

Modelling nitrogen flows and losses on dairy livestock farms

Nick Hutchings

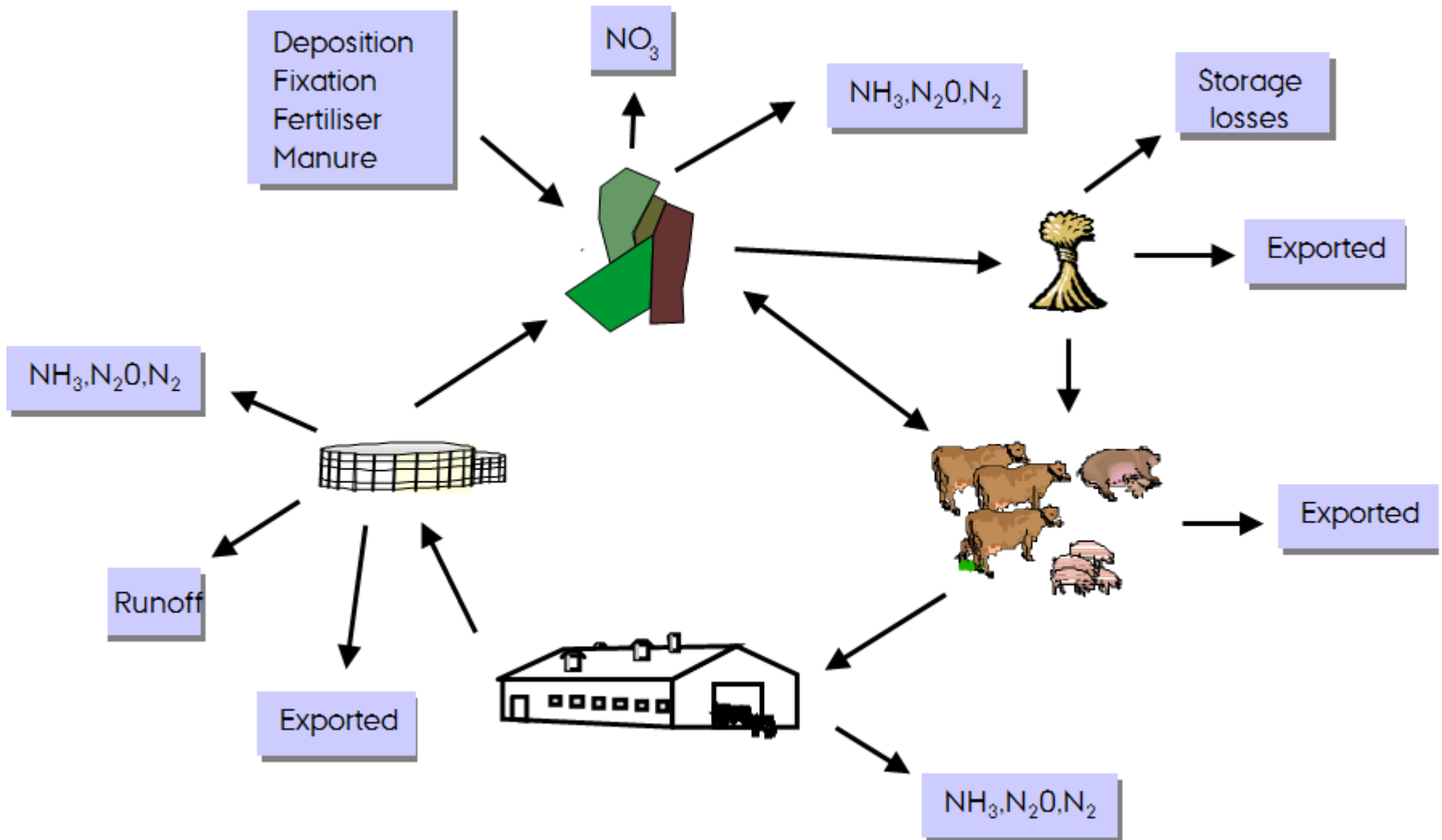


 European Project n° 266018 

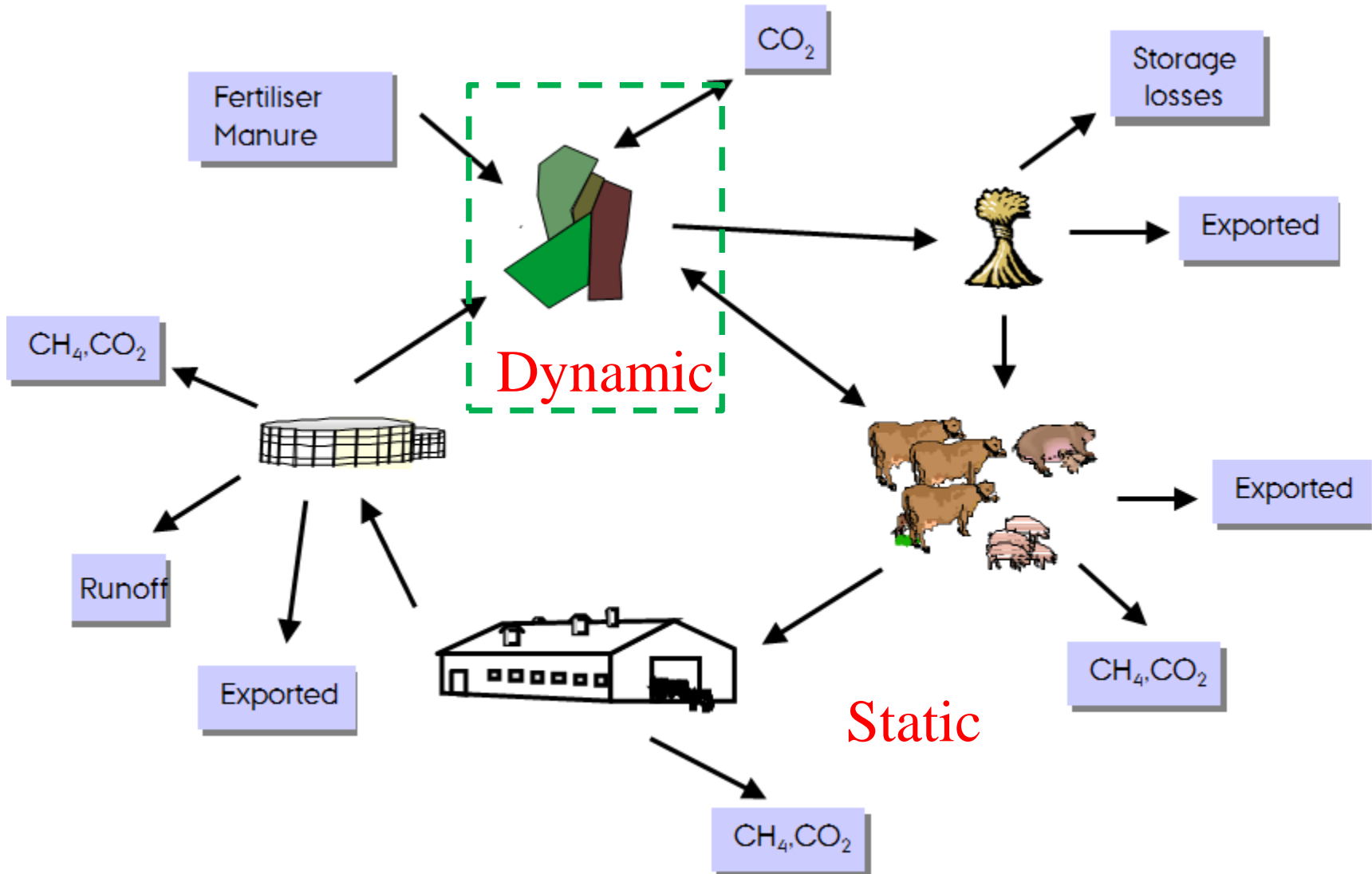
FarmAC - underlying philosophy

- › For researchers (advisors?)
- › Data-poor environments 😊
- › Low temporal resolution 😞
- › Highly flexible 😊
- › User inputs farm structure and management 😞

