Evaluation and optimization of emissons in dairy farming with NorFor feeding program

Nicolaj Ingemann Nielsen (ncn@seges.dk)

NorFor & Livestock Innovation, SEGES

Climate and environment-friendly dairy farming in the framework of the European Green Deal. Online Conference, 3rd of November 2020.

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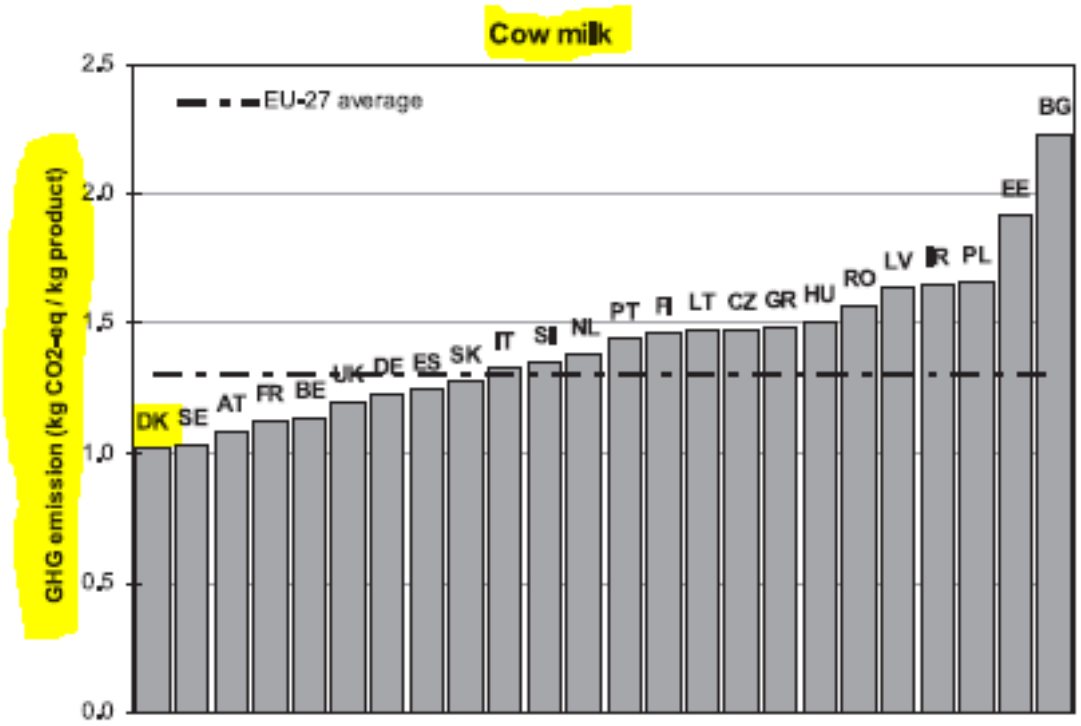
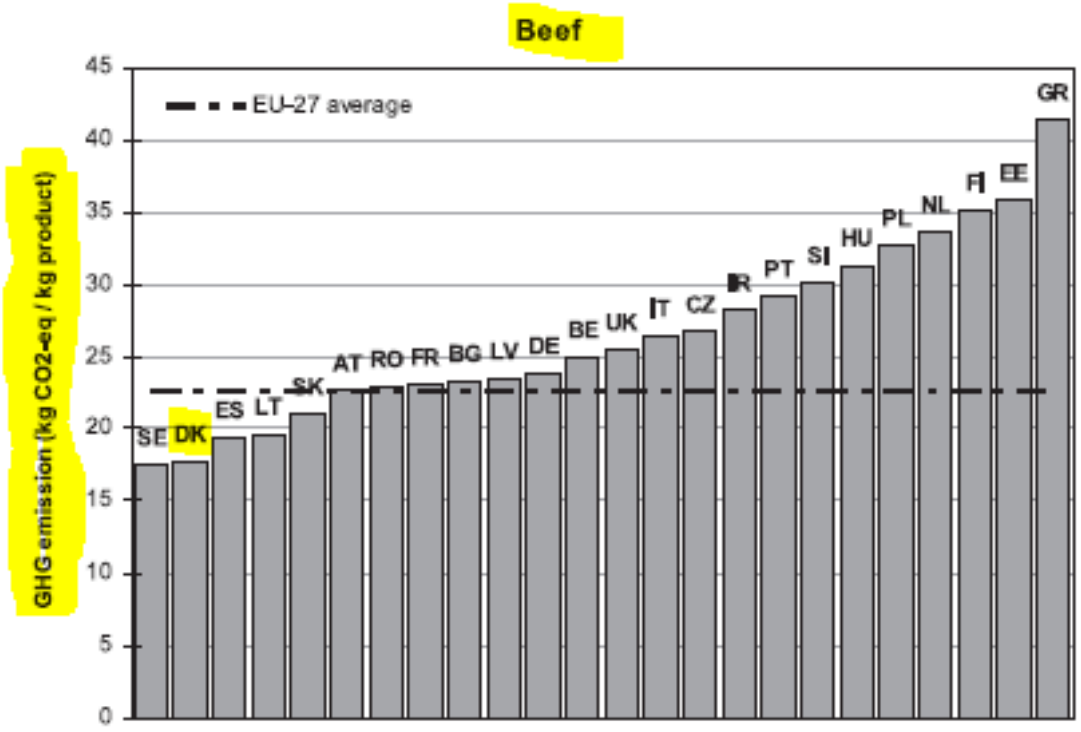
Who has the lowest Carbon Foot Print in Europe ?

