Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ

Emission reduction in manure chain

Walter Stinner

Progress in Manure and Digestate 2021, International Online Conference, January, 26th 2020

Agenda

(1) Introduction and background
(2) Emission relevant processes and factors
(3) Emission prevention
(4) Summary and outlook

(1) Introduction and background

Importance of low-emission digestate treatmend and use

- Digestate treatment and utilization is one of the most emission-relevant parts of biogas technology
- If biogas plants are further developed into nutrient hubs, the importance of fermentation product treatment processes will increase, regarding local nutrient balances
- Greenhouse gas avoidance requirements for biogas are high and will increase further (RED II, Building Energy Act)
- Future-capable biogas technology must be system-relevant in the areas of climate protection, circular economy, energy policy target-triangle and multifunctional agriculture

Climate Action Plan of Federal Government

DBFZ

Measure	GHG- Reduction (Mio t $CO_{2\ eq.}$)
Manure digestion (50 bis 70 %)	2,8 - 4
Reduction of N-surpluses (to 70 kg N/ha)	2,9 – 3,5
Enhancement of organic agriculture (> 12% - 20% of agricultural area)	0,4 – 1,15
GHG-Reductions in energy use	1,1
N-Inhibitors, Peat-land protection	?
Sum	Ca. 7-10

Source: B. Osterburg (vTI)

