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N_2O emissions resulting from N fertiliser application in sugar beet cultivation

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Agricultural soils and the application of N fertiliser are an important source of the greenhouse gas nitrous oxide (N_2O). More than half of the CO_2eq emissions in sugar beet cultivation are out of N_2O emissions. They are caused directly via field N_2O emissions and emissions out of crop residues remaining on the fields after harvest or indirectly via volatilisation, re-deposition, leaching and runoff (*Reay et al., 2012*). Aim of the present study was to evaluate the influence of different forms of fertilising (organic, mineral or both combined) on N_2O emissions in sugar beet cultivation in Germany.

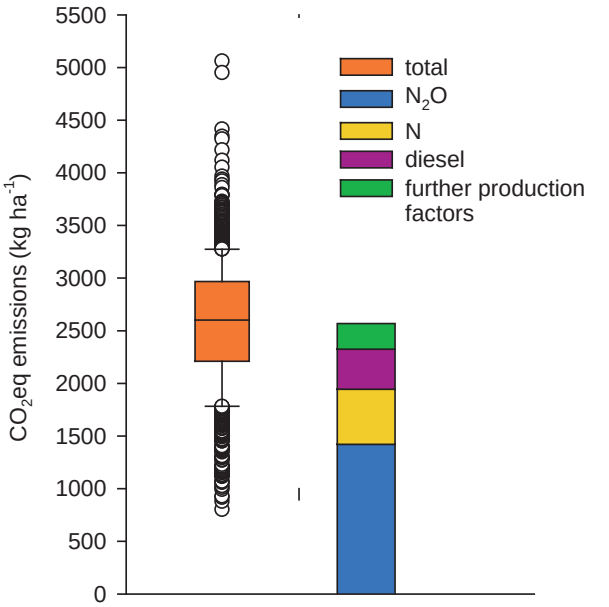

Fig.1: CO_2eq emissions in sugar beet cultivation in Germany, farm survey 2010-12, n=1181, in total (l.) and according to production factors (r.), further production factors: P_2O_5, K_2O, seeds, pesticides

Material & Methods

- o data collected 2010 – 2012
- o survey among 1181 sugar beet growers in Germany (*Stockfisch et al., 2013*)
- o calculation of greenhouse gas (GHG) emissions with the tool BIOGRACE (*Biograce, Version 4c, 2013*)
- o total GHG emissions in crop cultivation include applied fertilisers (incl. catch crops), pesticides, diesel, seeds
- o N_2O field emissions are taken into account (model calculations)
- o GHG emissions declared as equivalents of CO_2 (CO_2eq) with a Global Warming Potential of CH_4 = 23 and N_2O = 296 (*EU, 2009*)

Tab.1: Amount of N fertiliser, root yield and sugar yield in sugar beet cultivation in Germany, farm survey 2010-12, n=1181, median values

	2010	2011	2012
min. + org. N fertiliser (kg ha^{-1})	119.6	121.1	129.0
root yield (t ha^{-1})	71.1	78.8	75.7
sugar yield (t ha^{-1})	12.4	14.4	13.8

Results

The total CO_2eq emissions in sugar beet cultivation in Germany differ between 750 kg ha^{-1} and more than 5000 kg ha^{-1} (Fig. 1) with a median value of 2600 kg ha^{-1}. Most of the emissions are out of N_2O, even though the applied amount of N is rather low in sugar beet cultivation, followed by emissions out of the production of mineral N fertiliser.

While indirect N_2O emissions mostly occur according to fertilising, direct N_2O emissions result from N fertilising and from emissons out of crop residues, which are calculated according to the root yield. Thus, the increase of N_2O emissions in 2011 compared to 2010 (Fig. 2) is due to the relative high amount of applied organic N (88 kg ha^{-1} vs. 66 kg ha^{-1} in 2010 and 69 kg ha^{-1} in 2012; not shown) and the high root yields (Tab. 1). Farmers applying both, mineral and organic fertiliser, used an above-average amount of N and had therefore the highest emissions out of field N_2O field emissions and emissions out of N fertiliser production (Fig. 2).

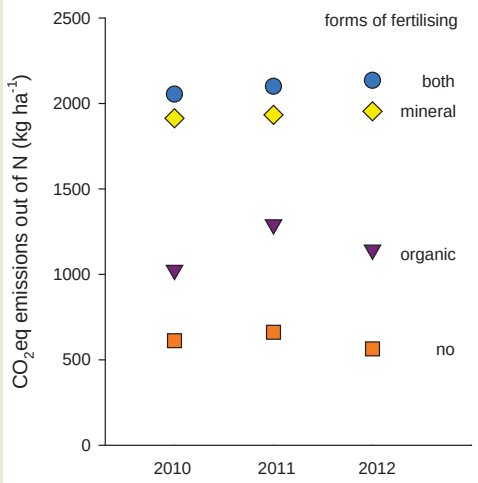

Fig.2: CO_2eq emissions calculated from N_2O field emissions and N fertiliser in sugar beet cultivation in Germany, farm survey 2010-12, n=1181, grouped by form of fertilising

Conclusion

In the sense of sustainable intensification, reducing environmental impacts of sugar beet cultivation without affecting economic aspects poses one of the actual challenges for commercial farms. Applying only as much N fertiliser as necessary, including organic N fertiliser and using proper techniques could help mitigate CO_2eq emissions. The way of calculating N_2O emissions has to be further discussed, as there are large uncertainties.

- o *Biograce (2013): Harmonised calculations of Bioenergy Greenhouse Gas Emissions in Europe, Version 4c, http://www.biograce.net/ (Stand: 06.05.2014)*
- o *European Union (EU) (2009): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (RED)*
- o *Reay, D.E.; Davidson, E.A.; Smith, K.A.; Smith, P.; Melillo, J.M.; Dentener, F.; Crutzen, P.J. (2012): Global agriculture and nitrous oxide emissions, Nature Climate Change, 2, 2012, 410-416*
- o *Stockfisch, N; Gallasch, M.; Reineke, H.; Trimpler, K.; Mielke, C.; Reiners, M.; Risser, P.; Schmitz, K. (2013):Betriebsbefragung zur Produktionstechnik im Zuckerrübenanbau: Datenbasis und Basisdaten, Sugar Industry/Zuckerindustrie 138, 10, 656-663*