J.P. Lesschen et al. / Animal Feed Science and Technology 166–167 (2011) 16–28





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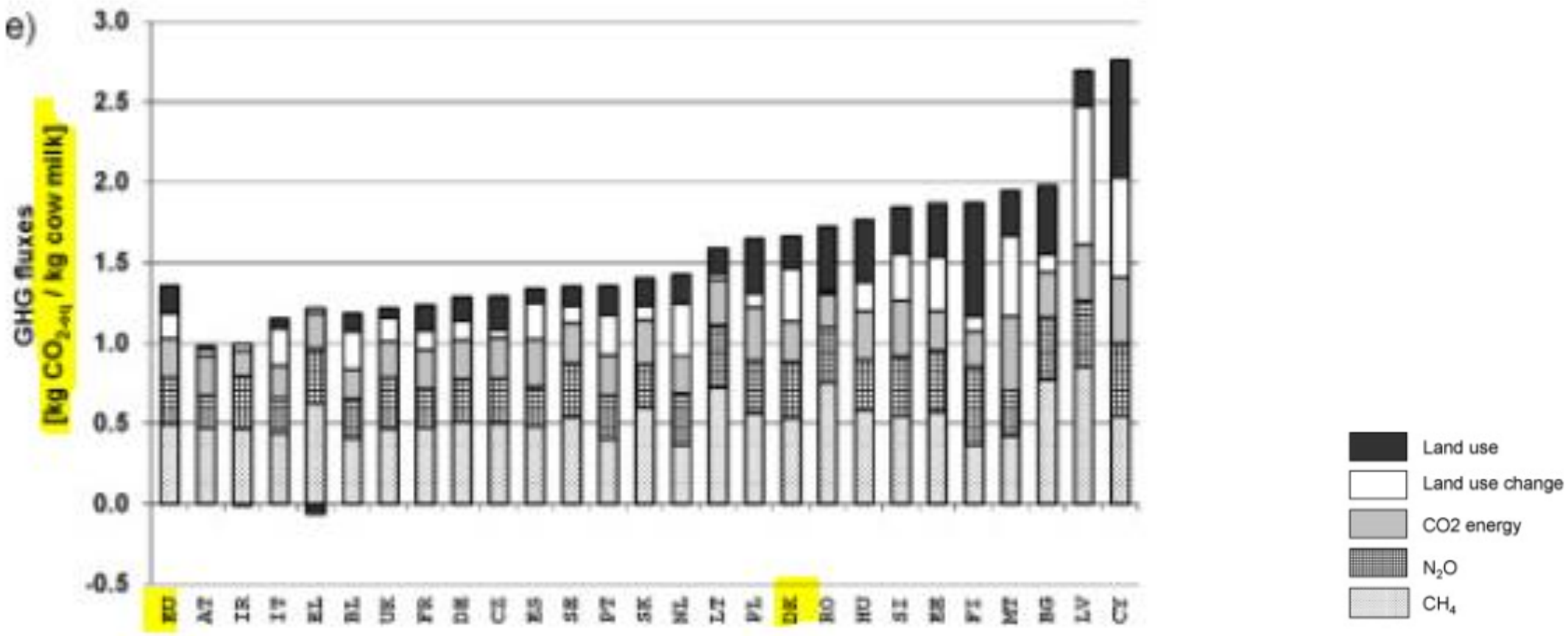
It all depends on data but especially method for calculation



Weiss & Leip, 2012

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September 2019: Milk and meat is challenged!

RethinkX

The writing on the wall: The coming collapse of the industrial livestock industry

A new report sees a major disruption in where we get our food.

ROBBY BERMAN 23 September, 2019

Image source: Gerweto / Shutterstock

- We're just a few years from the tipping point in engineered food.
- Traditional agriculture's 10,000-year-run is about over.
- Better foods, tastier foods, and cheaper foods are on the way.

'By 2030, the US dairy and cattle industry will have collapsed,' as microbial protein factories take over, predicts think tank

By Elaine Watson

17-Sep-2019 - Last updated on 17-Sep-2019 at 17:25 GMT

1.5K

A new report predicts the Armaggedon for the US meat industry

PRODUCTS

In 10 to 15 years, the alternative protein sector will dominate the market and reshape the landscape for the food industry, according to a study released by independent think thank RethinkX.

Posted on Sep 20, 05:02

19. SEP. 2019 KL. 07.53

Analytiker, der har fået ret gang på gang: Koen er færdig om ti år

Ny rapport fra amerikansk tænketank forudsiger, at mejeri- og kødindustrien vil blive nærmest udraderet i løbet af det næste årti af langt billigere kunstigt dyrkede kød- og mælkeproteiner. Det bliver den dybeste omvæltning i fødevareproduktionen i 10.000 år. Det er skidt for landmanden, men en kæmpe gave til klimaet, siger dansk ekspert, der dog ikke tror på, at det vil gå så hurtigt.

