

# Farm, Land, and Soil nitrogen budgets for Agriculture in Europe

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# N-budgets = Quantification of all relevant nitrogen fluxes across system boundaries

## → **Process understanding**

- quantification of soil nutrient cycle through field studies or soil nutrient modeling; link to other studies

## → **Performance indicator – awareness raising**

- Agri-Environmental Indicator, e.g. IRENA indicator 18.1
- OECD gross nutrient balances
- Assessment of environmental pressure
- Farm/regional performance

## → **Policy instrument**

- Farm accounting
- monitoring of nitrogen policies; farm efficiencies;

based on Oenema et al., 2003

For each application the appropriate boundaries must be defines

→ Soil / groundwater /  
surface waters

soil surface

→ Overall environmental  
pressure

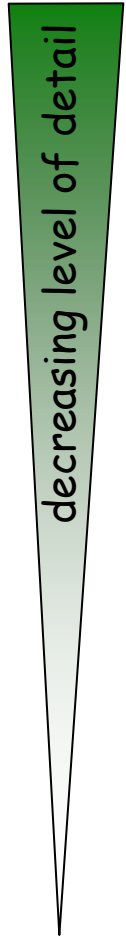
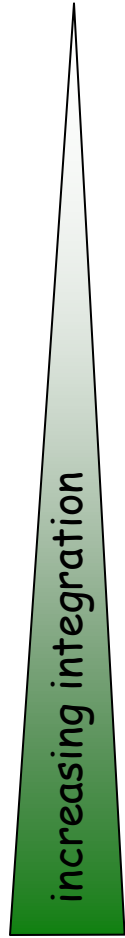
soil surface  
+ livestock

→ Farm performance

individual  
farm

→ Society

farm  
aggregates



# Issues / Objectives

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→ **General concepts are clear and many studies have been successful ...**

**BUT (at least for regional applications) ...**

→ **Data availability (soil mineralization, denitrification, manure import/export) is scarce and varies between countries**

→ **(Small) differences in methodologies still prevail**

**→ There is little comparability of results across countries (Eurostat, 2009 – TAPAS results)**

# A new/consolidated classification

		Detail	simple	detailed
		System		
Boundaries	Farm		<b>Farm Nitrogen Budget</b>	<b>Agricultural N System Budget</b>
	Land		<b>Land Nitrogen Budget</b>	<b>Land N System Budget</b>
	Soil		<b>Soil Nitrogen Budget</b>	<b>Soil N System Budget</b>



# Indicators

Nitrogen Surplus = N inputs - N outputs

usually\* measured in kt N year<sup>-1</sup> (per regional unit)  
... or kg N ha<sup>-1</sup> year<sup>-1</sup>

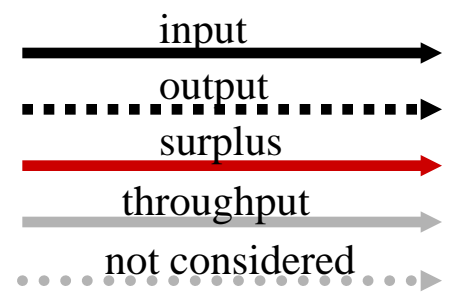
Nitrogen Use Efficiency = N outputs / N inputs

usually\* measured in relative units (%)

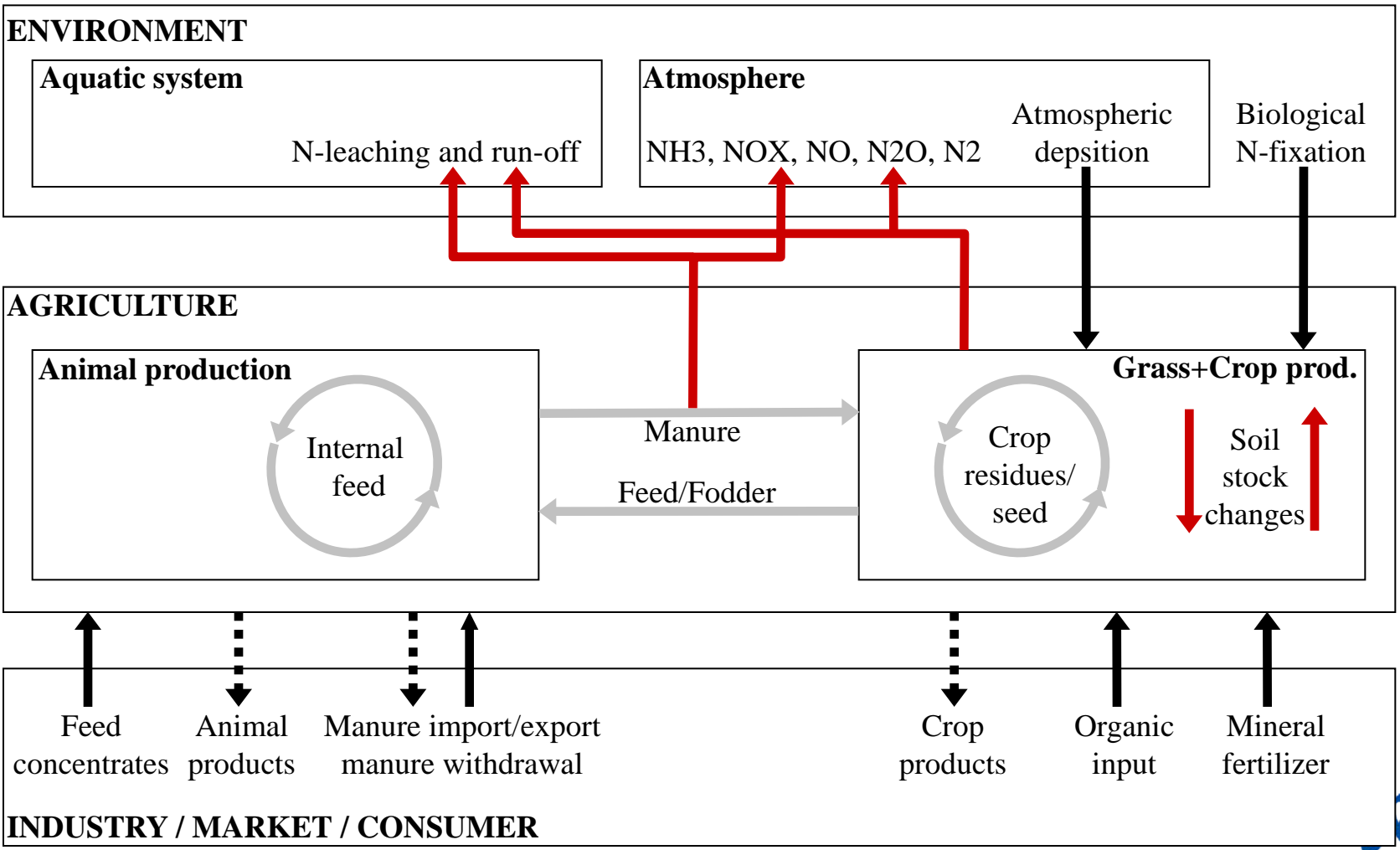
\* for the scope of this presentation ...

