Cradle-to-cradle recycling of nutrients from bio-digestion waste

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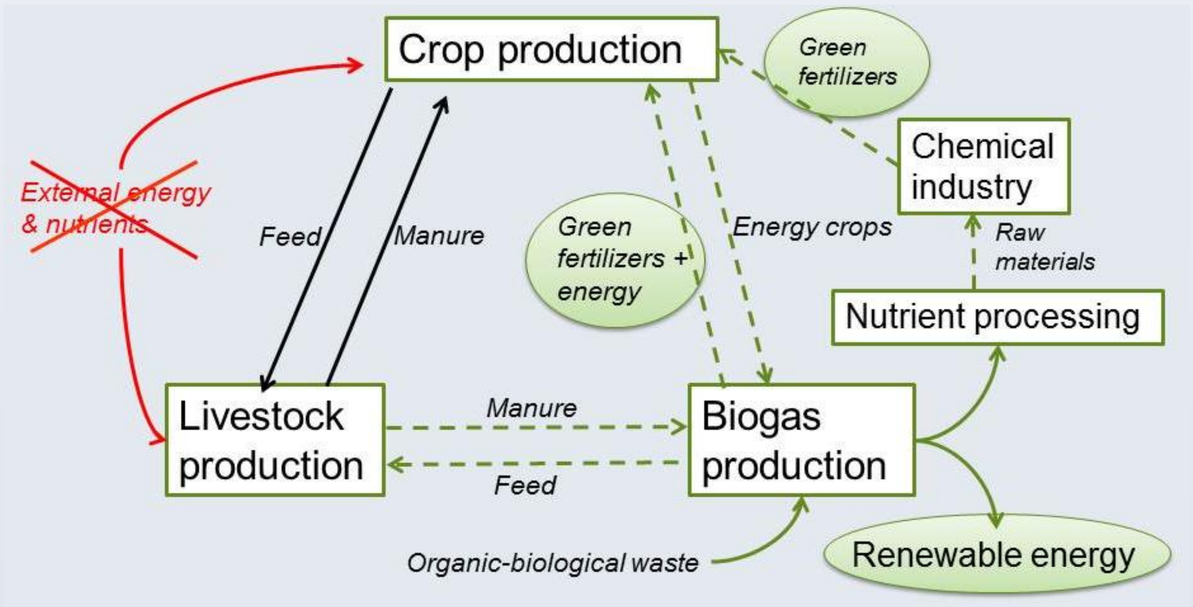
INTRODUCTION

Why is nutrient recycling an important challenge in the transition to a bio-based economy ?

- Nutrient resources are rapidly depleting, whereas the demand is still increasing[1]
- Significant amounts of fossil energy are required for the production and transport of chemical fertilizers[2]
- Costs for energy and fertilizers are increasing[3]

What are the aims of this study ?

- Recuperation of nutrients from bio-digestion waste as green fertilizers
- Evaluation of the impact on biomass yield and soil quality
- Economic and ecological analysis



FIELD EXPERIMENT

Eight different fertilization scenarios (n=4)

Scenario	Chemical start N	Animal manure	Chemical N	Air scrubber water	Mixture digestate/ liquid fraction	Liquid fraction digestate	Chemical K_2O
1	X	X	X	-	-	-	X
2	X	X	-	X	-	-	X
3	-	X	-	X	-	-	X
4	X	-	X	-	X	-	X
5	X	-	-	X	X	-	X
6	-	-	-	X	X	-	X
7	X	X	-	-	-	X	X
8	-	X	-	-	-	X	X

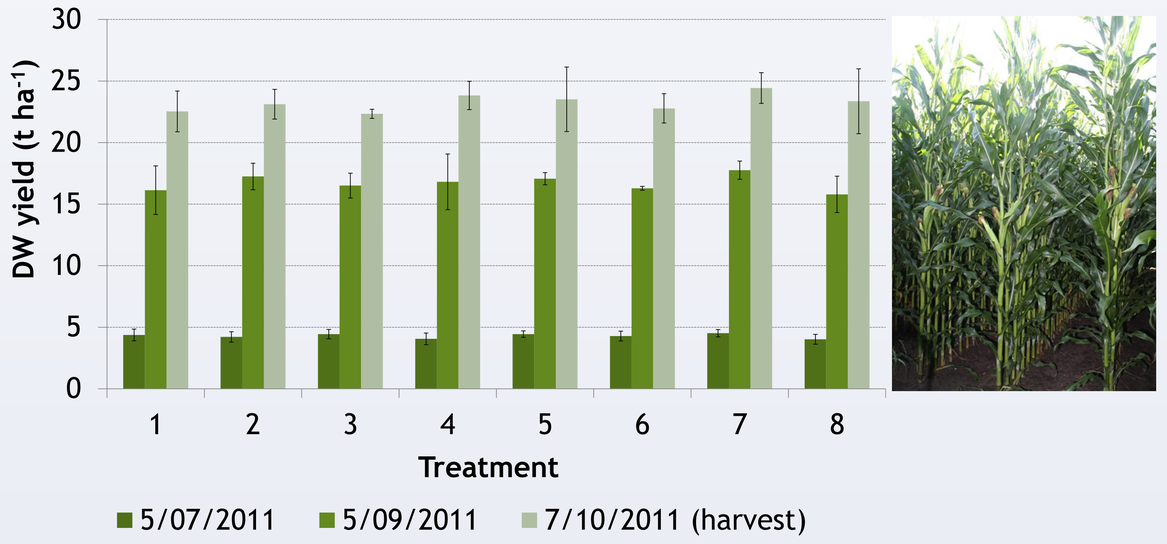
Product sampling (A), fertilizer application (B), soil and plant sampling (C)

