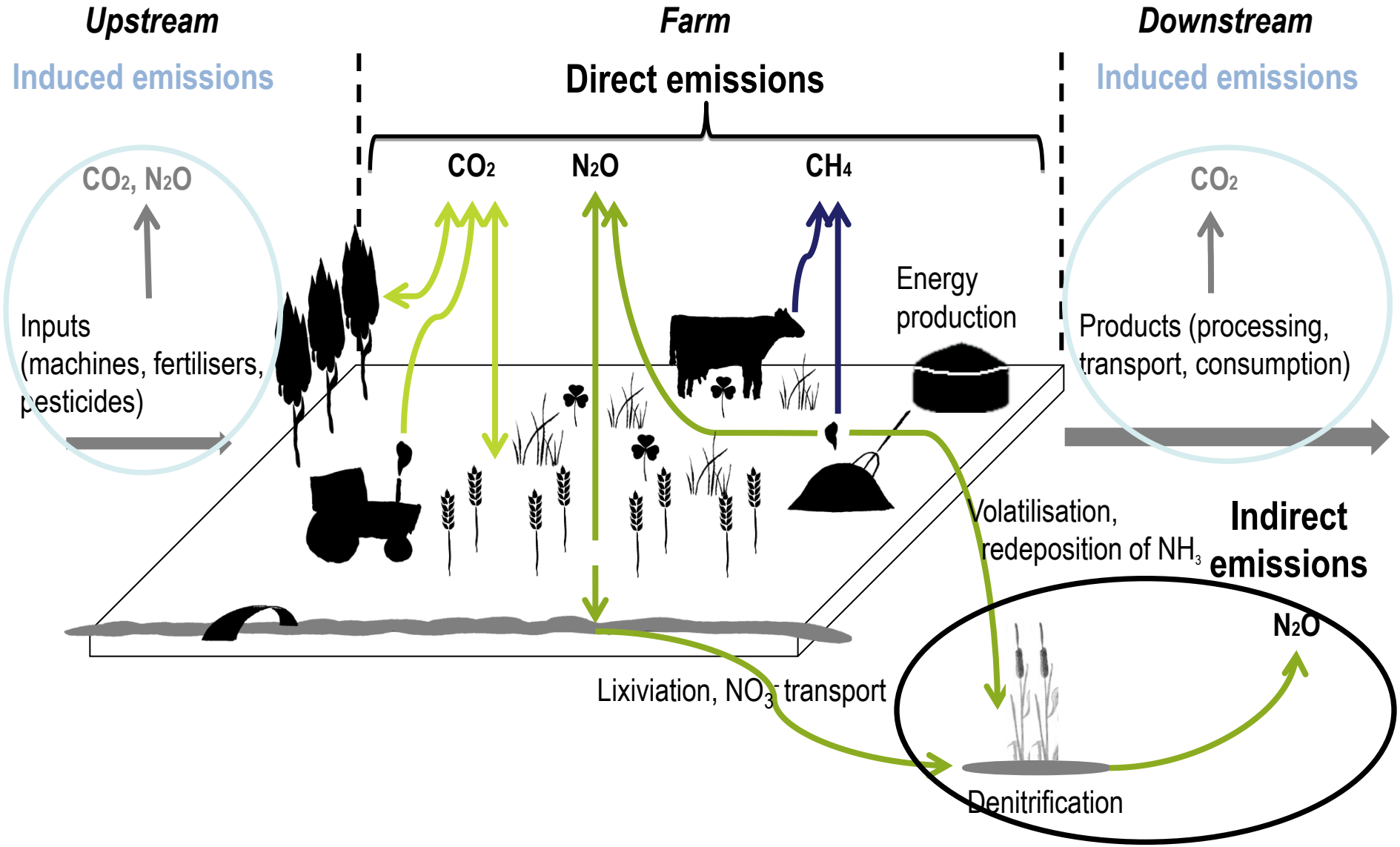
		Effect(s)
	Reduce the application of mineral nitrogen fertilisers in order to reduce the associated N_2O emissions	
❶	**Reduce the use of synthetic mineral fertilisers, through their more effective use and making greater use of organic resources:** **1A.** Adjust fertiliser application rates to more 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

Methodology : calculations



- Baseline : year 2010
- Calculation options :
  - Current national inventory rules or higher tiers (proposed by the experts)
  - with or without induced emissions
  - with or without state subsidies