	<b>N Inputs</b>	<b>N Outputs</b>	<b>N Surplus</b>
<b>FARM</b>	Fertilizer, feed (concentrates), external organic N sources, net N manure import/export, and withdrawals, crop residues, biological N fixation and deposition	Sold animal (meat, milk, manure etc.) and crop products.	N ( $\text{NH}_3$ , $\text{N}_2\text{O}$ , $\text{NO}_x$ and $\text{N}_2$ ) emissions and N leaching/ runoff from housing and manure storage systems and soil; soil nitrogen stock changes
<b>LAND</b>	Fertilizer, manure excretion, external organic sources, crop residues returned to/left on the soil, biological N fixation and atmospheric deposition, net N manure import/export, and withdrawals	Harvest of crop products (in arable land), above ground removal of grass, crop residues	N ( $\text{NH}_3$ , $\text{N}_2\text{O}$ , $\text{NO}_x$ and $\text{N}_2$ ) emissions and N leaching/ runoff from housing and manure storage systems and soil; soil nitrogen stock changes
<b>SOIL</b>	Fertilizer, manure application, grazing inputs, external organic sources, crop residues returned to/left on the soil, biological N fixation and atmospheric deposition	Removal of crop products (in arable land), above ground removal of grass, crop residues; soil nitrogen stock changes	N ( $\text{NH}_3$ , $\text{N}_2\text{O}$ , $\text{NO}_x$ and $\text{N}_2$ ) emissions and N leaching/ runoff from soil

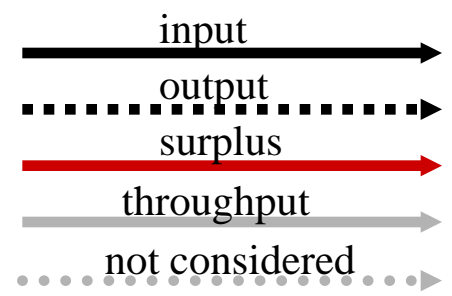
# Farm Nitrogen Budget



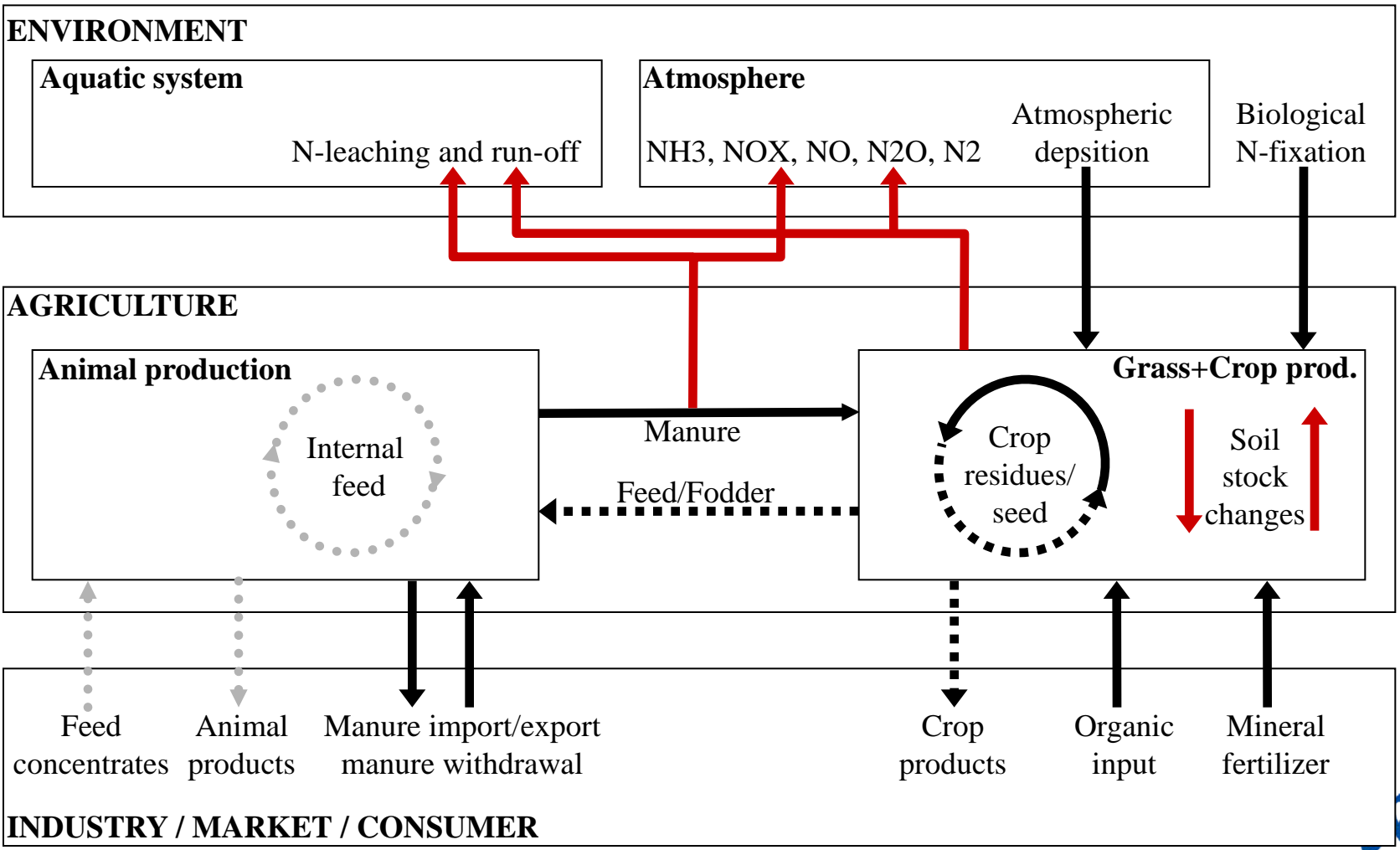
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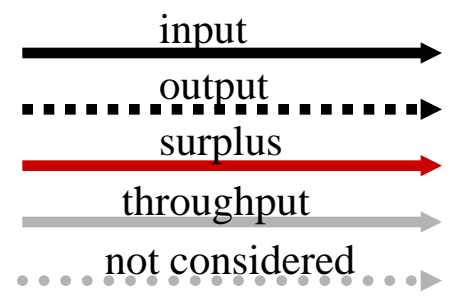
# Land Nitrogen Budget



