



# Tackling climate change in agriculture- key mechanisms in GHG mitigation

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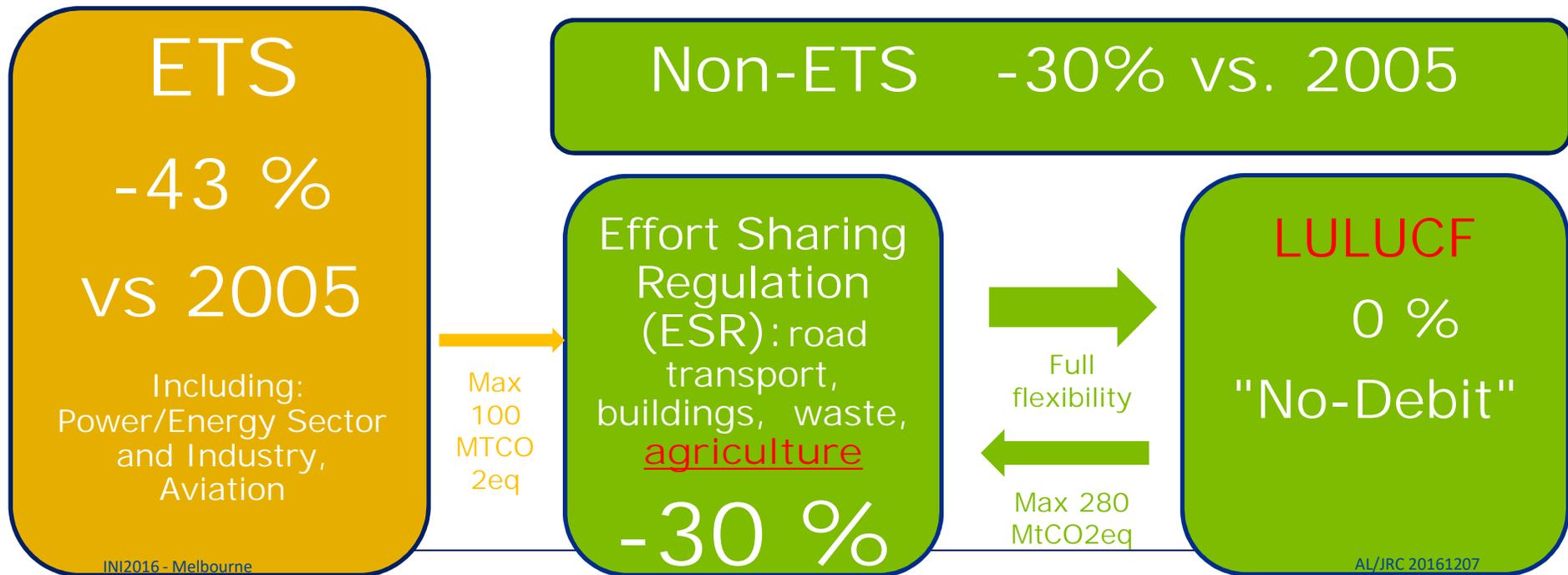
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Stimulating innovation  
Supporting legislation



