

# FarmAC model

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European Project n° 266018

INRA, ILRI, WUR,  
EMBPRAR, FAO and others

TATION

# Role of farm-scale N budgets (1)

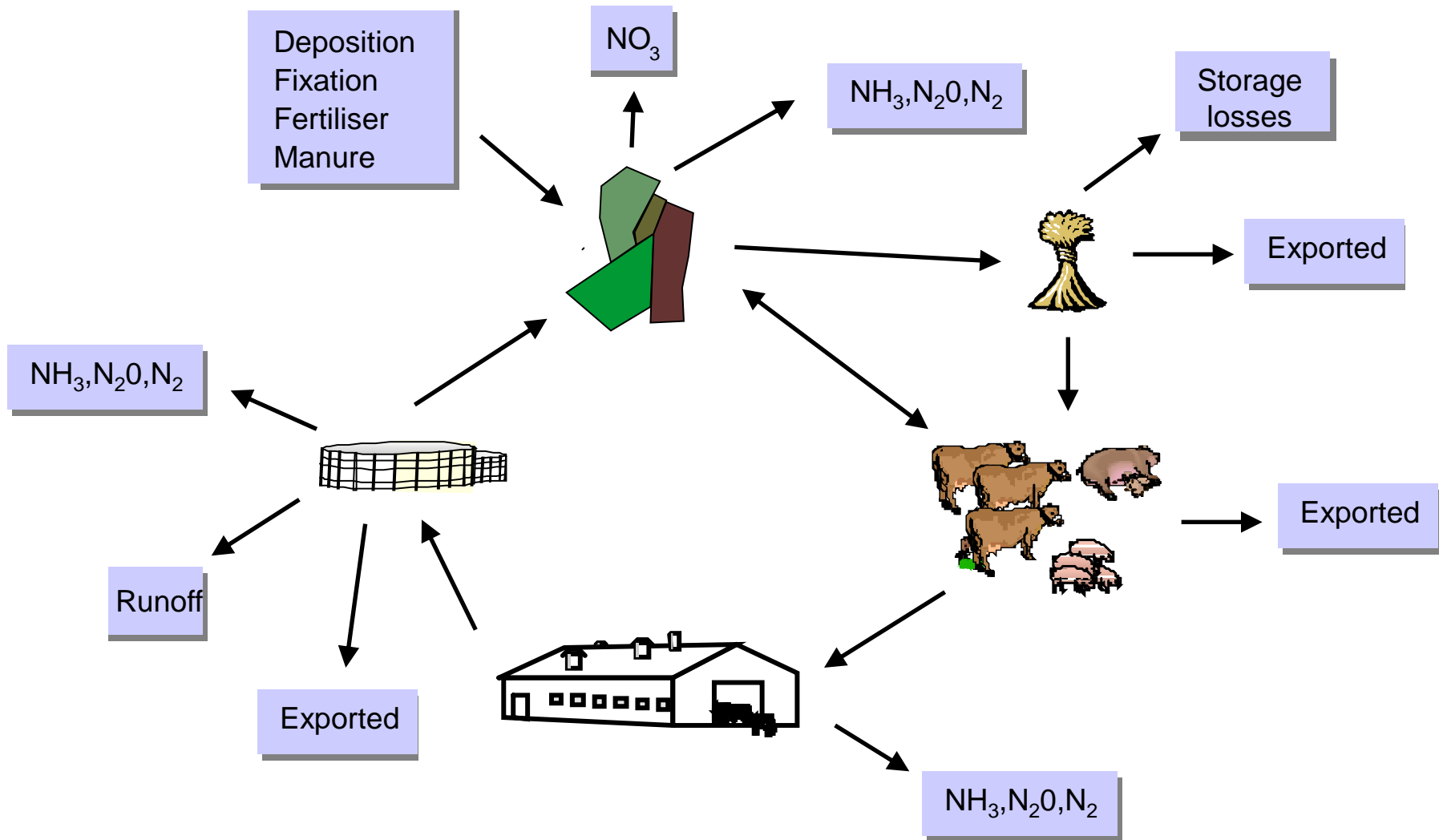
- Is there a problem?
  - Farm N balance (output of products – input of fertiliser etc)
  - Compare with standard or best-practice farms of same type
- Where is the problem?
  - Farm N budget, using measured data (e.g. milk production, crop production)
  - Compare N use efficiencies for livestock & crops with standard or best-practice farms of same type

# Role of farm-scale N budgets (2)

- What to do about the problem?
  - What measures can be applied?
  - How effective are they likely to be?
- Requires a quantitative understanding of the mechanisms driving N use and loss
  - Modelling
- Requires data and parameterisation

