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Strategic management of nitrogen within an organic cropping system using digestate from biogas production of recirculated crop residues

Food, energy and fertilizer production

Hypothesis

Our hypothesis is that anaerobic digestion of residues and recycling of the digestate will lead to an improved N use efficiency compared to incorporating the residues untreated in to the soil.

Key results & discussion

- The crops yielding the highest biomass for energy and fertilizer production in the first growth season were
1) pea intercropped with barley and under sown with ley,
2) lentil intercropped with oat and under sown with clover and grass,
3) and barley in pure stand (fig. 1).

- Pea & barley crop residues contained the highest amount of nitrogen per hectare (table 1.).
- The biomass fraction from the crop rotation produced 440 m^3 methane/ha and digestate with 64,5 kg N-tot/ha (16 kg NH4-N)..
- A medium sized organic farm in Sweden of 90 ha with a similar crop rotation (fig 2), could thus potentially produce 4000 m^3 of methane/year, (equivalent to 40 000 kWh) and 580 kg N-tot (145 kg NH4), as an addition to food products.

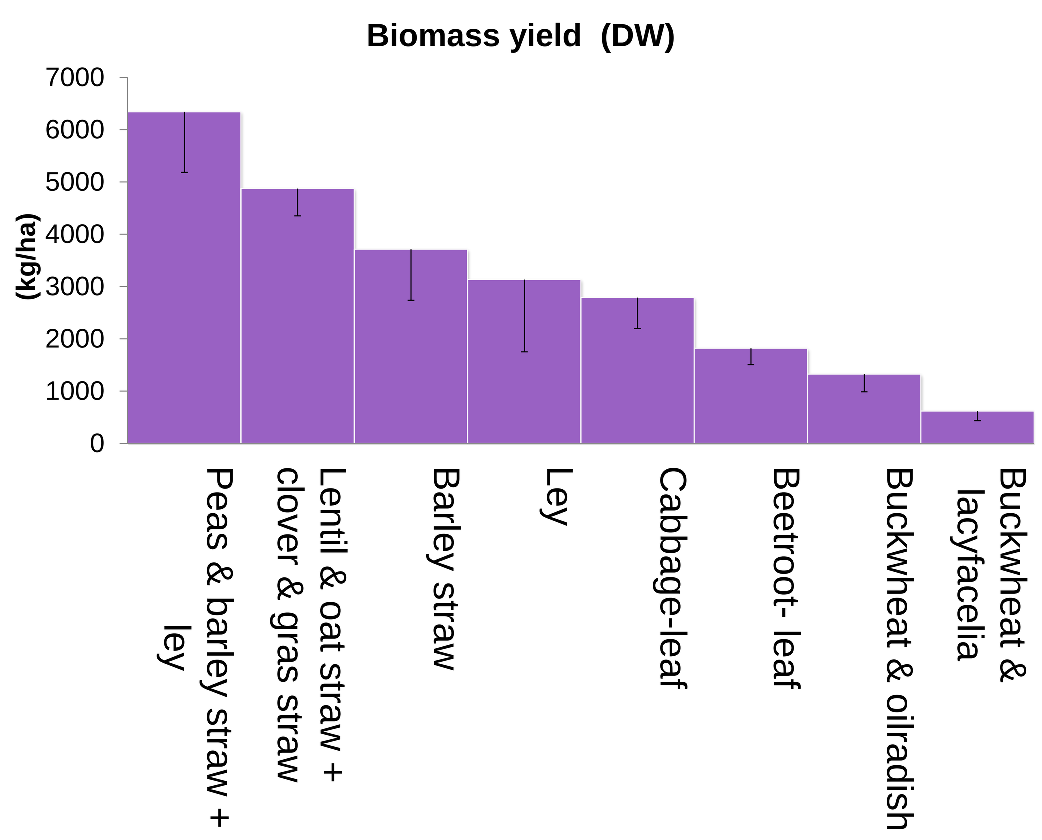

Fig.1. Biomass production (DW) of each main crop and catch crop.