# EU 2030 Energy and Climate Package - Emissions Sharing Regulation



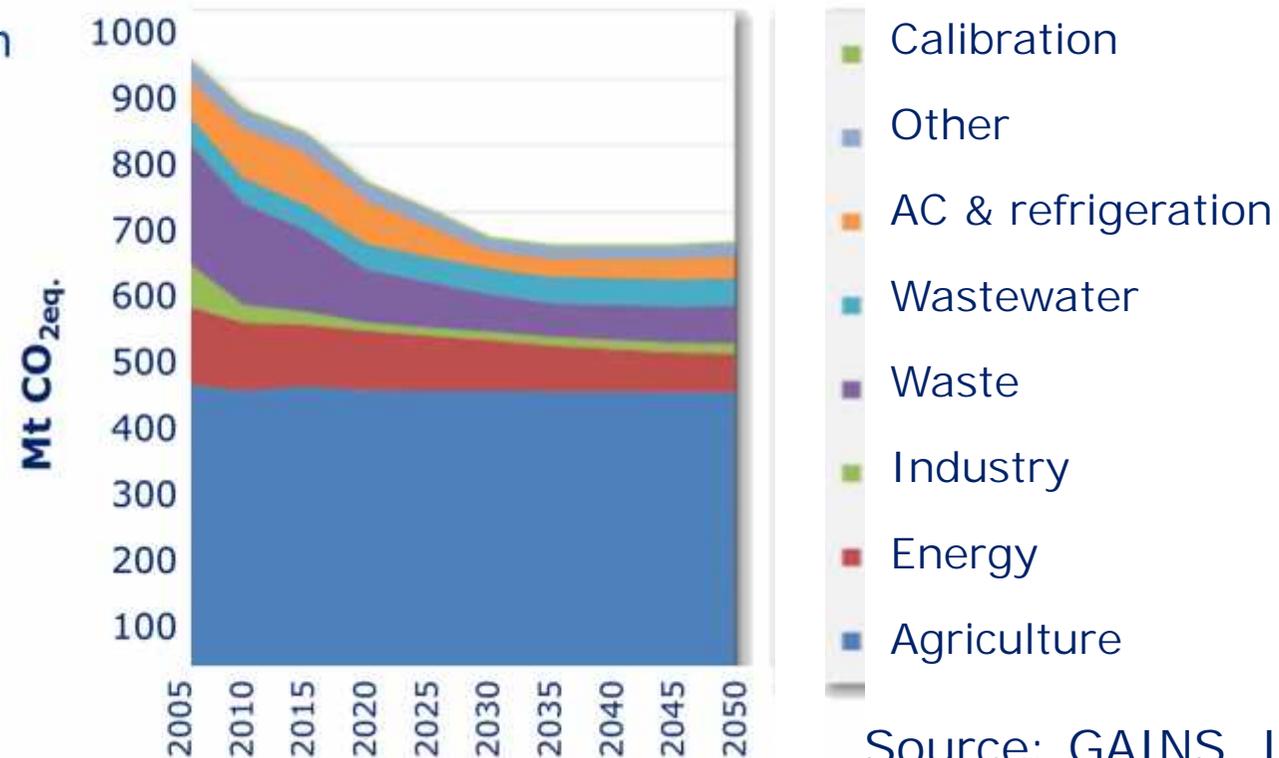
-40 % Greenhouse Gas Emissions (domestic)  
(vs 1990)