FORBRUG | LARS DAHLAGER

Agroecological farming, not cultured meat, is key to a sustainable future, says campaigner

By Oliver Morrison

11-Oct-2019 - Last updated on 11-Oct-2019 at 14:43 GMT

2 COMMENTS

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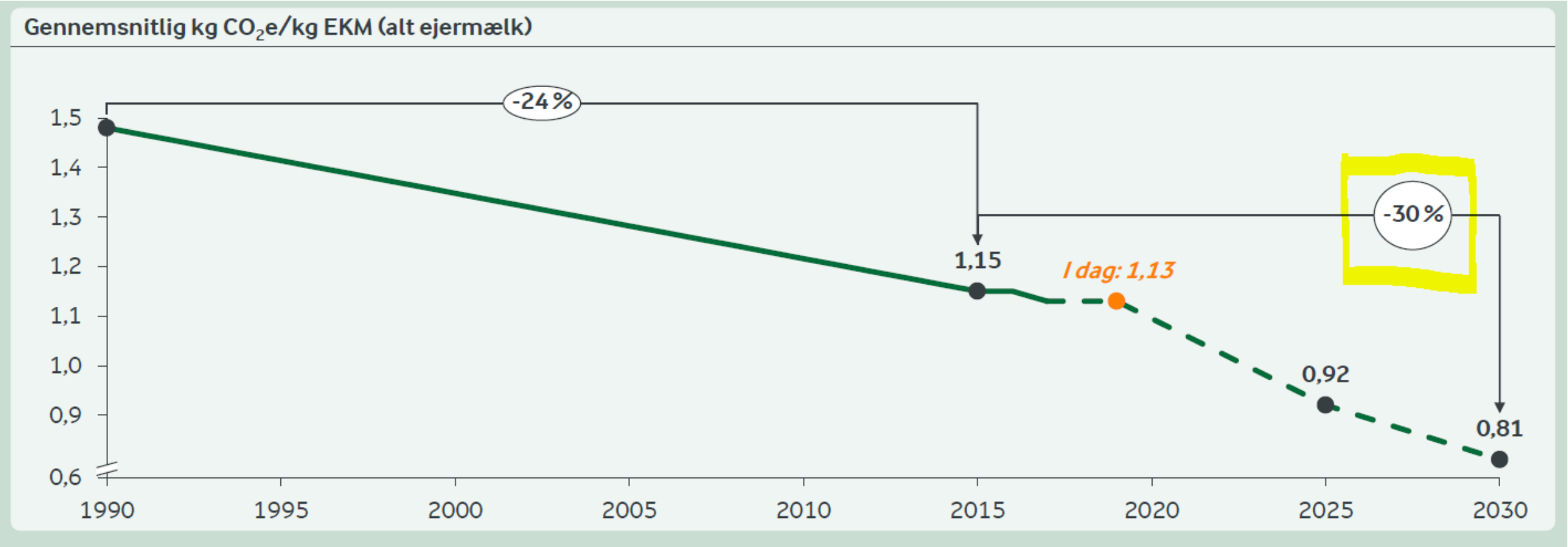
Arla & Danish Crown: No GHG-emission in 2050! (march 2019)

Arla’s climate goal 2030 – huge challenge!



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The feed industry in Denmark

CIBOMIX 33 MAX EXPRO NON-GM

Kvæg, non-GM

Cibomix - grundrationsblandinger med stabil næringsstofforsyning

CiboMix er grundrationsblandinger til at afbalancere den totale ration i forhold til besætningens eget foderinput. Sortimentet er bredt, så der altid er mulighed for at finde en optimal løsning til netop din bedrift. Denne blanding indeholder ExPro der af SEGES er afprøvet som alternativ til sojaskrå med rigtig goder resultater. ExPro er rapsskrå varmebehandlede med en helt speciel teknik, der optimere udnyttelsen af rapsen, mens man forhøjer AAT-indholdet. Blandingerne giver et stabilt indhold af næringsstoffer i en høj kvalitet. En blanding med stabil næringsstofforsyning grundlaget for en høj mælkeydelse. Blandingerne fås både i piller og i PC6 med sigteprofil, som sikrer, at køerne ikke sorterer i rationen.

Denne blanding:

- VLOG certificeret grundrationsblanding med 33% protein og et fokus på stabilt næringsstofindhold
- Indeholder min 80 % ExPro
- Fås både som piller og pillecross (PC6)

Analytiske bestanddele	Værdi	Enhed
Energi	1,00	FEk
Råprotein	33,0	%
Råfedt	6,0	%
Calcium	7,5	g/kg
Natrium	1,5	g/kg

Beregnet indhold	Værdi	Enhed
AAT	185	g/FE
PBV	64	g/FE
Fedtsyrer	30	g/FE
Stivelse	12	g/FE
Fordøjelige cellevægge	225	g/FE
NEL20 [1]	6,8	MJ/kg ts
AAT20 [1]	174	g/kg ts
PBV20 [1]	121	g/kg ts
NDF Norfor [1]	280	g/kg ts
GWP med LUC [2]	0,90	kg CO2 ækv./kg
GWP uden LUC [3]	0,73	kg CO2 ækv./kg

Eksempel på sammensætning	Typisk	Grænser	Enhed
Sojaskrå, afskallet		- 0,0	%
Rapsskrå/kage	80,0	75,0 - 90,0	%
- heraf Expro	80,0	75,0 - 90,0	%
Solsikkeskrå/kage	8,8	0,0 - 15,0	%
Kornbærme	5,0	- 35,0	%
Korn	0,0	- 0,0	%
- heraf majs [4]		0,0 - 15,0	%
Klid/glutenfoder	2,9	0,0 - 10,0	%
Ærter		0,0 - 5,0	%
Roepiller		0,0 - 5,0	%
Grøn-/lucernepiller		0,0 - 5,0	%
Sojaskaller		- 0,0	%
Citrus		0,0 - 5,0	%
Palmekage		0,0 - 5,0	%
Vegetabilsk fedt	2,5		%
Melasse [5]		0,0 - 4,0	%
Urea	0,0	- 0,0	%

