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Planning tool for calculating carbon footprint of milk and meat

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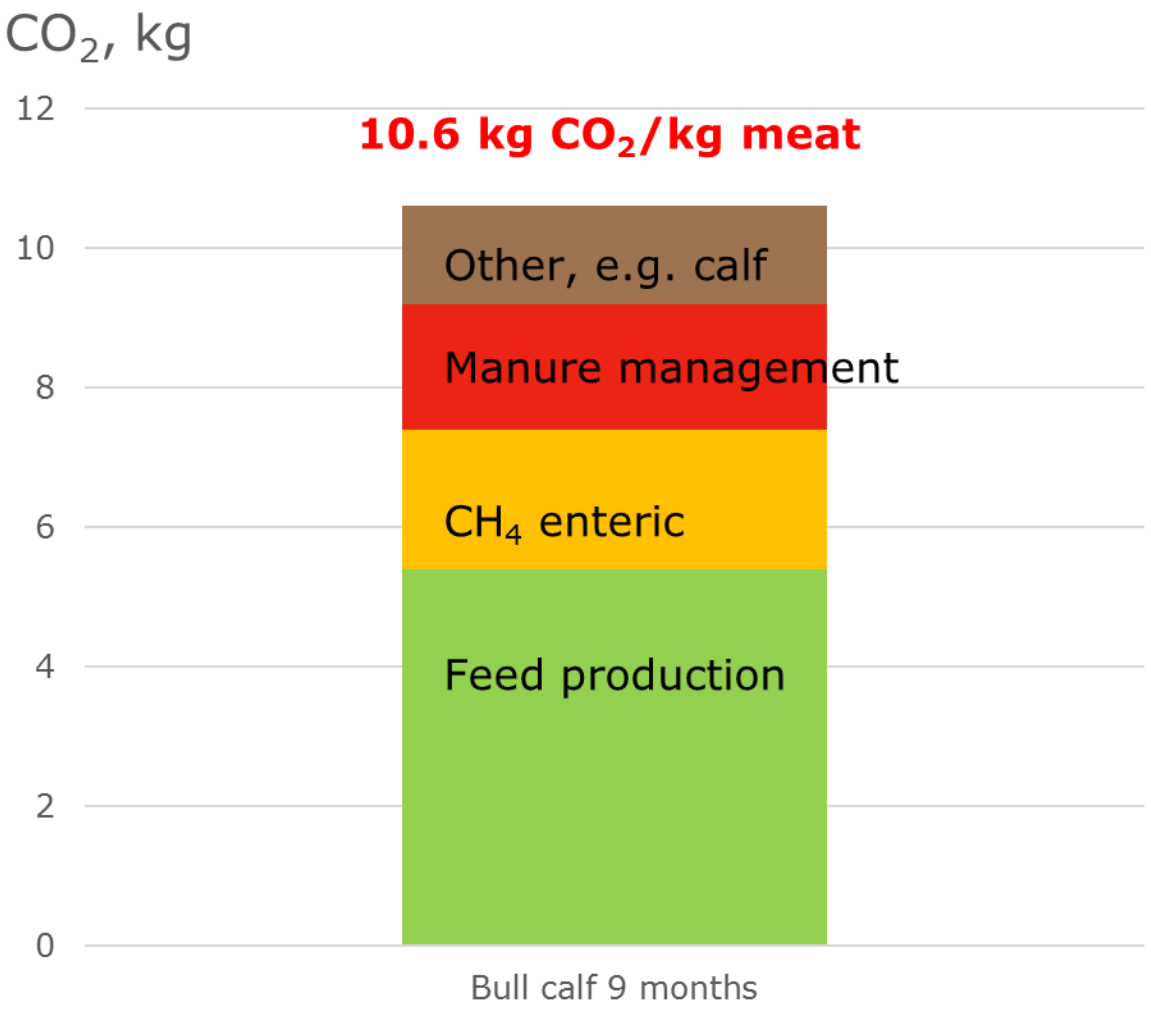
Background

Carbon footprint of meat from Holstein bull calves



(Mogensen et al., 2016)