# Projections: emissions go down, agri-emissions remain stable



Projected trends in sectors outside of the EU-Emissions Trading System



Source: GAINS, IIASA

# List of mitigation measures



Livestock disease management - Use of sexed semen for breeding dairy replacements - Genetically improved cow replacement rate - Animal breeding for enhanced productivity - Livestock selection based on growth, milk production and fertility - Use of products to increase production (meat or milk) per animal (like somatotropin) - Feed additives to reduce CH<sub>4</sub> (lipids, nitrates or sulphates, propionate precursors, plant bioactive compounds) - Breeding low methane emissions in ruminants - Vaccination against methanogenic bacteria in the rumen - Develop cross-breeding with lower emissions - Change fodder composition, favouring non-methanogenic compounds (increase sugar, tannins...) - Use of antibiotics to regulate microorganisms producing methane in the rumen - Use of biotechnology to control microorganisms in the rumen - Feed advisory tool - Optimised feed strategies (multi-phase feeding) - Changes in composition of animals' diet (optimising feed mix in ruminants) - Low nitrogen feed - Genetic improvement of cattle based on feed use efficiency - Increase concentrates in feed rations - Optimised manure storage and application - Covering slurry pits - Incorporation of slurry - Decrease the quantity of manure stock - Optimise the type of manure produced to balance N<sub>2</sub>O/CH<sub>4</sub> emissions - Anaerobic digestion - Produce dihydrogen from manure in anaerobic conditions - Slurry acidification - Rice - Soil and nutrient management plans - Improved nitrogen efficiency - Variable Rate Technology (VRT) - Precision farming - Genetic improvement of crops for better nitrogen uptake and use efficiency - Delay in applying mineral N in crops that have had slurry applied - Reducing soil compaction and avoiding fertilization in the traffic lanes - Biological N fixation in rotations and in grass mixes - Increase legume share in temporary grassland - Substitution of mineral fertilizer by N from legumes - Use of urease inhibitors and next-generation nitrification inhibitors - Nitrification inhibitors - Modify microbial communities in the soil, introducing microorganisms which reduce N<sub>2</sub>O and N<sub>2</sub> - Maintain soil pH at suitable level for crop/grass production - Burn - Agro-forestry, short rotation forestry - Maintaining permanent grasslands - Conversion of arable land to grassland to sequester carbon in the soil - Woodland creation (afforestation, including new shelterbelts, hedgerows, woody buffer strips and in-field trees) - Woodland management: preventing deforestation - Woodland management (including existing shelterbelts, hedgerows, woody buffer strips and in-field trees) - Improving grassland management (e.g. optimizing productivity, livestock density, nutrient management, grass varieties) to increase carbon sequestration - Extend the perennial phase of crop rotations - Leaving Crop Residues on the soil surface - Use cover/catch crops, green manure, and reduce bare fallow - Restoration of degraded soils to increase the production and stock of organic matter - Increase biomass production by optimising the input use, increasing carbon return to the soil - Select crops providing higher carbon return to soils - Measures targeting C-sequestration (reduced tillage, crop rotation, cover crops...) - Reduced Tillage - Zero Tillage - Biochar applied to soil - Wetland and peatland conservation/restoration - Fallowing histosols - Carbon calculator - Improved on-farm energy efficiency - Reduce the use of fossil energy use on-farm in buildings and machinery - Use of solar energy to dry agricultural products - Use of solar, wind, and geothermal energy - Biofuel production and use on site - Produce energy on-farm through biomass burning to decrease CO<sub>2</sub> emissions -



# Do mitigation measures show up in GHG emission inventories?

# Review of mitigation measures



- **Meta-review of Common Agricultural Policy (CAP) mainstreaming.** Effective performance of tools for climate action policy. DG-Clima.
- **ECAMPA project:** 'Economic assessment of GHG mitigation policy options for EU agriculture'. It selected a set of measures to be implemented in CAPRI (Common Agricultural Policy Regional Impact model) to allow the assessment of measures.
- Pellerin, S., Bamière, L., Angers, D., Béline, F., Benoît, M., Butault, J.,... Pardon, L. (2013). Quelle contribution de l'agriculture **française** à la réduction des émissions de gaz à effet de serre? Potentiel d'atténuation et coût de dix actions techniques (Synthèse du rapport d'étude). Paris: INRA.
- Finnish Ministry of Agriculture and Forestry (2014). Climate Programme for **Finnish** Agriculture- Steps towards Climate Friendly Food. ISBN 978-952-453-871-8.
- Osterburg, B., Rüter, S., Freibauer, A., de Witte, T., Elsasser, P., Kätsch, S., Leischner, B., Paulsen, H.M., Rock, J., Röder, N., Sanders, J., Schweinle, J., Steuk, J., Stichnothe, H., Stümer, W., Welling, J., Wolff, A. (2013). Handlungsoptionen für den Klimaschutz in der **deutschen** Agrar- und Forstwirtschaft. Thünen Report 11.

