SEGES INNOVATION

STØTTET AF
Promilleafgiftsfonden for landbrug

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LCIA of Maize silage cultivation in Denmark

Using primary data from SEGES

Blonk CONSULTANTS

www.blonksustainability.nl

About us

Blonk is a leading international expert in food system sustainability, inspiring and enabling the agri-food sector to give shape to sustainability. Blonk's purpose is to create a sustainable and healthy planet for current and future generations. We support organizations in understanding their environmental impact in the agri-food value chain by offering advice and developing tailored software tools based on the latest scientific developments and data.

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1. Introduction

SEGES asked Blonk Consultants to get a better understanding of how GFLI compliant datasets are made. Part of this exercise was to calculate the environmental impact of maize silage cultivation. On one end, SEGES developed a model that could calculate the impact using the same standards and data sources as used in AFP6/GFLI v2 database. As a cross check, the environmental impact of the same product was calculated using primary data collected on maize cultivation in Denmark and transformed into a AFP6/GFLI v2 compliant dataset. This paper presents the environmental impact results of this product.

1.1 Workflow

A brief description of the workflow:

- Primary data on maize silage cultivation in Denmark was collected by representatives from SEGES and shared with Blonk Consultants using the GFLI data collection template for cultivations.

- Collected data was processed similarly as other maize silages that are in the latest AFP6 version (maize silage are not included in the current GFLI database since it is not a feed ingredient). Primary data from SEGES overwrites the "default" data that is available in AFP, missing data was filled in using AFP/GFLI methodology. Two versions of the LCI are shared with SEGES:
    - AFP5 compliant background data. The AFP version that is currently available in OpenLCA
    - AFP6/GFLI v2 compliant background data (e.g. transport, fertilizers, etc.), an AFP version that will become available soon in OpenLCA. Other features of the latest version are: regionalized flows (for ammonia, nitrate, phosphor, land use, land transformations and nitrogen monoxide). Switch from ELCD to Ecoinvent background data. Nitrogen containing fertilizers are connected to a market mix (instead of production process in Europe)
- LCIA impacts of maize silage were generated using the same Methods and LCA software. Because if the differences in background data, the results are presented for both AFP5 and AFP6/GFLI v2 compliant background data. And because two methods are used in GFLI, 4 types of results are presented in total.

1.2 Notes on modelling

Some notes on data generation/modelling:

- All 3 inventoried types of bovine manure were summed up and modelled as 1 bovine type.

- The roughage model that was used for AFP6, is based on a slightly older model. Therefore, laughing gas emission calculations are therefore still based on IPCC 2006 standards (instead of IPCC 2019 for other feed crops that are in GFLI).
- Important parameters:
    - Crop residue calculation based on Non N-fixing forages

Crop (orig	Slope	Intercept	N_above_	Ratio_bel	N_below_	Source
Grains	1.09	0.88	0.006	0.22	0.009	IPCC (2006)
Beans&pu	1.13	0.85	0.008	0.19	0.008	IPCC (2006)
Tubers	0.1	1.06	0.019	0.2	0.014	IPCC (2006)
Root crops	1.07	1.54	0.016	0.2	0.014	IPCC (2006)
N-fixing fo	0.3	0	0.027	0.4	0.022	IPCC (2006)
Non N-fix	0.3	0	0.015	0.54	0.012	IPCC (2006)

    - Heavy metal uptake maize silage:

Product	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Source
Maize sila	0.03	0.072	1.08	0.003	0.2583	0.03	10.8	Delahaye et al. (2003), appendix 5: Snijmais (as is, 30%

- High manure amount in collected data. This has resulted in a high heavy metal deposition from manure. Impact of transporting manure is 0. Since not 30 km was assumed, but 0 km transport instead.

2. Results

As mentioned earlier, multiple results for maize silage cultivation are presented in multiple ways: using AFP5 and AFP6/GFLI v2 compliant background data and for two methods, the EF 3.1 method and ReCiPe method that are both available in SimaPro. Some categories are added (similar as in GFLI) to comply with the PEFCR. For example, impact of Land use and Peat oxidation are (also) presented separately.

