Sludge Ash as Chemical Phosphorus Fertilizer North American Research Project

Northeast Residuals And Biosolids Symposium
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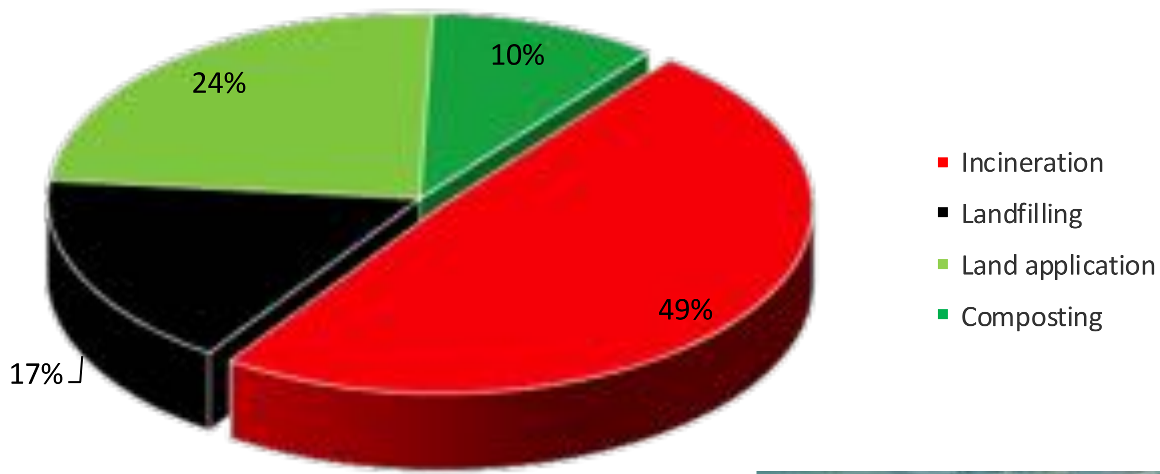
Développement durable, Environnement et Lutte contre les changements climatiques
Québec

Outline

1. Overview
2. Aim of the project
3. Scientific hypotheses
4. Experimental design
5. Preliminary results
6. Best practices

1-Overview

Sludge/biosolids management in Québec



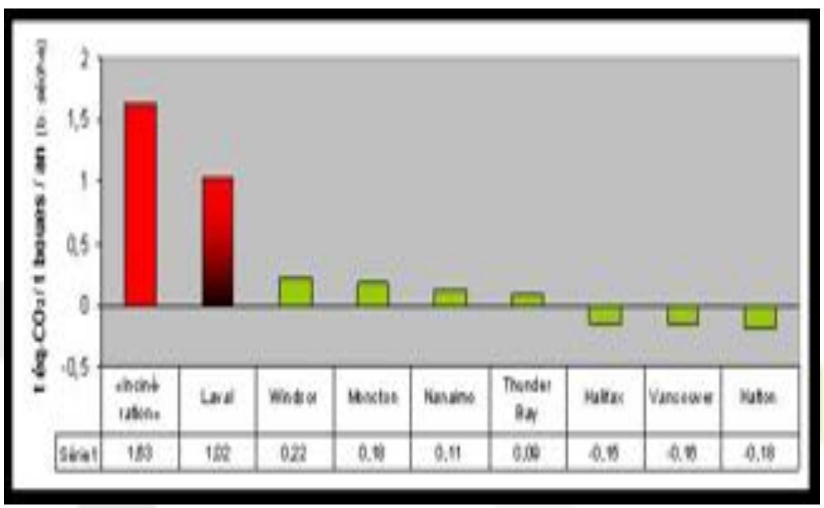
Problems with sludge incineration

- GhG emissions
  - CCME study
  - http://www.ccme.ca/files/Resources/waste/biosolids/beam_final_report_1432.pdf
- No/low energy recovery
- Loss of nutrients
  - Nitrogen
    - gas
  - Phosphorus, calcium, etc.
    - Ash landfilling

