Project brief

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Region-specific measures for the cost-efficient reduction of greenhouse gas emissions in the cultivation of crops – RekoRT

Heinz Stichnothe[1], Gerlind Öhlschläger[1], Janine Mallast[1], Stefan Prinz[1,2], Rolf Nieder[2], Daniela Drechsler[3], Pia Schneider[3], Theresa Stark[3], Sebastian Wulf[4], Meike Schmehl[4]

- **The use of farm manure can contribute to GHG mitigation; mitigation and economics are highly dependent on transport distance, and there is also a risk of increased ammonia emissions.**
- **Nitrification inhibitors can contribute to GHG mitigation, depending on location, if no problem shift occurs**
- **Establishing catch crops and legumes in extended crop rotations has been shown to have positive ecological effects, but economically it is a challenge.**
- **The regional soil and climate characteristics have a significant influence on the results of the ecological as well as the economic evaluation; there is no one-fits-all solution.**

In German agriculture, greenhouse gas emissions are to be reduced by 36% by 2030 compared with 1990, i.e. a maximum of 56 million metric tons of $CO_{2eq.}$ (million metric tons of carbon dioxide equivalents) are likely to be emitted. Together with our project partners in the RekoRT project, we have investigated which measures in the cultivation of agricultural raw materials at the regional level are suitable for achieving the set target.

Background and aims

Within the German Climate Protection Program 2030 various GHG mitigation measures were presented. In the agriculture sector, for example, reducing nitrogen (N) surpluses is a crucial measure for arable farming. The amended Fertilizer Ordinance of 2017 has already reduced N surpluses and associated GHG emissions. However, this success alone is not sufficient to meet the 2030 GHG reduction target. Moreover, nutrient input is considered as one of the environmental issues that has already exceeded the "Planetary Boundaries". Furthermore, it should be noted that agriculture is not only a source of greenhouse gas (GHG) emissions, but can also help to reduce GHG emissions or even assume the function of a CO_2 sink by providing climate-friendly raw materials and energy sources. When deriving measures to reduce GHG emissions, conflicting goals, such as nutrient inputs from fertilizers containing nitrogen and phosphorus, must also be taken into account without compromising food supply.

These **c**onflicting goals are made clear by linking the various strategies such as the EU's farm-to-fork strategy and biodiversity strategy.

Methodological approach

For the required regionalization of the measures, results and findings from previous projects were supplemented by data and findings from the literature and assigned to defined soil-climate spaces. In preparation for the ecological and economic analyses, the methodological approach was harmonized in order to obtain comparable and transparent results. This includes the selection of the regionalizable field emissions as well as the assumptions made for their calculation.

The ecological analysis was carried out using the LCA software GaBi supplemented by the database ecoinvent 3.7.1. The economic analysis was carried out using characteristic values from performance costing. For this purpose, the selected product systems were defined using the operations and associated costs from the KTBL database.

Results

The results were obtained in close cooperation with the project partners of the TFZ and the KTBL. The database used as a basis from previous projects was harmonized and compiled in a Microsoft Access-based database. The harmonized and compiled data can be used for fertilizer advice and thus for GHG emission reduction in agricultural practice.

As a prerequisite for the ecological and economic analyses, the methodological approach was determined. Nitrous oxide (N_2O), carbon dioxide (CO_2), ammonia (NH_3), nitrate (NO_3^-), phosphorus (P) and nitrogen monoxide (NO) were defined as regionalizable field emissions as well as the resulting impact categories greenhouse effect, acidification and eutrophication.

Life cycle assessment results are only comparable if they have been calculated on the same methodological basis. In this context, the calculation methodology was analyzed with regard to conformity with existing guidelines and mapped in a decision tree, here exemplary shown for the handling of co-products.