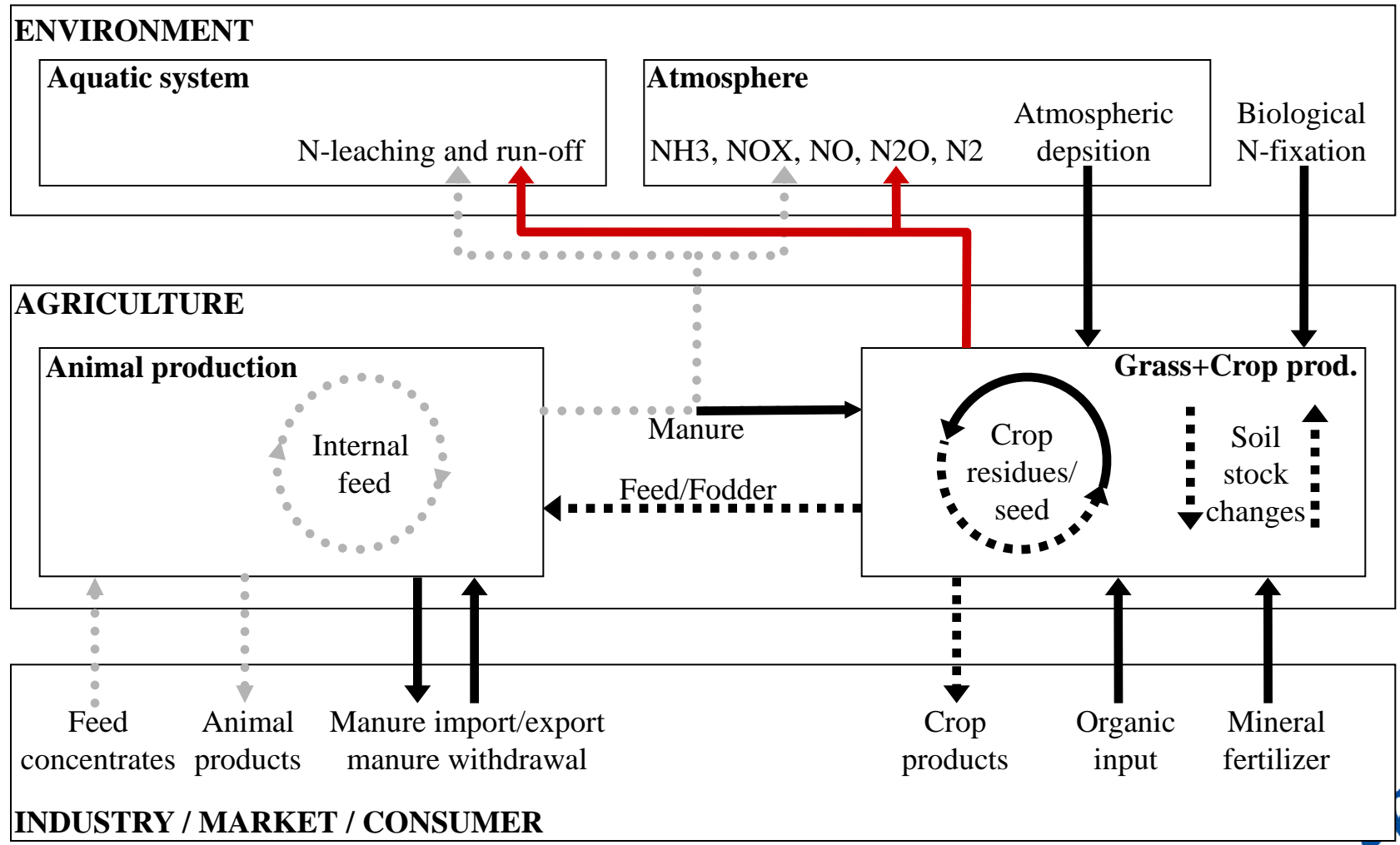
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# Soil Nitrogen Budget



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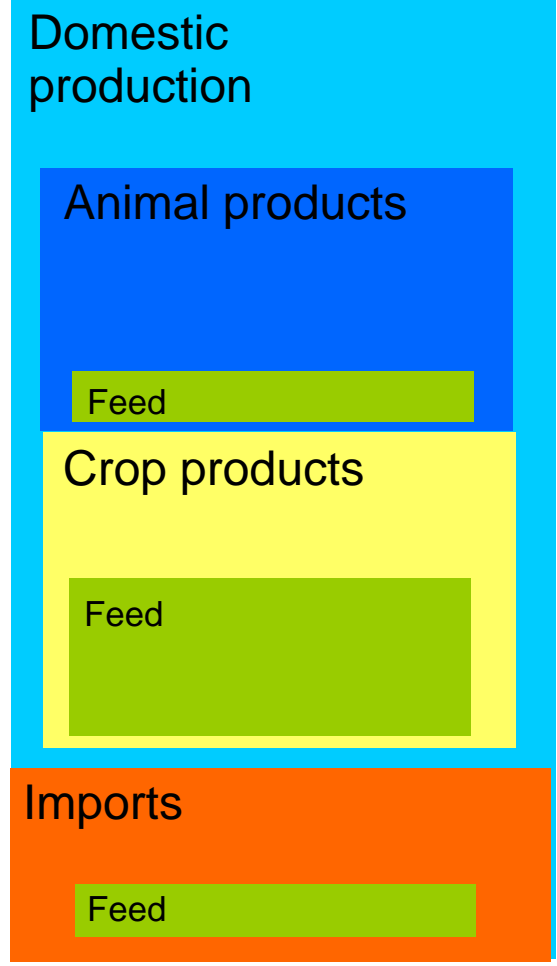