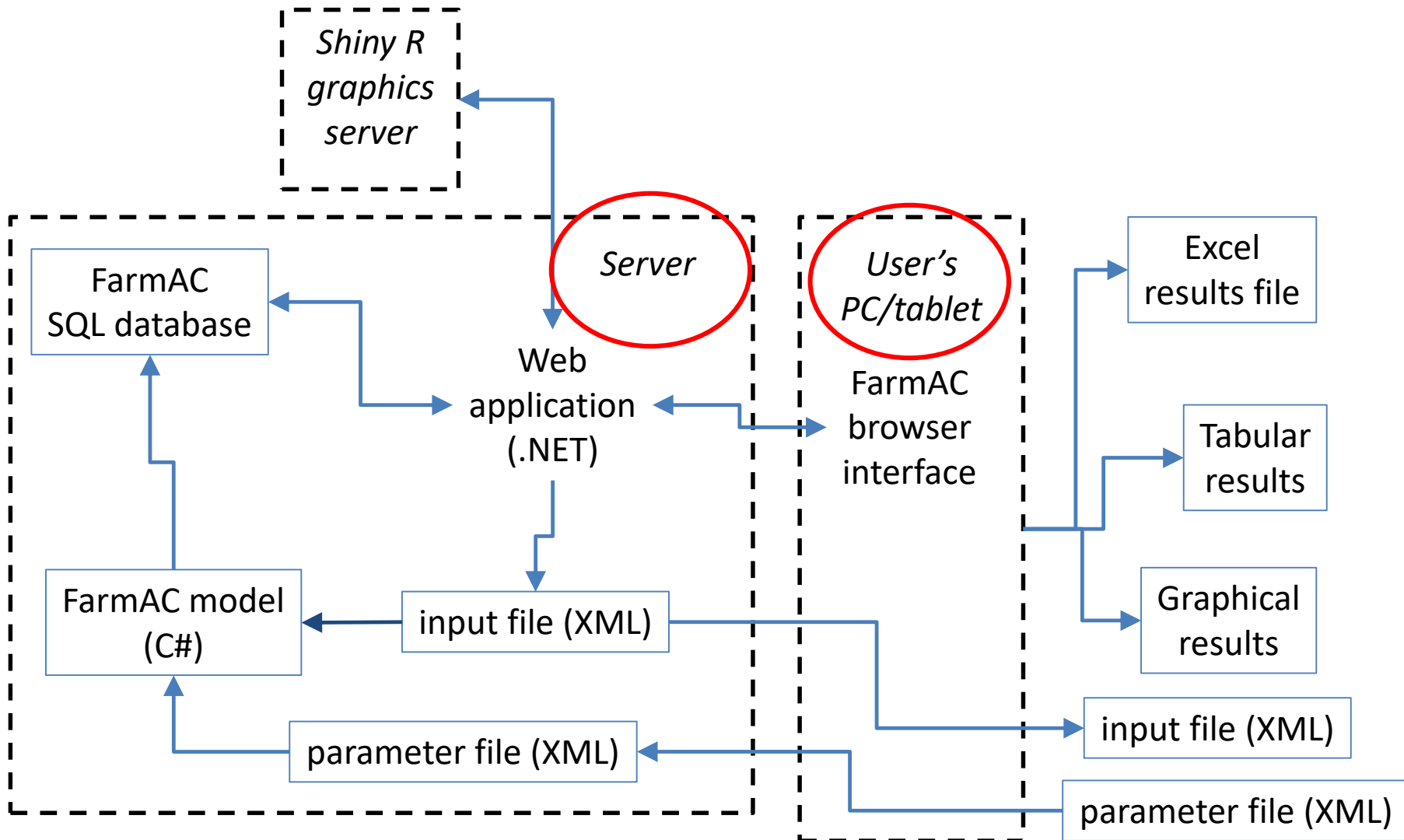
FarmAC - Nitrogen



FarmAC - Carbon



Some technology...