TABLE 1:ENVIRONMENTAL IMPACT OF MAIZE SILAGE CULTIVATION IN DENMARK, EF3.1 METHOD (IMPACT PER KG MAIZE SILAGE)

Impact category	Unit	AFP 5	AFP 6
Climate change	kg CO2 eq	0.110502368	0.109185207
Ozone depletion	kg CFC11 eq	1.68883E-10	3.26116E-09
Ionising radiation	kBq U-235 eq	0.000276833	0.001458169
Photochemical ozone formation	kg NMVOC eq	0.000327781	0.00036145
Particulate matter	disease inc.	2.61813E-08	2.62786E-08
Human toxicity, non-cancer	CTUh	1.9738E-08	2.00103E-08
Human toxicity, cancer	CTUh	3.84483E-10	3.92874E-10
Acidification	mol H+ eq	0.003838759	0.003103758
Eutrophication, freshwater	kg P eq	4.80754E-05	5.11245E-05
Eutrophication, marine	kg N eq	0.003226953	0.003231215
Eutrophication, terrestrial	mol N eq	0.017458666	0.006752748
Ecotoxicity, freshwater	CTUe	0.321952733	0.614932663
Land use	Pt	13.00477565	15.8225017
Water use	m3 depriv.	0.019176326	0.02125116
Resource use, fossils	MJ	0.279524716	0.277426443
Resource use, minerals and metals	kg Sb eq	1.69802E-08	3.39384E-07
Climate change - Fossil	kg CO2 eq	0.080085991	0.079137233
Climate change - Biogenic	kg CO2 eq	0	1.8504E-05
Climate change - Land use and LU change	kg CO2 eq	0	1.24826E-05
Climate change - Peat oxidation	kg CO2 eq	0.030416377	0.030016988
Human toxicity, non-cancer - organics	CTUh	7.3321E-12	1.8717E-11
Human toxicity, non-cancer - inorganics	CTUh	1.89408E-11	7.83437E-11
Human toxicity, non-cancer - metals	CTUh	1.97117E-08	1.99146E-08
Human toxicity, cancer - organics	CTUh	2.94724E-12	4.78336E-12
Human toxicity, cancer - inorganics	CTUh	7.05428E-23	1.83473E-25
Human toxicity, cancer - metals	CTUh	3.81536E-10	3.88091E-10
Ecotoxicity, freshwater - organics	CTUe	0.030923127	0.041984621
Ecotoxicity, freshwater - inorganics	CTUe	0.165460342	0.205029528
Ecotoxicity, freshwater - metals	CTUe	0.125569264	0.367918514

TABLE 2: ENVIRONMENTAL IMPACT OF MAIZE SILAGE CULTIVATION IN DENMARK, RECIPE METHOD (IMPACT PER KG MAIZE SILAGE)

Impact category	Unit	AFP 5	AFP 6
Global warming - incl LUC and peat ox	kg CO2 eq	0.116038025	0.114846989
Global warming - excl LUC and peat ox	kg CO2 eq	0.085613789	0.084417068
Global warming - only LUC	kg CO2 eq	0	1.30125E-05
Global warming - only peat ox	kg CO2 eq	0.030424237	0.030416909
Stratospheric ozone depletion	kg CFC11 eq	2.36447E-06	2.46375E-06
Ionizing radiation	kBq Co-60 eq	0.000132803	0.000686717
Ozone formation, Human health	kg NOx eq	0.000443054	0.000276617
Fine particulate matter formation	kg PM2.5 eq	0.000335462	0.0002243
Ozone formation, Terrestrial ecosysten	kg NOx eq	0.000443179	0.000553288
Terrestrial acidification	kg SO2 eq	0.00244095	0.00129004
Freshwater eutrophication	kg P eq	4.81401E-05	5.30337E-05
Marine eutrophication	kg N eq	0.000875599	0.00087554
Terrestrial ecotoxicity	kg 1,4-DCB	0.009014695	0.096275296
Freshwater ecotoxicity	kg 1,4-DCB	0.001097359	0.002166306
Marine ecotoxicity	kg 1,4-DCB	0.00039111	0.001788062
Human carcinogenic toxicity	kg 1,4-DCB	9.06228E-05	0.00118873
Human non-carcinogenic toxicity	kg 1,4-DCB	0.769688709	0.790625571
Land use	m2a crop eq	0.259172681	0.259536873
Mineral resource scarcity	kg Cu eq	5.88951E-05	0.000140313
Fossil resource scarcity	kg oil eq	0.005861268	0.006242008
Water consumption	m3	0.005202739	0.005283197

3. Supplementary materials

Additional data that is provided to SEGES:

- LCIA results and contribution results of maize silage cultivation in Excel format
- LCI of maize silage (from SimaPro, which might need some formatting for OpenLCA)
    - Maize silage Denmark SEGES – AFP5
    - Maize silage Denmark SEGES – AFP6