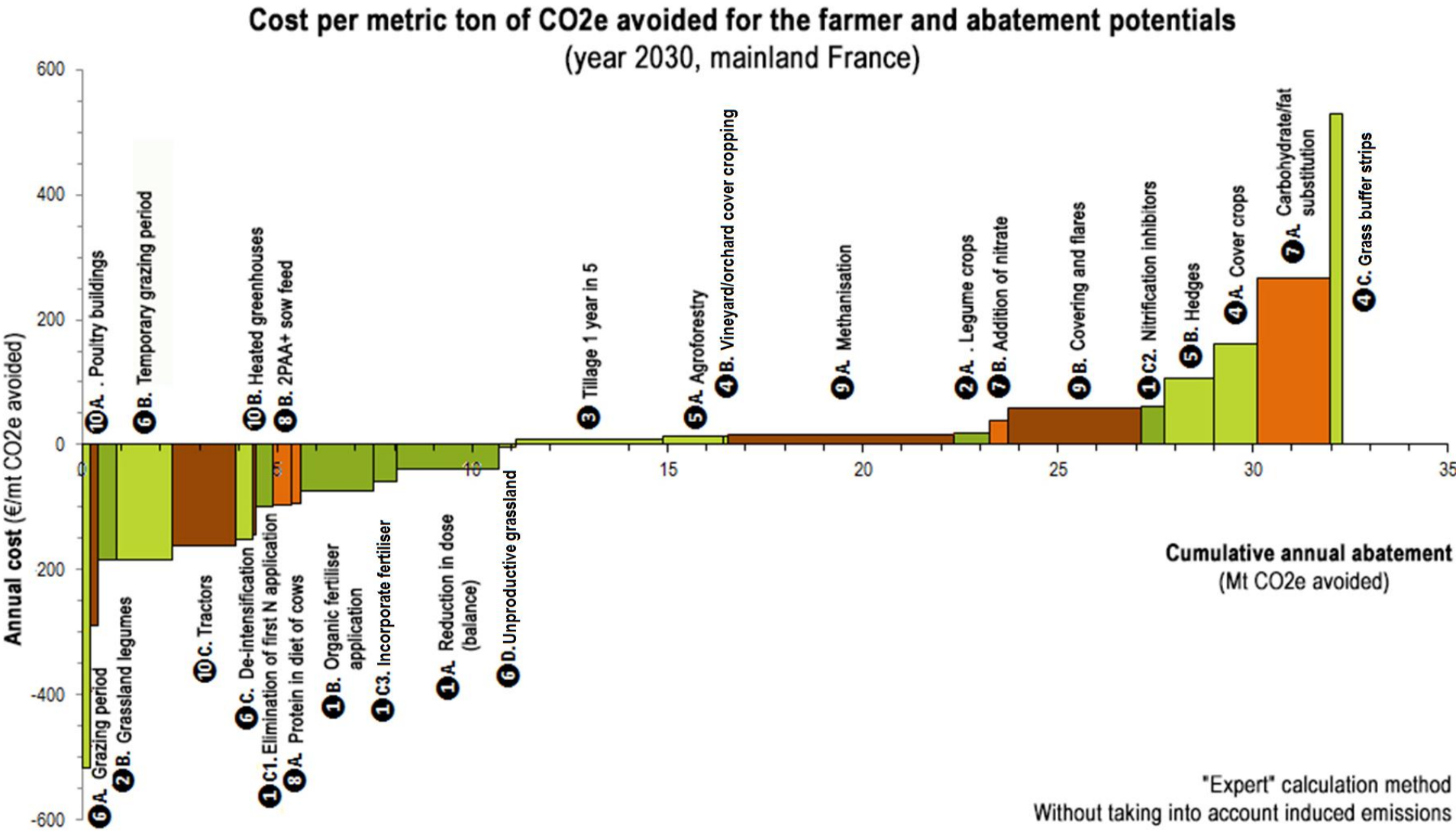
Calculation of the unitary abatement

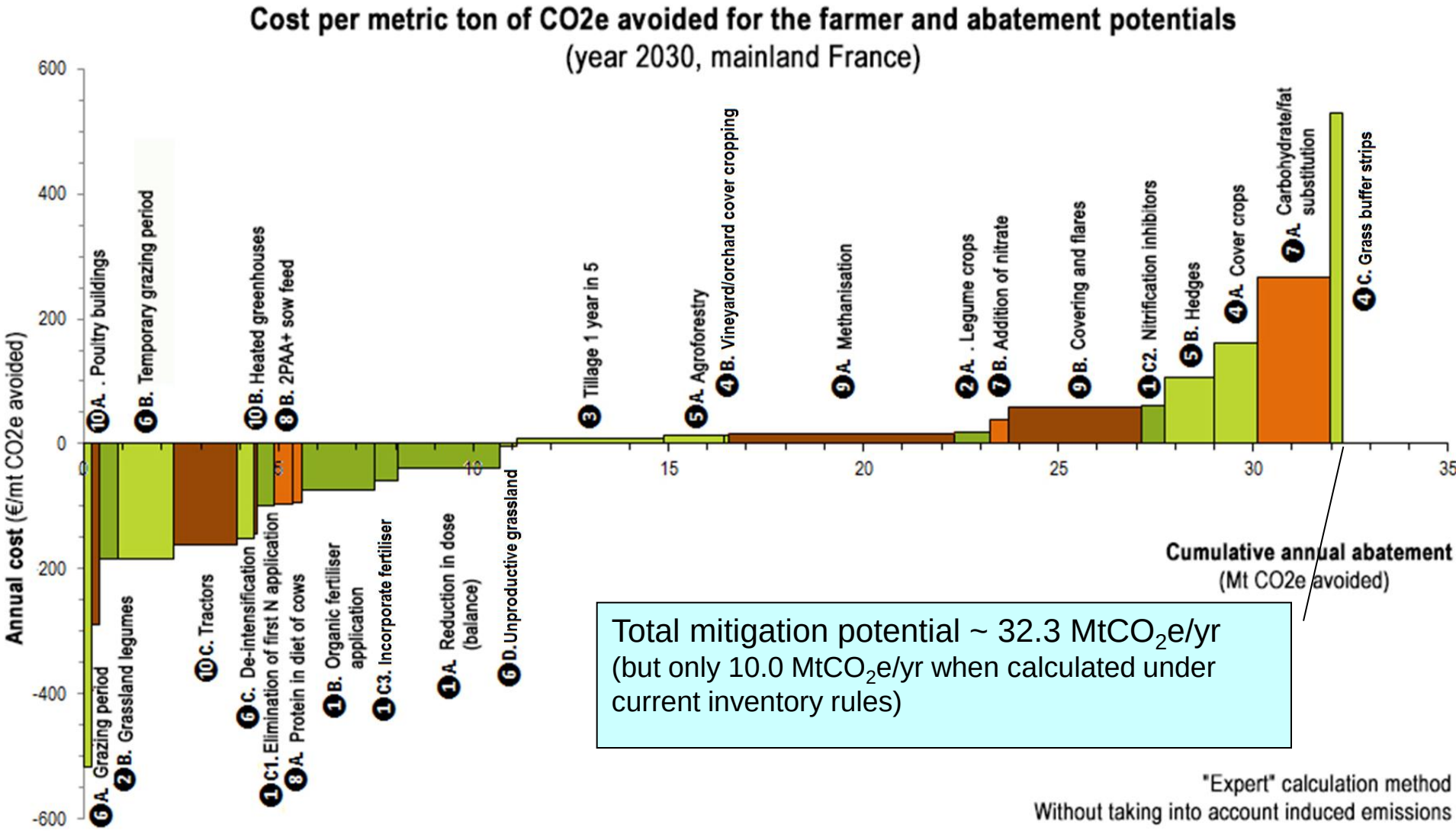


Effect of state subsidies on calculated costs

		Abatement cost (€/metric ton $CO2_e$ avoided)	
Sub-measure	**State subsidy (explicit or implicit)**	Including state subsidies	Not including state subsidies
Methanisation	Subsidised purchase of « green » electricity	17	55
Reduced tillage (Tillage 1 year in 5)	Tax exemption for agricultural fuels	8	-13
Energy savings of agricultural machinery	Tax exemption for agricultural fuels	-164	-317

