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Modelling nitrogen flows and losses on dairy livestock farms

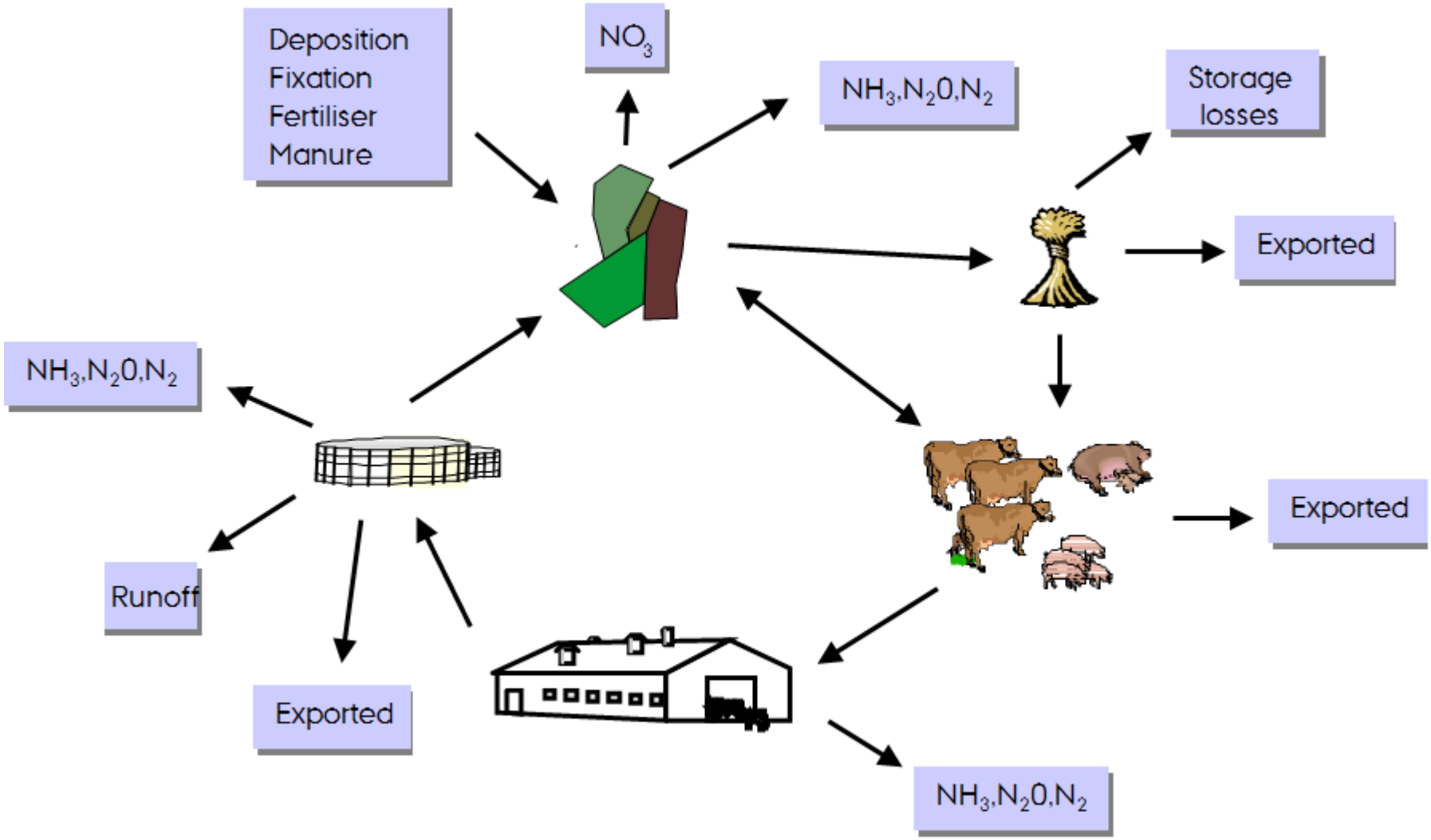
Nick Hutchings

European Project n° 266018

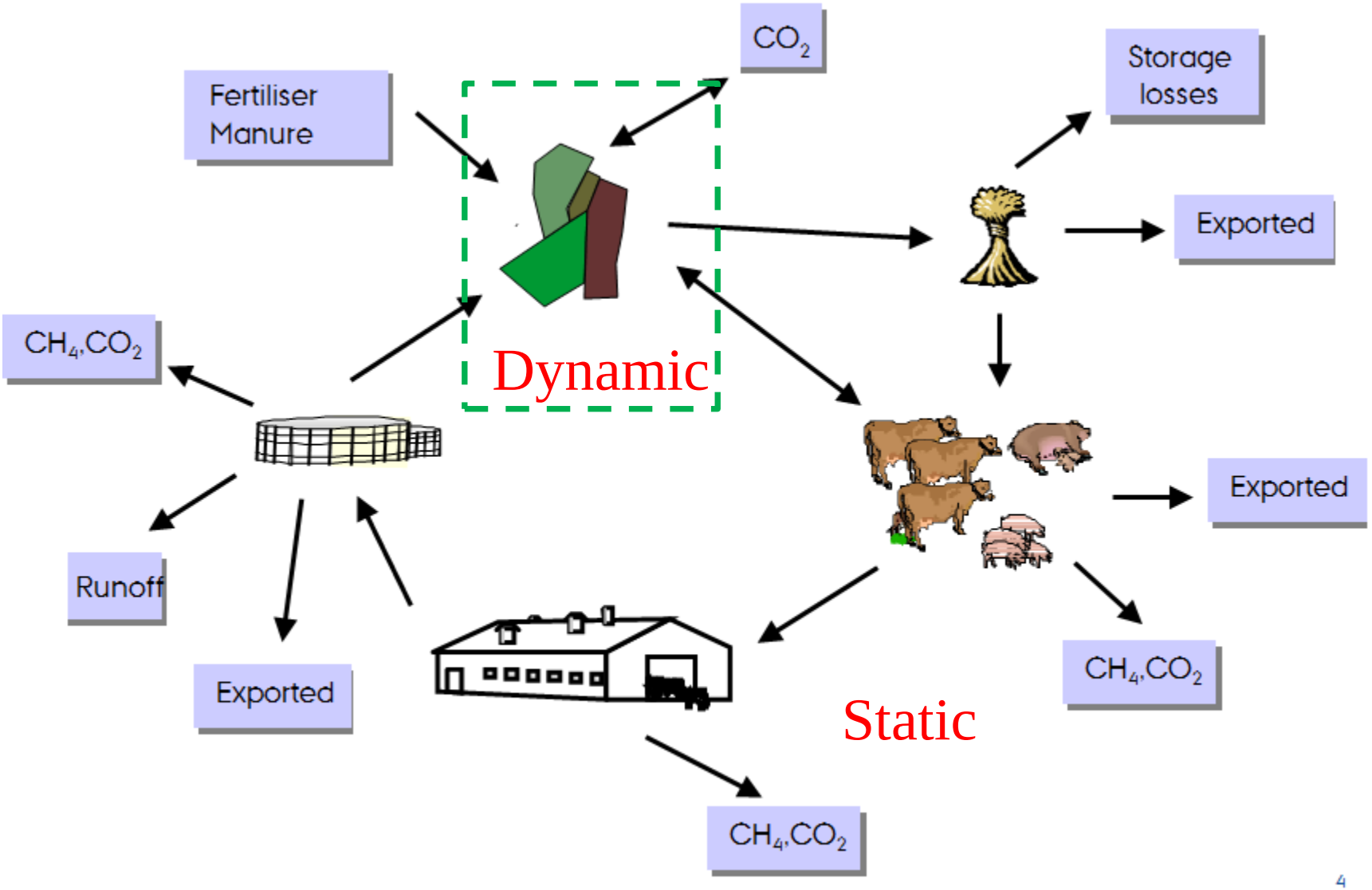