Aim I

The aim with this tool: the carbon footprint (CF) is calculated as the sum of the major GHG contributions:

- feed production
- enteric methane emissions
- emissions related to manure management and
- other smaller contributions

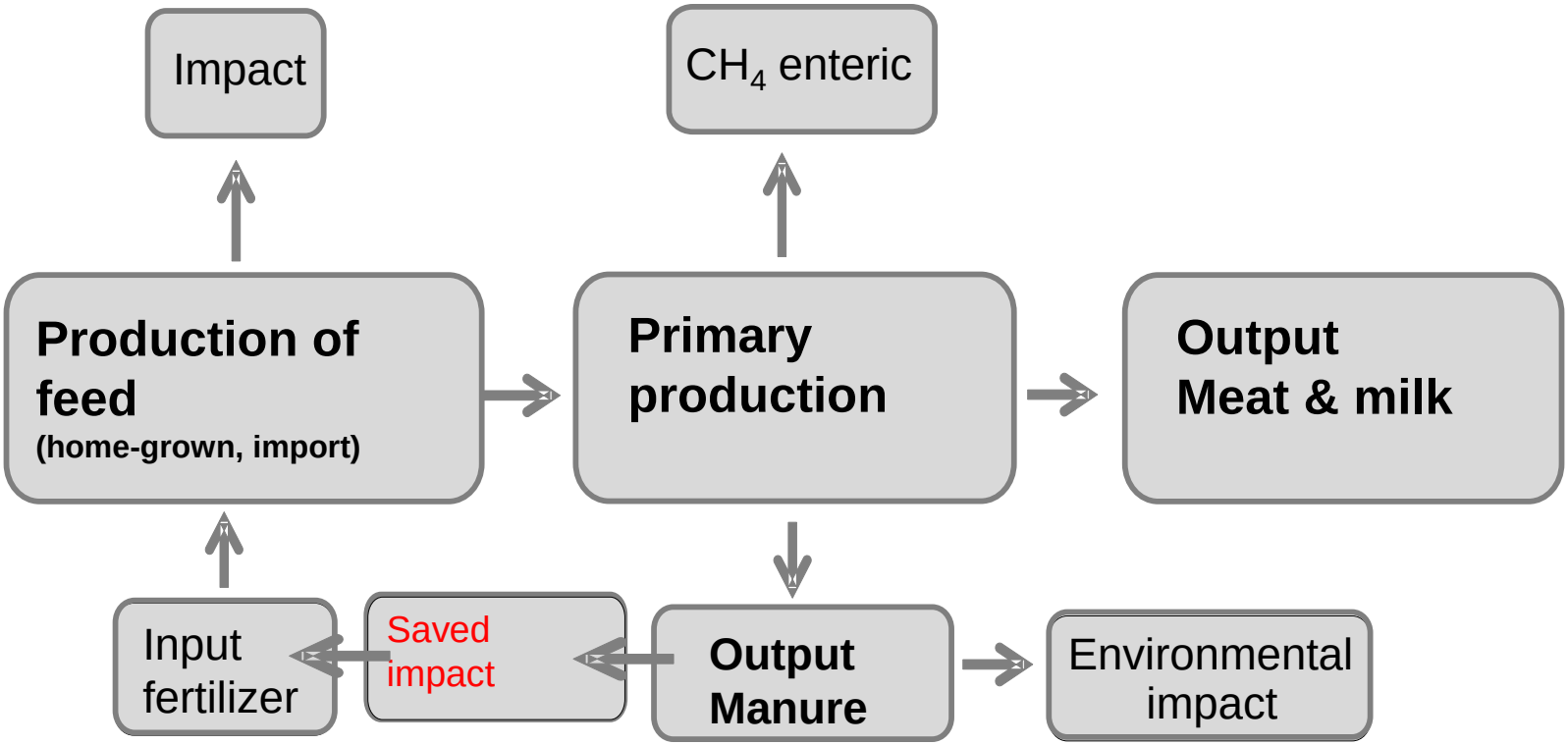
The most important input data to the tool is the planned feeding per animal per day (kg DM) and technologies used for manure management.