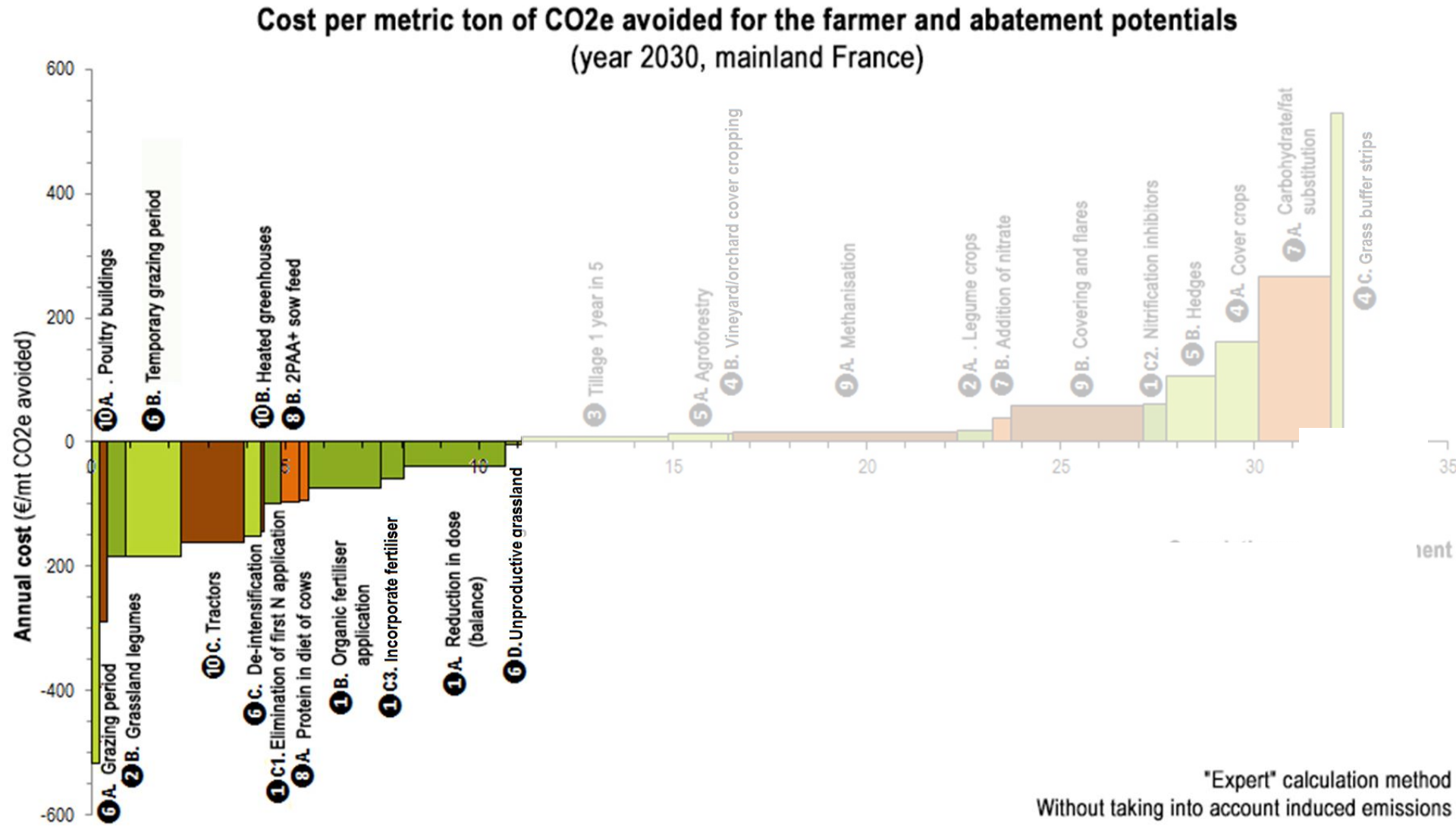
Compared abatement potential and costs of the proposed sub-measures





Total mitigation potential ~ 32.3 $MtCO_2e/yr$
(but only 10.0 $MtCO_2e/yr$ when calculated under current inventory rules)