# FarmAC model

- Developed as part of EU AnimalChange project
  - [www.AnimalChange.eu](http://www.AnimalChange.eu)
- Intended to have wide applicability
  - W Europe, Senegal, S Africa, Brazil
- Simple enough – limited demand for inputs and parameters
- Complex enough - describe consequences of abatement/mitigation measures
- C and N mass flows
- Web-based user interface



N model

# Livestock

- User defines:
  - Number of each livestock type
  - Composition of feed ration
- Energy and protein budget to predict:
  - Maintenance
  - Growth
  - Milk production

# Manure management

- EEA/EMEP Guidebook Tier 2
  - Emission factors
- $\text{NH}_3$  emission from animal housing
- $\text{NH}_3$ ,  $\text{N}_2$  and  $\text{N}_2\text{O}$  emission from manure storage
- Includes runoff from storage
- $\text{NH}_3$  emission from field-applied manures



# Cattle

**Herd**

**Average**

Farm: 67905  
Scenario: Farm  
Herd

Feed ration

Tied stall

Dunghill without cover

Slurry tank without crust/cover

Delete

Holst

Grass - silage

Barley, husk

Rapeseed

Select feedstuff

0

Kg DM/animal/day

Save

New

Model calculations OK

	(Kg/day)	Weight change (g/day)
1 - Holstein types - dairy	154.8	73.3
	1.3	80.1
	16.4	27.4

Grazing balance (Kg DM)

