International Conference "SOIL PROTECTION STRATEGY - NEEDS AND APPROACHES FOR POLICY SUPPORT"
9-11 March 2006 - IUNG, Pulawy, Poland

Sewage sludge use on soil: approaches and effects

Paolo MANTOVI

Research Centre on Animal Production (CRPA)
Reggio Emilia, Italy
www.crpa.it

Outline

Sewage sludge in EU policy

Long-term field experiment (organisation)

Application standards comparison
- Sewage sludge directive
- Nitrate directive
(effects on soil)

Conclusions

Sewage sludge Directive 86/278/EEC

Purpose:
"to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and man."

Limit values for concentration of heavy metals:
- in sewage sludge intended for agricultural use
- in sludge-treated soils

Sewage sludge in the "Towards" Communication

3.3 Soil contamination

3.3.2 Diffuse soil contamination

with regard to waste

"the final product of the treatment of wastewater ...
... **potentially contaminated** by a whole range of pollutants, such as **heavy metals** and poorly biodegradable **trace organic compounds** ... Potentially **pathogenic organisms** like viruses and bacteria are also present."

Sewage sludge in the “Towards” Communication

“However, sewage sludge contains **organic matter** and **nutrients** such as nitrogen, phosphorus and potassium, of value to the soil and the options for its use include **application on agricultural land** ... the careful and **monitored** use of sewage sludge on soil should not cause a problem, and, indeed, on the contrary **could be beneficial** and contribute to an increase of soil organic matter content.”

Long-term field experiment (from 1988)

To evaluate the effects of sewage sludge on:

- Crop yields and products quality;
- Soil fertility;
- Possible heavy metal accumulation in soil;
- Possible heavy metal transfer in plant products.

2006 --> focus on the risks of toxic organic compounds accumulation in soil (AOX, DEHP, NP/NPE, LAS, PCB, PAH, PCDD/F - reference Working document on sludge, 3rd draft)

Organisation of the trial

Coordination: Research Centre on Animal Production (CRPA)

Location: “Marani” Experimental Farm - Ravenna (eastern Po Valley)

Funding: Department for Agriculture of the Emilia-Romagna Region

Materials and methods - Soil characteristics

Layer 0-40 cm, year 1988

SILTY-LOAM TEXTURE

(23% sand, 55% loam, 22% clay)

pH in water	**7.8**	**(*subalcaline soil*)**
C.E.C.	**13.8 meq 100 g^{-1}**	**(*medium content*)**
Total $CaCO_3$	21 %	(high content)
Organic matter	**1.6 %**	**(*medium content*)**
Total N	1.18 ‰	(*medium content*)
Olsen P	16 mg kg^{-1}	(*medium content*)
Exchangeable K	177 mg kg^{-1}	(*high content*)

C.R.P.A.

Materials and methods - crops

Rotation:

Maize
(Zea mais)

Winter wheat
(Triticum aestivum)

No irrigation

Sugarbeet
(Beta vulgaris)

Crop residues removed from the field, apart from sugar beet leaves

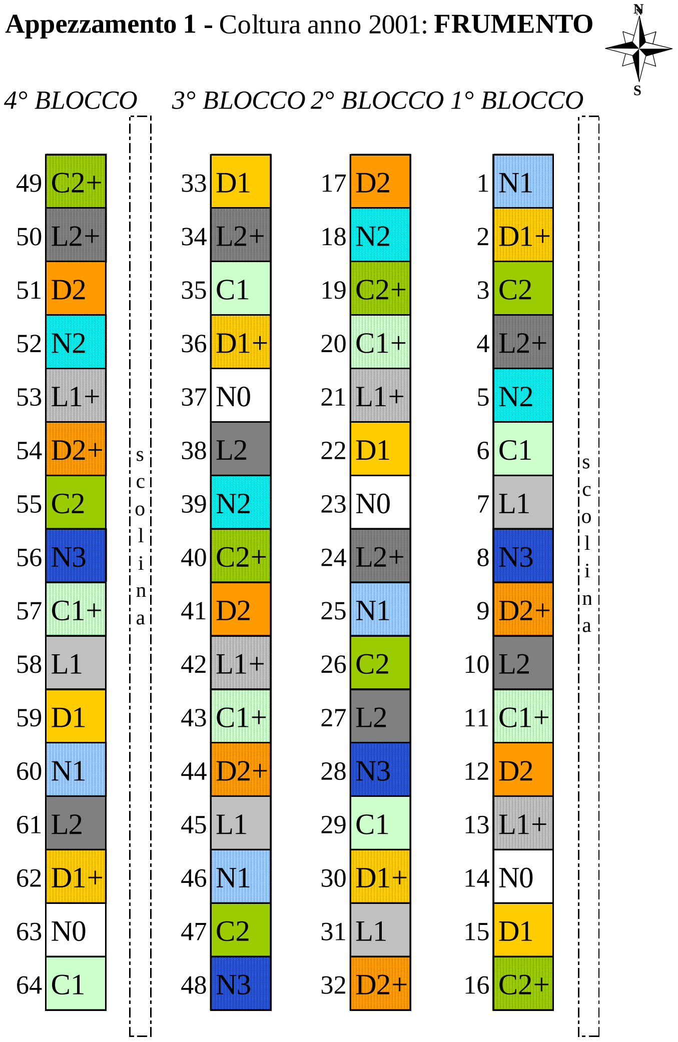
Materials and methods - Experimental design