FarmAC - underlying philosophy

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

FarmAC - Nitrogen



FarmAC - Carbon



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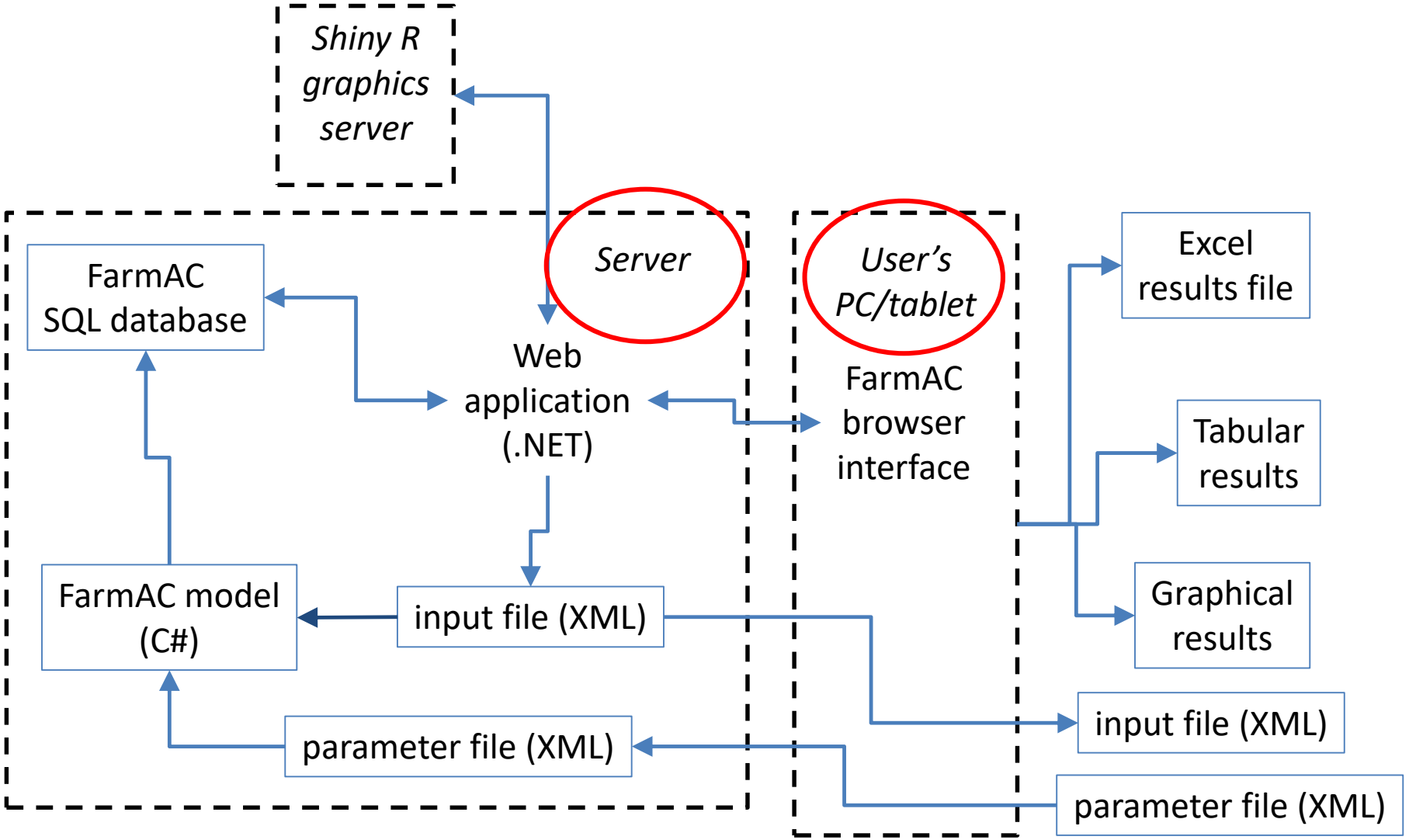