Produced field

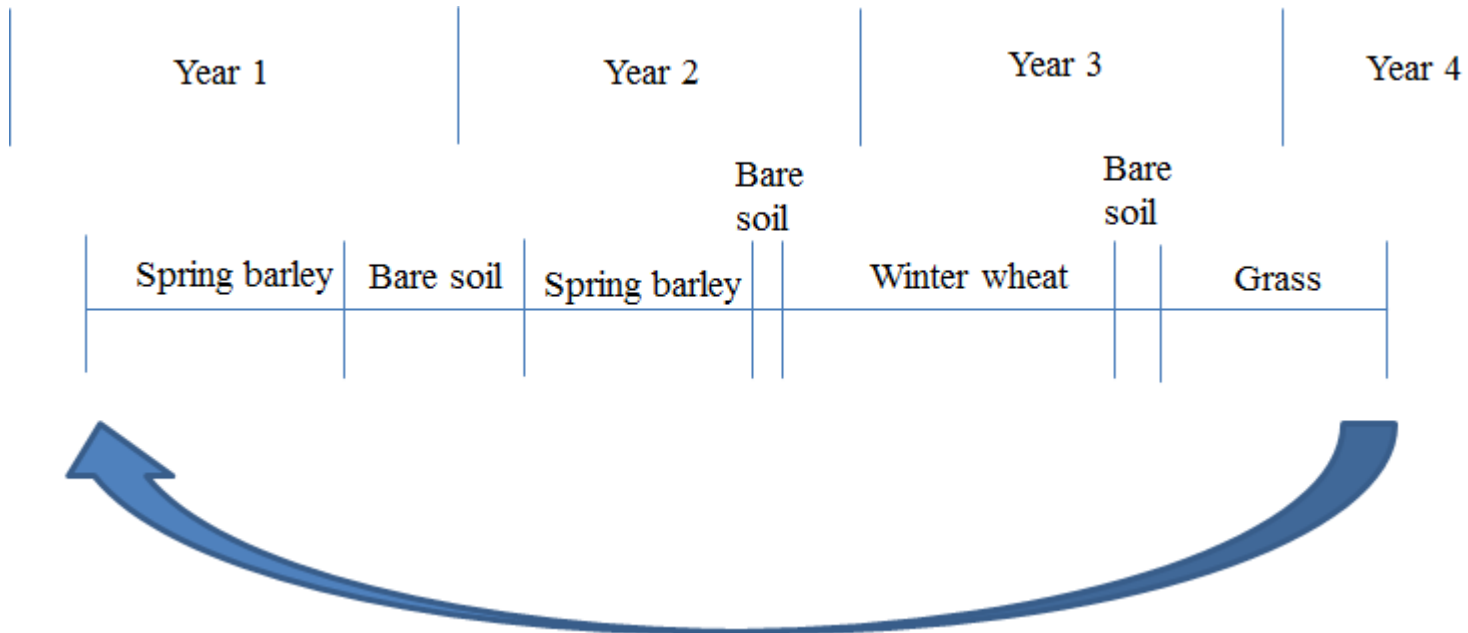
Used

Balance



# Cropping

- None, one or many crop rotations



# Fields

Farm	<b>Rotation</b>	Yield	Ruminants	Non ruminants
<b>Rotation name:</b>				
Cereal				
<b>Crop</b>				
Spring barley				
Winter wheat				
Oat				
Grass				
<input type="button" value="New crop"/> <input type="button" value="Save rotation"/> <input type="button" value="Delete rota"/>				
<b>Rotation name:</b>				
Permanent grass				
<b>Crop</b>				
Grass				
<input type="button" value="New crop"/> <input type="button" value="Save rotation"/> <input type="button" value="Delete rota"/>				
<b>Rotation name:</b>				
Italian ryegrass, spring, early				
<b>Crop</b>				
Grass				
<input type="button" value="New crop"/> <input type="button" value="Save rotation"/> <input type="button" value="Delete rota"/>				
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JB 1)	Start date	End date	Irrigation	
	21-03-2000	08-08-2000	Irrigated ▾	<input type="button" value="Delete crop"/>
	09-09-2000	27-07-2001		<input type="button" value="Delete crop"/>
	01-04-2002	01-08-2002		<input type="button" value="Delete crop"/>

JB 1)	End date	Irrigation	
	08-08-2000	Irrigated ▾	<input type="button" value="Delete crop"/>
	27-07-2001		<input type="button" value="Delete crop"/>
	01-08-2002		<input type="button" value="Delete crop"/>
	31-08-2003		<input type="button" value="Delete crop"/>

# Fertilizer and manure applications

Farm: 67892 [Select farm](#)  
 Kopi af 67891  
 Scenario 1  
 Farm | Rotation | Yield | Ruminants | Non ruminants | **Manure** | Balance | Result

Fertilizer

Yield	Crop	Type of fertilizer	Spreading-method	Kg N/ha		
Cereal	Spring barley	Cattle slurry	Injection	100	March	✗
		Ammonium nitrate	Fertilizer spreading	50	April	✗
		Select manure/fertilizer	Select delivery method	0	Select month	✗

Cereal	Winter wheat	Ammonium nitrate	Fertilizer spreading	120	March	✗
		Select manure/fertilizer	Select delivery method	0	Select month	✗
Cereal	Spring barley	Cattle slurry	Trailing hose	120	March	✗
		Select manure/fertilizer	Select delivery method	0	Select month	✗
Grassland	Permanent grass	Ammonium nitrate	Fertilizer spreading	120	March	✗
		Select manure/fertilizer	Select delivery method	0	Select month	✗

[Save](#)

# Mineral N supply

- Atmospheric deposition
- Fertilizer N input
- Manure ammonium N input
- Urine N input
- N fixation
- N mineralization/immobilization in soil
  - Crop residues, manure organic N, faeces
  - Simple dynamic soil N model
- Carry-over from previous crop

# Mineral N losses & availability

- Ammonia emission from fertilizer
  - Depends on fertilizer type and spreading method
- $N_2$  and  $N_2O$  from manure, crop residues etc.
  - Source-specific emission factors
- N leaching
  - Simple index-based model for nitrate leaching
  - Organic N leaching – soil model
- Mineral N available to crop = supply - losses

# Crop dry matter yield

- User inputs potential crop DM yield
  - Primary product (e.g. grain, grass)
  - Secondary product (e.g. straw), if relevant
- Actual yield is determined by:
  - Availability of water
  - Availability of mineral N in soil

Farm: 67905 [Select farm](#) [Log out](#)  
 67905 Grass farm with dairy cows and one cropping sequence  
 Scenario 1

Farm | Cropping

N in imported bedding	1.825	kg N/ha/yr
N in imported crop products	22.5583	kg N/ha/yr
N sold in crop products	62.8316	kg N/ha/yr
N sold in crop products	16.6218	kg N/ha/yr
N sold in crop products	0.208	kg N/ha/yr
N sold in crop products	0	kg N/ha/yr
N sold in crop products	0	kg N/ha/yr
N sold in crop products	79.6614	kg N/ha/yr
NH3 emission from housing	5.3182	kg N/ha/yr
N in N2 emission from manure storage	3.0635	kg N/ha/yr
N lost in N2O emission from manure storage	1.0212	kg N/ha/yr
N lost in NH3 emission from manure storage	2.1273	kg N/ha/yr
N lost in runoff from manure storage	0	kg N/ha/yr
Emission of N2 from the field	32.8511	kg N/ha/yr

Carbon flows  
and greenhouse gas emissions

# Applications

- Use to estimate effect of farm-specific measures to improve N use efficiency and reduce N losses
  - Especially where local adaptability is important
- Farm N management data collection
  - Use the interface without using the model
  - Open access



# Future

- Adding phosphorus, ash and water flows
  - Economics + LCA
- Improved modelling of nitrate leaching
- Tier 3 approach for gaseous emissions
  - e.g. temperature-dependent emissions factors
- [nick.hutchings@agrsci.dk](mailto:nick.hutchings@agrsci.dk)