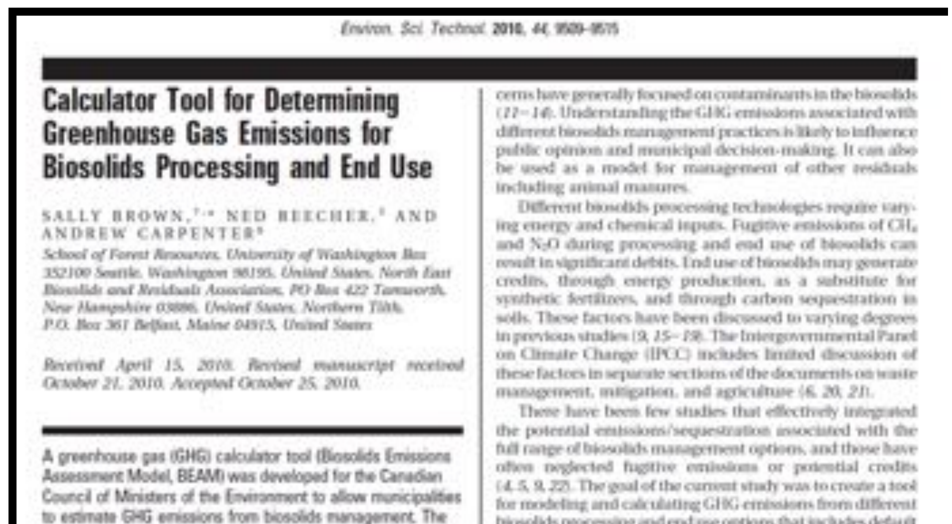
The Biosolids Emissions Assessment Model (BEAM): A Method for Determining Greenhouse Gas Emissions from Canadian Biosolids Management Practices

Final Report

July 2009



http://www.mddelcc.gouv.qc.ca/matieres/articles/boues-municipales-pol.pdf



Environ. Sci. Technol. 2010, 44, 9509–9515

Calculator Tool for Determining Greenhouse Gas Emissions for Biosolids Processing and End Use

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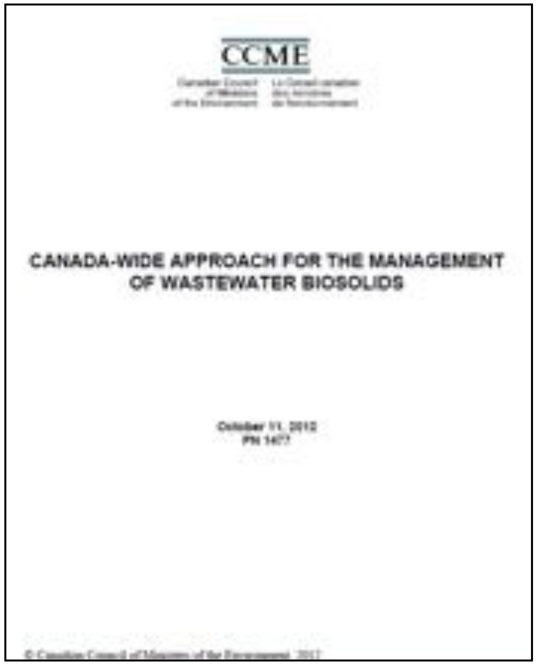
A greenhouse gas (GHG) calculator tool (Biosolids Emissions Assessment Model, BEAM) was developed for the Canadian Council of Ministers of the Environment to allow municipalities to estimate GHG emissions from biosolids management. The

cerns have generally focused on contaminants in the biosolids (11–14). Understanding the GHG emissions associated with different biosolids management practices is likely to influence public opinion and municipal decision-making. It can also be used as a model for management of other residuals including animal manures.

Different biosolids processing technologies require varying energy and chemical inputs. Fugitive emissions of CH_4 and N_2O during processing and end use of biosolids can result in significant debits. End use of biosolids may generate credits, through energy production, as a substitute for synthetic fertilizers, and through carbon sequestration in soils. These factors have been discussed to varying degrees in previous studies (9, 15–19). The Intergovernmental Panel on Climate Change (IPCC) includes limited discussion of these factors in separate sections of the documents on waste management, mitigation, and agriculture (6, 20, 21).