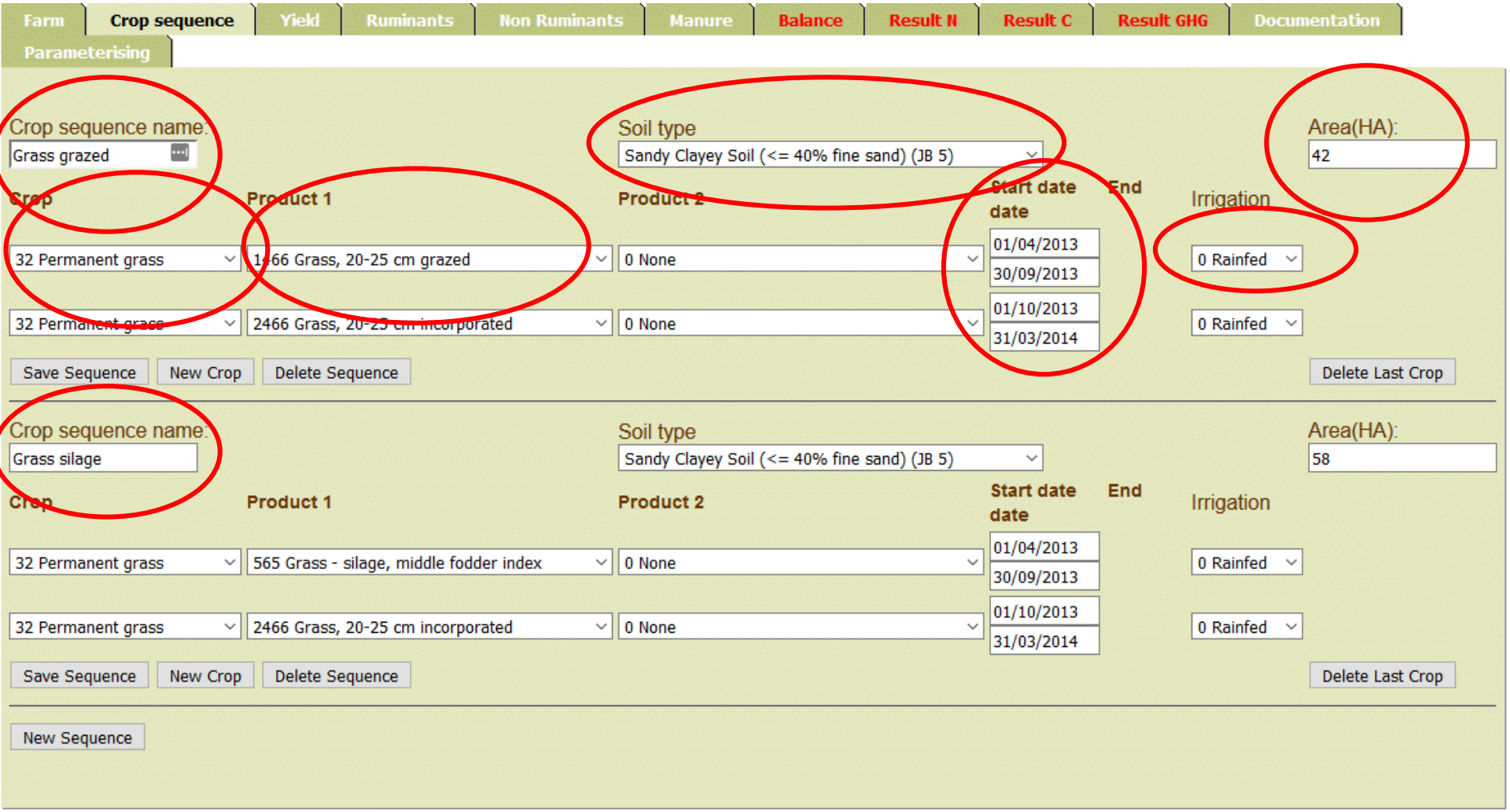
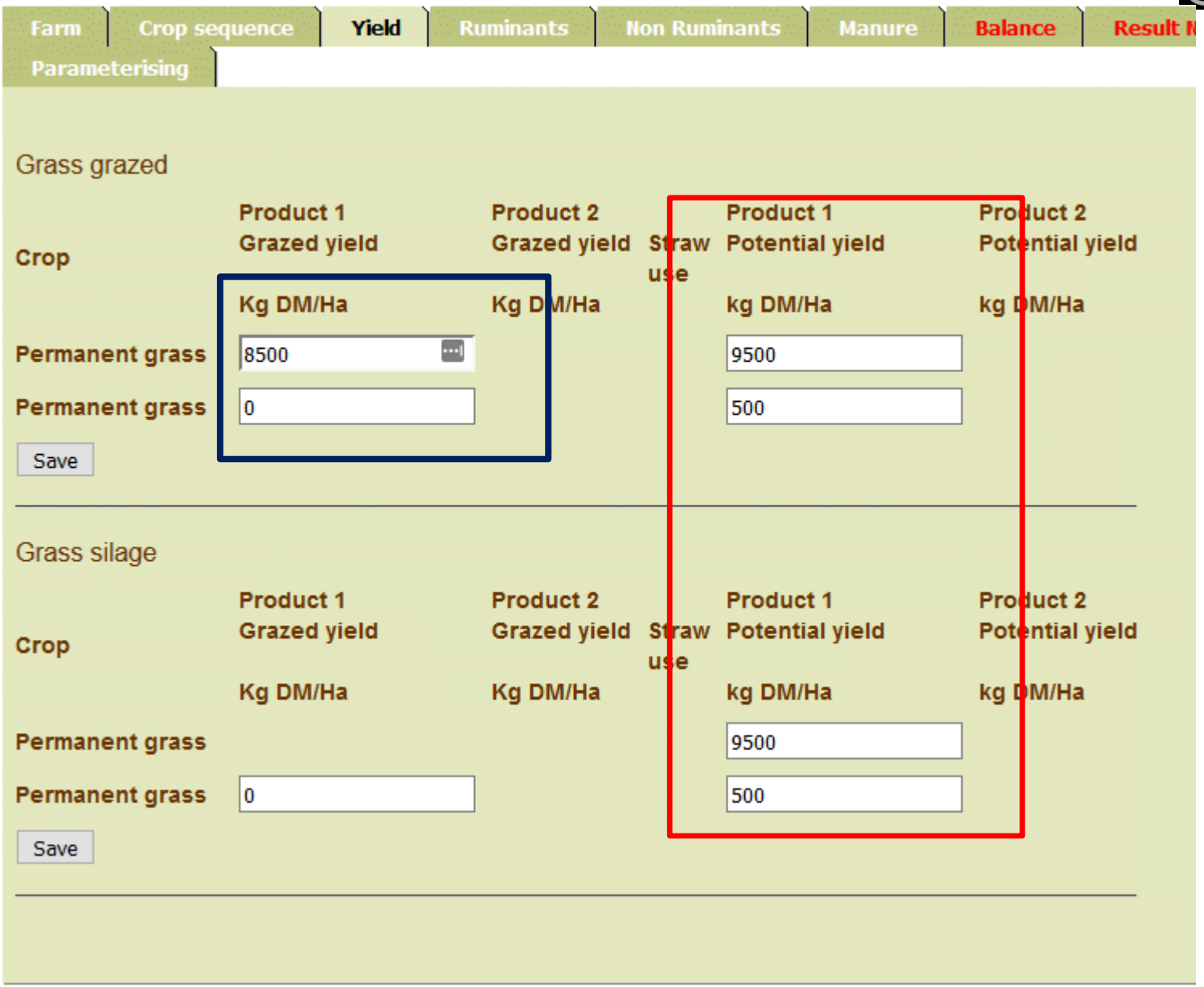
Some technology…



