GREEN CYCLE – an innovative and efficient fertigation approach towards sustainable agriculture

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ABSTRACT SUBITTED FOR THE SUWANU CONFERENCE

Background

Conventional fertilization methods of farm manure are mostly based on a one-time depot fertilization in spring. Moreover, the fertilizer material needs to be worked into the soil due to high dry matter content. Only very rarely, due to economic and technical constraints, a second or even third fertilization with farm manure are carried out during the season into the growing or maturing crop. Instead, mineral fertilizers or urea solutions are usually used to apply any missing N quantities by vehicle. The depot fertilization of farm manure in spring is suspected to be N-inefficient in certain weather conditions, since fertilized N-quantities are only available to plants when there is sufficient soil moisture. If sufficient precipitation does not occur or is too low, unused N quantities remain in the soil. These are then transferred with the seepage water to deeper soil layers, especially in wetter and cooler seasons, and in extreme cases can cause excessive nitrate levels in the groundwater.

Objectives of GreenCycle

GreenCycle aims to make N-fertilization with liquid fertilizers efficient and practicable throughout the year. As a side effect, storage capacities can be reduced and costs for mineral fertilizers as well as wages and fuel can be reduced. GreenCycle sees itself as a building block of precision agriculture in the near future.

A key aspect of GreenCycle is the technical processing of liquid fertilizers by means of mechanical micro-separation. In this process, liquid manure, such as liquid manure or fermentation residues, is reduced to a particle size of less than 1 mm by means of appropriate screens. The resulting fugate can either be applied immediately or stored temporarily. The fugate is spread by conventional irrigation circular sprinkler systems. The fugate is mixed with irrigation water in an adjustable ratio. These do not have to be specially converted. Due to low solids content, additional incorporation into the soil is not necessary. Therefore, the GreenCycle approach can be used to efficiently irrigate crops site-specifically and all year round.

Facts and Data

Digestate contains solids of different sizes. GreenCycle has been able to show that the majority of the solids have particle sizes smaller than 63 µm. In addition, the proportion of mineral components decreases with decreasing sieve size. In our opinion, this can be generalized to all fermentation residues. In the present investigations, the proportions of dry matter after a separation of 1000µm were considered.

Table 1: summary of particle distribution, ash content and organic carbon of different biogas residues fractions after filtration using a 1mm separator

particle size [mm]	**dry matter [%]**	**ash content [%]**	**Corg [%]**
>1	0,6	15,6	--
1 – 0,63	1,3	33,2	--
0,63-0,4	3,6	56,4	--
0,4-0,25	7,2	76,1	13,6
0,25-0,125	11,2	79,4	14,5
0,125-0,063	10,6	71,6	17,3
<0,063	65,5	---	--

Slurry and digestate have different N concentrations depending on their origin and age. In the GreenCycle project, different fermentation residues were examined with regard to their composition. In all substrates, the dissolved nitrogen is present as ammonium. Separation, here at 500µm in the pre-test, does not change the ammonium content in the fugate compared to the initial substrate. The thick sludge is recirculated.

Table 2: exemplary changes of physical and chemical parameters of mikroseparation of biogas residues (non-official pre-test of a pre-separated residue (1mm sieve) and a 500µm mikrosieve)

	native biogas residue	**separated residue (fugat)**	**thickend rest**
dry matter [%]	4,6	4,05	~9,2
Corg [%]	3,0	2,6	6,2
N total [%]	0,4	0,3	0,4
NH4 [%]	0,2	0,2	0,2
NO3 [%]	0	0	0
pH	7,5	7,7	7,5

When applied via a high mixing ratio >1:9, infiltration into the soil and root-effective application is achieved.

As the available soil tests and evaluations show, concentration of N is often unevenly distributed horizontally. GreenCycle and the required site-specific fertigation scheme (fertilization + irrigation) can take this into account. Conventional depot fertilization is currently only able to do this to a limited extent.

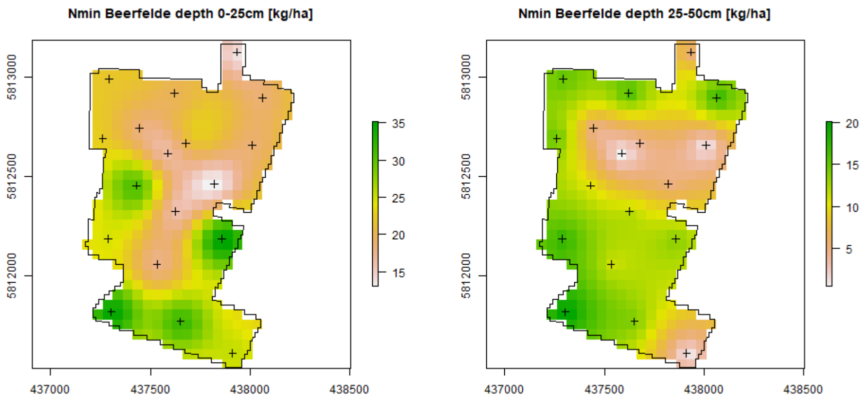

Figure 1: Overview about exemplary spatial Nmin distribution in a plot in Brandenburg (Germany)

<u>Conclusion</u>

By means of an adjustable mixing ratio between fugate and well water, the required amount of nitrogen can be adjusted. Depot fertilization in spring time can therefore be reduced or even completely discontinued by the GreenCycle system.

On average, in Brandenburg (Eastern Germany), an irrigation quantity of 100mm is needed between April and June. The necessary total N-applications can therefore be distributed over this irrigation quantity. Future optimizations of the GreenCycle approach concern mainly the intra-seasonal nutrient demand. We hope that the additional use of available satellite data will lead to promising solutions. However, these data have to be calibrated with an appropriate crop-development model and actual field data.