P budget calculations of German farmland and resulting manure surpluses in livestock hotspot regions.

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Abstract

The agricultural sector in Germany is characterized by regionally spezialised managing systems. Livestock and biogas production is concentrated in the northwest and the south east regions, resulting in locally high amounts of manures (organic fertilizers such as slurry and digestates). The research work described here aimes at the budgeting of soil P on district level, and further the assessment of regional surplus of P in agricultural systems, in order to evaluate strategies for regional manure export and/or appropiate manure processing systems. Based on soil P budgets and two P-depletion scenarios, a manure surplus and thus a transporting or manure processing potential of about 20 - 30 million t FM per year is calculated, which is about 9 - 14 % of the total manure in Germany.

Keywords: livestock farming; manures; digestates; Germany; regional N and P surplus; manure surplus; Soil P depletion

1. Introduction

The agricultural sector in Germany is characterized by regionally spezialised managing systems. Livestock and biogas production is concentrated in the northwest and the south east regions, resulting in locally high amounts of manures (organic fertilizers such as slurry and digestates). The research work described here aimes at the budgeting of soil P on district level, and further the assessment of regional surplus of P in agricultural systems, in order to evaluate strategies for regional manure export and/or appropiate manure processing systems.

1. Methods

Based on the methodology for calculating regionalized soil N budgets according to Häußermann et al. (2019), regionalized soil P budgets with a resolution at district level were calculated. The P soil surface budgets are essentially based on the same activity data and the same system boundaries as for the regionalized soil N budgets (Häußermann et al. 2019).

The coefficients of P removal via harvested products (export outside of the farm) are either based on the German Fertilizer Ordinance or on the implementation recommendations for the Fertilizer Ordinance (2017) of the federal state authorities responsible. The coefficients for P excreted by animal are also taken from the Fertilizer Ordinance. The activity data of mineral phosphorus fertilizers is based on publications of the Federal Statistical Office; due to a lack of sufficiently precise data on the regional distribution of mineral phosphorus fertilizers application, the regional distribution is carried out according to the approach for the regional distribution of nitrogenous mineral fertilizers in Häußermann et al. (2019).

Within the P budgeting methodology we assume no losses of P to the environment occur. The results of the P budgeting calculations represent the basis for the determination of manure (livestock and digestate) surpluses in the five most relevant German livestock hotspot regions, which are analysed in more detail in this project.

The use of livestock manure is limited by the regulations of the Fertilizer Ordinance (limit of 170 kg N/ha UAA from organic fertilizers, medium soil P-content). These regulations

thus also determine the export requirement of P and N in farm manure.

In order to calculate P surpluses and depletion scenarios, a literature search was carried out on P contents and P enrichment in German soils. Unfortunately recently established data sets are hardly available anymore, but data published at the end of the last millennium indicate very high P contents in soils of the hotspot regions.

Estimation of actual manure export needs is further limited by the fact that original soil P stocks are not known prior to the period covered by our P budgeting calculations. It is likely that a significantly greater amount of P was accumulated through the 1980s and early 1990s than in the period thereafter.

Current data on the regional distribution of soil P content classes and thus on the further uptake capacity of phosphorus were not available for this project, nevertheless, based on the regionalized P soil surface budgets available since 1995 and the analyses from the 1990s, e.g., from LUFA Oldenburg can be concluded (figure 1), that the soils of the five hotspot regions are still P oversupplied, so export requirements can be determined assuming a certain P depletion.

Two scenarios were defined for this purpose. Scenario 1 assumes a (district-based) P supply of 20% below P removal and scenario 2 assumes 50% below removal.

Figure 1: Frequency distribution of the contents of DL-soluble phosphate in 1094 soil samples from the agrarian intensive area from South Oldenburg (P soil content classes LUFAOldenburg,1992).
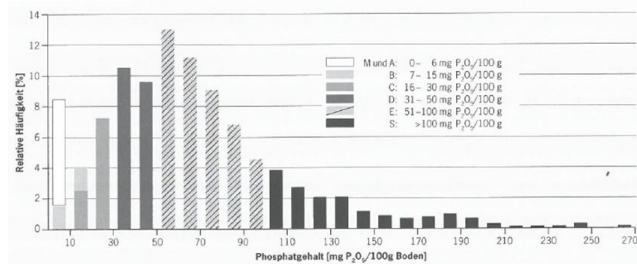
2. Results

Based on soil P budgets and the two depletion scenarios, a manure surplus and thus a transporting or manure processing potential of about 20 million t FM (scenario 1) - 30 million t FM per year (scenario 2) is calculated, which is about 9 – 14 % of the total manure amount in Germany. Assuming that these manures have to be transported at least 100 km to arable farming regions, this results in annual costs of about €400 million for the sector.

For the economic analysis of the processing techniques, the quantities of farm manure and digestate that are produced and, if necessary, have to be processed, as well as their nutrient contents, are also required. To calculate the farm manure quantities, the animal place-specific livestock manure

quantity is derived from the Fertilizer Ordinance (2017, Annex 9 Table 1) and the mean value of the livestock populations from the General and Representative Livestock Survey in the years 2016 to 2018 (Destatis, Genesis Online Table 41311). Based on this, together with the previously calculated livestock populations in the various housing rsp. manure management systems, the manure quantity is calculated.

The livestock manure and nutrient (N and P) volumes and surpluses in the five hotspot regions and processing potential resulting from the two scenarios are shown in Table 1.

Table 1: P surplus and corresponding livestock manure and digestate quantities in the five German hotspot regions.

Region	P-Surplus in t P p.a.		Amount of manure in Mio. t FM p.a.	
	Scen. 1	Scen. 2	Scen. 1	Scen 2
Münsterland[1]	6.922	9.846	4.6	6.6
Vechta-Cloppenburg[2]	14.667	18.317	9.0	11.2
Hohenlohe/Franken[3]	968	2.775	0.8	2.2
Allgäu[4]	3.534	5.886	3.2	5.4
Südostbayern[5]	2.372	4.880	2.2	4.4

[1]districts Borken, Coesfeld, Steinfurt, and Warendorf
[2]districts Cloppenburg, Emsland, Grafschaft Bentheim, and Vechta
[3]districts Hohenlohe, Schwäbisch Hall, and Ansbach
[4]districts Ravensburg, Lindau (Bodensee), Ostallgäu, Unterallgäu, and Oberallgäu
[5]districts Altötting, Ebersberg, Erding, Mühldorf a.Inn, Rosenheim, and Traunstein

Acknowledgements

References

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