- **Economic model for agriculture, designed as tool for impact assessment of agricultural policies, including environmental impacts of agriculture**
- **Includes mutually consistent data base of national and regional data for agriculture (acreages, herds, yields, market balances, fertilizer applications etc.), which are basis for N accounting**

# Nitrogen budgeting in CAPRI (i)

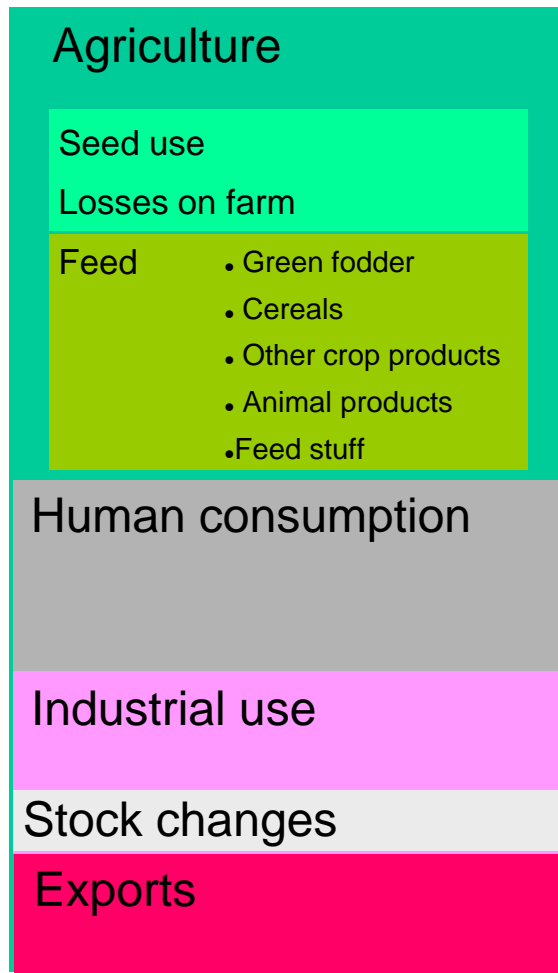
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## Product delivery



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## Product use



# Nitrogen budgeting in CAPRI (ii)

## Animal-balance

$$N_{man,ex} = \frac{N_{protein,req}}{6} - N_{animalproducts} - N_{animalwaste}$$

## Manure-balance

$$N_{man,ex} = N_{grazing} + N_{application} + N_{gas,housto} + N_{runoff,hou+sto}$$

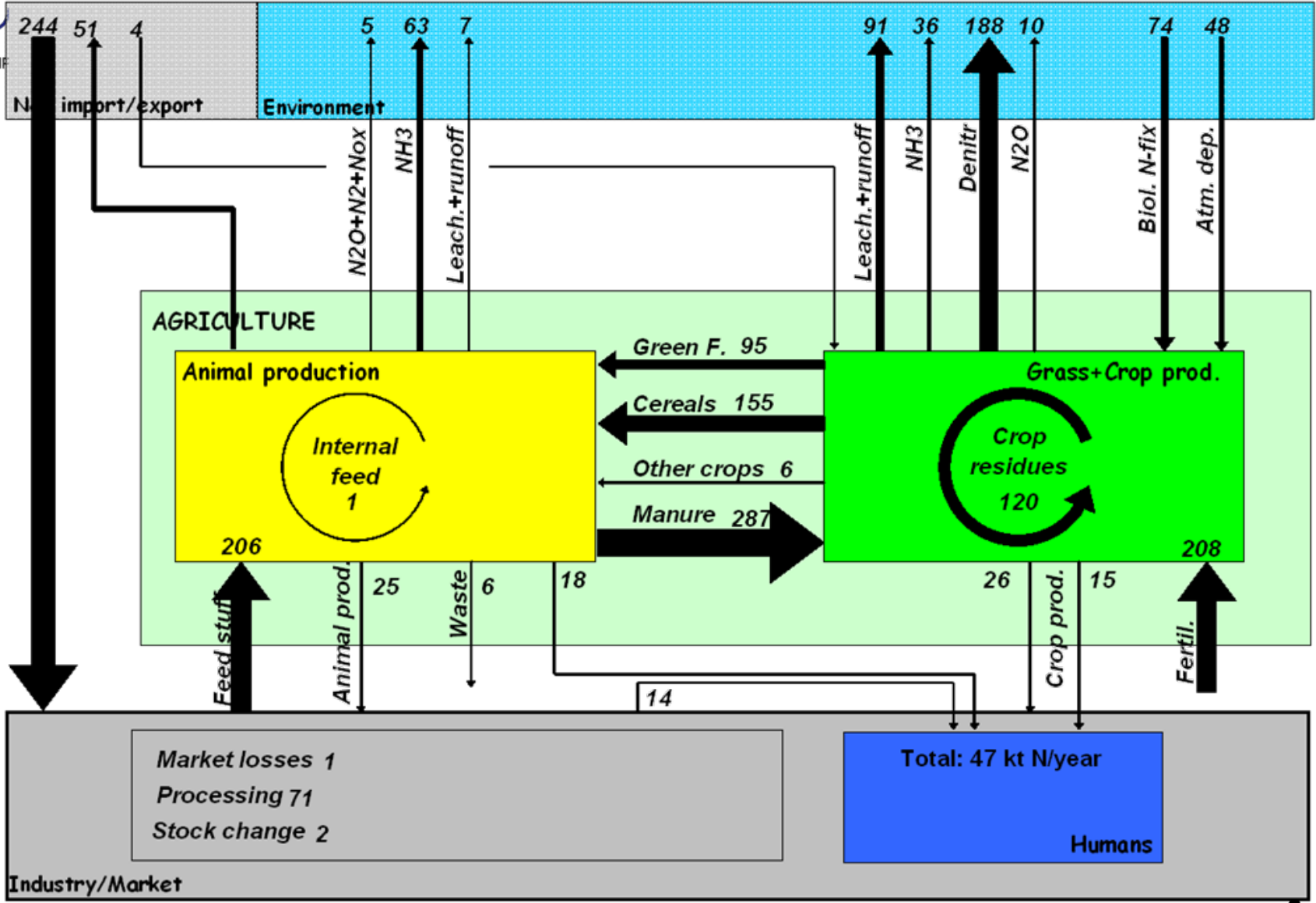
## Soil-balance

$$\begin{aligned} &N_{grazing} + N_{appl} + N_{minfert} + N_{cropres} + N_{biolfix} + N_{atmdep} \\ &= N_{crop\_products} + N_{crop\_residues} + N_{gas.soil} + \\ &N_{runoff,soil} + N_{leach,soil} + N_{N2} + N_{accum,soil} \end{aligned}$$