"Expert" calculation method
Without taking into account induced emissions


Cost per metric ton of CO2e avoided for the farmer and abatement potentials
(year 2030, mainland France)
Annual cost (€/mt CO2e avoided)
600
400
200
0
-400
-600
0
15
20
25
30
35
10A. . Poultry buildings
6B. Temporary grazing period
10B. Heated greenhouses
8B. 2PAA+ sow feed
3 Tillage 1 year in 5
5A. Agroforestry
4B. Vineyard/orchard cover cropping
9A. Methanisation
2A. . Legume crops
7B. Addition of nitrate
9B. Covering and flares
1C2. Nitrification inhibitors
5B. Hedges
4A. Cover crops
7A. Carbohydrate/fat substitution
4C. Grass buffer strips
6A. Grazing period
2B. Grassland legumes
10C. Tractors
6C. De-intensification
1C1. Elimination of first N application
8A. Protein in diet of cows
1B. Organic fertiliser application
1C3. Incorporate fertiliser
1A. Reduction in dose (balance)
6D. Unproductive grassland
"Expert" calculation method
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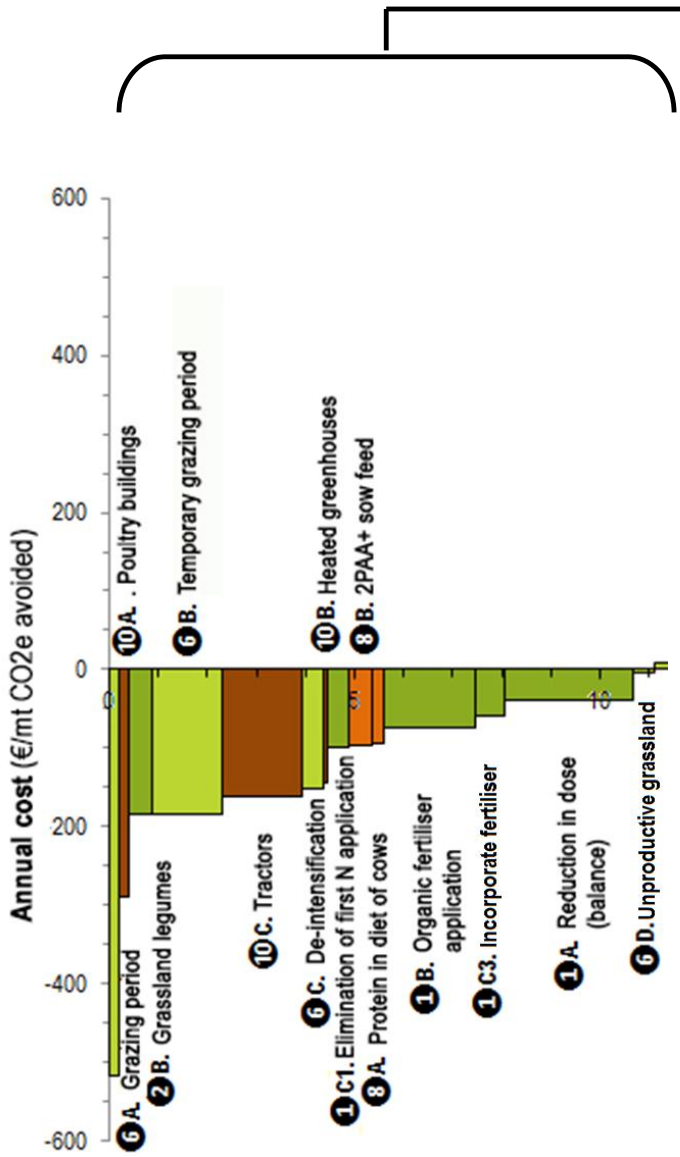
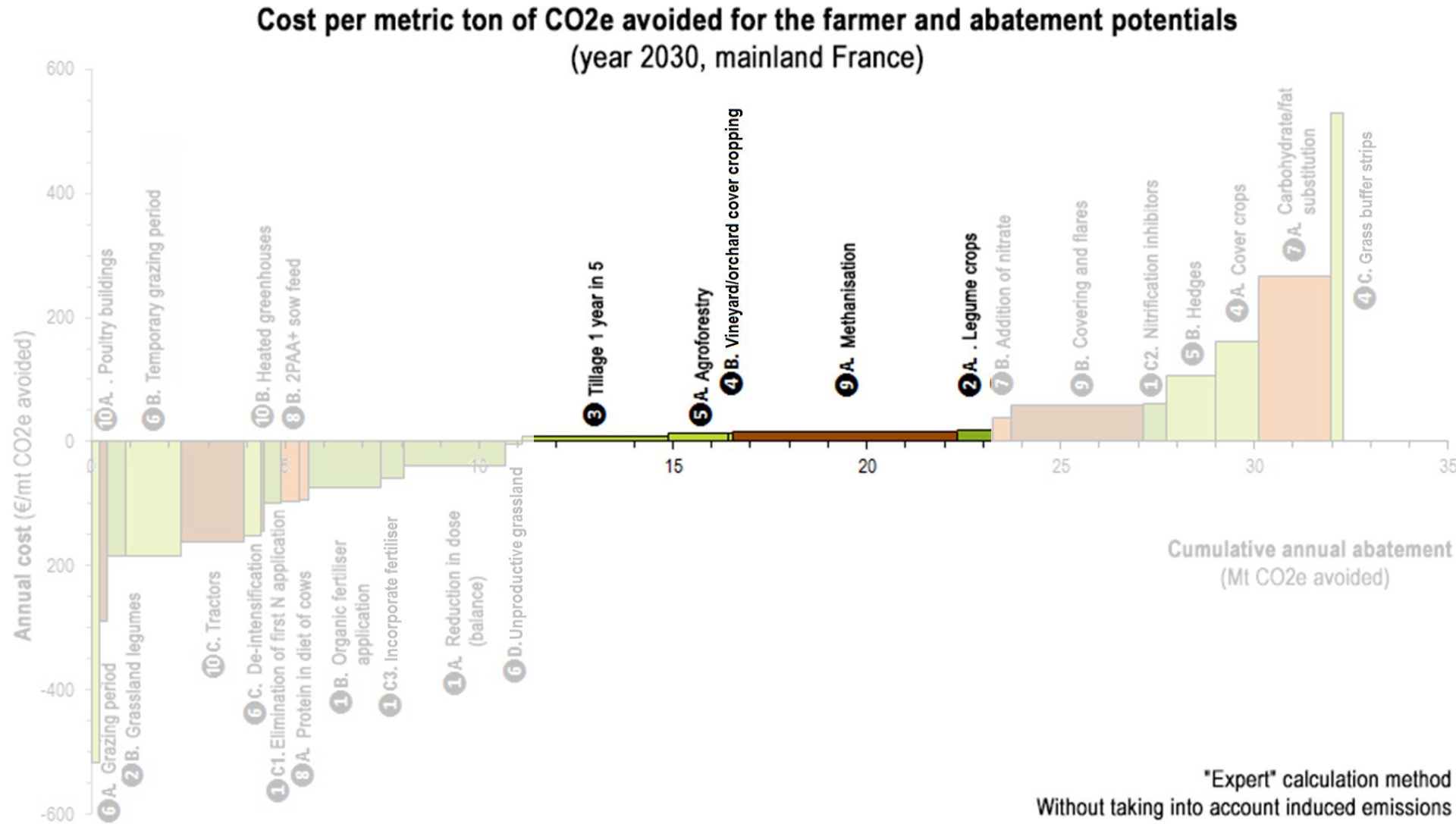