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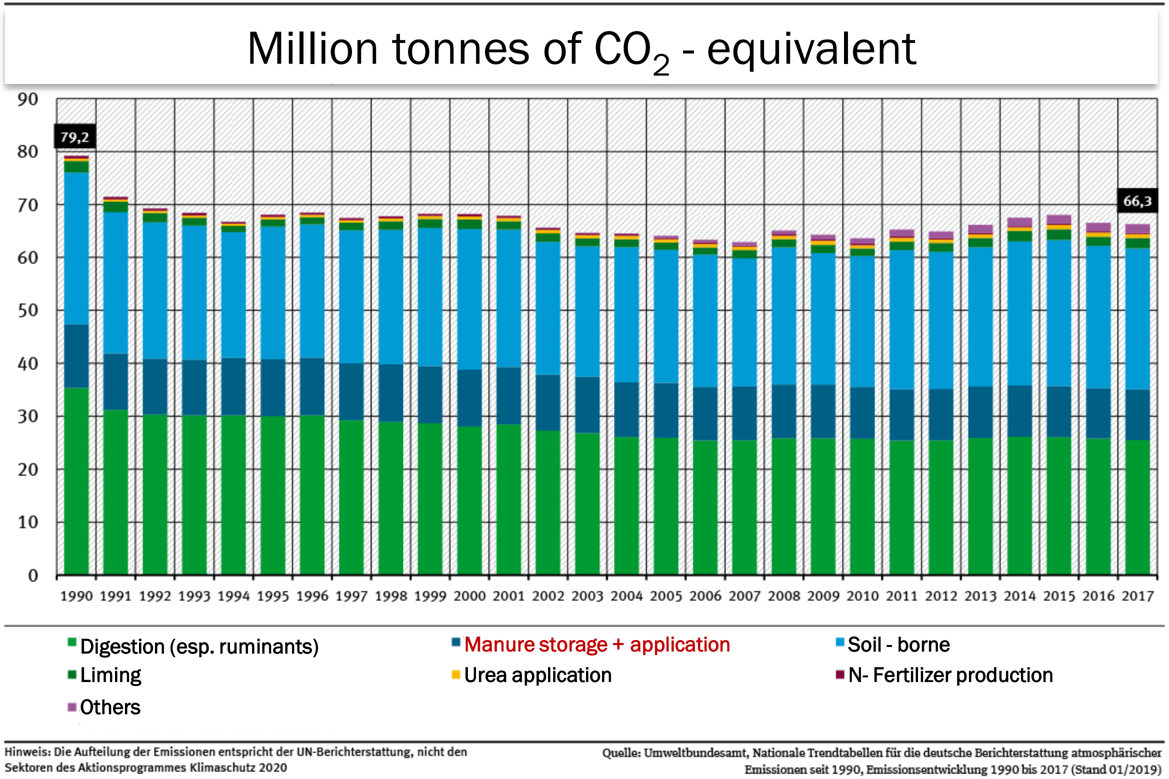
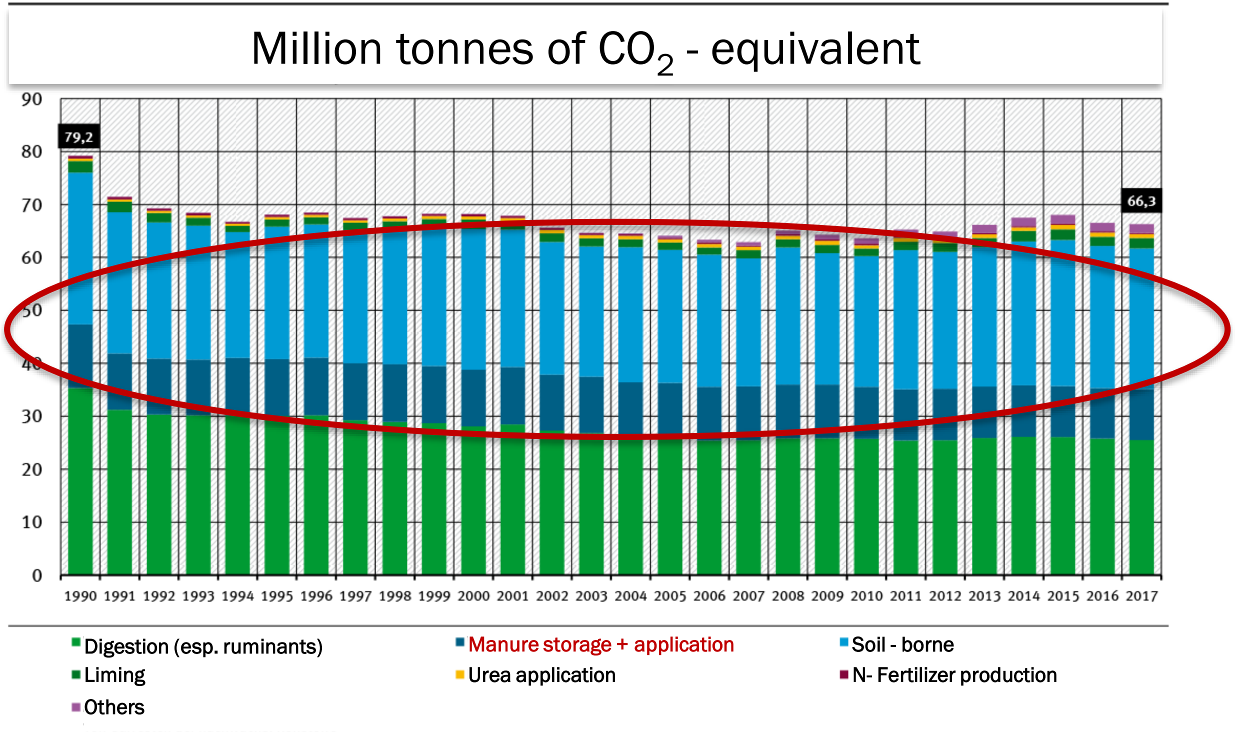
Greenhouse gas emissions (GHG) in agricultural sector (Germany)