Define crop sequences

Farm | **Crop sequence** | Yield | Ruminants | Non Ruminants | Manure | Balance | Result N | Result C | Result GHG | Documentation

Parameterising

Crop sequence name:	Soil type	Area(HA):
Grass grazed	Sandy Clayey Soil (<= 40% fine sand) (JB 5)	42
Crop	Product 1	Product 2
32 Permanent grass	1466 Grass, 20-25 cm grazed	0 None
32 Permanent grass	2466 Grass, 20-25 cm incorporated	0 None
	Start date	End date
	01/04/2013	30/09/2013
	01/10/2013	31/03/2014
		Irrigation
		0 Rainfed
		0 Rainfed

Save Sequence | New Crop | Delete Sequence | Delete Last Crop

Crop sequence name:	Soil type	Area(HA):
Grass silage	Sandy Clayey Soil (<= 40% fine sand) (JB 5)	58
Crop	Product 1	Product 2
32 Permanent grass	565 Grass - silage, middle fodder index	0 None
32 Permanent grass	2466 Grass, 20-25 cm incorporated	0 None
	Start date	End date
	01/04/2013	30/09/2013
	01/10/2013	31/03/2014
		Irrigation
		0 Rainfed
		0 Rainfed

Save Sequence | New Crop | Delete Sequence | Delete Last Crop

New Sequence

Parameterising

Grass grazed

Crop	Product 1	Product 2	Straw use	Product 1	Product 2
	Grazed yield	Grazed yield		Potential yield	Potential yield
	Kg DM/Ha			kg DM/Ha	
Permanent grass	<input type="text" value="8500"/>			<input type="text" value="9500"/>	
Permanent grass	<input type="text" value="0"/>			<input type="text" value="500"/>	

Save

Grass silage

Crop	Product 1	Product 2	Straw use	Product 1	Product 2
	Grazed yield	Grazed yield		Potential yield	Potential yield
	Kg DM/Ha			kg DM/Ha	
Permanent grass				<input type="text" value="9500"/>	
Permanent grass	<input type="text" value="0"/>			<input type="text" value="500"/>	

Save

Number of livestock and feed ration

Farm	Crop sequence	Yield	Ruminants	Non Ruminants	Manure	Balance	Result N	Result C	Result GHG	Documentation																						
			<p>Average animal population (365 feeding days)</p> <p>1 Holstein types - dairy <input type="text" value="90.00"/></p>	<p>Feed ration</p> <table border="1"> <tr> <td>1466 Grass, 20-25 cm grazed</td> <td>9.3</td> <td>KgDM/animal/day</td> <td>Delete</td> </tr> <tr> <td>201 Spring barley</td> <td>1</td> <td>KgDM/animal/day</td> <td>Delete</td> </tr> <tr> <td>565 Grass - silage, middle fodder index</td> <td>2</td> <td>KgDM/animal/day</td> <td>Delete</td> </tr> <tr> <td>781 Spring barley - straw</td> <td>0.53</td> <td>KgDM/animal/day</td> <td>Delete</td> </tr> <tr> <td>151 Soyabean cake</td> <td>0.8</td> <td>KgDM/animal/day</td> <td>Delete</td> <td>new Feedstuff</td> </tr> </table>								1466 Grass, 20-25 cm grazed	9.3	KgDM/animal/day	Delete	201 Spring barley	1	KgDM/animal/day	Delete	565 Grass - silage, middle fodder index	2	KgDM/animal/day	Delete	781 Spring barley - straw	0.53	KgDM/animal/day	Delete	151 Soyabean cake	0.8	KgDM/animal/day	Delete	new Feedstuff
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			<p>Save <input type="button" value="New"/> <input type="button" value="Update"/></p>																													

Herd	Average animal population (365 feeding days)	Feed ration	Housing type
1 Holstein types - dairy	90.0	1466 Grass, 20-25 cm grazed 9.3 KgDM/animal/day Delete 201 Spring barley 1 KgDM/animal/day Delete 565 Grass - silage, middle fodder index 2 KgDM/animal/day Delete 781 Spring barley - straw 0.53 KgDM/animal/day Delete 151 Soyabean cake 0.8 KgDM/animal/day Delete new Feedstuff	3 Cubical ho
1 Holstein types - dairy	90.0	593 Maize - silage, middle fodder index 12 KgDM/animal/day Delete 151 Soyabean cake 1 KgDM/animal/day Delete new Feedstuff	3 Cubical ho
2 Holstein types - heifers	90.0	565 Grass - silage, middle fodder index 2 KgDM/animal/day Delete new Feedstuff	4 Fully slatte
1 Holstein types - dairy	90.0	1466 Grass, 20-25 cm grazed 2 KgDM/animal/day Delete new Feedstuff	0 None