Denmark

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Source: CAPRI, rev. 2714; 03/2009

Values in kt N/year



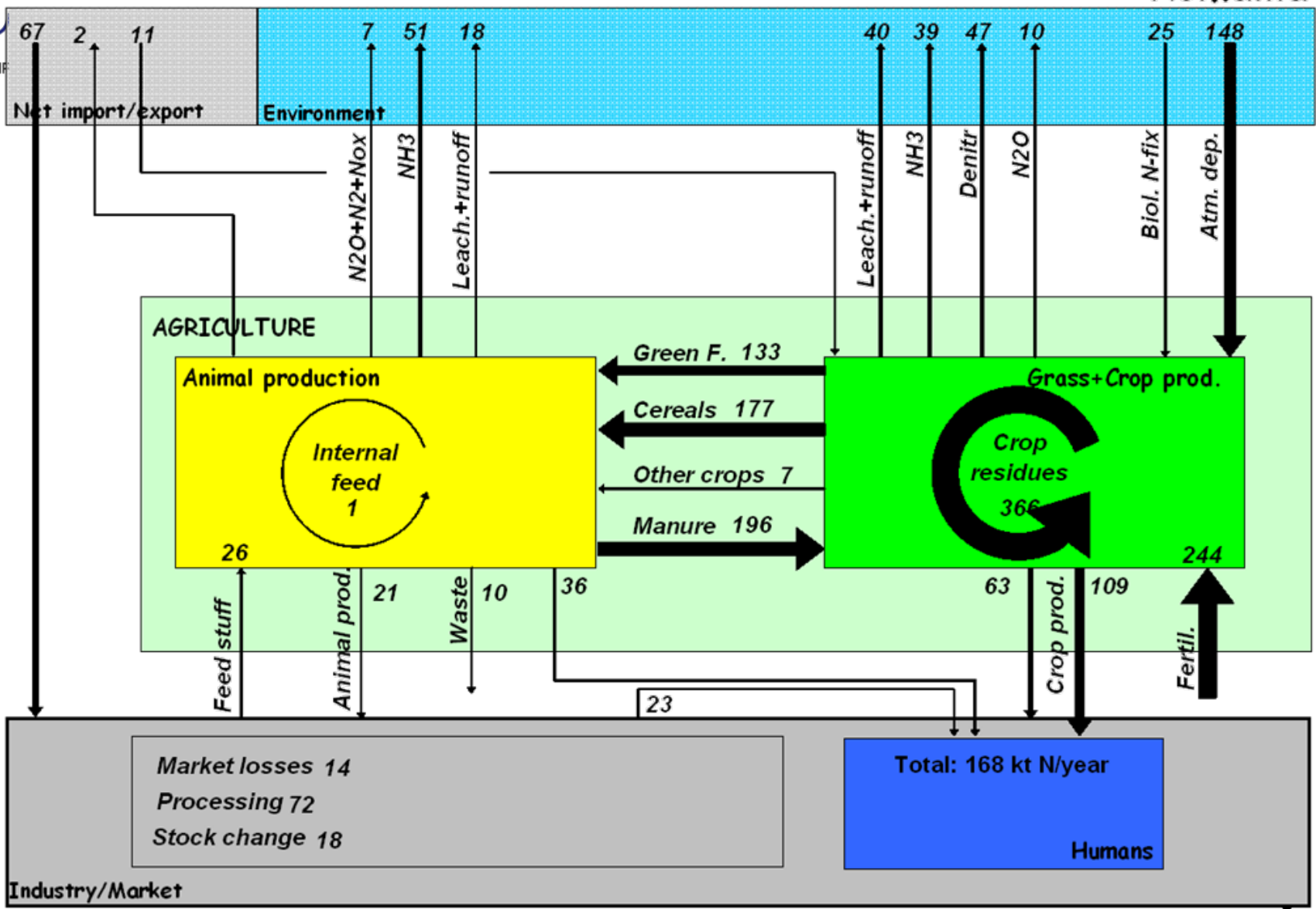






Romania

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Source: CAPRI, rev. 2714; 03/2009