Aim II

- At the moment testing of the tool

- Next step is implemented the carbon footprint of feeds in the Danish 'NorFor model', which is a ration formulation tool used on commercial dairy and beef farms for optimization of nutritional and economic parameters and – in the future also climate parameters at the same time.

Methods
Life cycle assessment (LCA)

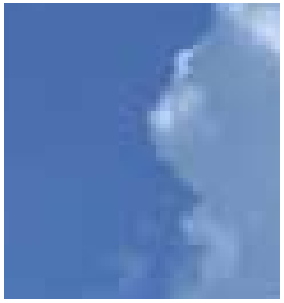


Materials and methods

Life cycle assesment (LCA)

Impact categories

Carbon footprint (kg CO_2)



Eutrophication (EP)

Fossil energy (NRE)

Biodiversity loss

Land use (m^2)

Methods
Enteric methane emission

Young stock:

CH_4 (MJ/d) = (-0.046 * conc. share + 7.1379)/100* GE

Where:
Conc. Share: proportion of concentrated feed as % of DM,
GE: gross energy (MJ per day)

Cows:

CH4 (MJ/d) = 1.39*DMI-0.091*FA

Where:
DMI: dry matter intake (kg DM per day) and
FA: fatty acids (g per kg DM)

(Nielsen et al, 2013)

Environmental impact of feed

Emissions to air (N_2O, NH_3, CO_2 etc.)

INPUT

Materials

e.g. fertilizer

Energy

e.g. fuel

Chemicals

e.g. pesticides

Other

OUTPUT

Crop yield

Residues or co-product

Emissions to soil and water

(NO_3^-, pesticides etc.)

