Nutriënten Management Instituut B.V.
Postbus 250, 6700 AG Wageningen
T: 088 8761280
E: nmi@nmi-agro.nl
I: www.nmi-agro.nl

Perspectives of biochar as a soil conditioner

End conference “biochar; climate saving soils”

Groningen, 10 december ’13

Romke Postma

Soil for life

The Interreg IVB North Sea Region Programme
Investing in the future by working together for a sustainable and competitive region

nmi

Questions

- What is a soil conditioner?
- What are regular soil conditioners?
- What are the results of field experiments with soil conditioners?
- What is the perspective of biochar as a soil conditioner?
- How does biochar fit within the management of a farmer?

Soil for life

What is a soil conditioner?

Important elements in most definitions:

- It may exist of organic and/or inorganic constituents
- Focus is on improving (physical and/or biological) soil characteristics, e.g.
  - water retention,
  - water infiltration / drainage,
  - resistance (e.g. for root penetration),
  - aeration and
  - structure / stability of soil aggregates.
- To be effective, it requires a long term strategy → 5-10 years
- **Not**: direct nutrient supply ←→ **fertilizer**
- The goal is to provide a better environment for roots.

What are regular soil conditioners?

- Composts: at the basis of organic waste (urban or green)
  - Contains a high content of stable organic matter
  - Organic matter plays a very important role in soil quality
- Liming material: often calcium- and/or magnesium-carbonates. Affects pH of the soil, thus affecting:
  - nutrient suppy
  - soil structure (by effect on base saturation) and/or
  - soil biology → processes are pH dependent
- Gypsum (calcium sulfate)
  - Soil structure by calcium saturation of CEC

Soil for life

The Interreg IVB North Sea Region Programme

Investing in the future by working together for a sustainable and competitive region

Field experiments: soil conditioners tested

- calcium / liming materials
  - Agrigyps (gypsum)
  - PRP-SOL (Ca/Mg-fert. + trace elements
  - Betacal-carbo (lime from sugar industry
  - Quick lime (CaO+MgO)

- stimulating soil micro-organisms
  - Condit 7% N (proteins)
  - Xurian Optimum (B, Zn)

- references / others
  - Biochar(s)
  - Greenwaste compost

Soil for life

PRAKTIJKONDERZOEK PLANT & OMGEVING WAGENINGEN UR

The Interreg IVB North Sea Region Programme

Investing in the future by working together for a sustainable and competitive region

nmi

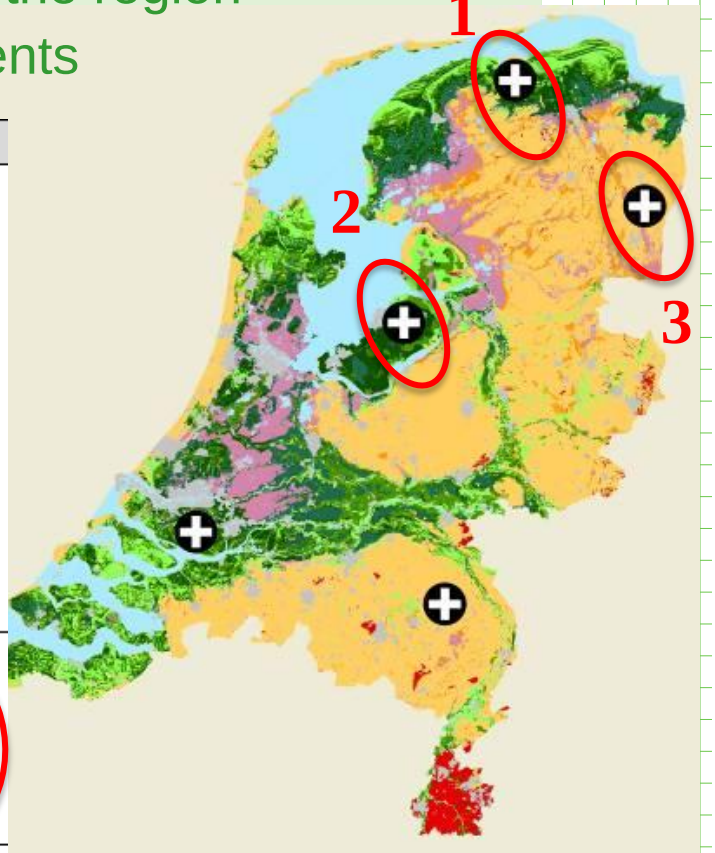
Soil conditioners in field experiment: doses per ha