Source: Umweltbundesamt 1/2019

Effect of manure digestion

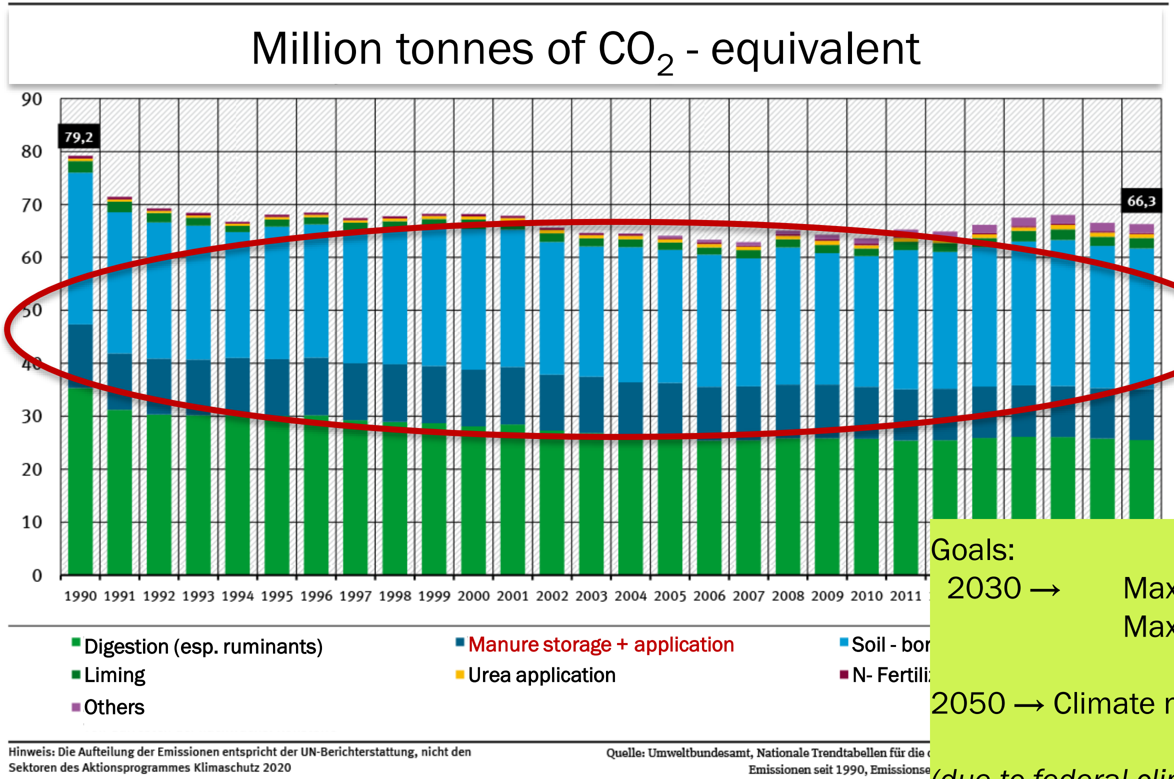


Hinweis: Die Aufteilung der Emissionen entspricht der UN-Berichterstattung, nicht den Sektoren des Aktionsprogrammes Klimaschutz 2020

Quelle: Umweltbundesamt, Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen seit 1990, Emissionsentwicklung 1990 bis 2017 (Stand 01/2019)

Source: Umweltbundesamt 1/2019

Effect of manure digestion



Goals:
2030 → Max. 543 Mio t CO_{2equiv}
Max. 58 Mio t CO_{2equiv} from agr.

2050 → Climate neutrality

(due to federal climate action plan 2030)

Source: Umweltbundesamt 1/2019

(2) Emission relevant processes and factors

Relevant Greenhouse Gases (GHG)

- CH_4
- N_2O
- NH_3

CH_4

- CO_2 – Equivalent factor = 25[1)];
- Anaerobic formation under humid (warm) conditions;
- Formation mainly in slurry and open digestate stores, inside piles and heaps of solid fermentation products, of manure, feed residues....);
- Mitigation: (i) Anaerobic digestion, gastight cover of digestate storage and utilization of biogas; (ii) Cool storage (below 12 ° C; Other measures with complex interactions;

Fourth IPCC report, related to 100years effect; https://www.ipcc.ch/site/assets/uploads/2018/08/IPCC2007-SYR-german.pdf

N_2O

- CO_2 – Equivalent factor = 298[1)];
- Formation by nitrification and denitrification, i.e. mainly under semi-aerobic conditions; source of N loss;
- Promoting: narrow C/N ratio (= N-surplus), semi-aerobic conditions;
- Formation mainly in floating covers, in the near-surface area of heaps.
- Mitigation: Gastight storage, wide C/N ratio of solid materials; Other measures with complex interactions;