Randomised block design

16 treatments * 4 replicates = 64 plots for each field

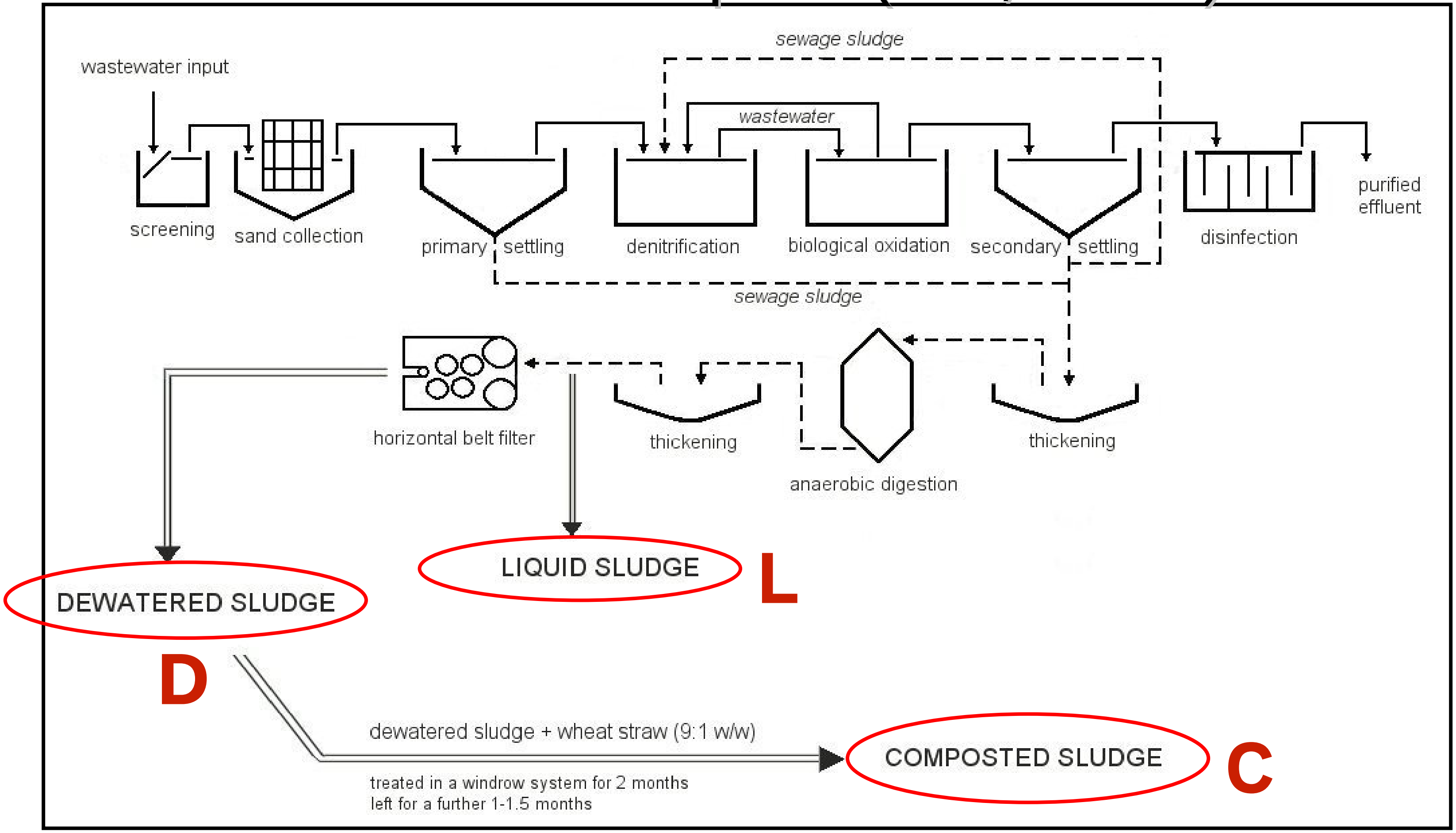
3 field

In total 192 plots



Materials and methods - Sewage sludge types

Faenza town treatment plant (120,000 EI)