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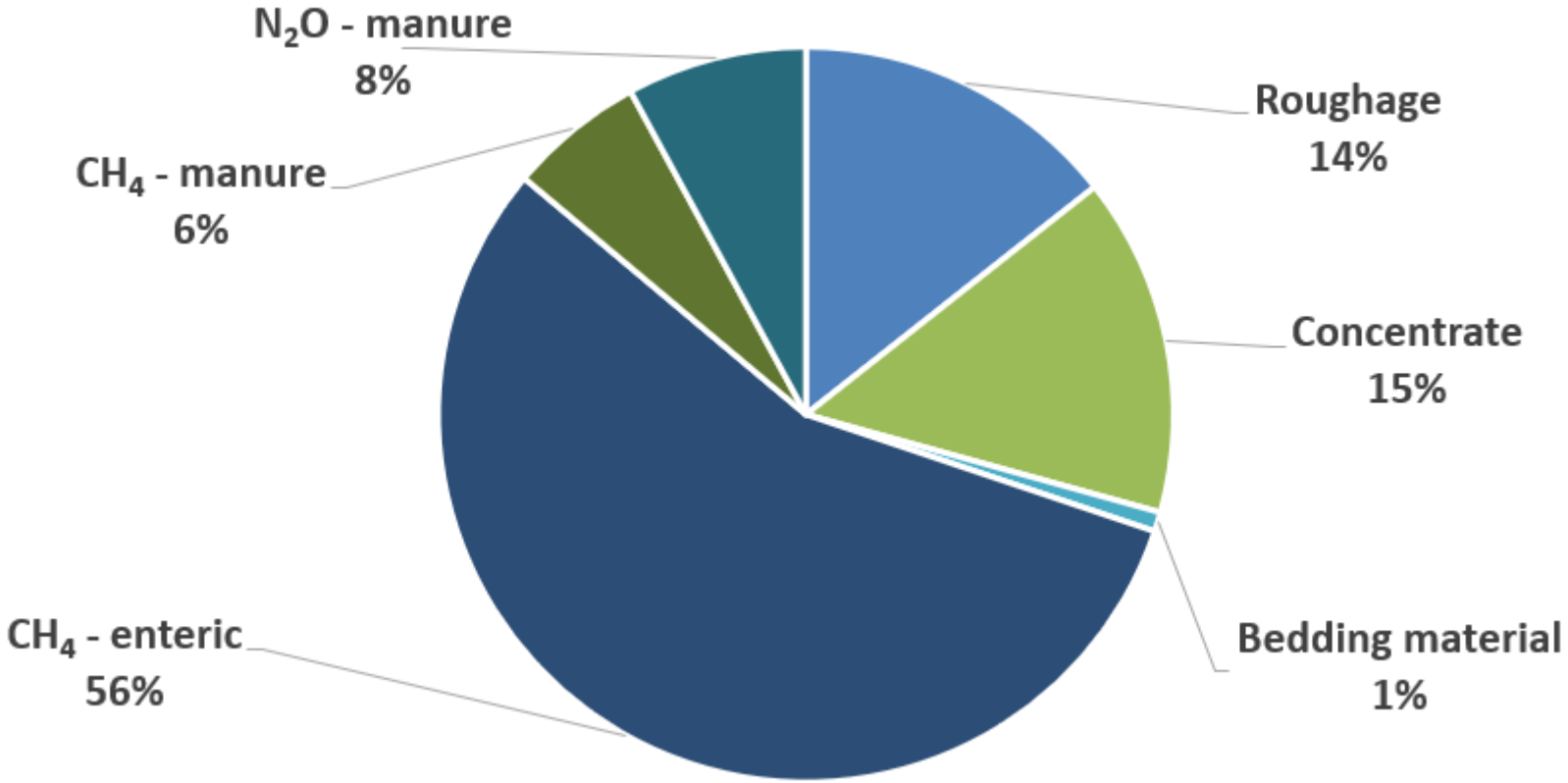
Feed & methane are major contributors to the CFP of milk

– data from 13 Danish dairy herds



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Purpose in NorFor

- NorFor should be able to estimate GHG-emissions from both enteric methane and the feedstuffs in the ration
- Identify rations and feedstuffs that can reduce CFP of milk
- Quantify the potential for CO_2-reductions by smart choice of feedstuffs

NorFor has for quite some years estimated enteric methane from feed rations

ORIGINAL ARTICLE

A prediction equation for enteric methane emission from dairy cows for use in NorFor

N. I. NIELSEN[1], H. VOLDEN[2,3], M. ÅKERLIND[4], M. BRASK[5], A. L. F. HELLWING[5], T. STORLIEN[3] & J. BERTILSSON[6]

[1]*AgroTech A/S & Knowledge Centre of Agriculture - Cattle, Agro Food Park 15, Aarhus, Denmark;* [2]*TINE SA, Ås, Norway;* [3]*Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences, Ås, Norway;* [4]*Swedish Dairy Association, Stockholm, Sweden;* [5]*Department of Animal Science, Aarhus University, Tjele, Denmark;* [6]*Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences, Uppsala, Swed*

Abstract

A data-set with 47 treatment means (N = 211) was compiled from research institutions in Denr in order to develop a prediction equation for enteric methane (CH_4) emissions from dairy cows. the equation in the Nordic feed evaluation system NorFor. The equation should therefore b available in NorFor. The best equation to predict CH_4 (MJ/d) was based on dry matter intake ((g/kg DM) fatty acids (FA), crude protein (CP), and neutral detergent fiber (NDF). The equati × DMI – 0.125 (±0.039) × FA – 0.02 (±0.012) × CP + 0.017 (±0.005) × NDF (RMSE = 3. R^2 = 0.77), where RMSE is the root mean square error and CV is the coefficient of variatio

128 *N. I. Nielsen et al.*

Table II. Prediction equations for enteric CH_4 production (MJ/d) for dairy cows based on a Nordic data-set (n = 47).