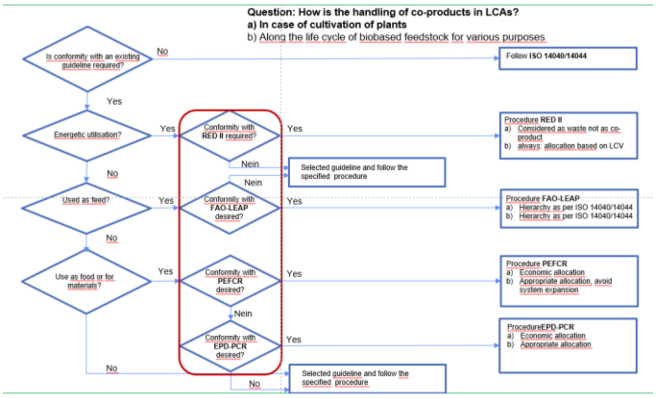

Fig. 1: Decision tree for handling of bio-based co-products if conformity with existing guidelines is desired

The life cycle assessment results of the calculated scenarios on the co-product straw illustrate that the method should be chosen depending on the intended use of the main and by-product, unless compliance requirements apply.

The crop rotation effects nutrient transfer, phytosanitary effects and effects on the production process were analyzed based on the crop rotation design. Here it became clear that the yield potential of a site can affect the environmental benefits of diversification. It is true that diversification can reduce the use of pesticides and nitrogen fertilizers across the entire crop rotation. However, this is offset by lower biomass yields.

In the case of the greenhouse effect, mineral fertilizer production and nitrous oxide emissions are the main drivers, while field emissions of ammonia, nitrate and phosphorus are the main drivers in the other impact categories.

A comparison of these impact parameters with the political framework and legislation resulted in a selection of individual measures that were evaluated ecologically and economically. These included the use of farm manure, the use of nitrification inhibitors and the diversification of crop rotations.

The amount of GHG savings from the use of farm manure depends largely on the composition of the manure and the transport distance. Pig slurry in particular has a considerable GHG savings potential and can also be transported approx. 80 km from an economic point of view; this is clearly shown in the Figure 2 and Figure 3.

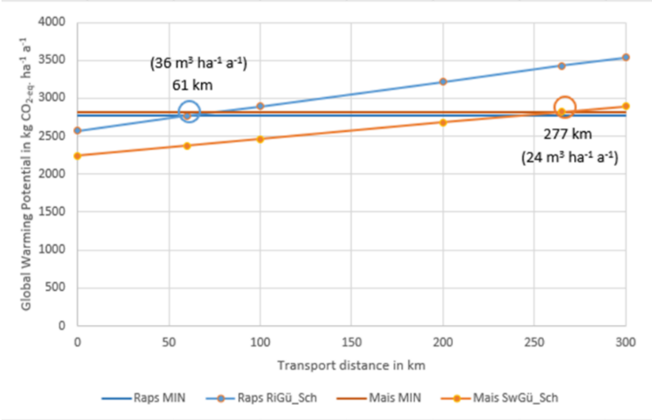

Fig. 2: GHG savings from cattle manure (RiGü) or pig manure (SwGü) as a function of the transport distance.

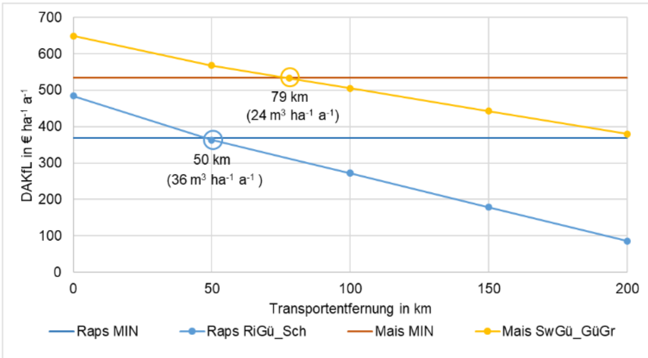

Fig. 3: Direct and labor cost-free performance (DAKfL) depending on the transport distance

Conclusions

- GHG abatement measures can lead to problem shifts and are not always economically viable under the current political framework
- GHG mitigation measures must be balanced against other environmental goals, e.g. NH_3 mitigation
- Measures have different effects at different locations, this is a complication for the policy framework.

Weitere Informationen

Kontakt

[1] Thünen-Institut für Agrartechnologie
Heinz.stichnothe@thuenen.de
www.thuenen.de/at

Partner

[2] TU-Braunschweig
[3] TFZ Straubing
[4] KTBL

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