Materials and methods - Application standards

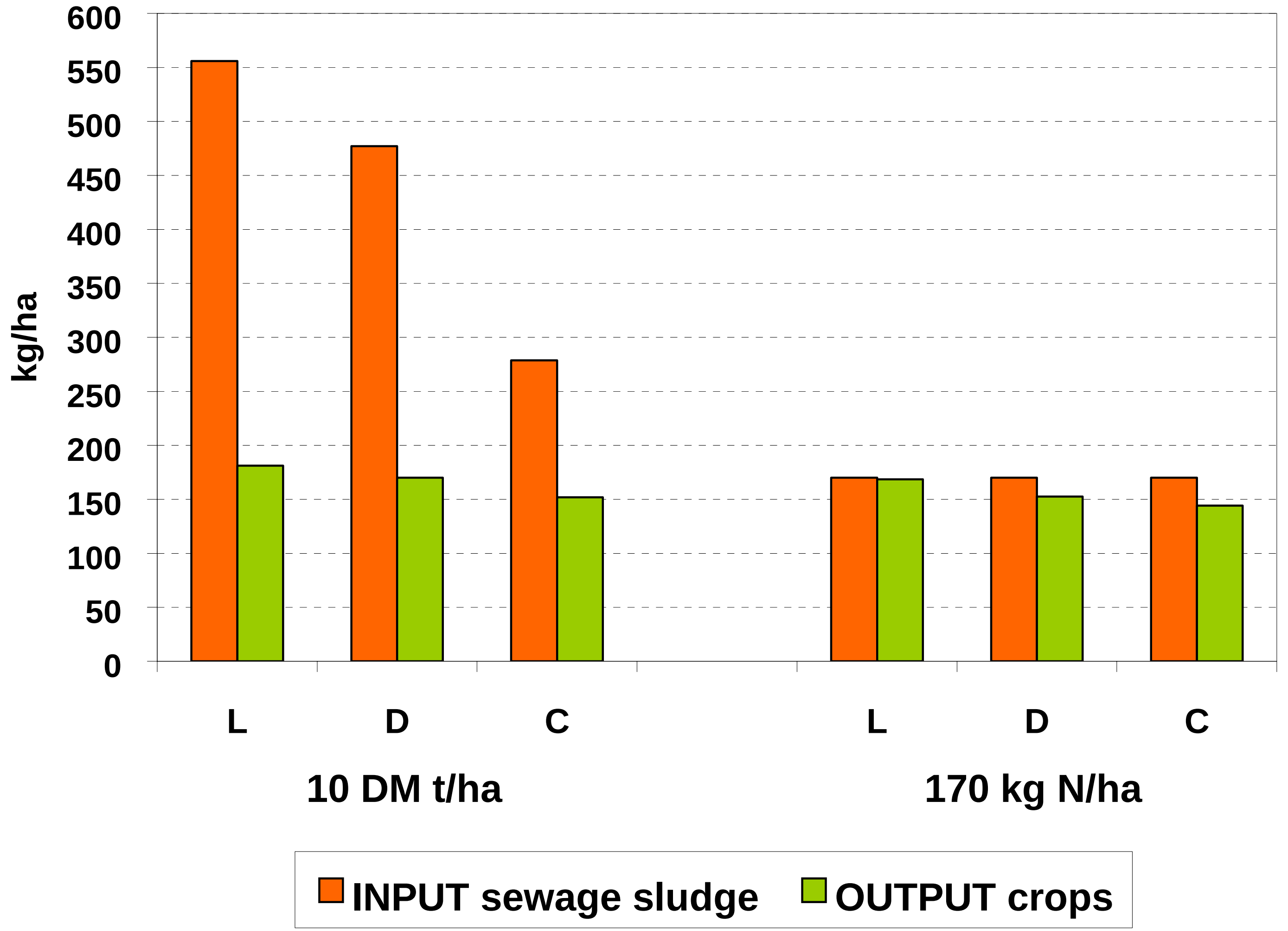
- Sewage sludge Directive 86/278/EEC,

dry matter input (from 5 to 10 DM t/ha year)

- Nitrate Directive 91/676/EEC,

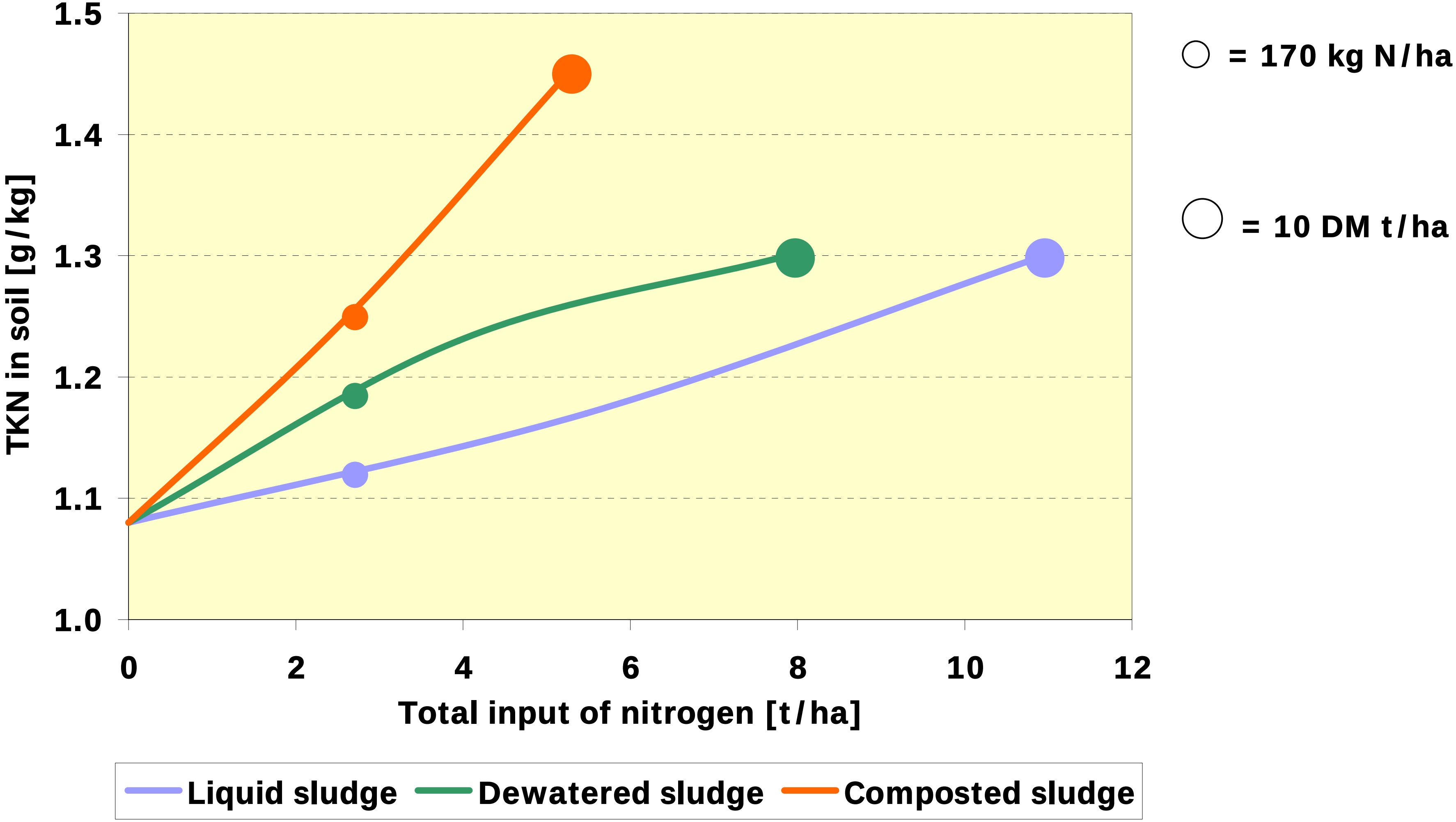
nitrogen input for application of livestock manure in Nitrate Vulnerable Zones (170 kg N/ha year)