One third of the cumulative annual abatement with a negative cost

⇒ sub-measures involving technical adjustments (e.g. adjusting fertiliser rates or animal diets, improving insulation of livestock buildings,…) with input savings ⇒ increase in input-use efficiency (N, energy)

⇒ « win-win » sub-measures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(Mt CO2e avoided)
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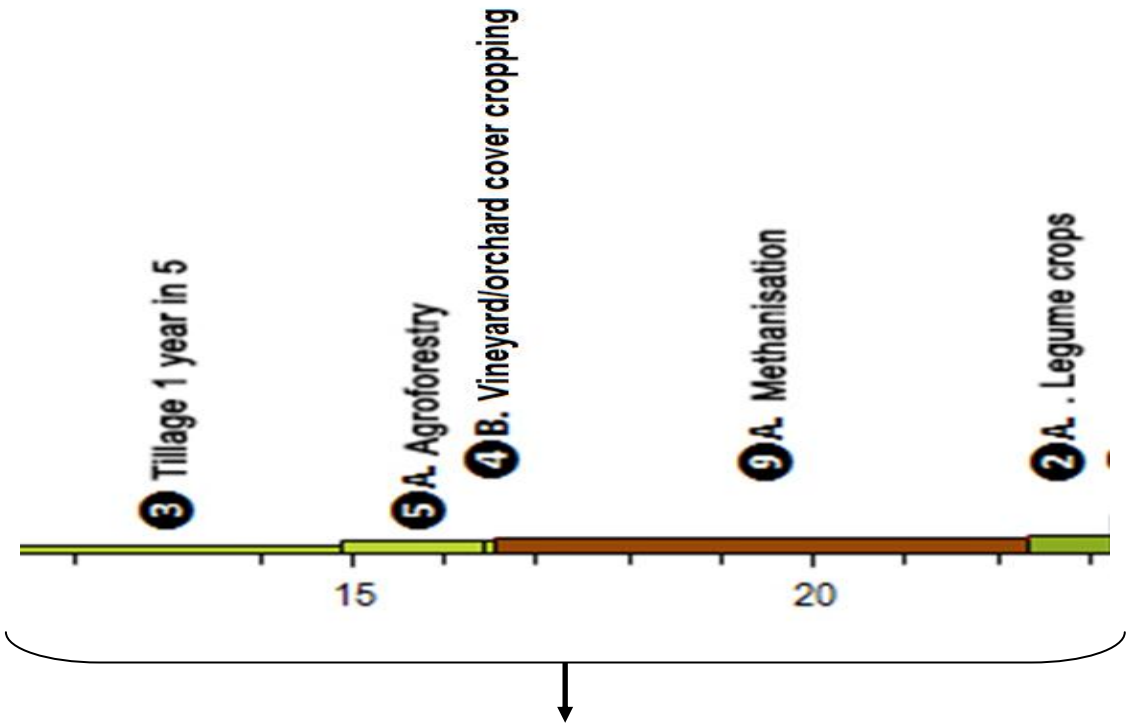
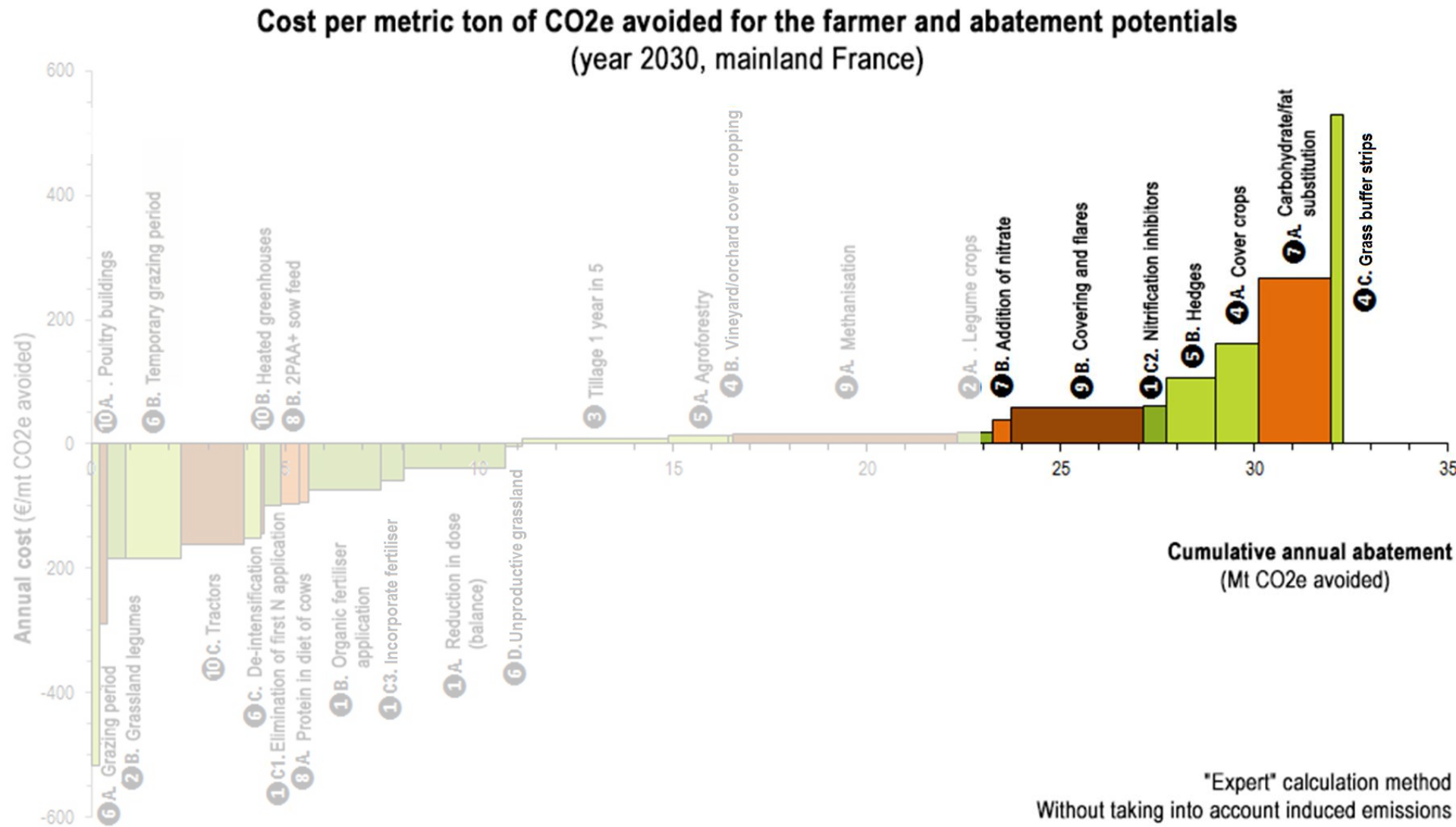