# Classification of mitigation measures



Mitigation strategies

Mitigation mechanisms



## JRC TECHNICAL REPORTS

# Mitigation measures in the Agriculture, Forestry, and Other Land Use (AFOLU) sector

*Quantifying mitigation effects at  
the farm level and in national  
greenhouse gas inventories*

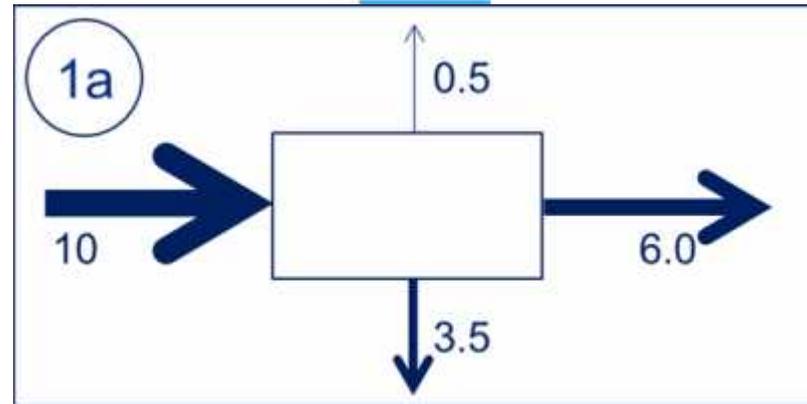
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2016