Results - Nitrogen balance

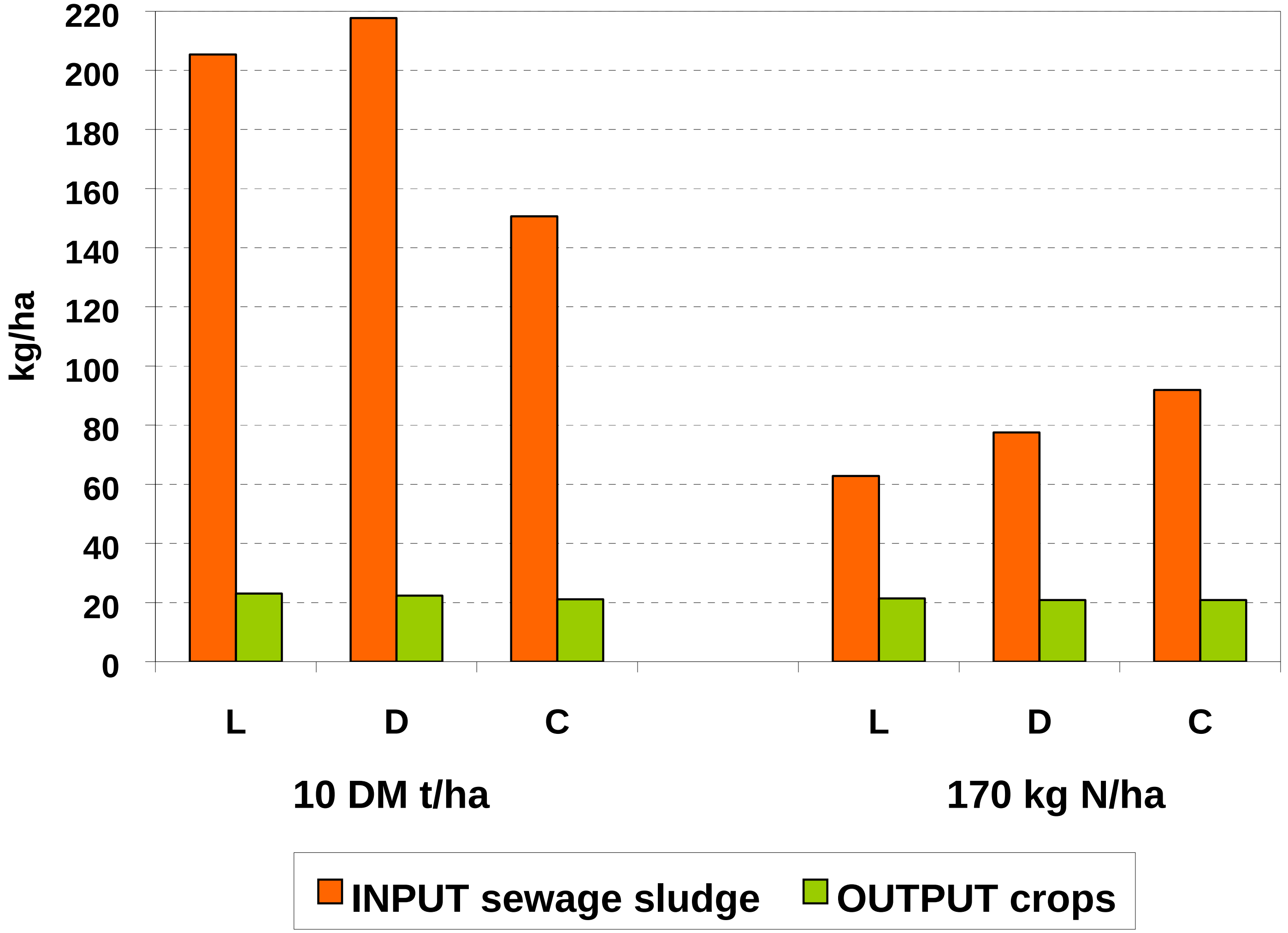


C.R.P.A.