transport

Production of inputs

transport

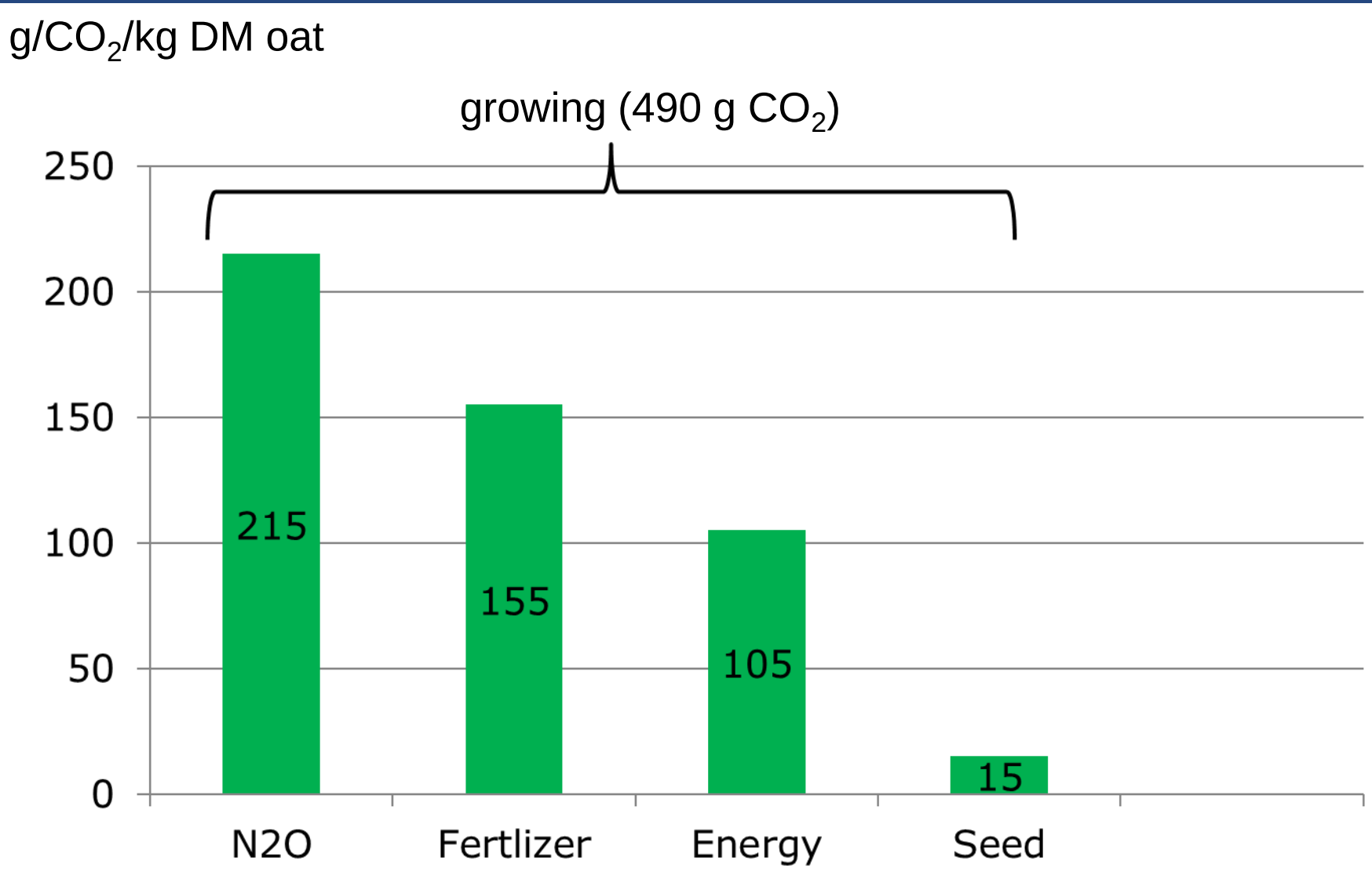
Agricultural production

Processing

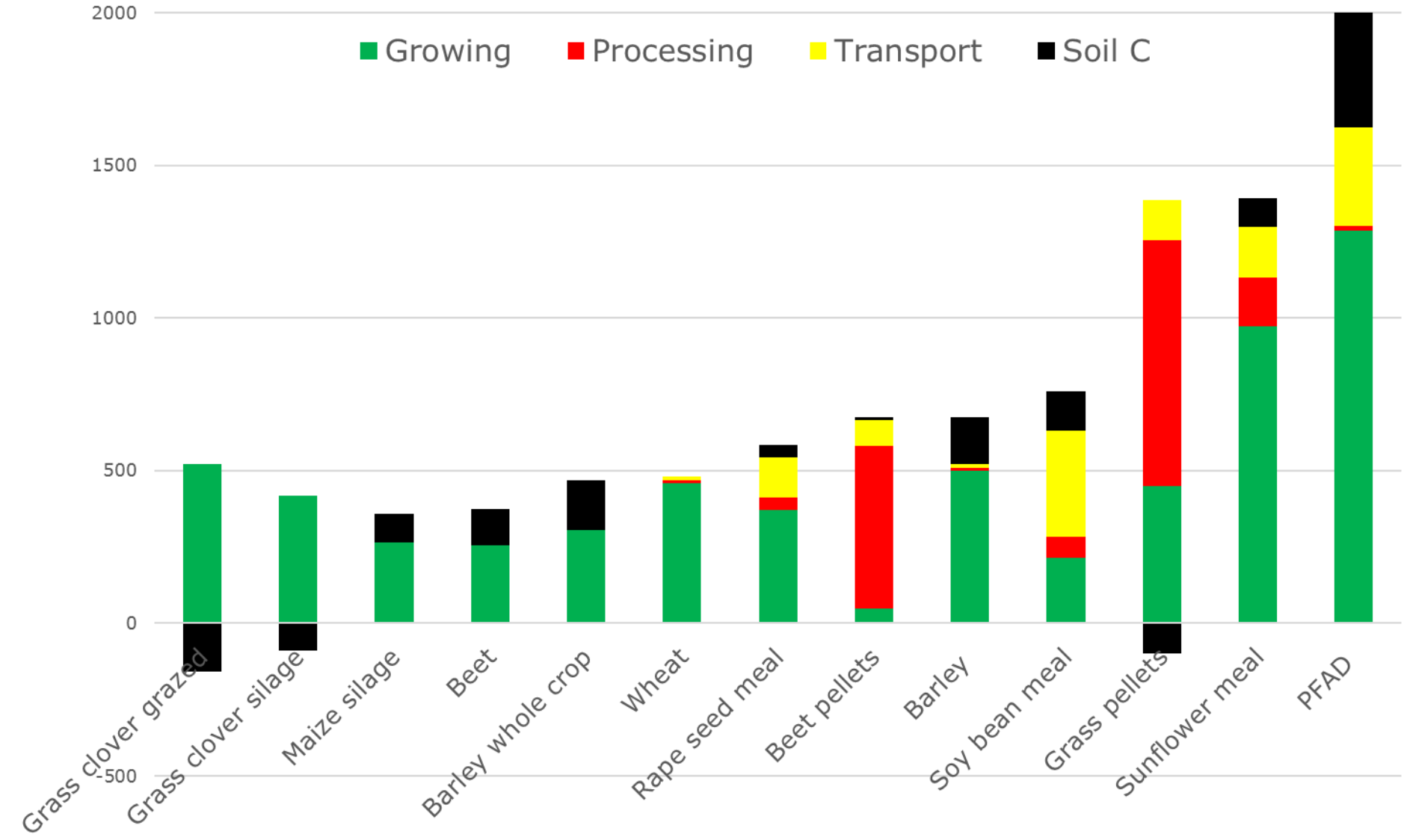
transport

Oat for feed

Carbon footprint of oat from farm



Carbon footprint per kg DM feed, g CO_2