Values in kt N/year



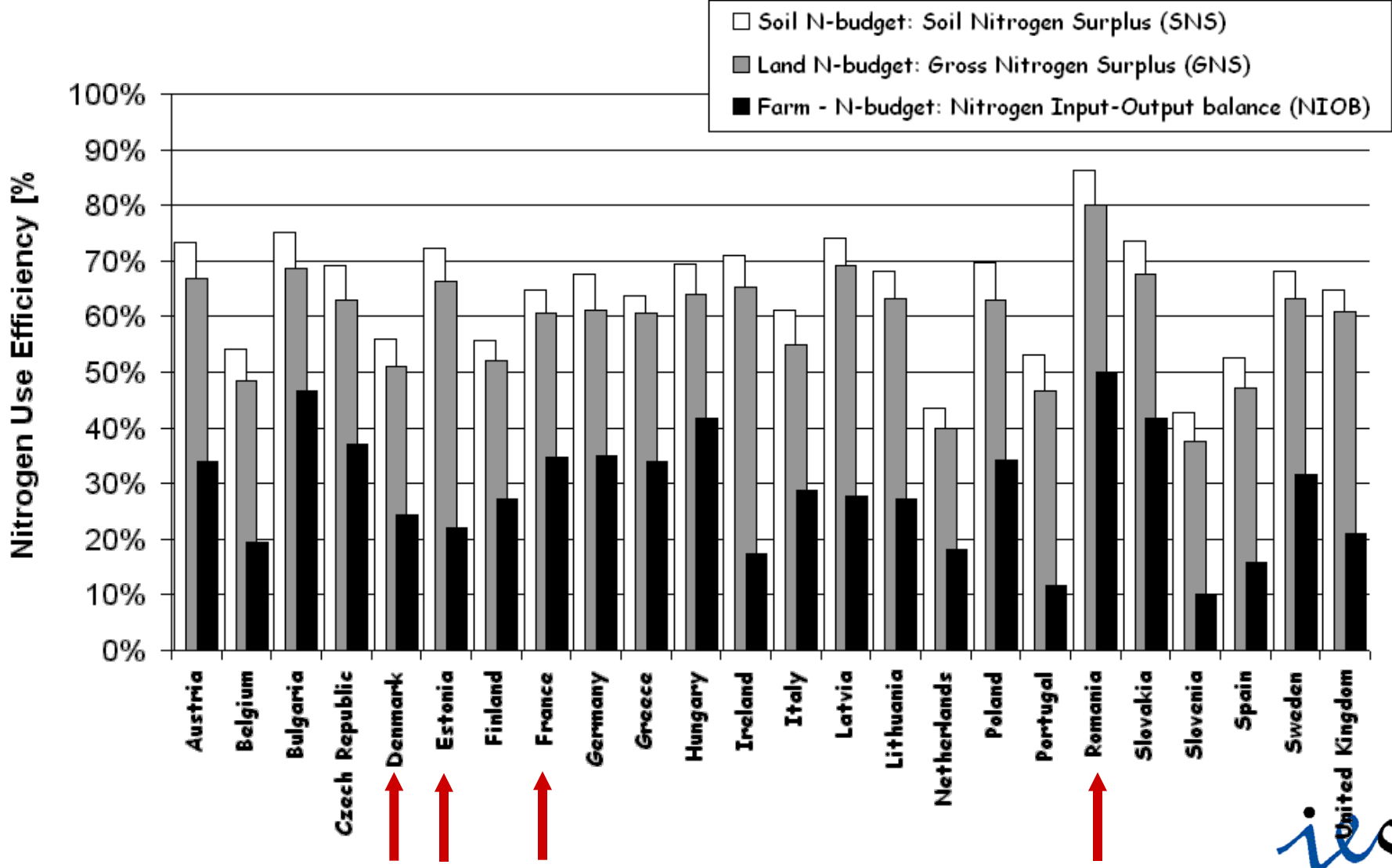
# Questions

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	Denmark	France	Estonia	Romania
<b>1. Feed import/mineral fertilizer input</b>	<b>0.99</b>	<b>0.19</b>	<b>0.17</b>	<b>0.10</b>
<b>2. Crop residues/ (food+feed+ fodder products)</b>	<b>0.41</b>	<b>0.45</b>	<b>0.83</b>	<b>0.77</b>
<b>3. Animal products/Crop products</b>	<b>2.52</b>	<b>0.37</b>	<b>2.45</b>	<b>0.37</b>