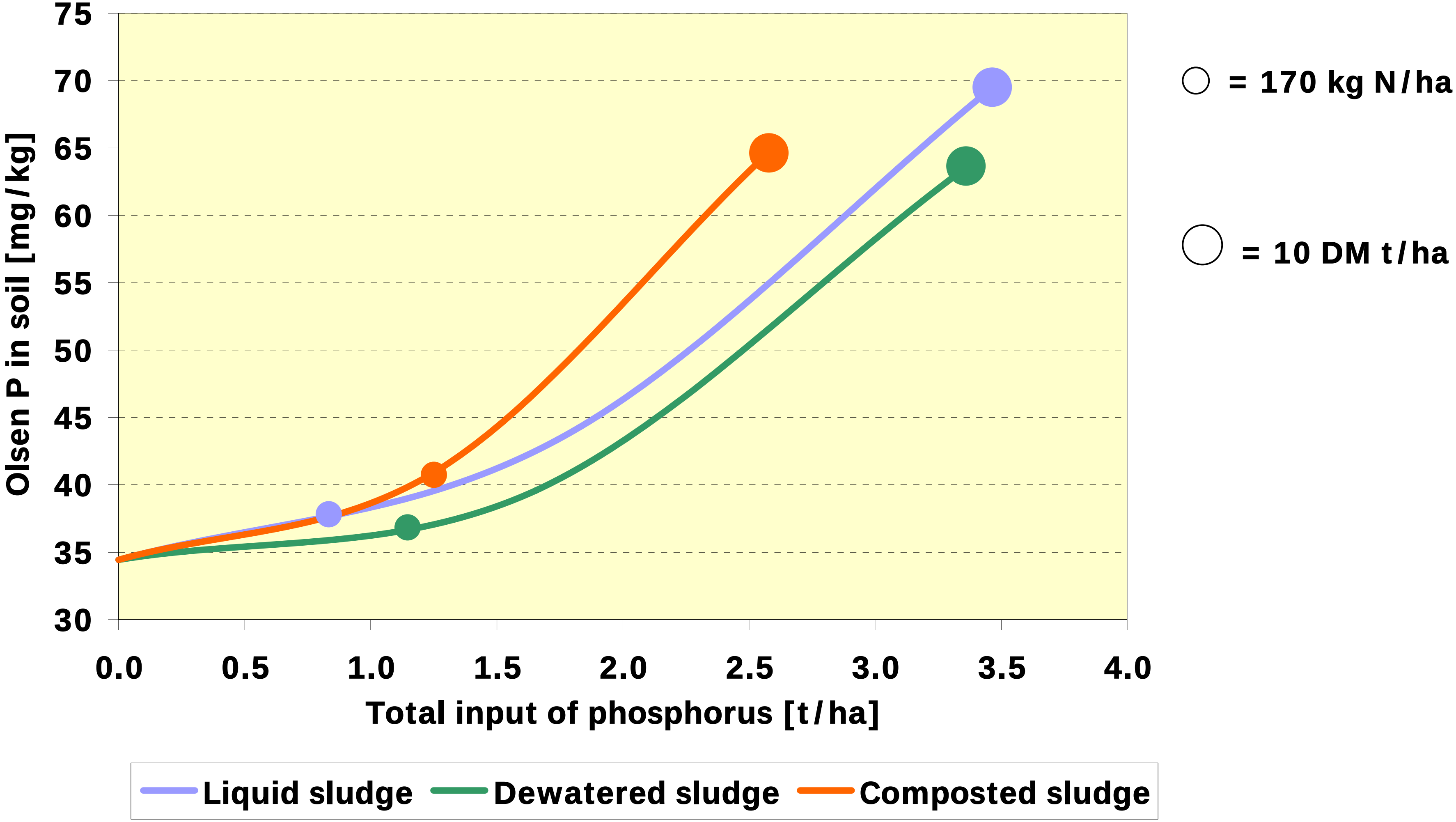
Results - N input vs. TKN in soil



Results - Phosphorus balance

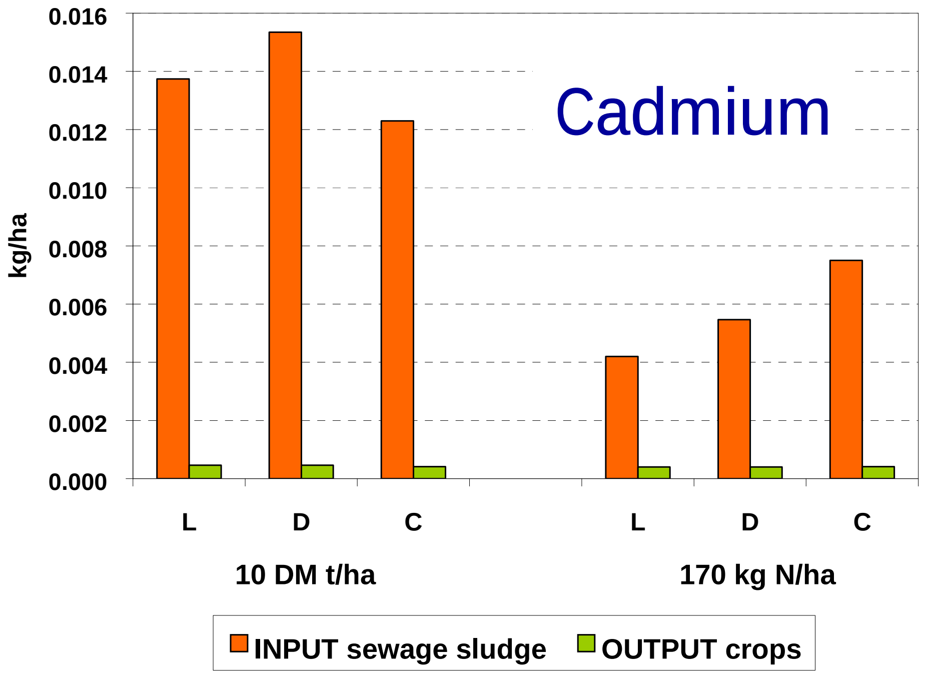