Define crop sequences




Farm
Crop sequence
Yield
Ruminants
Non Ruminants
Manure
Balance
Result N
Parameterising
Grass grazed
Crop
Product 1 Grazed yield
Kg DM/Ha
Product 2 Grazed yield
Kg DM/Ha
Straw use
Product 1 Potential yield
kg DM/Ha
Product 2 Potential yield
kg DM/Ha
Permanent grass
8500
9500
Permanent grass
0
500
Save
Grass silage
Crop
Product 1 Grazed yield
Kg DM/Ha
Product 2 Grazed yield
Kg DM/Ha
Straw use
Product 1 Potential yield
kg DM/Ha
Product 2 Potential yield
kg DM/Ha
Permanent grass
9500
Permanent grass
0
500
Save

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Number of livestock and feed ration

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

Herd	Average animal population (365 feeding days)	Feed ration				
1 Holstein types - dairy	90.00	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
1 Holstein types - dairy	90.00	593 Maize - silage, middle fodder index	12	KgDM/animal/day	Delete	
		151 Soyabean cake	1	KgDM/animal/day	Delete	new Feedstuff
2 Holstein types - heifers	90.00	565 Grass - silage, middle fodder index	2	KgDM/animal/day	Delete	new Feedstuff
1 Holstein types - dairy	90.00	1466 Grass, 20-25 cm grazed	2	KgDM/animal/day	Delete	new Feedstuff

Save | New | Update

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

Herd	Average animal population (365 feeding days)	Feed ration			Housing ty
1 Holstein types - dairy	90.0	1466 Grass, 20-25 cm grazed	9.3	KgDM/animal/day Delete	3 Cubical ho
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1 Holstein types - dairy	90.0	1466 Grass, 20-25 cm grazed	2	KgDM/animal/day Delete new Feedstuff	0 None

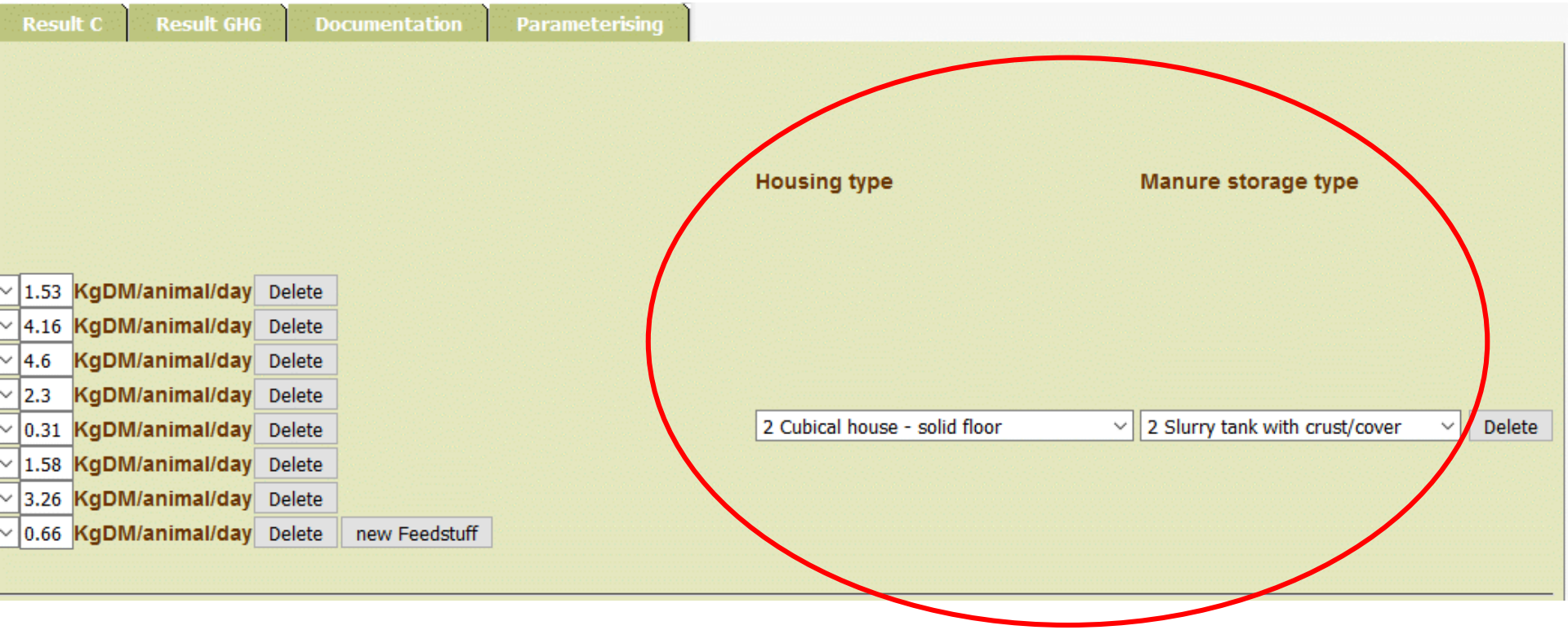
Save | New | Update

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/anima	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	27.3973
2 - Holstein types - heifers	20.4573	28.5048			8.0474		-416.534
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