Equation	RMSE	CV	R^2	Equation
CH_4 = 1.36 (±0.10) × DMI – 0.125 (±0.039) × FA – 0.02 (±0.012) × CP + 0.017 (±0.005) × NDF	3.00	13.8	0.77	1
CH_4 = 1.23 (±0.08) × DMI – 0.145 (±0.039) × FA + 0.012 (±0.005) × NDF	3.10	14.3	0.75	1
CH_4 = 1.39 (±0.06) × DMI – 0.091 (±0.036) × FA	3.31	15.3	0.70	1
CH_4 = 1.26 (±0.03) × DMI	3.50	16.1	0.66	1
CH_4 = 738 (±54) × DMI_BW – 0.145 (±0.044) × FA + 0.013 (±0.005) × NDF	3.46	15.9	0.68	2
CH_4 = 0.0026 (±0.0004) × rd_NDF + 0.0020 (±0.0004) × rd_starch + 0.0032 (±0.0004) × rd_restCHO	3.94	18.1	0.59	3
CH_4 = 0.0018 (±0.0001) × rd_OM-0.135 (±0.046) × FA + 0.012 (±0.006) × NDF	3.64	16.8	0.65	4
CH_4 = 0.0017 (±0.0001) × td_OM-0.165 (±0.045) × FA + 0.015 (±0.005) × NDF	3.58	16.5	0.66	5

Note: All model terms included are significant (P < 0.05). See Table I for units of explanatory variables.

DMI, NDF and fatty acids are main predictors

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Climate values on feedstuffs in NorFor are based on a Danish report using LCA methodology

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Life cycle assessment
LCA method
Carbon foot print for barley

Emissions to air

(N_2O, NH_3, CO_2)

INPUT per ha

Artificial fertilizer:

119 kg N/ha

21 kg P/ha

55 kg K/ha

78 l diesel

150 kg seed

8 l oil

34 kWh for water

98 kWh for drying

OUTPUT

5165 kg barley

4390 kg DM barley

2439 kg DM straw

Emissions to soil and water

(NO_3^-)

Life cycle assessment
LCA method
Carbon foot print for barley

Emissions to air

(N_2O, NH_3, CO_2)

INPUT per ha

Artificial fertilizer:

119 kg N/ha

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OUTPUT

5165 kg barley

4390 kg DM barley

2439 kg DM straw

Emissions to soil and water

(NO_3^-)

transport **transport** **transport**

Production of inputs

Growing

Processing

Dairy farm

Land use (Carbon in soil)

Indirect LUC (Land Use Change) put the GHG emissions from rain forest depletion on all crops

Høje fødevarepriser fører til ny skovrydning i Amazonas

Satellitbilleder afslører voldsomt accelereret fældning af træer i den brasilianske regnskov. Højere priser på sojabønner og oksekød er drivkraften

Rydningen af regnskoven i Amazonas accelererer voldsomt. Alene i april forsvandt 1.100 kvadratkilometer skov.
Marcelo Sayao

Information

With $LUC_{indirect}$ is the climate impact from rainforest depletion put on all crops depending on their area usage

Avarage factor $LUC_{indirect}$: 143 g CO_2 per m^2

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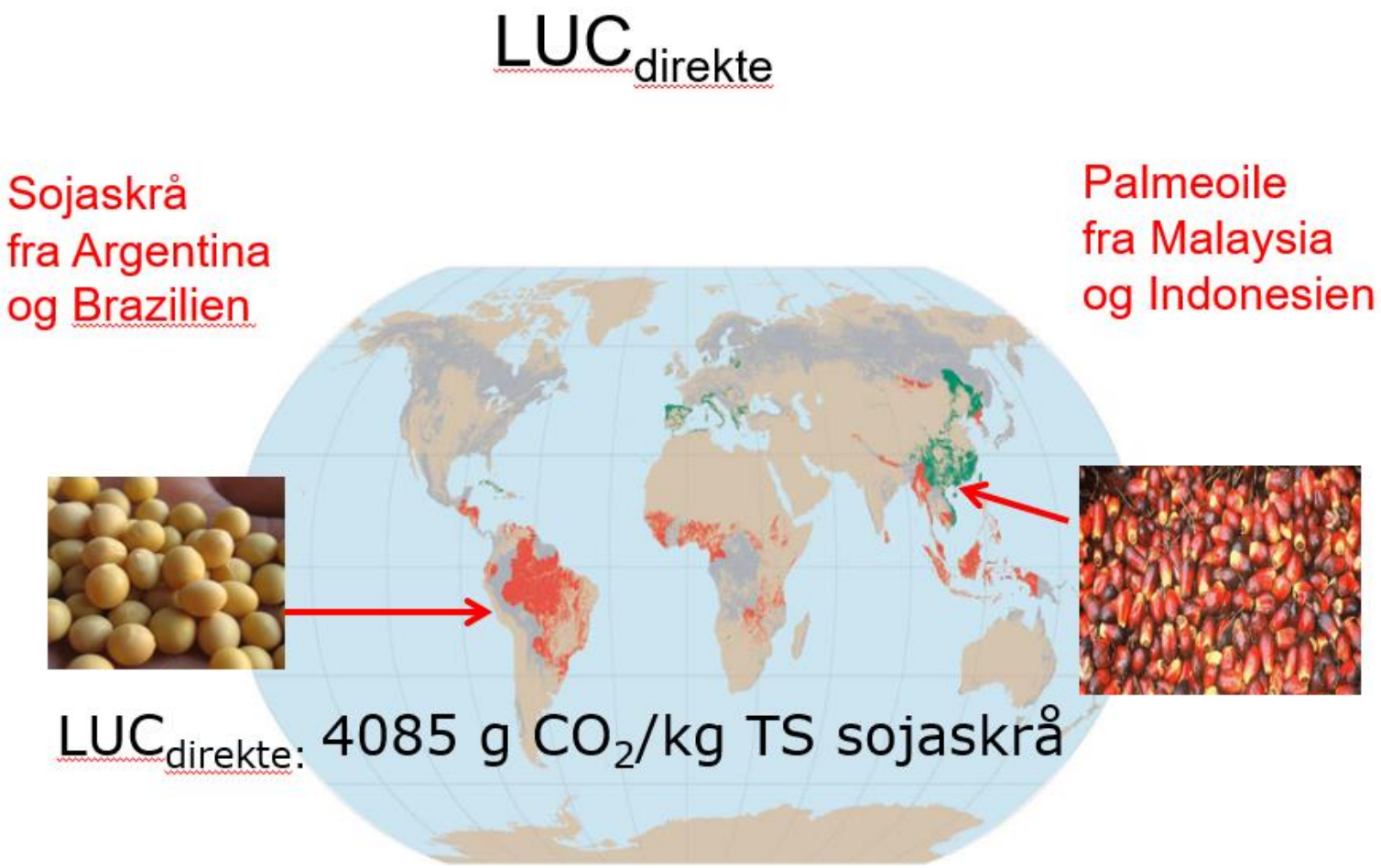
Direct-LUC put the GHG emissions on mainly soybean meal and palm oil