There have been few studies that effectively integrated the potential emissions/sequestration associated with the full range of biosolids management options, and those have often neglected fugitive emissions or potential credits (4, 5, 9, 22). The goal of the current study was to create a tool for modeling and calculating GHG emissions from different

CANADA - CCME policy for combustion


CCME

CANADA-WIDE APPROACH FOR THE MANAGEMENT OF WASTEWATER BIOSOLIDS

October 11, 2012
PN 1477

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Fertilizer products from sewage sludge and meat and bone meal ashes

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(b) Institute of Landscape Ecology and Resources Management, University of Giessen, Giessen, Germany

Fraunhofer IME

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

«To qualify as a beneficial use option, combustion must meet the following three criteria:

- *result in a positive energy balance*
- *emit low levels of nitrous oxides*
- *recover a significant portion of ash or phosphorus.»*

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CCME Guidelines


CCME

GUIDANCE DOCUMENT FOR THE BENEFICIAL USE OF MUNICIPAL BIOSOLIDS, MUNICIPAL SLUDGE AND TREATED SEPTAGE

Québec

Québec policies

- «Green tax»
  - Landfilling
  - Incineration
- Ban on landfilling of organic matter
  - 2020
- Toward «Green combustion» of sludge
  - Low N2O emissions
  - Energy recovery/efficiency
  - Ash recovery as P fertilizer

2- Aim of the North-American project

- Assess ashes quality (trace elements)
- Demonstrate the fertilizing value of municipal sludge ashes
- Produce scientific publications
- Train graduate students
- Ensure the confidentiality of partners' nominal data

Partners - WWTP

- Québec
  - Longueuil (Yvan Breault)
  - Montréal (Tony DiFruscia)
  - Salaberry-de-Valleyfield
    - Pilot scale
  - Sanimax
    - Renderer
- Ontario
  - London (Rossum Van)
  - Peel region- Lakeview (John Glass)
- U.S.
  - Manchester NH (Fred McNeil / Rick Cantu)
  - Cranston RI (Dan Gorka, Veolia)
  - + 3 others

Partners (cont.)

- Laval University
  - Hatem Farhat
  - Claude Alla Joseph
  - Sidki Bouslama
  - Renel Lhérisson
  - Haifa Labidi
- Ontario govt
  - Shelly Bonte-Gelok
- NEBRA
  - Ned Beecher
- NSERC

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3- Scientific hypotheses

- In soil poor in phosphorus, sludge ash
  - increase crop yields
    - yield increase is dose-dependent
  - Improve soil fertility
    - P and pH
- The fertilizing efficiency of ashes phosphorus varies
  - according to soil type
  - according to the type of ash

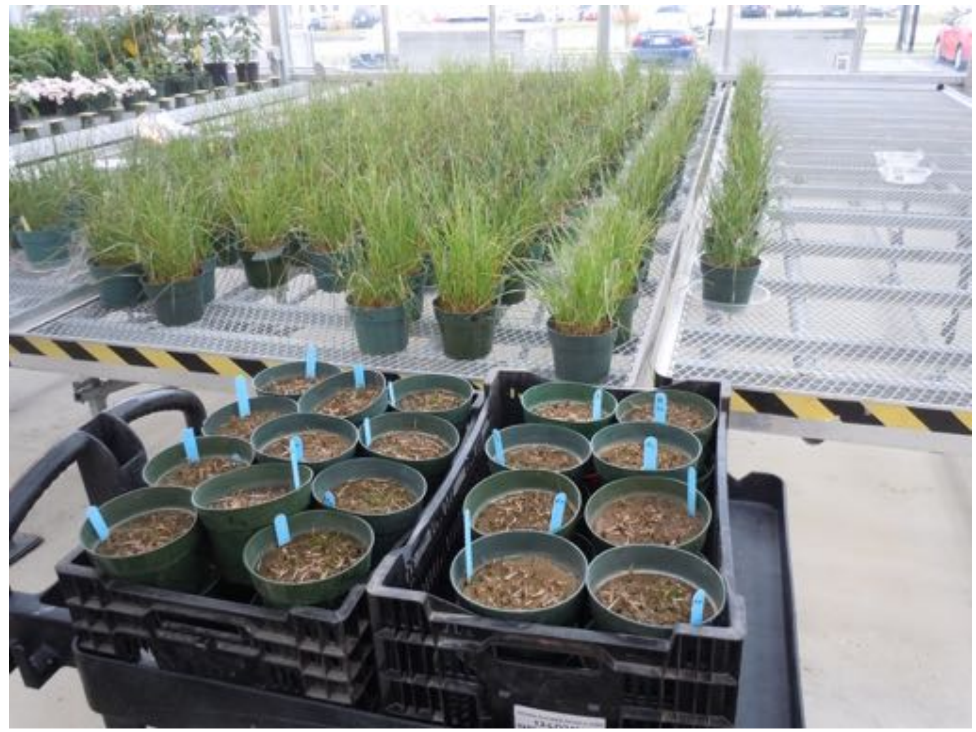
4- Experimental design

- 10 WWTP incinerators
  - Combustion conditions
- 11 ashes
- Total P_2O_5
  - 13%
    - 2 to 24%
- Neutralizing value
  - 14%
    - 3 to 35%