- Agrigyps : 500 kg CaO/ha → 1700 kg
- Betacal-carbo : ” ” → 3600 kg
- Quick lime (< 35% MgO): ” ” → 1700 kg
- PRP-SOL → Ca/Mg fertilizer enriched with trace elements
  → 300 kg
- Condit 7% N → hydrolysed protein + zeolite, contains OM +7% N
  → 1 ton
- Xurian Opt. → fertilizer with B, Zn en Pseudomonas bacteria
  → 0,9 kg spraying
  (after harvest or before plowing catch crop)
- Biochars → stable C, after pyrolysis of wood chips
  → 2,5 & 5 ton per year or 15-20 ton at once

Field experiments: locations in NL

- Locations differed in soil type and crop rotation
- Crop rotations were representative for the region
- At 3 of the 5 locations: biochar treatments

Property	1 Kollumerwaard	2 Lelystad	3 Valthermond
Clay content (%)	25	18	<3.2
Texture class (USDA)	Clay Loam	Loam	Sand
Organic matter (%)	3.5	2.0	11.6
Total N (mg N kg^{-1})	1420	970	2875
CN ratio (-)	12	10	23.5
pH (-)	7.0	6.8	5.2
CEC (mmol+ kg^{-1})	169	139	158
P-AL (mg P_2O_5 100 g^{-1})	42	42	30
K (mg K kg^{-1})	89	57	52
Crop rotation			
2009	Sugar beet	Seed Potato	Starch potato
2010	Spring wheat	Spring barley	Sugar beet
2011	Seed Potato	Sugar beet	Starch potato
2012	Winter wheat	Onion	Spring barley
2013	Sugar beet	Winter Carrot	Starch potato