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NorFor feed stuff table

Carbon Foot Print (g CO_2 eq./kg DM)	Rape seed cake
Growing	422
Processing	17
Transport	71
Total CFP	**510**
C in soil	**44**
$LUC_{indirect}$	209

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Feedstuffs in NorFor with climate values

Parameter	Unit	0038-002 Distillers dried grains, wheat based	0042-002 Rapeseed meal	0053-003 Soybean meal	0226-001 Clover grass silage, high OMD	0307-005 Maize silage, high OMD
Protein						
Crude protein	g/kg DM	347	385	487	157	74
Fat						
Crude fat	g/kg DM	68	40	29	46	22
NDF						
NDF	g/kg DM	257	279	135	419	322
Starch						
Starch	g/kg DM	35	26	62	10	347
Standard feed values						
Net energy lactation 20 kg DM	MJ/kg DM	7,54	6,63	8,35	6,45	6,45
AAT 20 kg DM	g/kg DM	143	148	209	79	86
PBV 20 kg DM	g/kg DM	139	172	219	27	-61
Other parameters						
CO2e	g/kg DM	839	545	631	414	265

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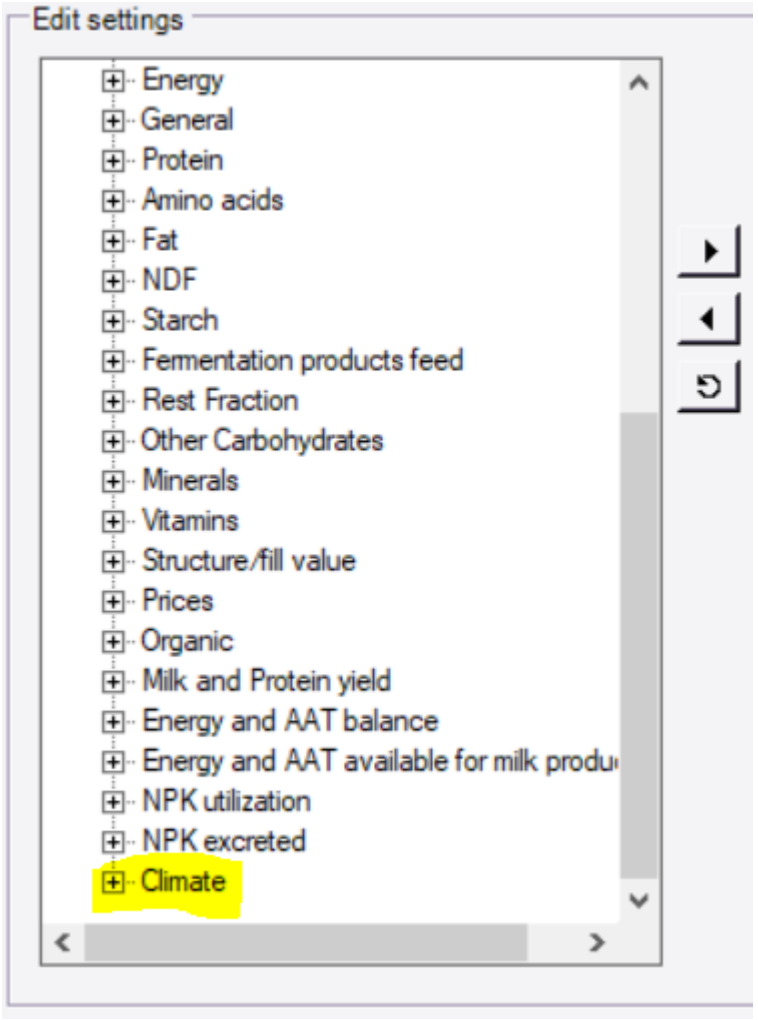
Parameters in NorFor when planning and evaluating rations