**FORTHCOMING**



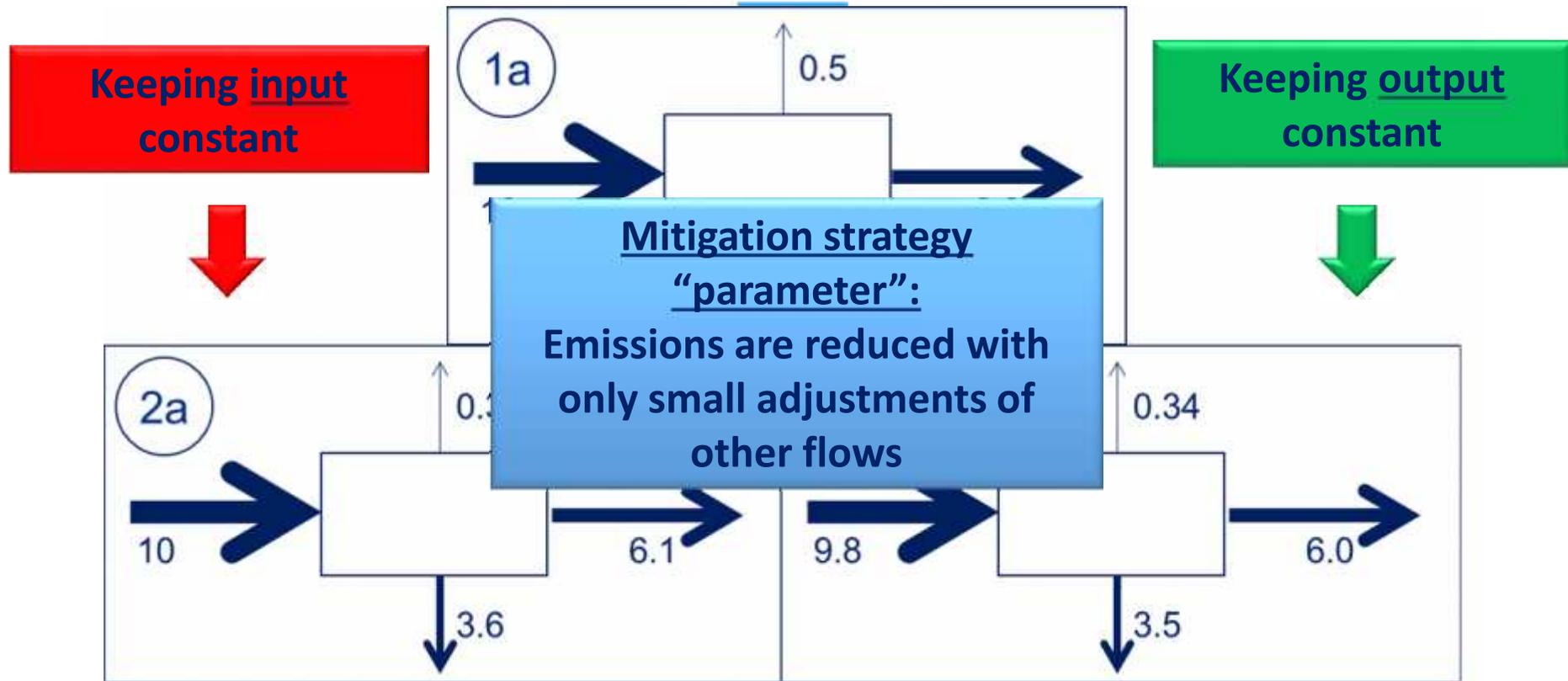
# Mitigation strategies



# Mitigation strategies



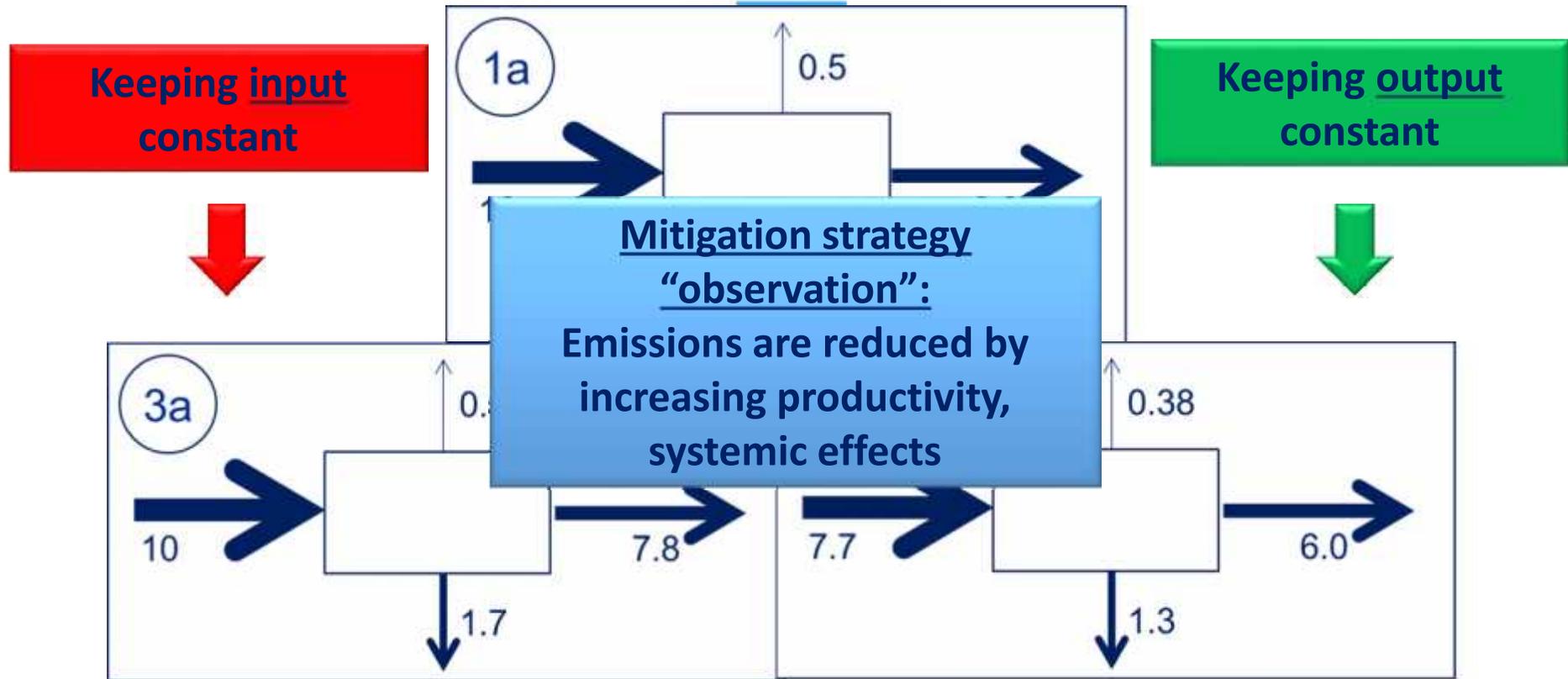
30% decrease of parameter



# Mitigation strategies



30% increase in productivity



# Mitigation mechanisms



- Bundle of individual mitigation measures
- Common mitigation strategy
- Based on 'term' in the standard estimation procedures
- Allow focusing the later discussion on the traceability of mitigation measures.