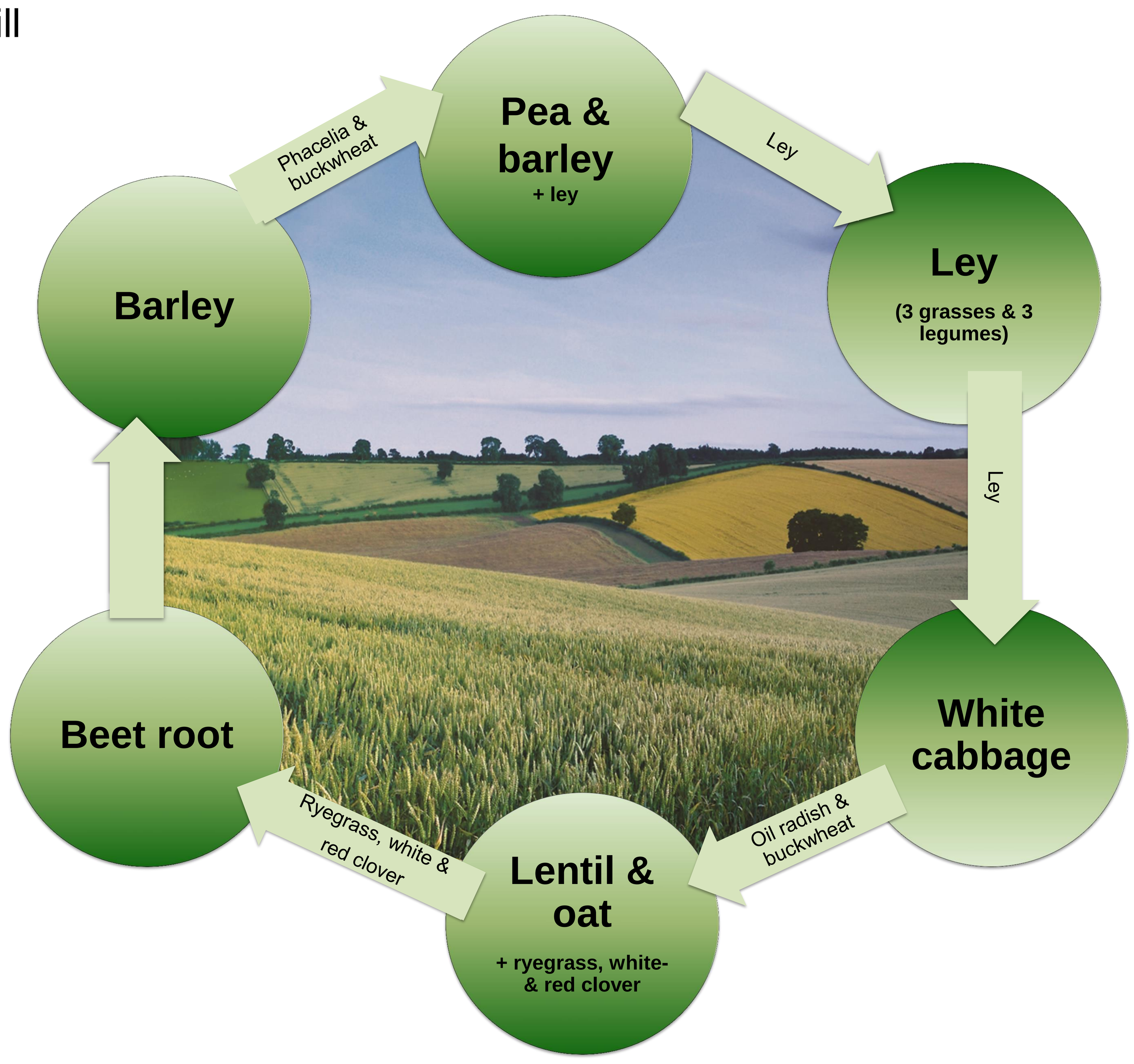

Fig. 2. The crop rotation consists of six main crops and three catch crops.

Background & objectives

This strategy address four important aspects of food production: sustainable land use, timely and efficient cycling of nutrients, reduction of N losses and self-sufficiency in renewable energy.

The main objective is to

- determine the effects of strategic field application of biogas digestate on crop yield, crop quality, and methane potential, based on anaerobic digestion of crop residues, catch crop and ley from the cropping system.

How work was carried out?

This organic field experiment runs from 2012 to 2015 in Alnarp, Sweden. Three management methods are compared in a cropping system including six main crops and three catch crops (fig 2):

1) Leaving biomass in situ
2) Moving biomass resources to nitrogen-demanding crops.
3) Collecting the biomass resources for anaerobic digestion in a leach bed reactor and using the resulting digestate for nitrogen demanding crops.

Implications

The approach offers potential for diversified farmer income, as food crops, feedstock for biogas and digestate for nutrient cycling are produced simultaneously. This type of multifunctional cropping system provides solutions that can also help to solve issues on conventional farms, such as N emissions, and provide local production of biogas.

Table 1. Nitrogen content of the biomass for recirculation as fertilizer (kg/ha).

Crop	Nitrogen (kg/ha)
Pea & barley + ley straw	95
Lentil & oat straw + clover & grass	73
Beet root leaf	64
Ley	63
Cabbage leaf	59
Buckwheat & oilradish	48
Barley straw	37
Buckwheat & lacyfacelia	22

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