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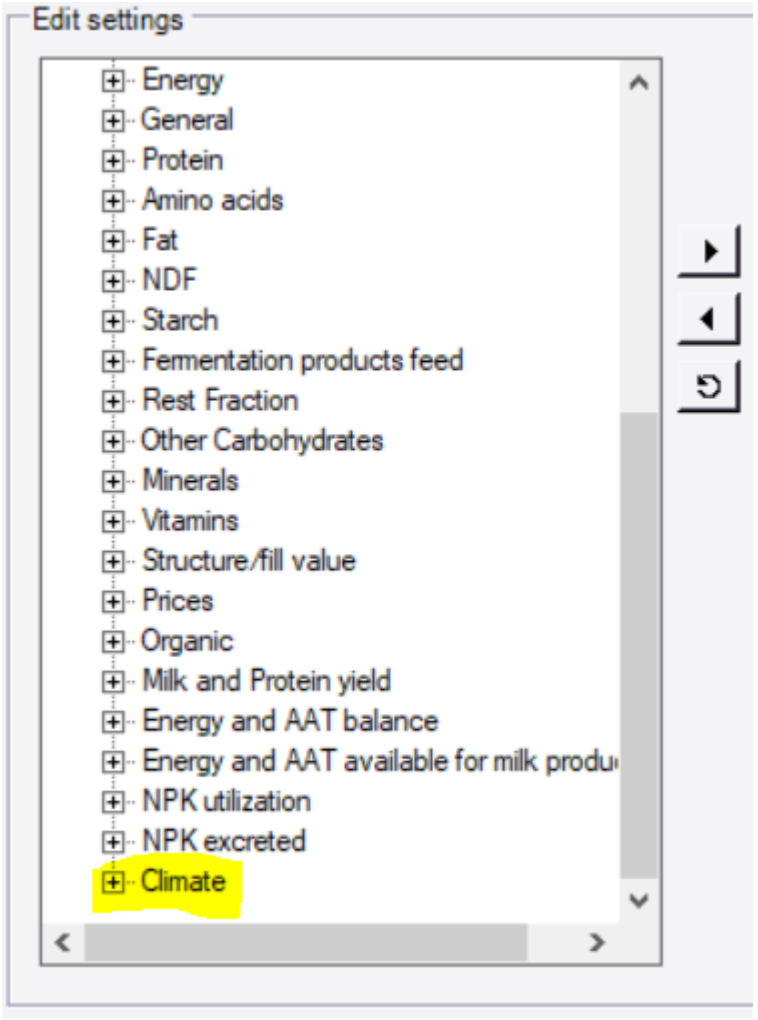
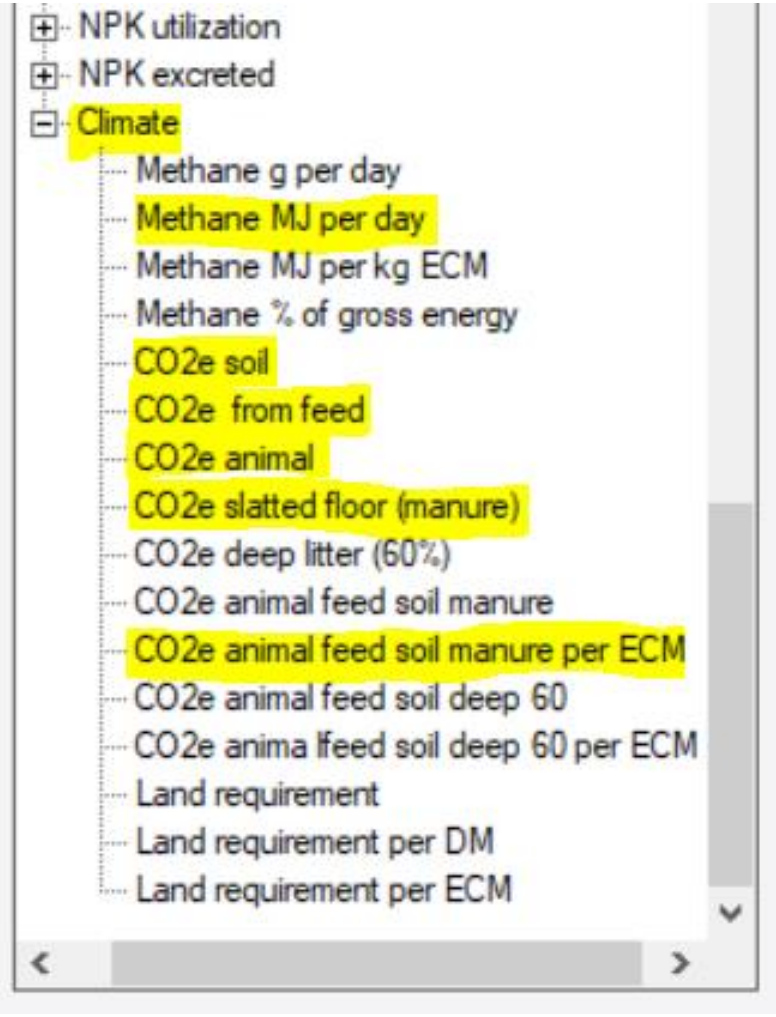
Parameters in NorFor when planning and evaluating rations





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Effect of ration on Carbon Foot Print and ECM-yield