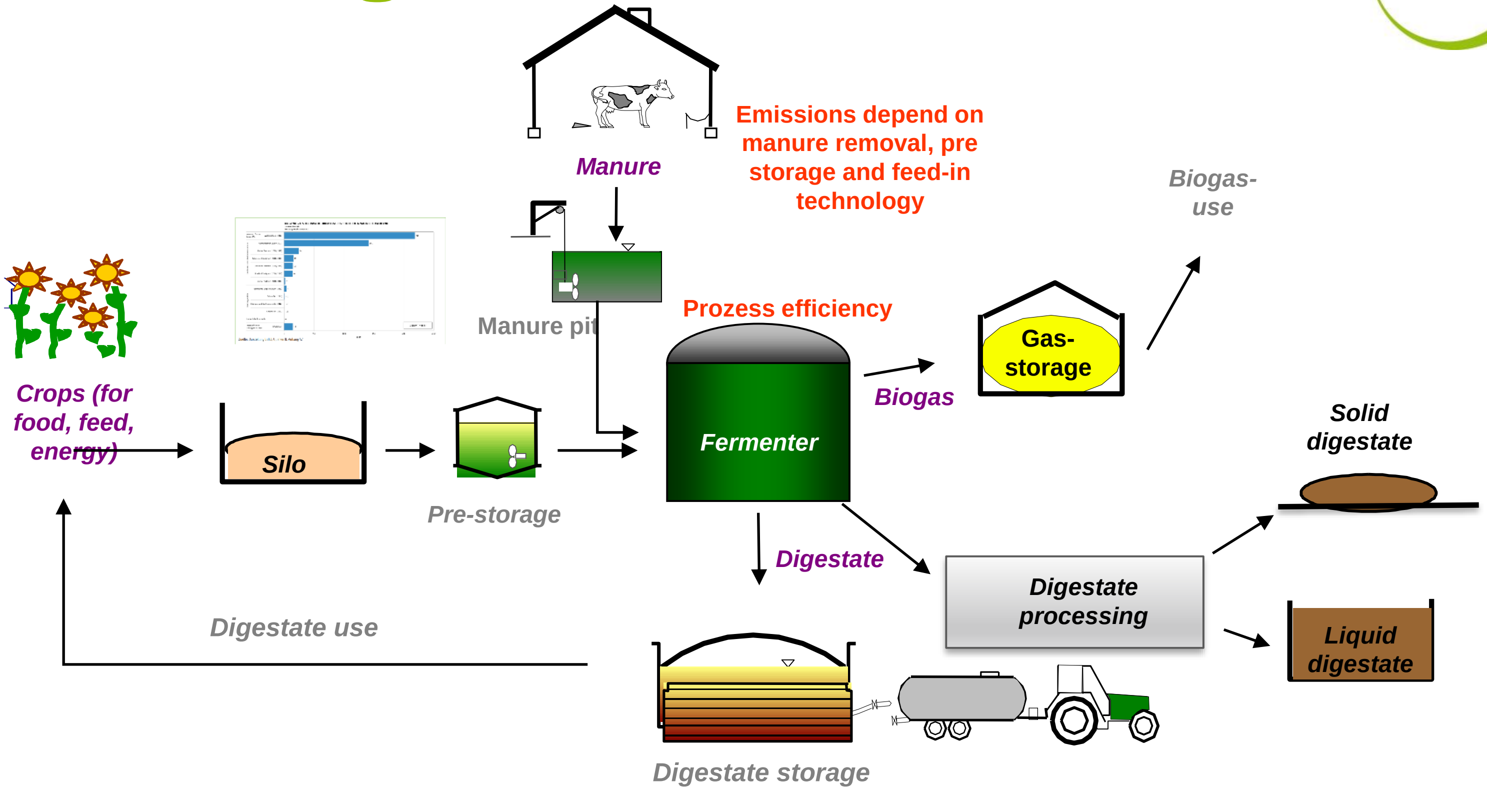
Fourth IPCC report, related to 100years effect; https://www.ipcc.ch/site/assets/uploads/2018/08/IPCC2007-SYR-german.pdf

NH_3

- Indirectly acting greenhouse gas (via N_2O);
- Acidifying, eutrophying, N loss source;
- Main N form in liquid fermentation product;
- Emission promoting: intense air contact, vacuum, high temperature, high pH, high NH_4/NH_3 concentration;
- Emission from open fermentation product storage, during separation, from deposited solid fermentation product, during drying without acid wash, during open transport, during fermentation product application to surface;
- Tank trucks with vacuum technology;