Soil for life

PRAKTIJKONDERZOEK PLANT & OMGEVING WAGENINGEN UR

The Interreg IVB North Sea Region Programme

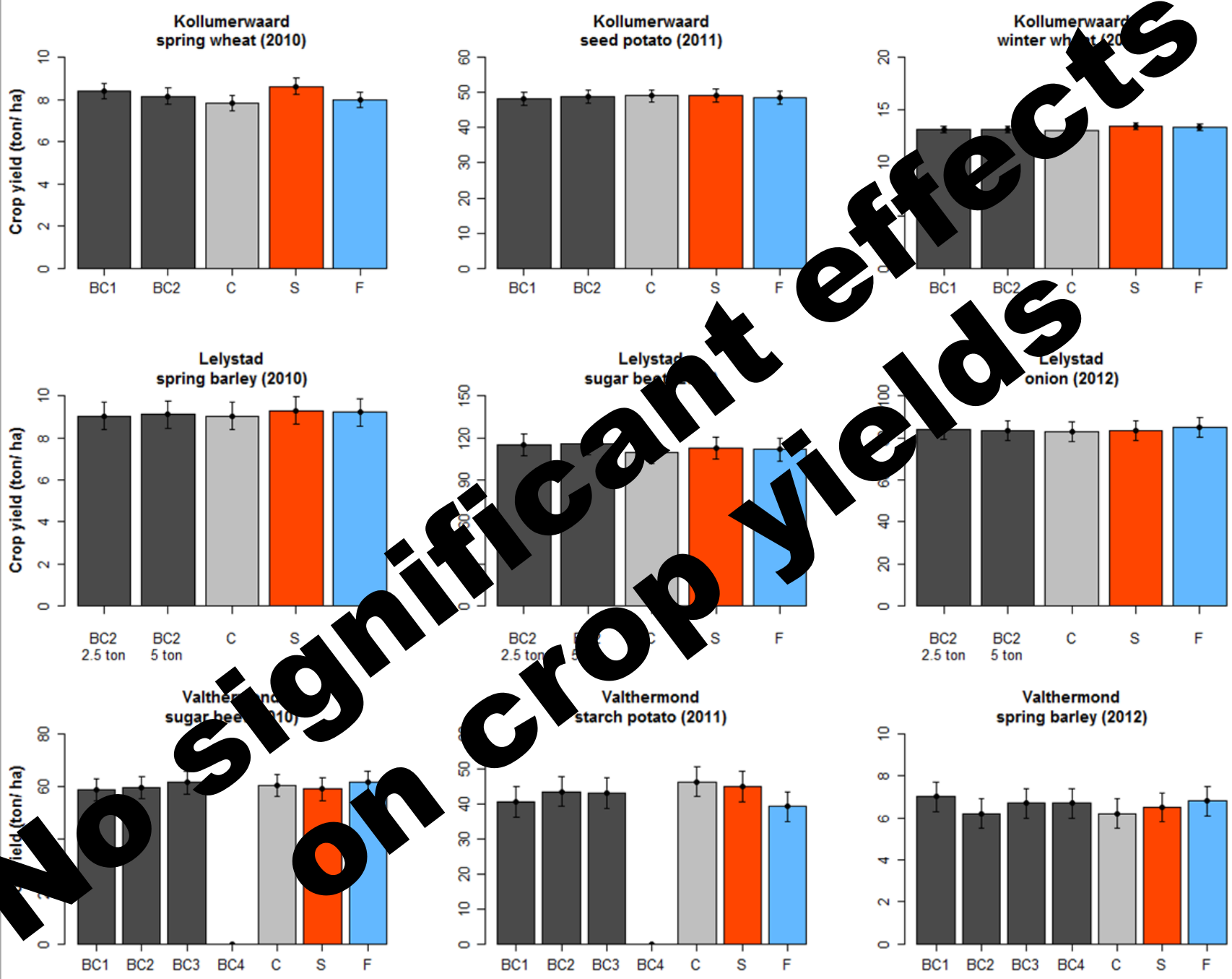
Investing in the future by working together for a sustainable and competitive region

nmi

Biochar treatments per location

- Biochar additions varied between locations (table; t/ha)
- Charcoal, activated carbon, torrefied material and romchar
- Randomized block design with 3 replicates

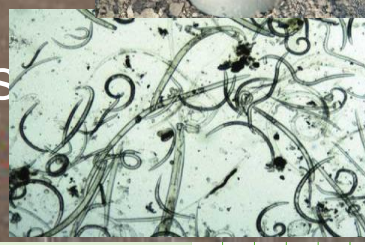
Location	Treatment	2010 spring	2010 autumn	2011 spring	2011 autumn	2012 spring
Kollumerwaard	Biochar wood	5		5	5	
	Biochar norit	5		5	5	
	Compost	9	9		9	
	Pig slurry	25				25
Lelystad	Biochar wood*	2.5		2.5		2.5
	Biochar wood*	5		5		5
	Compost	9	9		9	
	Pig slurry		15			
Valthermond	Biochar ECN	15				
	Biochar wood	5		5		5
	Biochar norit	5		5		5
	Romchar				24.5	
	Compost	18		9		9
	Pig slurry	20		20		



No significant effects on crop yields

Results of field experiments

- No significant effects of soil conditioners on crop yield **and soil properties** at three locations in NL
- This is not only the case for the biochar(s), but also for regular soil conditioners, such as compost
- Reference / control treatments: **with mineral fertilizers!!**
- Obviously, the nutrient and water supply is not significantly improved by the soil conditioners as compared to the control with only mineral fertilizers
- Possibly, this will change at the long term ...