- Crop: Ray-Grass
- Controlled conditions
- 2 soils poor in P
  - Sand
  - Clay
- Agronomic rates
- Control pots
  - Unfertilized
  - Chemical P fertilizer
  - Rock Phosphate
  - Bone powder

Analytical parameters

- Ashes
  - P (total, assimilable, oxalate)
  - Al, Fe and Ca
  - Neutralizing value
  - Others (K, Mg, S, metals)
- Soils
  - pH
  - P, Fe, Al, K (Mehlich 3)
- Crop
  - Yield, total P, metals, others



5- Preliminary results

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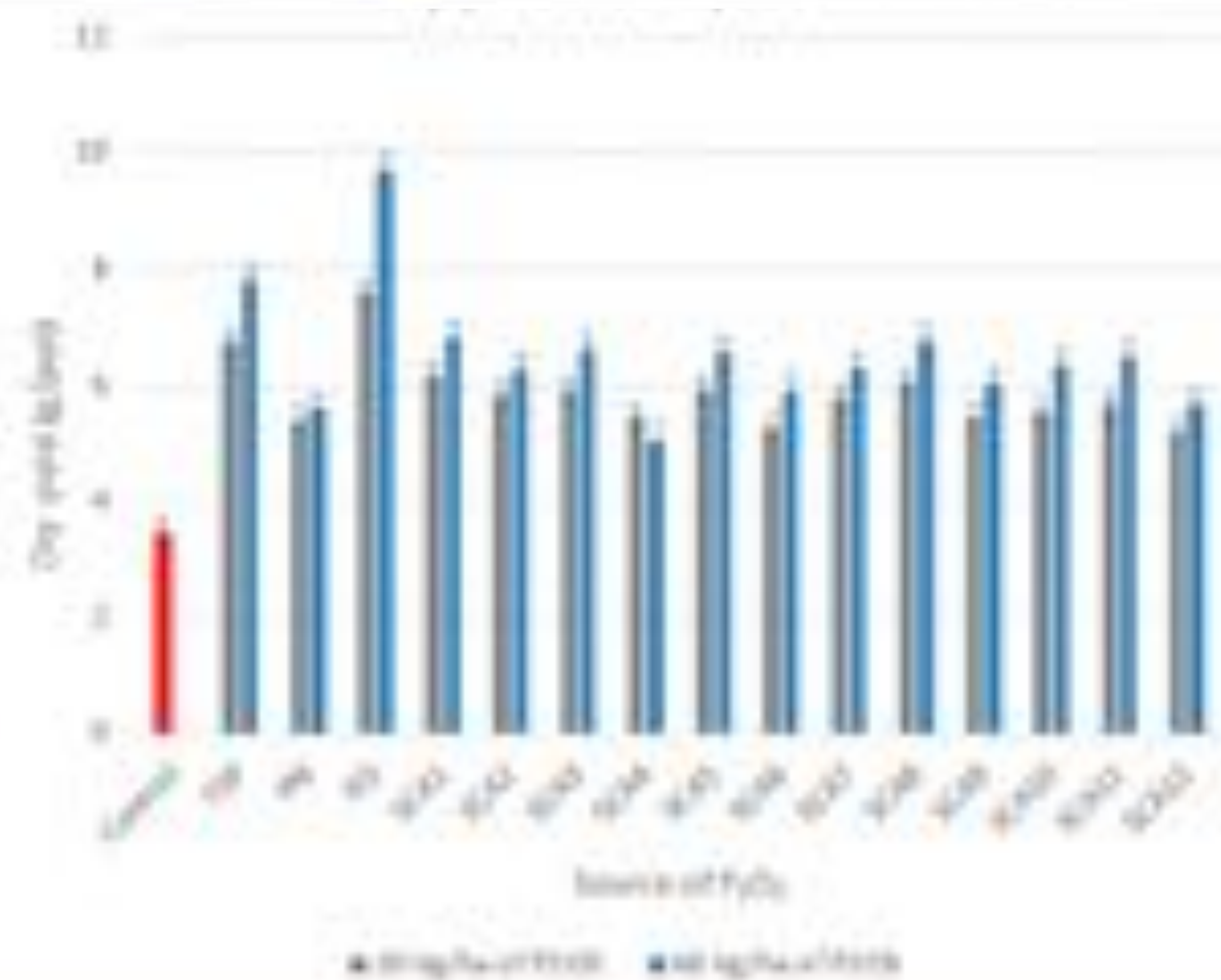
Trace elements in 11 ashes