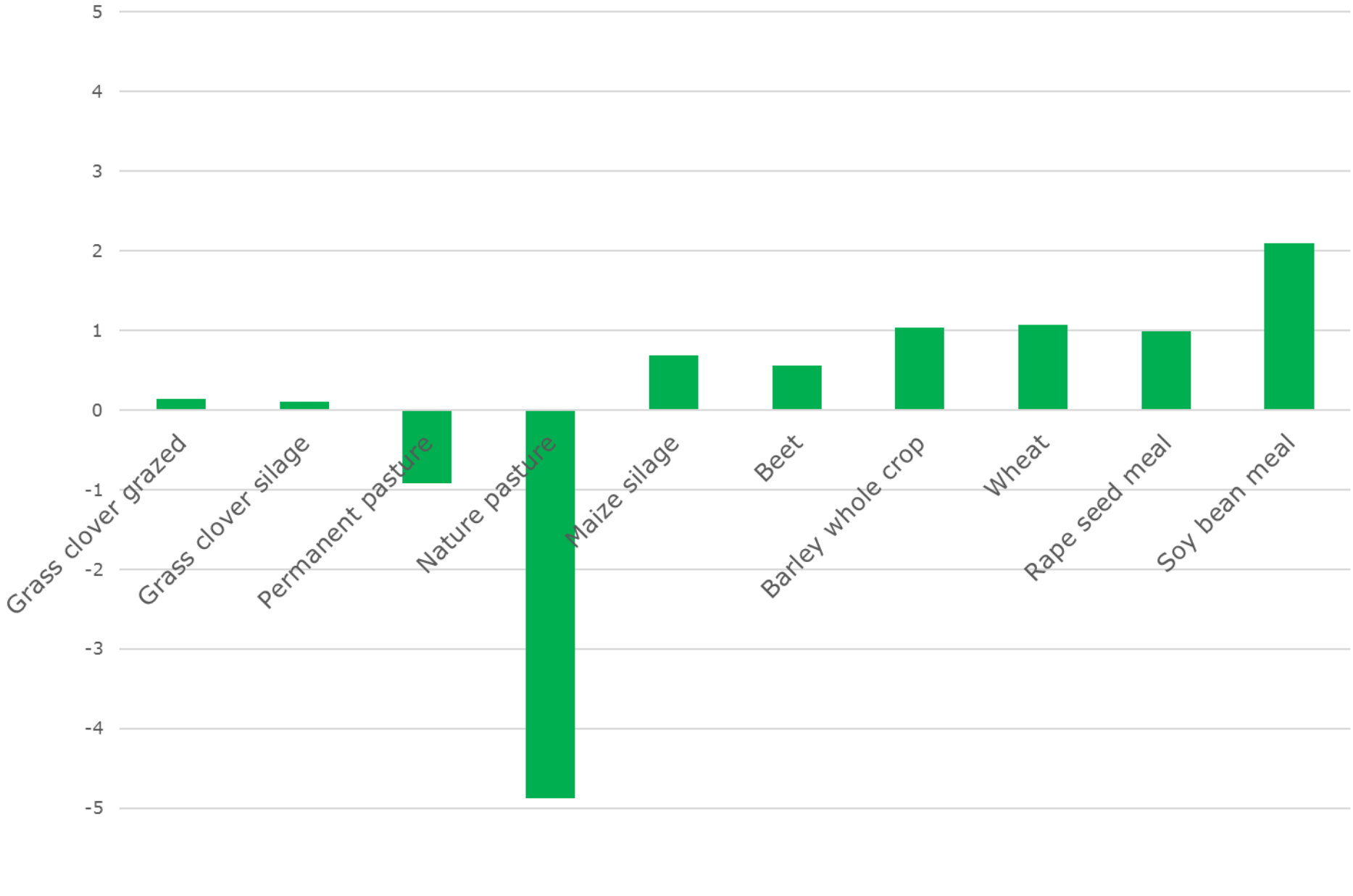
Effect on biodiversity loss

PDF = potential disappeared fraction

Crop		Plant species	PDF
Annual crop, not grass	Conv.	6	0.68
	Organic	14	0.29
Grass in rotation	Conv.	18	0.09
Natural forest, EU		20	0
Grass in rotation	Organic	22	- 0.12
Permanent pasture	Conv.	25	- 0.23
	Organic	27	- 0.34
Nature pasture		27	- 0.34

(Knudsen et al., 2017)

Biodiversity loss per kg DM feed, PDF-index



Methods

Manure management

Manure excretion:

N ex animal = N in feed –
(N in milk N in gain + N in embryo)