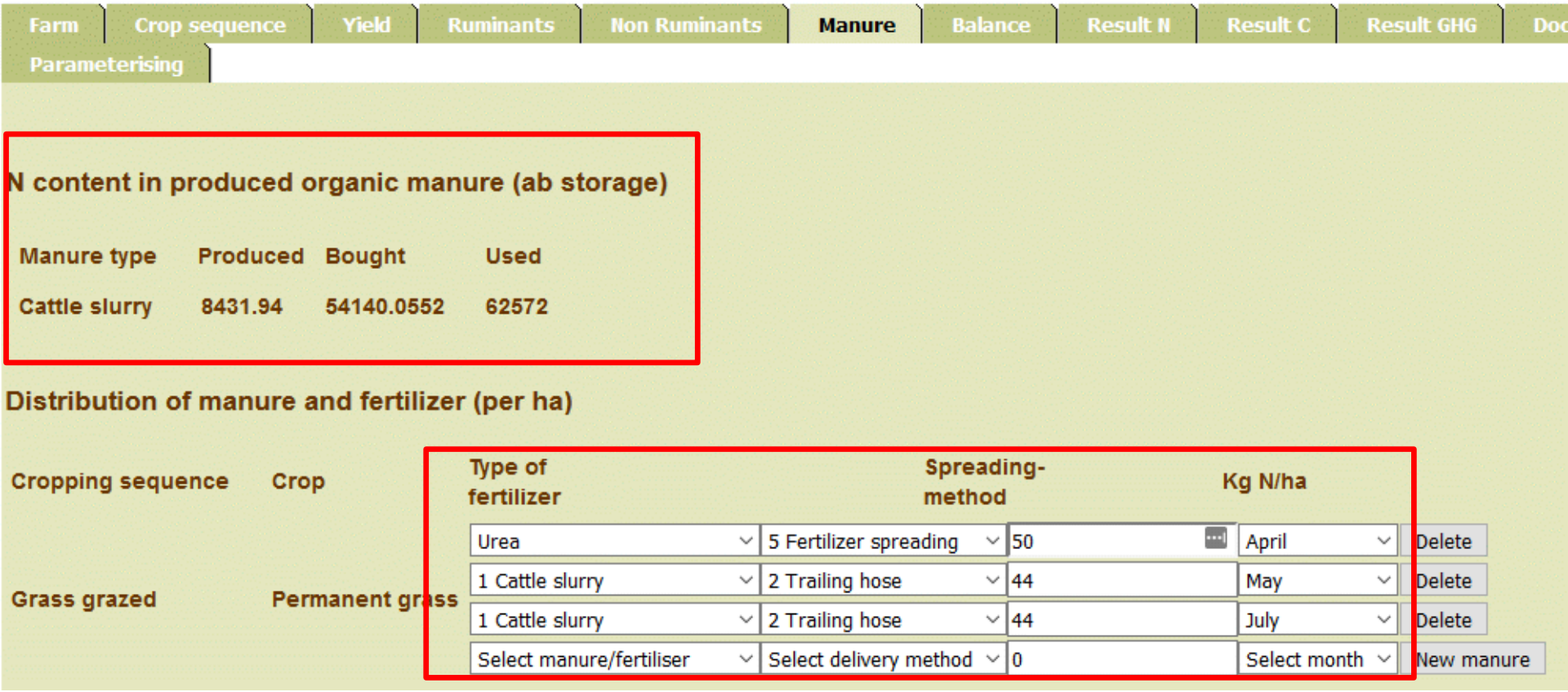
Manure management system



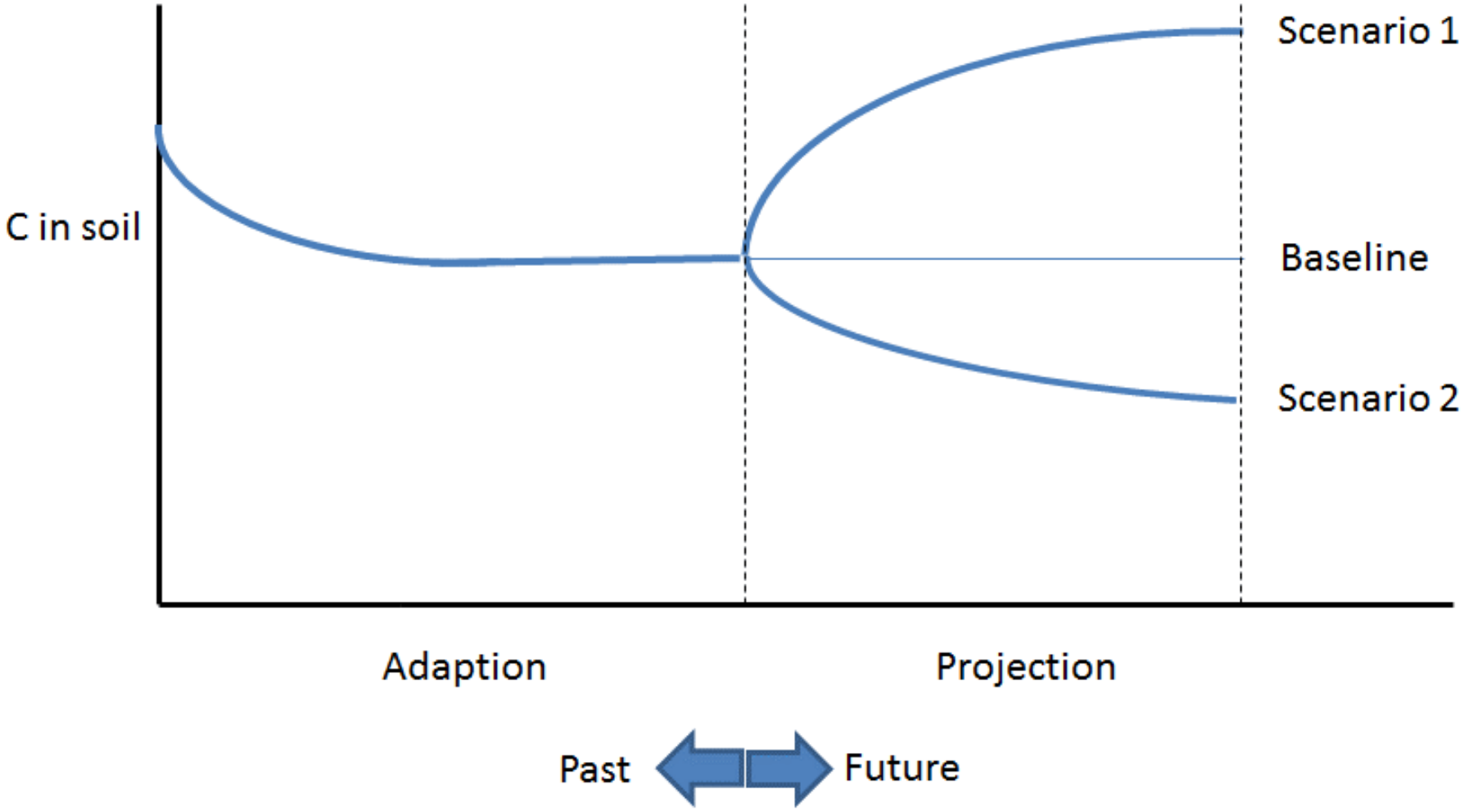
Grazed feed is different

- 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



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 beddding	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

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FarmAC - contributors

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- UFRGS, Brazil
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Thank you

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