Physico-chemical analysis

- Fertilizer value: total content and plant available contents of macro- and micronutrients in products, soils and plants
- Soil quality: pH, EC, organic carbon, nitrate residue, nutrient leaching, sodium adsorption ratio, phosphorus and heavy metal accumulation

RESULTS & DISCUSSION

Dry weight biomass yield



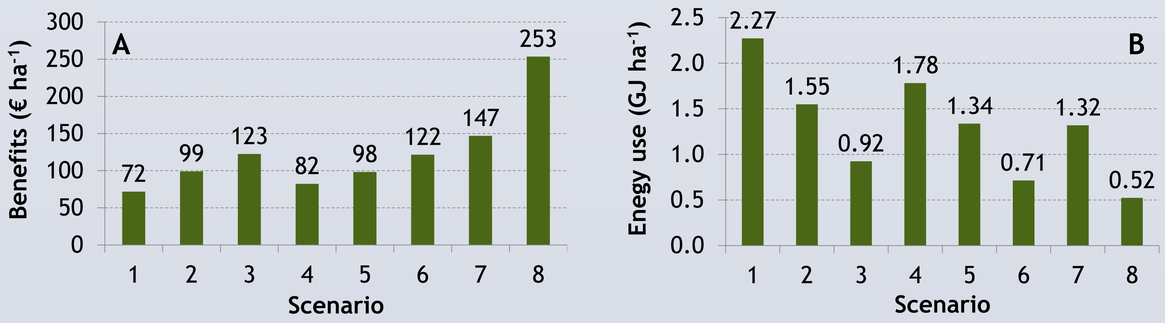
Nitrogen balance (Conducted with NDICEA 6.0.16)

N (kg/ha)	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Manure supply	216 ± 0	216 ± 0	216 ± 0	217 ± 1	217 ± 1	217 ± 1	225 ± 0	230 ± 0
Nitrogen fixation	0	0	0	0	0	0	0	0
Deposition	25	25	25	25	25	25	25	25
Total supply	241 ± 0	241 ± 0	241 ± 0	242 ± 1	242 ± 1	242 ± 1	250 ± 0	255 ± 0
Removal with products	306 ± 42	301 ± 21	309 ± 20	329 ± 33	317 ± 40	313 ± 28	344 ± 42	303 ± 53
Surplus	-65 ± 42	-60 ± 21	-68 ± 20	-87 ± 33	-75 ± 40	-71 ± 28	-94 ± 42	-49 ± 53
Volatilization	-17	-18	-19	-16	-19	-24	-17	-17
Denitrification	-17	-14	-16	-21	-21	-18	-31	-19
Leaching/denitrification	-58	-53	-56	-53	-47	-52	-60	-55
Decomposition organic	156	145	162	182	165	169	206	142
Equilibrium balance	-0.6	0.4	3.1	5	3	4	4	2.2

Phosphorus balance

P_2O_5 (kg/ha)	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Manure supply	108 ± 3	108 ± 3	108 ± 3	74 ± 7	74 ± 7	74 ± 7	105 ± 3	105 ± 3
Deposition	3	3	3	3	3	3	3	3
Total supply	111 ± 3	111 ± 3	111 ± 3	77 ± 7	77 ± 7	77 ± 7	105 ± 3	105 ± 3
Removal with products	135 ± 18	130 ± 9	123 ± 12	141 ± 12	146 ± 22	142 ± 4	151 ± 19	140 ± 30
Surplus	-24 ± 21	-19 ± 12	-12 ± 15	-64 ± 19	-69 ± 29	-65 ± 11	-46 ± 22	-35 ± 33
Soil available April	6,389	6,389	6,389	6,389	6,389	6,389	6,389	6,389
Soil available Oct	1,837 ± 382	1,909 ± 273	1,790 ± 121	1,702 ± 349	1,772 ± 372	1,829 ± 224	1,910 ± 114	1,658 ± 93
Leaching/pollution	4,529 ± 403	4,461 ± 285	4,588 ± 136	4,624 ± 368	4,548 ± 401	4,495 ± 235	4,434 ± 136	4,696 ± 126

Economic (A) and ecological (B) evaluation



CONCLUSIONS & PERSPECTIVES

Recycling of nutrients from bio-digestion waste derivatives in agriculture can:

- create sustainable substitutes for chemical fertilizers
- increase the soil nutrient use efficiency
- result in significant economic and ecological benefits

⇒The use of these products should be stimulated in European legislation

⇒Further field research is on-going in order to validate the results and evaluate the impact on soil quality in the longer term

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