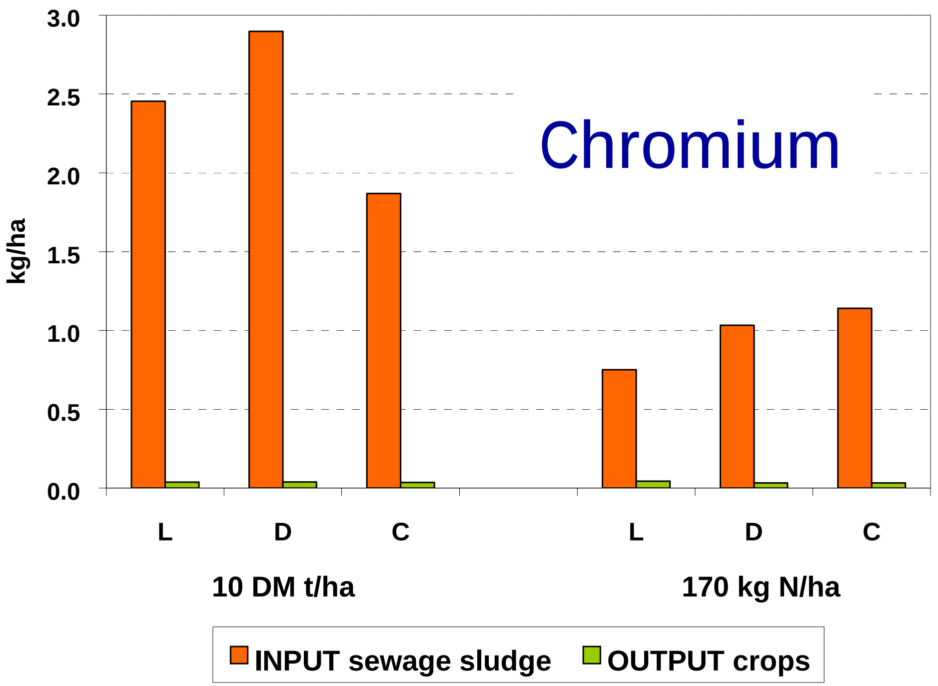
Results - P input vs. Olsen P in soil



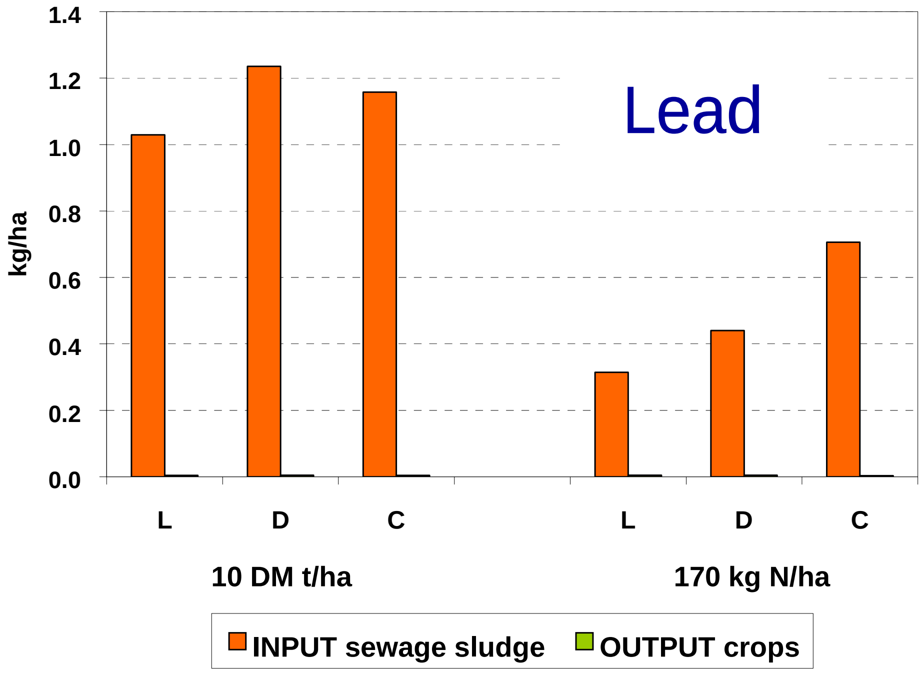
C.R.P.A.