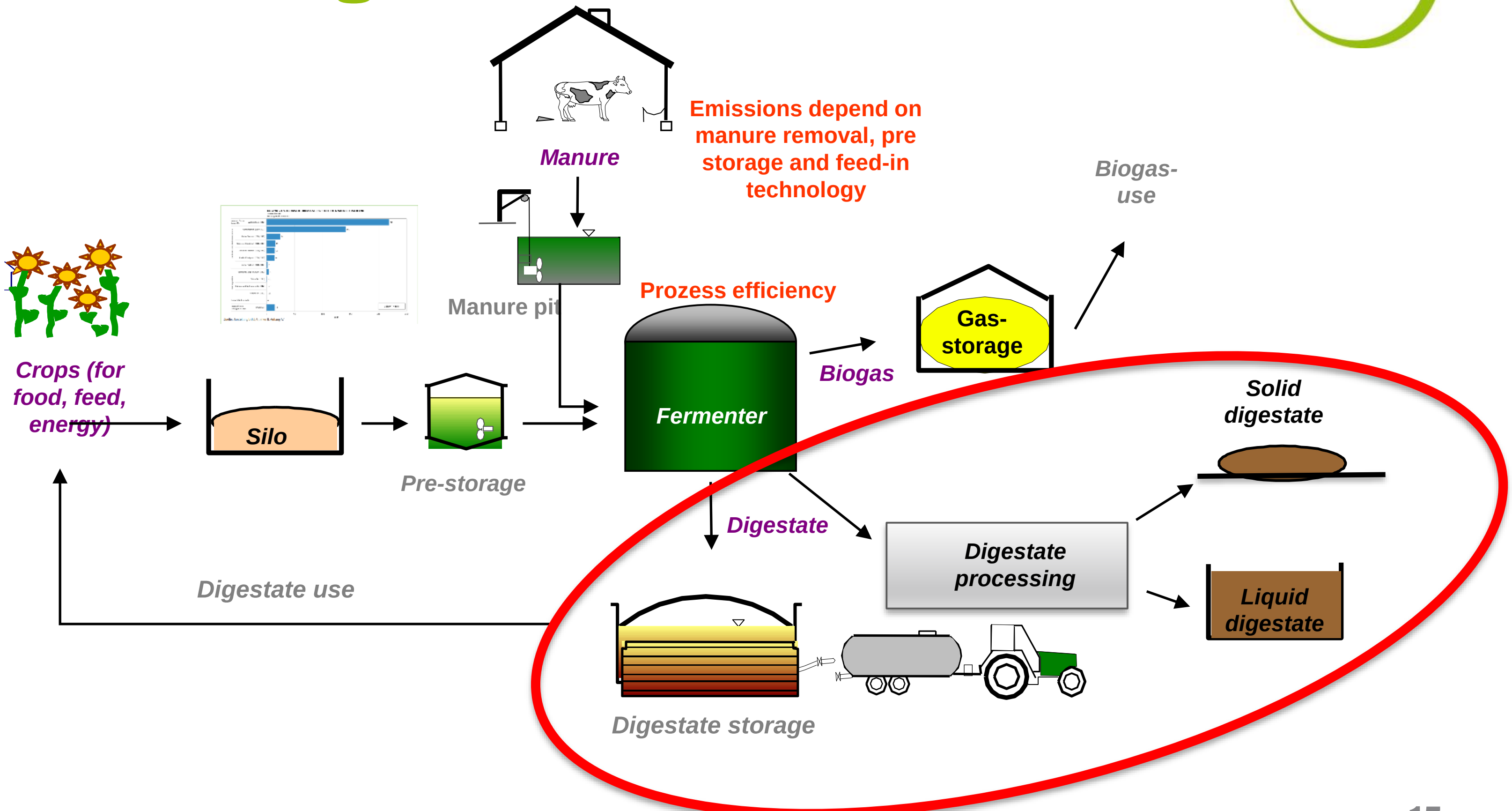
(3) Emission prevention

Prozess Chain Biogas



Changed after Daniel-Gromke et al.: Estimation of climate relevant gas emissions released from biogas facilities. BioFuel Met 2008 – biofuels and metrology, 6. November 2008, Strasbourg