[Save](#) [New](#) [Update](#)

Herd requirements, production and manure

Herd	Energy intake (MJ/day/animal)	Energy used for maintenance (MJ/day/animal)	Energy used for growth (MJ/day/animal)	Energy used for milk production (MJ/day/animal)	Energy supplied by remobilisation (MJ/year/animal)	Average daily milk production (Kg/day)	Average weight change (g/day)
1 - Holstein types - dairy	149.3301	72.992	1.3518	74.9863		15.2838	27.3973
1 - Holstein types - dairy	141.1695	72.4183	1.3637	67.3875		13.6921	27.3977
2 - Holstein types - heifers	20.4573	28.5048			8.0474		-416.834
1 - Holstein types - dairy	21.8953	61.5367			39.6414		-2051.8324

Grazing balance (Kg DM)	Produced	Used	Balance	Balance %
Grass, 20-25 cm	357000	371205	-14205	-3.98

Manure management system

Result C | Result GHG | Documentation | Parameterising

	Housing type	Manure storage type	
1.53 KgDM/animal/day			Delete
4.16 KgDM/animal/day			Delete
4.6 KgDM/animal/day			Delete
2.3 KgDM/animal/day			Delete
0.31 KgDM/animal/day			Delete
1.58 KgDM/animal/day			Delete
3.26 KgDM/animal/day			Delete
0.66 KgDM/animal/day			Delete
	new Feedstuff		

2 Cubical house - solid floor | 2 Slurry tank with crust/cover | Delete

Grazed feed is different

> Non-grazed feed

- > Difference between consumption & production results in import or export
- > Realistic

> Grazed feed

- > Mainly occurs on the farm – no import/export
 - > Emissions associated with deposited excreta
- > User must balance DM consumption and production
- > Grazed feed production must be achieved

Fertiliser and manure

Farm	Crop sequence	Yield	Ruminants	Non Ruminants	Manure	Balance	Result N	Result C	Result GHG	Doc
Parameterising										