One third of the cumulative annual abatement with a moderate cost (<€25/mt CO_2e avoided)

Sub-measures
⇒ requiring specific investments (e.g. methanisation) or modifying the cropping system slightly more (e.g. reducing tillage, agroforestry, development of grain legumes)
⇒ with possible reduction in costs (e.g. fuels) and/or additional income (e.g. electricity, wood)

Potential abatement and cost highly dependant on putative dissemination scenario and calculation mode (e.g. with or without public subsidies)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Cumulative annual abatement
(Mt CO2e avoided)
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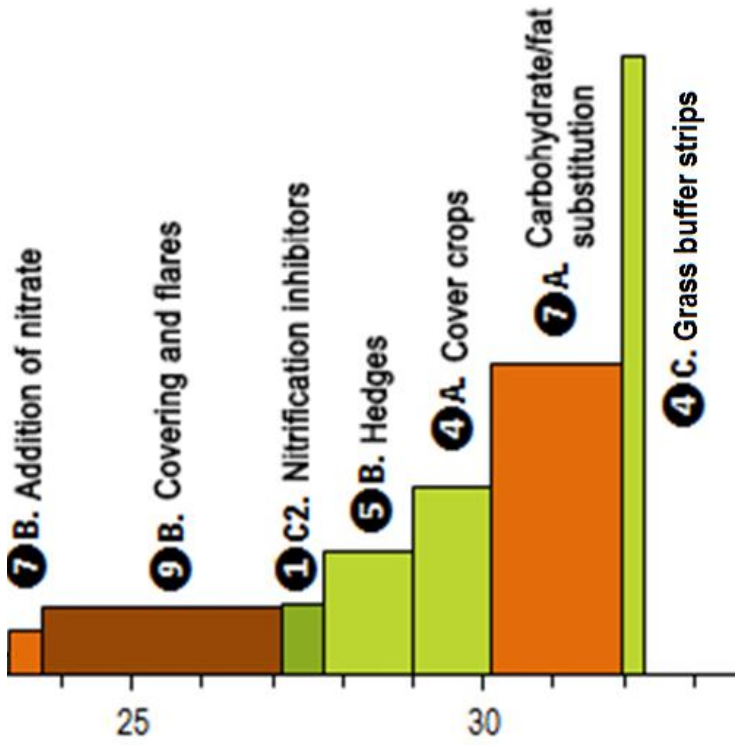
One third of the cumulative annual abatement with a high cost (>€25/mt CO_2e)

Sub-measures

⇒ requiring an investment (e.g. flares), the purchase of specific inputs (e.g. nitrification inhibitor, additives for animal diets), or dedicated labour time (e.g. cover crops, hedges)

⇒ or involving production losses (e.g. grass buffer strips)

⇒ with no reductions in cost and with no or little additional income (no additional marketable products)



Some of these sub-measures have a positive impact on other environmental services (e.g. biodiversity, erosion control,…).

Conclusion

- A significant abatement potential (32.3 $MtCO_2e/yr$)
  - Despite a cautious (conservative?) approach (e.g. measures having a low social acceptability or still at a research stage were discarded)
  - Compatible with the maintenance of efficient agriculture (no major change to production systems and no major reduction in production output)

- Sub-measures can be separated into three classes
  - Increase in input –use efficiency (N, energy) ⇒ « win-win » measures
  - Investments and/or changes in practices with additional income (<25€/tCO_2e)
  - Investments and/or changes in practices with no additional income (>25€/tCO_2e)

- The study emphasises a need for upgrading the national emission inventory system in order to take better into account efforts done to reduce emissions

- The outcomes of this study are currently used by policy makers to build scenarios

Thank you for your attention!

To download the summary of the report:
http://institut.inra.fr/Missions/Eclairer-les-decisions/Etudes/Toutes-les-actualites/Etude-Reduction-des-GES-en-agriculture