Prozess Chain Biogas



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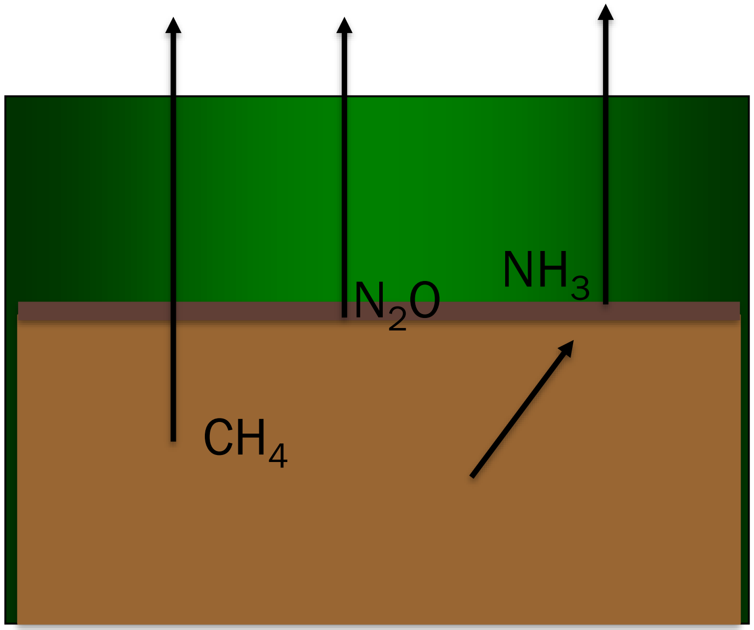
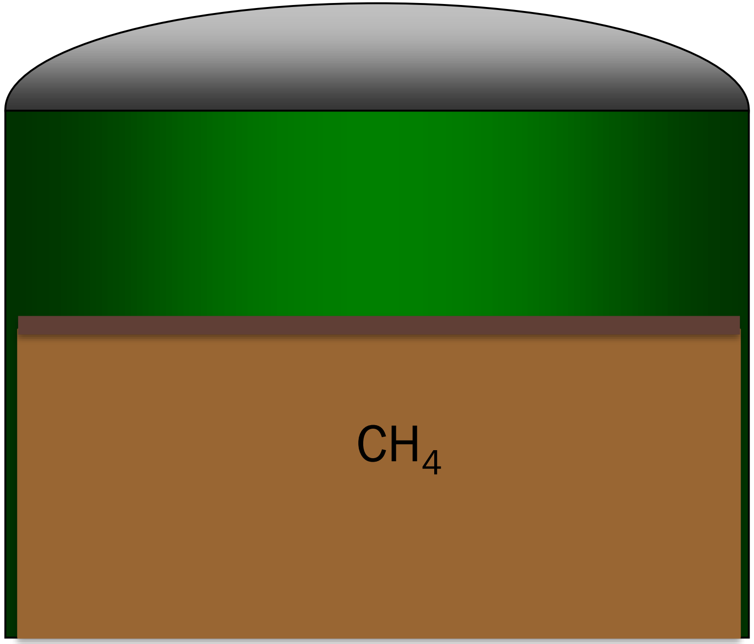
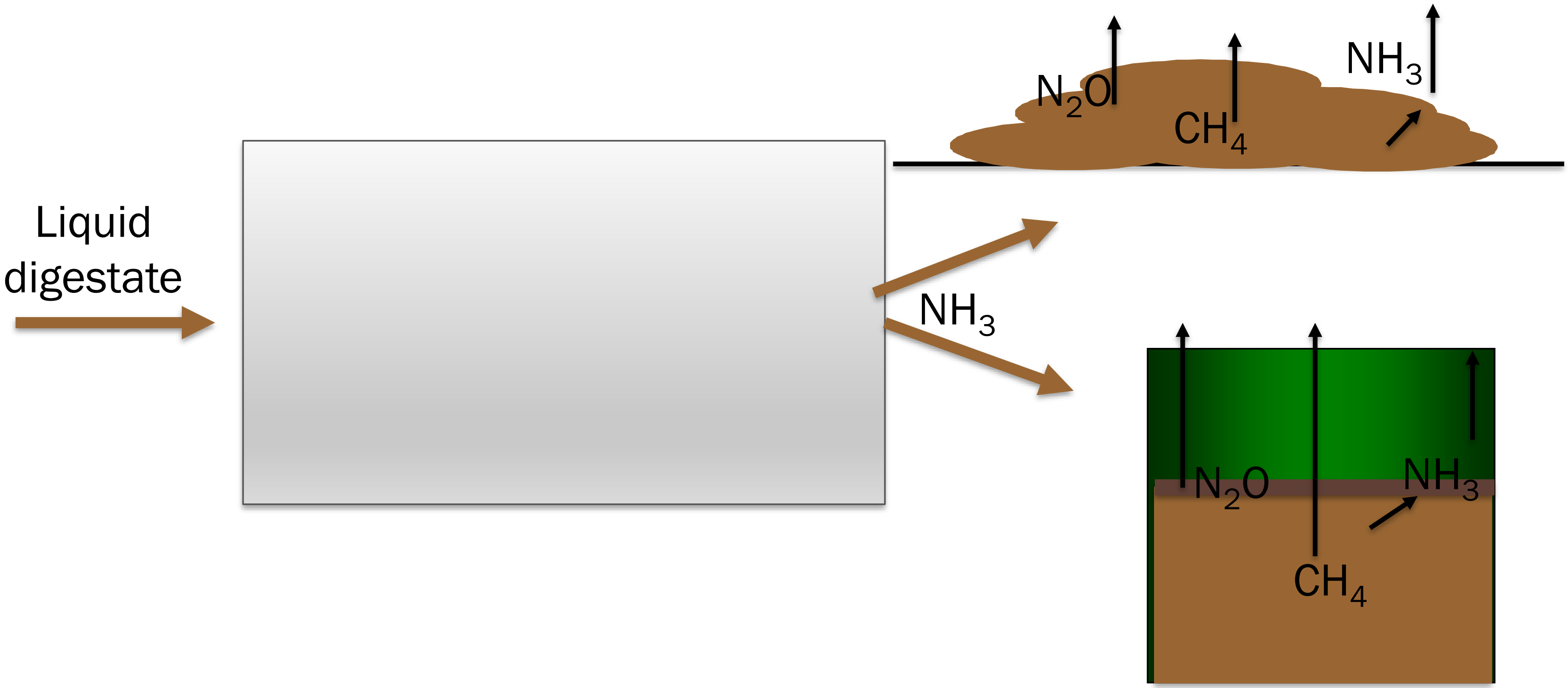
Digestate storage