Soil for life

PRAKTIJKONDERZOEK PLANT & OMGEVING WAGENINGEN UR

The Interreg IVB North Sea Region Programme

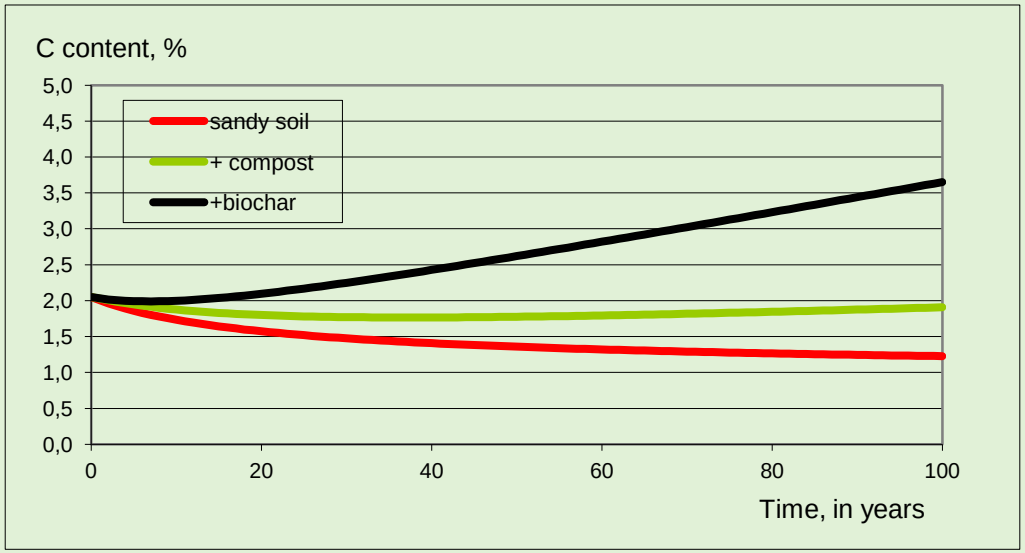
Investing in the future by working together for a sustainable and competitive region

nmi

Long term model calculations

Assumptions:

- Average sandy soil in NL with 2% C (4% OM)
- C inputs via crop residues, etc. left out of consideration
- Yearly applications of compost and/or biochar
  - Compost: 6 ton DM/ha/yr
  - Biochar: 5 ton DM/ha/yr



- C content increases after repeated biochar application
- Biochar is more effective than compost
- It takes decades before effects on C contents can be observed

Soil for life

The Interreg IVB North Sea Region Programme

Investing in the future by working together for a sustainable and competitive region

nmi

Effects of BC at the long term

- Biochar is much more stable than compost
- At the long term (decades), repeated applications of biochar will lead to increased C contents in the soil
- This effect is larger than with compost
- It is still unclear whether biochar in the soil will obtain the same positive properties as SOM, e.g. with respect to:
  - CEC
  - Water holding capacity, etc.

Material	CEC pH-KCl 4,5 (mmol+/kg)	CEC pH-KCl 7-7.5 (mmol+/kg)
Organic matter (humus)	500	2750
Fresh biochar[(1)]	8	8
1 yr old biochar[(1)]	31	73
130 yr old biochar[(1)]	390	1160

Perspective of biochar as soil conditioner?

- Agricultural value
  - Stable C
  - Low nutrient supply - feedstock
  - Properties similar to SOM?
- Environmental aspects
  - Heavy metals, PAH's, etc.`→ feedstock / process
  - Strongly depends on feedstock and quality control → **certification**
- Legal aspects
  - Not allowed in all countries, at this moment → evt. in EU fert reg.
- Price (€)
  - Relatively expensive as compared to alternatives (~600-800 €/ton)

How does BC fit within farm management?

- Part of strategy that aims to keep organic matter contents at a desired level
- Important elements:
  - Crop rotation (e.g. root crops, cereals, catch crops)
  - Soil improvers/conditioners (e.g. compost, biochar)
    - Organic matter (OM) content & stability
    - Nutrient content

    → properties of biochar differ from that of other soil conditioners
  - Fate of crop residues (straw)
  - Tillage practices (e.g. minimum tillage)

Conclusions

- In field experiments in NL the effect of biochar was not better or worse than other, regular soil conditioners
  - Crop yield and quality
  - Soil quality
- At the long term (decades), repeated applications of biochar will lead to increased C contents in the soil. This effect is larger than with compost.
- The perspectives of biochar depend on agricultural value, environmental effects and price → still unsure
- In farm management, biochar could be part of a strategy to keep organic C conents at a desired level → still unsure if biochar will behave like SOM