- optimised for Holstein's in NorFor for 11.500 kg ECM

	Ration (kg TS/ko/dag)				
Feed stuff	'Standard'	'Maize silage'	'Fat'	'Roughage'	'Fodder beets'
Barley	3,5	3	2,5	2,3	2,2
Rape seed meal	2	2,5	0	2	2
Rape seed cake	1	1	3	1	1
Soy bean meal	2	2	2	2	2
Fodder beets	2	2	2	2	3,5
Grass silage	5	3	5	5,5	5
Maize silage	9	11	9	10	9
Fat supplement			0,4		
Carbon foot print (g CO_2-eq/kg ECM)	651	643	606	652	623
Change vs "standard" (%)		-1	-7	0	-3
Area usage (m^2/kg ECM)	0,87	0,85	0,84	0,84	0,85

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Rapeseed as fat source in NorFor

	Standard 'Danish'	Rapeseed 0,6 kg	Rapeseed 1,3 kg
Fatty acids (g/kg DM)	34	44	54
	CO_2-eq/kg ECM		
Methane	328	308	292
Feedstuffs	267	269	273
Carbon in soil	35	25	23
Manure	40	40	40
Land use change, indirect	118	120	121
Carbon foot print, total	**788**	**762**	**749**
Carbon foot print per kg ECM (%)	**100**	**97**	**95**

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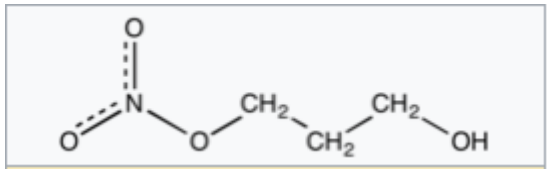
What is 3-NOP ?

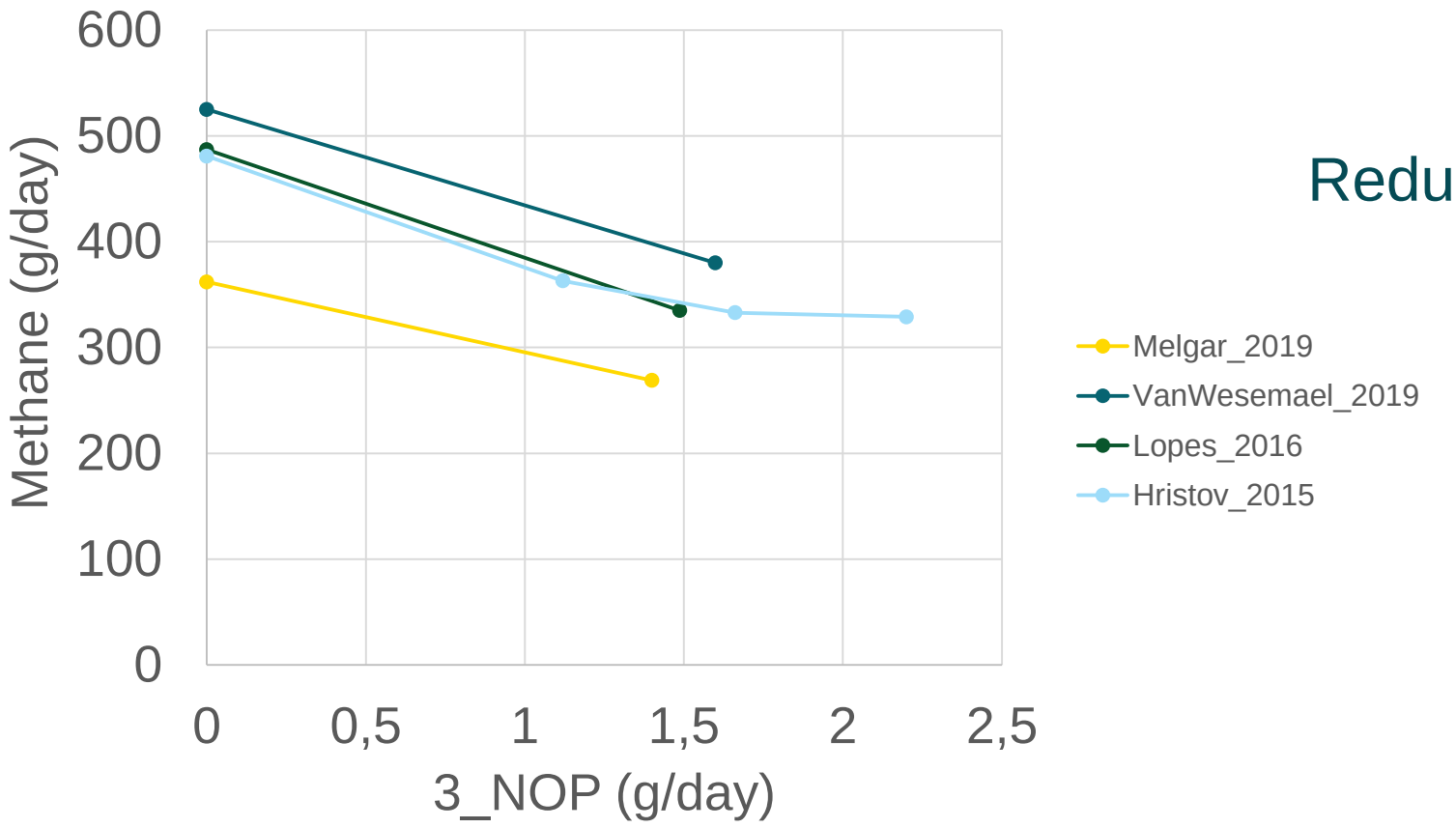
- An organic compound: 3-NitroOxyPropanol



- Blocks step in the formation of methane in the rumen

- In this proces 3-NOP is split into two pre existing metabolites in the rumen

Bovaer®/3-NOP (and 'X' and seaweed) needs to be included in NorFor prediction… Dairy cows



Reduction on 29 %

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Questions ?
& comments

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