Digestate storage



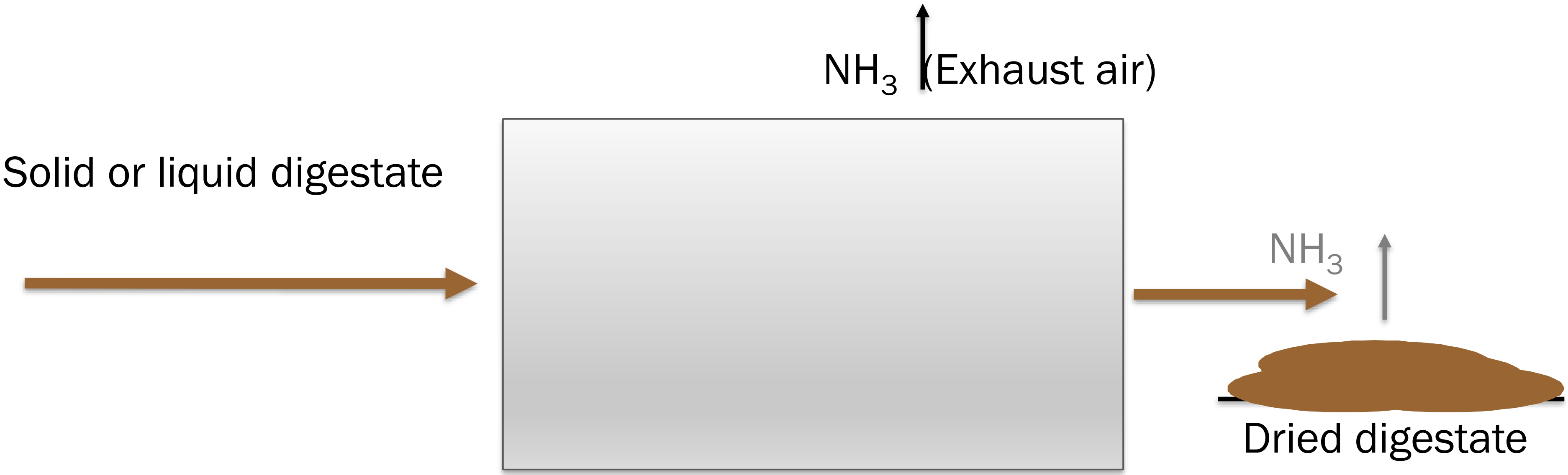
Digestate separation techniques



Measures

- Store liquid fermentation products gas-tight (all emissions), ideally cooled down (for lowering NH_3 emissions when fertilizing)
- Strip or stabilize NH_3 before separation
- Enclose separation plants, acid scrubbing of exhaust air (NH_3)
- Store solid fermentation products at least protected from wind, cool, covered with fleece (NH_3)
- Set wide C/N ratio, strip or stabilize NH_3 beforehand (N_2O, NH_3),
- Create aerobic conditions (CH_4) by mixing structural material into heaps
- Observe conflicting goals (aerobization, covering)