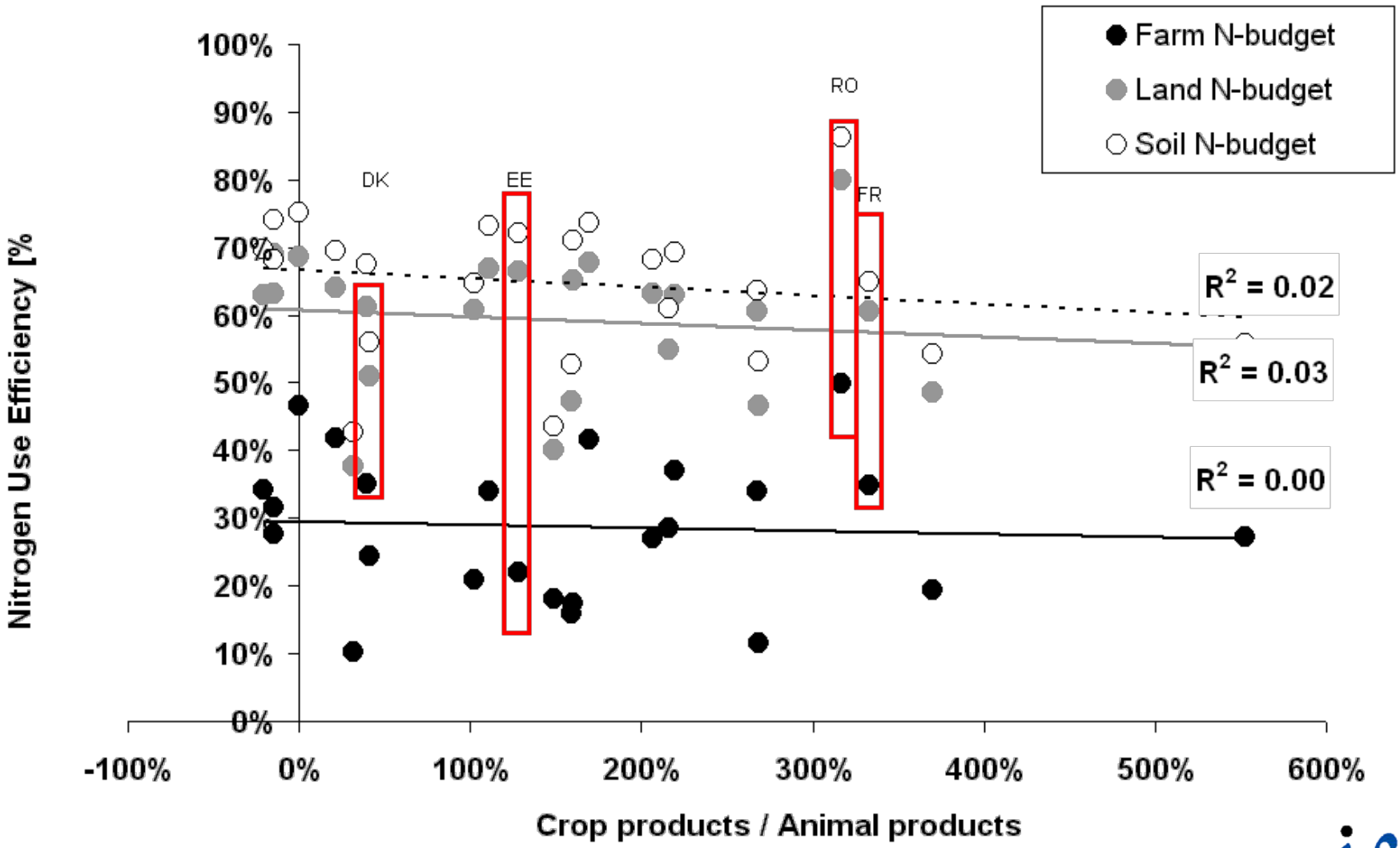
# Soil, Farm, and Land Nitrogen Surplus

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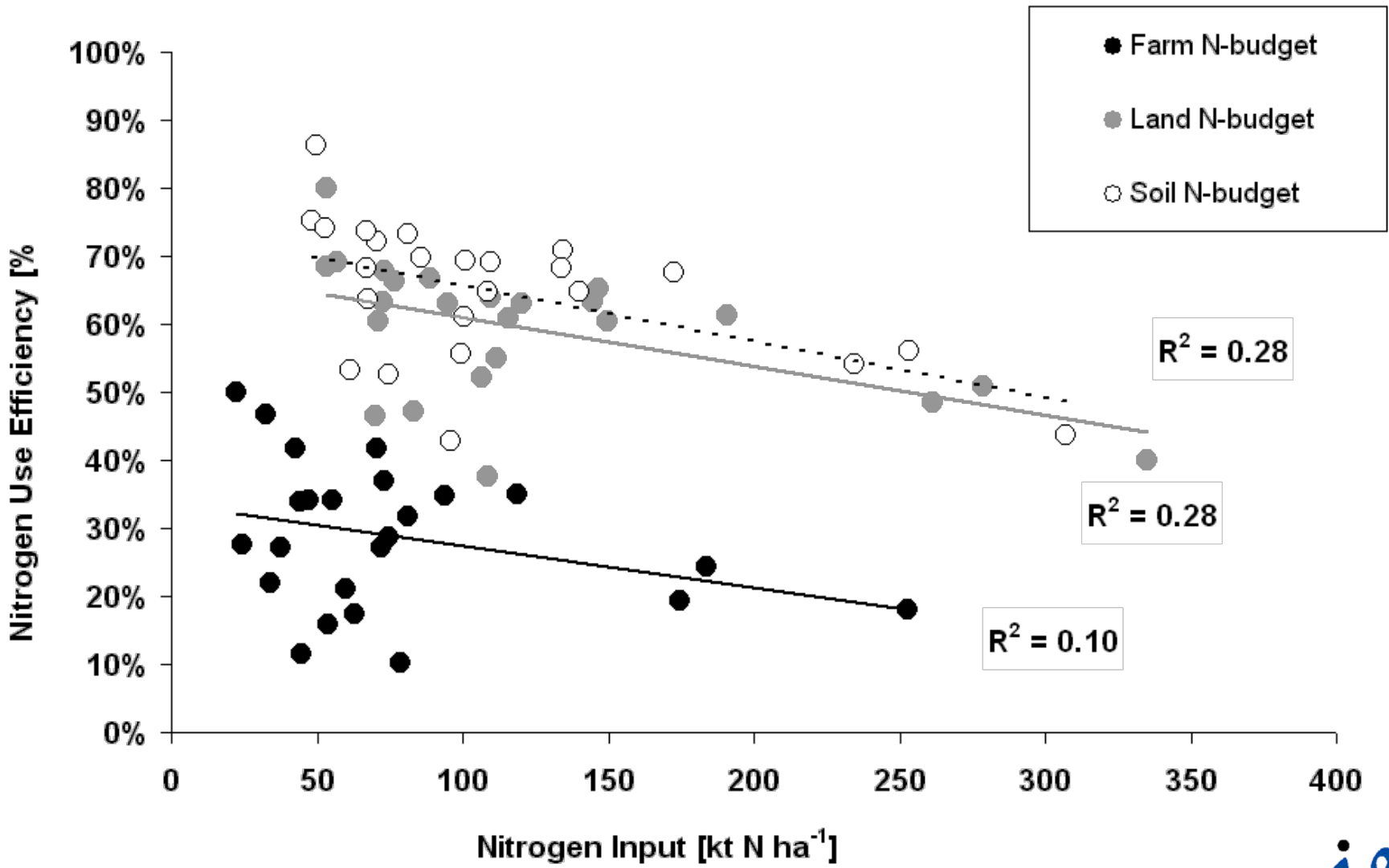


# Crop vs. Animal production

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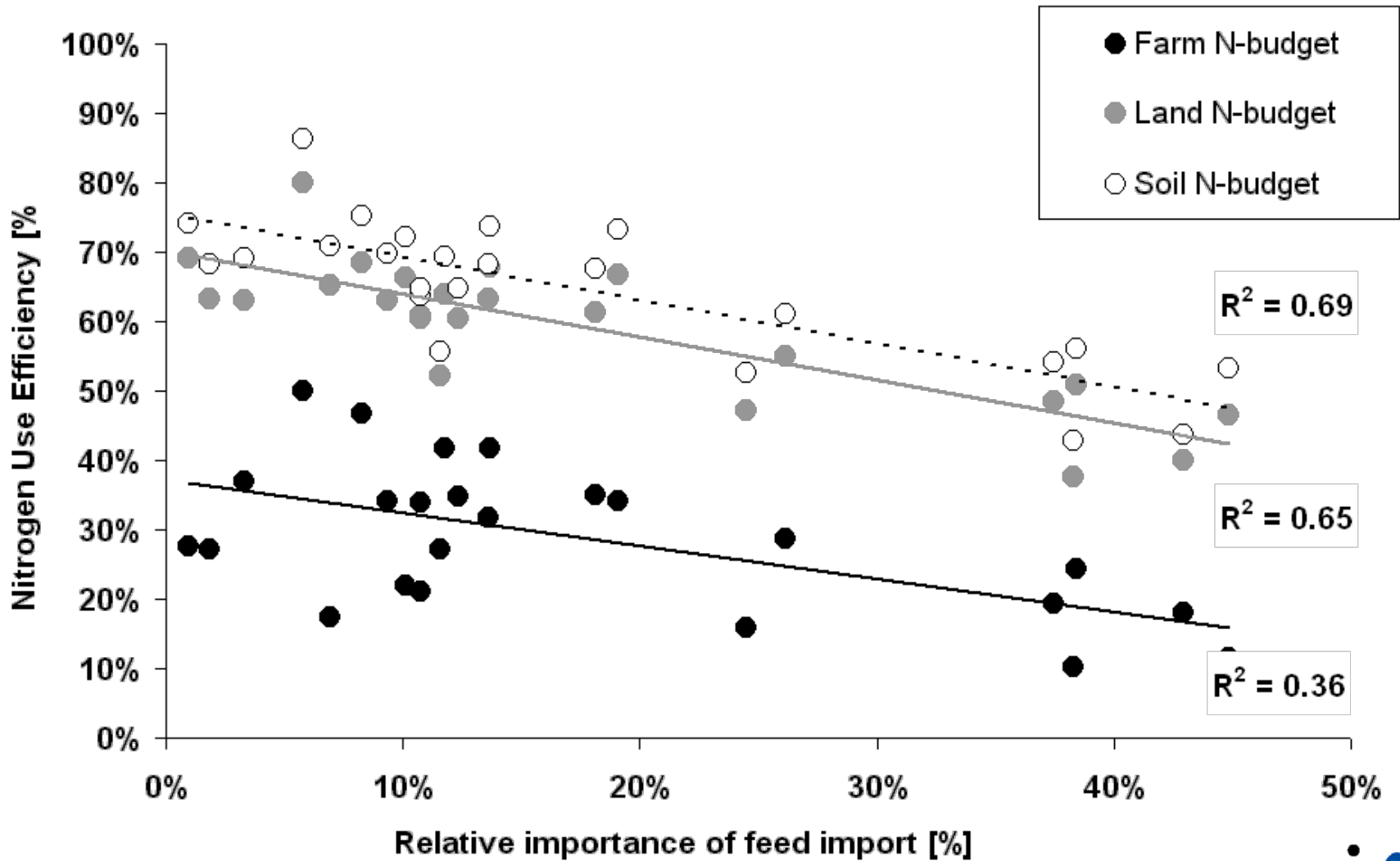