# Mitigation mechanisms: Example Enteric Fermentation



**HERD**  
 Reducing #of animal maintaining production (sanitary, increased health, optimised gender balance, etc.)

**Eq. 10.19:**

**FEED**  
 Optimise feed ration (feed supplements, selective breeding programs)

$$w = \sum_{(I)} \frac{(( \quad )) \cdot (( \quad ))}{10^6}$$

**BREED**  
 Improving productivity (EF needs to be checked as well)

**Eq. 10.21:**

$$= \left[ \frac{(\dots) \cdot 0.265}{(\dots)} \right]$$

**METHGEN**  
 Selectively reducing enteric fermentation (feed supplements, selective breeding programs)

# 16 Mitigation mechanism groups



Mitigation mechanism groups	Mitigation strategy	Changes provoked	Tackles	Gas(es) targeted	Other gases affected
HERD	Observation	Improves herd productivity, but not individual one	$N_{(T)}$	all	
BREED	Observation	Improves animal productivity	$N_{(T)}$	$CH_{4Ent}, CH_{4Man}, N_{2OMan}$	
METHGEN	Parameter	Additives or breeding reducing selectively $CH_4$ production in rumen	$Y_m$	$CH_{4Ent}$	--
FEED	Observation	Adjust rations to (energy, N content) feed needs	GE/DE/Nex	$CH_{4Ent}, CH_{4Man}, N_{2OMan}$	3D-N2O
MANSYS	Observation	% manure in each MMS	MS	$CH_{4Man}, N_{2OMan}$	
ADIG	Observation	Anaerobic digesters, to reduce emissions form manure and produce energy	MS	$CH_{4Man}, N_{2OMan}$	$CO_2$ energy
MANEF	Parameter	Additives, etc, affecting directly emission factors	MCF/ $EF_3$	$CH_{4Man}/N_{2OMan}$	--
RICE	Observation	Management practices (e.g. aeration)	$t_{i,j,k}, A_{i,j,k}$	$CH_{4Rice}$	--
NMANAG	Observation	Improved use of available sources (% each type, timing....)	$F_{SN}, F_{PRP}, Frac_{GASF}, Frac_{GASM}, \dots$	all $N_2O$	
LEGU	Observation	Increase leguminous share	$F_{SN}, F_{CR}^{(*)}, F_{PRP}$	$N_{2O}Direct, CH_{4Ent}$	$N_{2O}ATD, N_{2O}LEACH, N_{2O}Man, CH_{4Man}$
NEF	Parameter	Substances/ techniques to reduce EFs	$EF_1, EF_3$	$N_{2O}Direct$	--
BURN	Observation	Reduce burnt biomass	A	$L_{fire}$	
LUSE	Observation	Increasing carbon sequestration/Reducing carbon losses	A	$CO_2$	$CH_4, N_2O$
LMAN	Parameter (Observation)	Reducing carbon losses	Stock Change Factors	$CO_2$	$N_2O$
ORGSOILS	Observation	Increasing carbon sequestration/preventing carbon losses	Area	$CO_2, N_2O$	$CH_4$
ENER	Observation	Measures to reduce farm energy use	Energy data in agric.	$CO_2$	