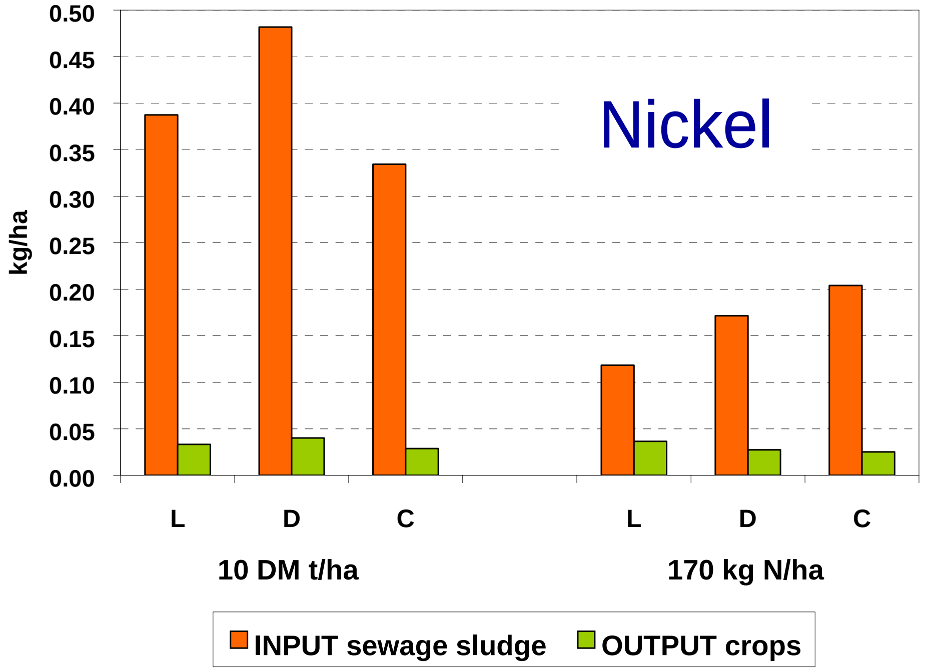
Results - Heavy metals balance



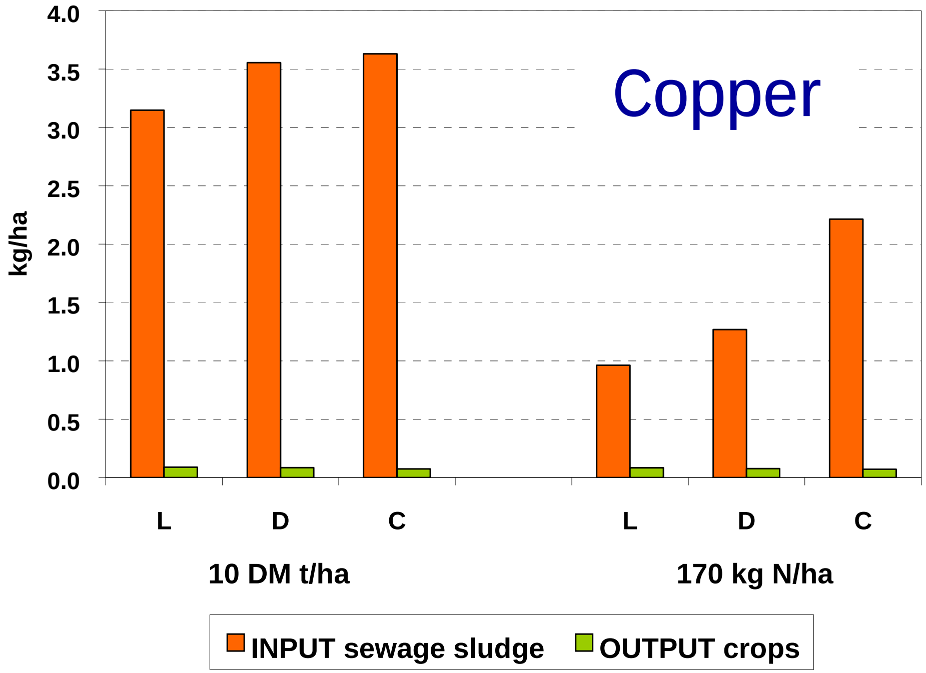