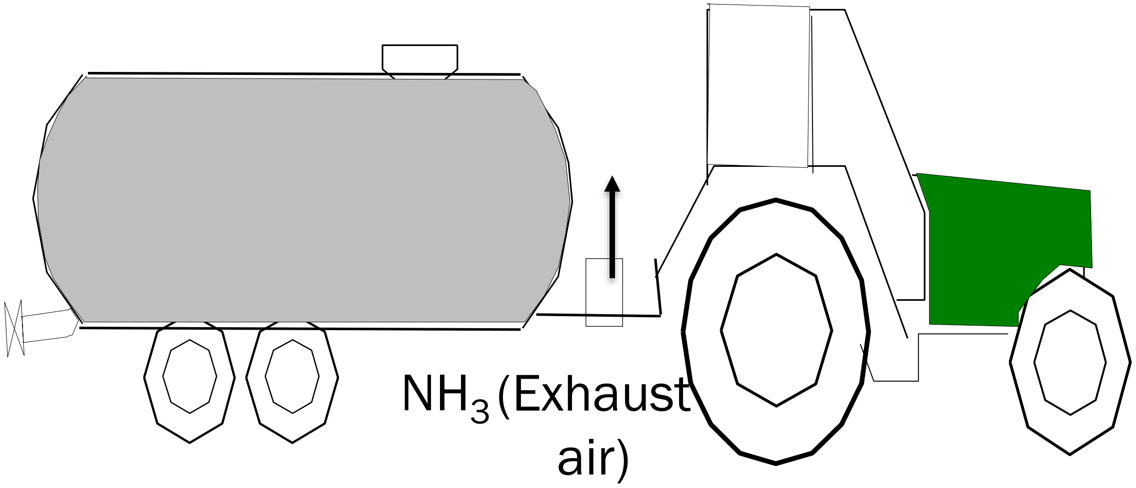
Digestate drying



Measures

- Capture exhaust air, acid wash!
- Store dried fermentation products dry, if possible cooled down.

Vacuum tanker



Measures

- NH_3 emissions during suction with vacuum technology (not quantified so far).
- If possible, use tank trucks with pump technology or fill with pump
- If possible, do not use vacuum tank trucks for pumping over
- Ammonia trap at air outlet?
- If necessary, stabilize NH_4 previously

(4) Summary and outlook

Emission avoidance during digestate management

- Biogas technology is a cross-sectional technology for climate protection, circular economy, flexible cross-sectoral energy and multifunctional agriculture
- This requires low-emission technologies throughout the entire chain
- Digestate treatment processes important for nutrient hub function
- Emission risks for CH_4, N_2O and NH_3 must be minimized
- Avoid conflicts of objectives especially for solid fermentation products!
- Technical developments over the entire chain needed

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Smart Bioenergy – Innovations for sustainable future

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Relevante Klimagase

- CH_4 : CO_2 – Äquivalenzfaktor = 25[1)] ; Bildung anaerob unter feucht (-warmen) Bedingungen; Bildung v.a. in Gülle- und offenen Gärproduktlagern, im Inneren von Haufwerken und Mieten fester Gärprodukte, von Mist, Futterresten....)
- N_2O : CO_2 – Äquivalenzfaktor = 298[1)] ; Bildung durch Nitrifizierung und Denitrifizierung, d.h. v.a. unter semiaeroben Bedingungen; N-Verlustquelle; Fördernd: Enges C/N – Verhältnis (= N-Überschuss), semi-aerobe- Verhältnisse; Bildung v.a. in Schwimmdecken, im oberflächennahen Bereich von Haufwerken
- NH_3: Indirekt wirkendes Treibhausgas (via N_2O); versauernd, eutrophierend, N-Verlustquelle; Hauptsächliche N-Form in flüssigem Gärprodukt; Emissionsfördernd: intensiver Luftkontakt, Vakuum, hohe Temperatur, hoher pH-Wert, hohe NH_4/NH_3-Konzentration;

Entspr. viertem Sachstandsbericht der IPCC im 100-Jahrehorizont; https://www.ipcc.ch/site/assets/uploads/2018/08/IPCC2007-SYR-german.pdf