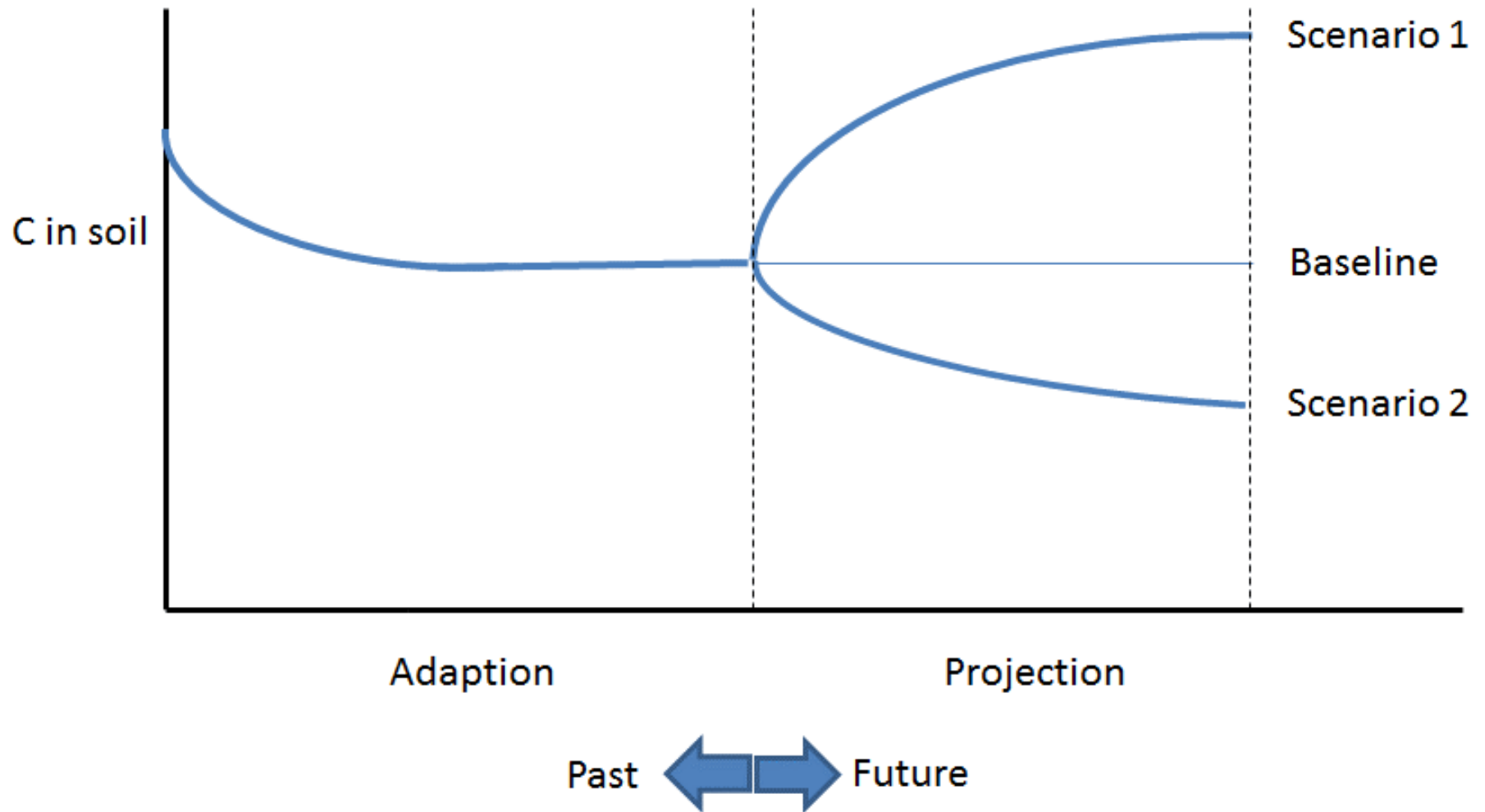
N content in produced organic manure (ab storage)

Manure type	Produced	Bought	Used
Cattle slurry	8431.94	54140.0552	62572

Distribution of manure and fertilizer (per ha)

Cropping sequence	Crop	Type of fertilizer	Spreading-method	Kg N/ha		
Grass grazed	Permanent grass	Urea	5 Fertilizer spreading	50	April	Delete
		1 Cattle slurry	2 Trailing hose	44	May	Delete
		1 Cattle slurry	2 Trailing hose	44	July	Delete
		Select manure/fertiliser	Select delivery method	0	Select month	New manure

Soil C and N storage



Farm manure and feed balance

Farm	Crop sequence	Yield	Ruminants	Non Ruminants	Manure	Balance
Parameterising						
Manure– kg N						
		Produced	Bought	Sold	Used	
Manure type						
	cattle slurry, with cover	0	22792.62	0	22792.62	
	cattle slurry, with cover	8431.94	0	0	8431.94	
Feed						
		Produced	Bought	Sold	Used	
	Feed type	Kg DM	Kg DM	Kg DM	Kg DM	
	Corn cob maize	0	86748.33	0	86748.33	
	default bedding	0	31122.4	0	31122.4	
	Grass - silage, high fodder quality	662020.61	0	488523.95	173496.67	
	Grass, 12-15 cm	52000	0	64.15	51935.85	
	Hay, standard	0	59592.33	0	59592.33	
	Maize - silage, high fodder quality	557986.86	0	401085.53	156901.33	
	Soyabean meal	0	24893	0	24893	
	Spring barley	0	122956.33	0	122956.33	
	Wheat meal	0	11692.17	0	11692.17	

Outputs

- › Animal and crop production
- › C and N budgets
 - › Livestock, manure management, field, farm
- › Direct and indirect GHG budgets
 - › Including C sequestration in soil

Model is most applicable to:

- › Need farm-specific estimates of GHG emissions
- › Livestock farms (especially ruminants)
 - › Balance feed production and consumption
- › Where crop/manure residues are particularly important
- › Need to assess GHG mitigation measures
- › Limited availability of data means more complex models cannot be used

FarmAC - contributors

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Thank you

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