	Mean	Max
As	7	15
Cd	8	53
Co	36	183
Cr	88	188
Cu	804	1 610
Hg	0,1	0,5
Mo	8	24
Ni	51	75
Pb	114	286
Se	2	13
Zn	1 051	2 500

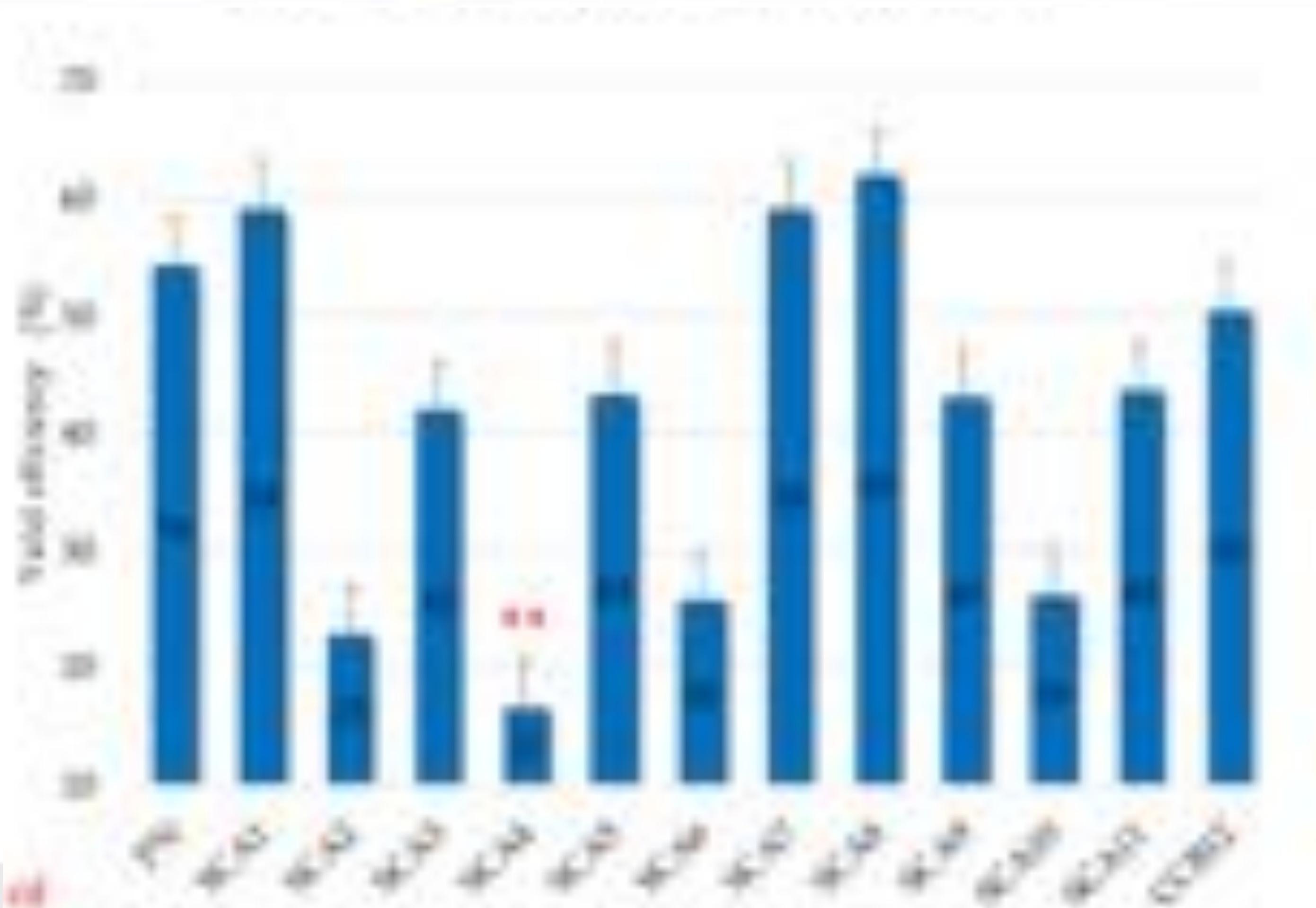
Trace elements in 11 ashes

	Mean	Max	US-EQ	Can-CFIA 2,2 tons/ha
As	7	15	41	150
Cd	8	53	39	40
Co	36	183	-	300
Cr	88	188	1200	2120
Cu	804	1 610	1500	1514
Hg	0,1	0,5	17	10
Mo	8	24	-	40
Ni	51	75	420	360
Pb	114	286	300	1000
Se	2	13	36	28
Zn	1 051	2 500	2800	3700