# N surplus vs. total N input



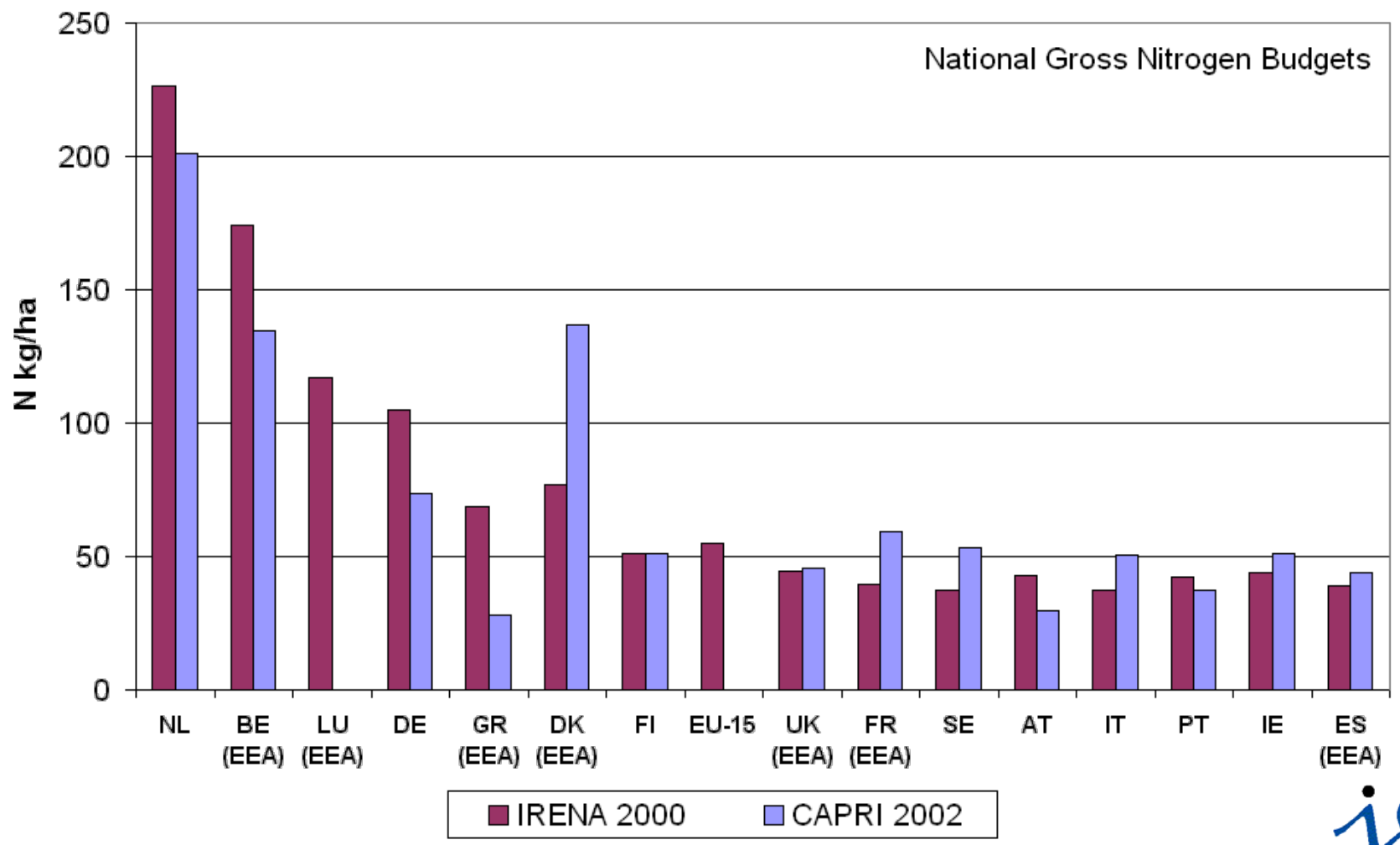
# Feed imports

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# CAPRI vs. IRENA (OECD)

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# Conclusions

- Even though a large number of definitions for N-budgets already exists, a consolidation is needed to avoid misinterpretations ...
- CAPRI is the only model/data base known to us able to calculate all three proposed N-budgets (farm, land, soil) at the regional level
- Basic accounting scheme can be also applied ex-ante, in policy evaluation, and in linkage to bio-physical modeling

# Conclusions cont'd

- **Agricultural system budgets are the most comprehensive ones as they avoid “leakages”**
- **Societal N-use efficiency (national farm-N-budget) can be as low as 10% in some countries**
- **No simple statements are possible on the causes of low NUE, but reliance on external N or animal raising could be a good candidate ...**