# Traceability in UNFCCC national inventory reports - with current scientific understanding

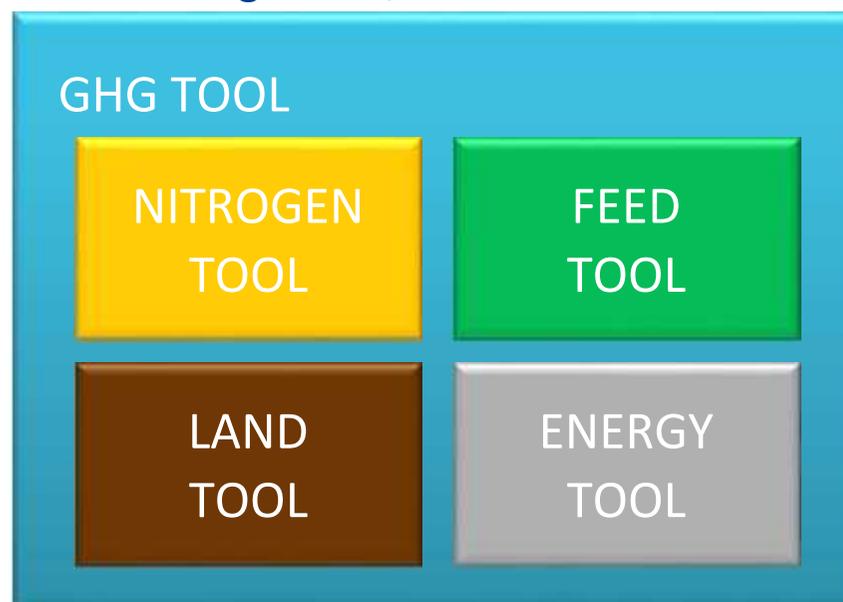


	Tier1	Tier 2	Emissions affected	Comment
HERD	X		Cat. 3A, 3B1, 3B2, 3D	
BREED		X	Cat. 3A, 3B1, 3B2, 3D	Tier 2 Method usually already in use
METHGEN		X	Cat. 3A	EFs not available
FEED		X	Cat. 3A, 3B1, 3B2, 3D	Surveys required
MANSYS	X		Cat. 3B1, 3B2, 3D	Surveys required
ADIG	X (for N <sub>2</sub> O)	X (for CH <sub>4</sub> )	Cat. 3B1, 3B2, energy sector	Method being developed by IPCC
MANEF		X	Cat. 3B1, 3B2	EFs not available
RICE	X		Cat. 3C	
NMANAG	X		Cat. 3B2, 3D	
LEGU	X		Cat. 3D	Surveys required
NEF		X	Cat. 3D	EFs not available
BURN	X		Cat. 3F	
LUSE	X		Cat 4	
LMAN	X		Cat 4	
ORGSOILS	X		Cat 3D, 4	

# What about the farm level?



- Feed and food are key!!
- Reduce (monitor) external N inputs (mineral fertilizer, feed)
- Land use data exist (in Europe) but are (usually) not available
- Additional data for GHG tool: manure management, embodied emissions in inputs
- Many mitigation measures have 'systemic' effect
- They can be monitored and implemented via relatively simple N and Feed farm-level tools



# Conclusions



- Differentiation in AD and EF acc. to IPCC terminology not optimal for assessing traceability of mitigation options
- Observations and parameters link directly to ‘accessibility’ of required information
- Mitigation can be achieved by reducing specific *emissions* (mitigation strategy parameter) or by increasing *productivity* (mitigation strategy observation)
- Mitigation mechanisms groups mitigation options that target similar ‘terms’ in the emission accounting equations
- Assessment of effects on non-target emission sources is important!
- All mitigation measures impact farmer’s income (positively or negatively)

# Conclusions



Thank you!

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- Many mitigation mechanisms 'show up' easily in UNFCCC national GHG emission inventories, but
  - Some require Tier 2 methodology (feed, breed, ...) -> mostly key categories for which Tier 2 is required
  - Some require additional collection of statistical data (manure management systems, feed intake, ...)
  - Some require the development of emission factors (direct N<sub>2</sub>O emission factors, methanogenic inhibitors, ...)