Yields – sandy soil



P availability – sandy soil



General findings

- Trace elements
  - Generally meet federal requirements
- Municipal sludge ashes increase yields
- Ash acts as a P fertilizer
- Available P
  - 43% of total P (median)
    - 8 to 62%
- N-P-K
  - ≈ 0-7-1
- Impact of
  - Fe content ?
  - Particle size ?
  - Combustion temperature ?

Next steps

- Laval University
  - Further statistical analysis
  - Chemistry of P availability
  - Specific results to partners
  - Scientific publications
- Québec gvt
  - Integration into «green combustion» requirements
- WWTP
  - Consider ash recycling!

6- Best practices – WWTP level

- Make your own tests!
  - Check available P (fertilizer test)
- Do some R&D
  - Al vs Fe
  - Temperature
  - Sieving/grinding
  - Ash chemical conditioning/post-cooking?

Farm level

- Soils
  - Prefer poor P soils
- Spreader
  - Powder
- Crops
  - Avoid corn, soybeans and other large row crops
    - Ash powder far from the seed
- Rates
  - Based on P needs (agronomic rates)
  - Lower rates for ashes with high available P content
  - Higher rates with
    - poor available P soils
    - degraded sites (single application)
- Soil incorporation

Merci

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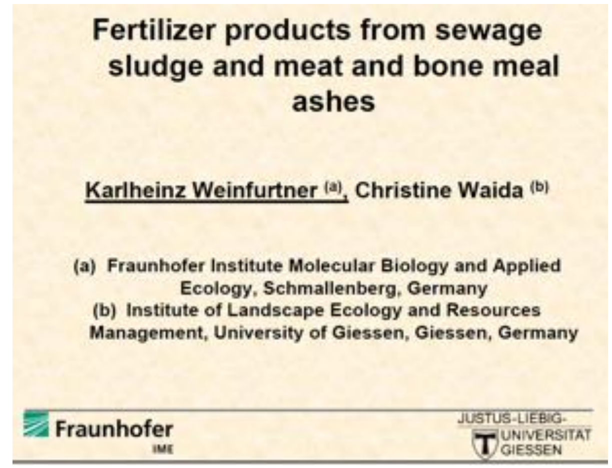
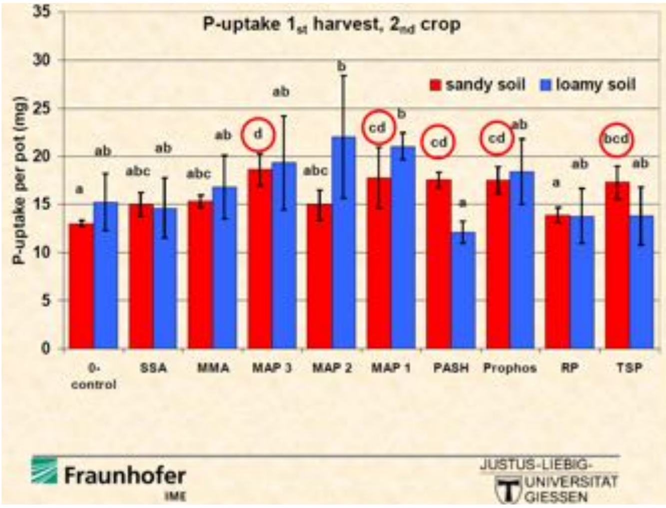
European context

- Anticipated shortage of mineral sources
- Recent interest in sludge ashes as phosphorus fertilizer
- Better chemical quality of municipal sludge/ash
- Spreading allowed in Germany since 2009



German findings

- Ash is a phosphorus fertilizer
- Efficiency in greenhouse is
  – lower (%) than chemical fertilizer
  – higher than bone meal
- P efficiency depends on:
  – Ash type
  – Soil type



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