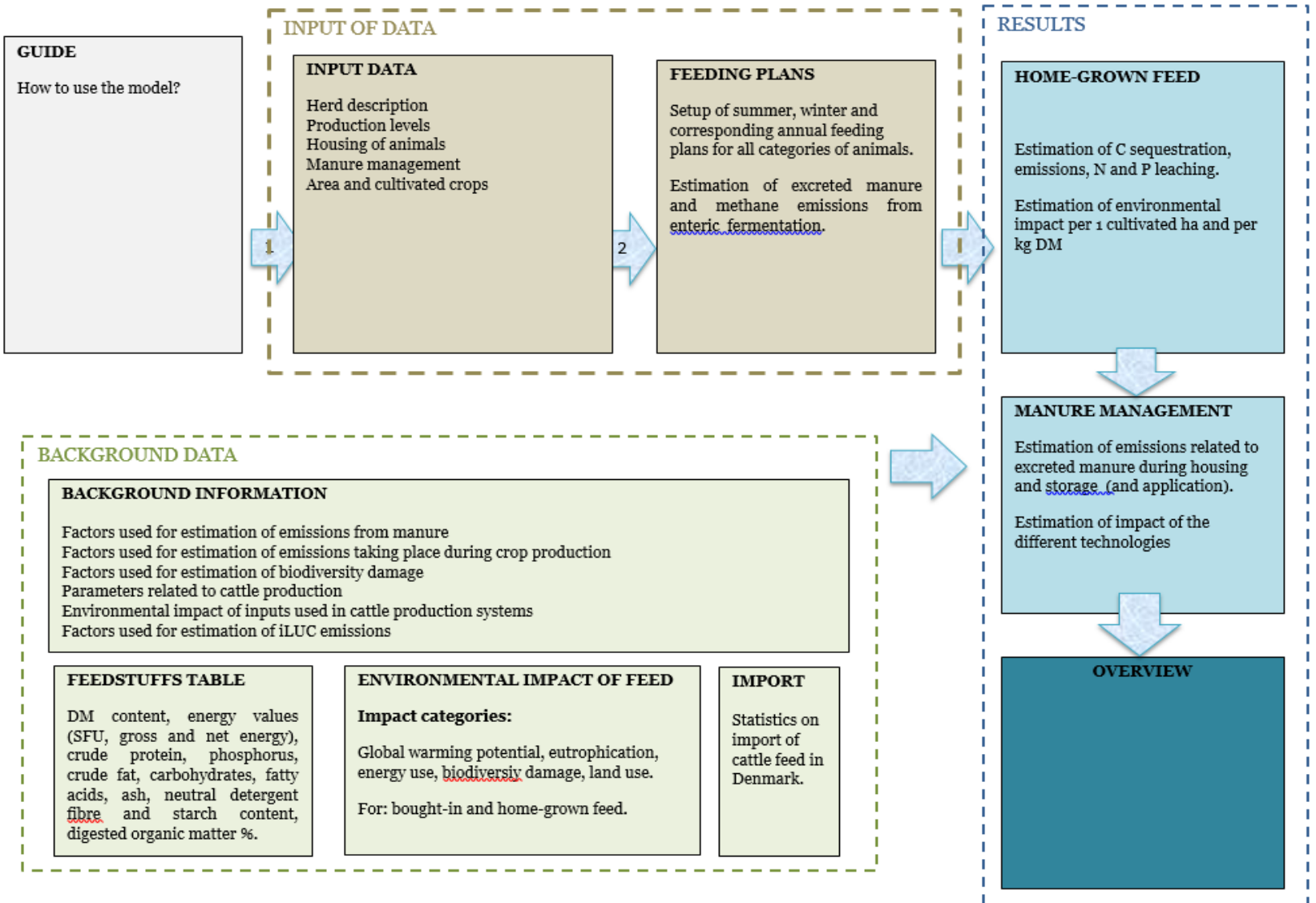
Emissions from Manure management

Exampel 100 kg N ex animal as slurry

Emissions from manure handling	**kg CO_2-eq**.
N_2O-N direct, NH_3-N, N_2O-N indirect	1171
C sequestration from manure	- 287
N from manure stored in soil -> avoided leaching	- 17
Total GHG from manure handling	**867**
Avoided fertilizer production	
Fertilizer value of manure	- 418
Avoided fertilizer emission	-574
Total GHG from avoided fertilizer production	**-992**
GHG from 100 kg N	**-125**

(Mogensen et al., 2014)

Design of the planning tool



The four rations for cows with 10.500 kg ECM

- A: Standard ration
- B: By-products, brewers grain & sugar beet pulp
- C: Roughage from maize silage
- D: Feeds with low carbon footprint (CF)

Composition of rations (157 MJ NEL)

kg DM/day	A Standard	B By-products	C Maize	D Low CF
Barley	3.8	2.7	2.7	
Wheat				3.9
Rapeseed cake	3.7	4.0	4.5	2.2
Soybean meal	1.0	1.0	1.1	
Sugar beet pellets	1.3		1.3	
Grass clover silage	5.0	3.0	3.1	13.4
Maize silage	8.9	9.0	11.0	
Brewers grain		2.0		2.0
Sugar beet pulp		2.0		2.0
Fat				0.4
Total	**23.7**	**23.7**	**23.7**	**23.9**
Roughage, % DM	58	51	59	56
Fatty acids,g/kg DM	27	34	29	45

Environmental impact of the rations

	A Standard	**B By-products**	**C Maize**	**D Low CF**
Methane, g CH_4	550	539	545	522
Methane, g CO_2-eq.	13750	13475	13625	13050
Δ, %		*-2*	*-1*	*-5*
Feed production, g CO_2-eq	11090	9608	10996	9529
Δ, %		*-13*	*-1*	*-14*
Total, g CO_2 -eq.	24840	23083	24621	22579
Total, g CO_2-eq./kg ECM	**677**	**629**	**671**	**615**
Δ, %		*-7*	*-1*	*-9*
Land use, m^2	**32**	**28**	**31**	**27**
Δ, %		*-12*	*-3*	*-16*
Biodiversity loss, PDF-index	**18.3**	**17.2**	**18.9**	**8.7**
Δ, %		*-6*	*+3*	*-52*

Conclusion

- Overall, the planning tool can support practical implementation of carbon reduction measures at the farm level.


Thank you for your attention