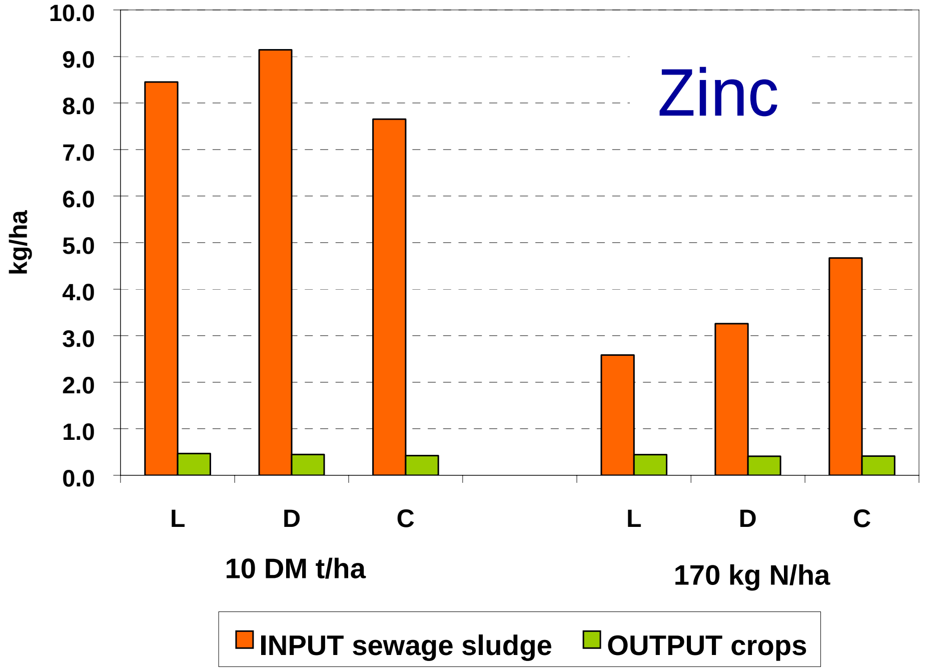
Results - Heavy metals balance



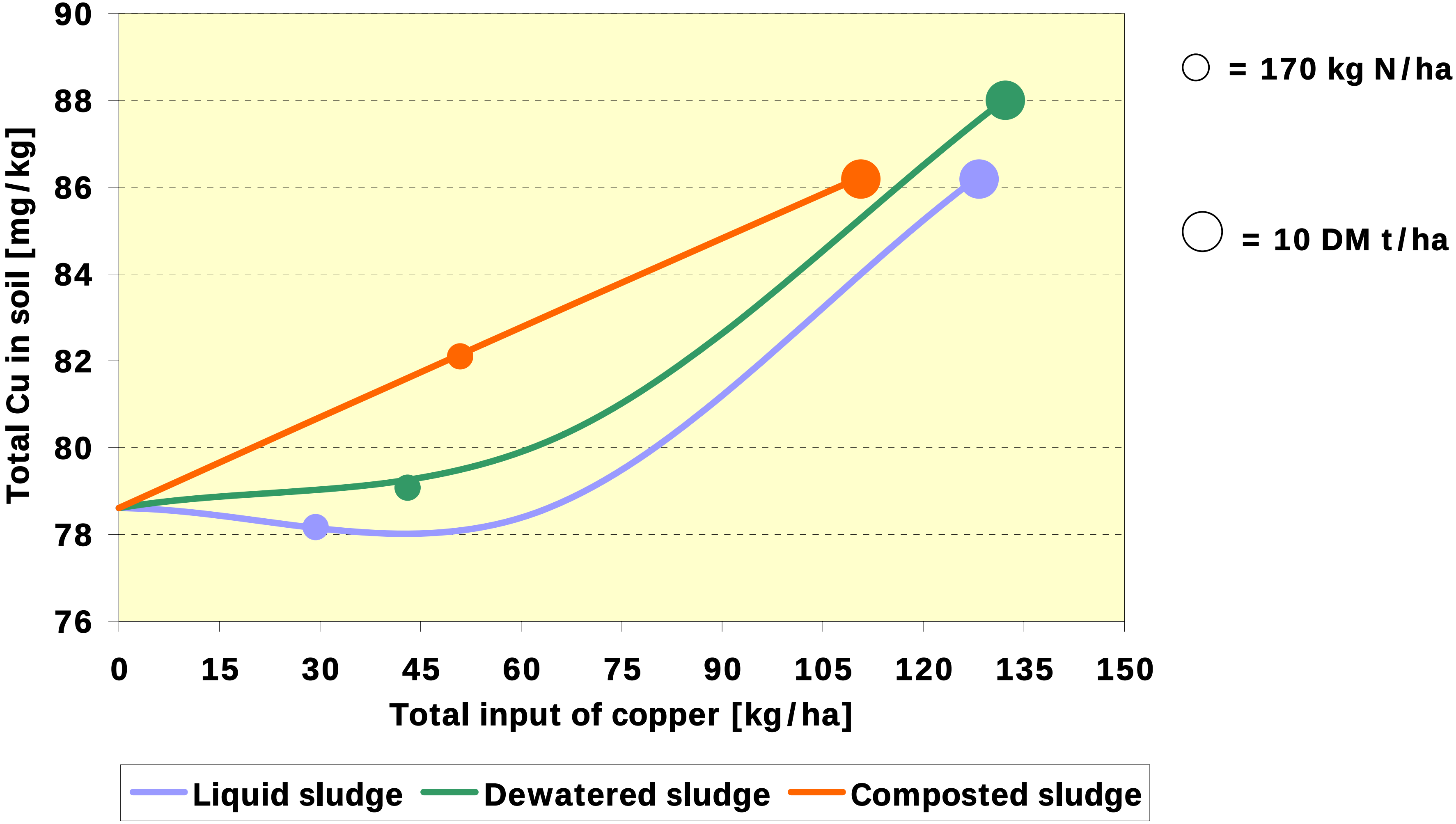


Results - Heavy metals balance



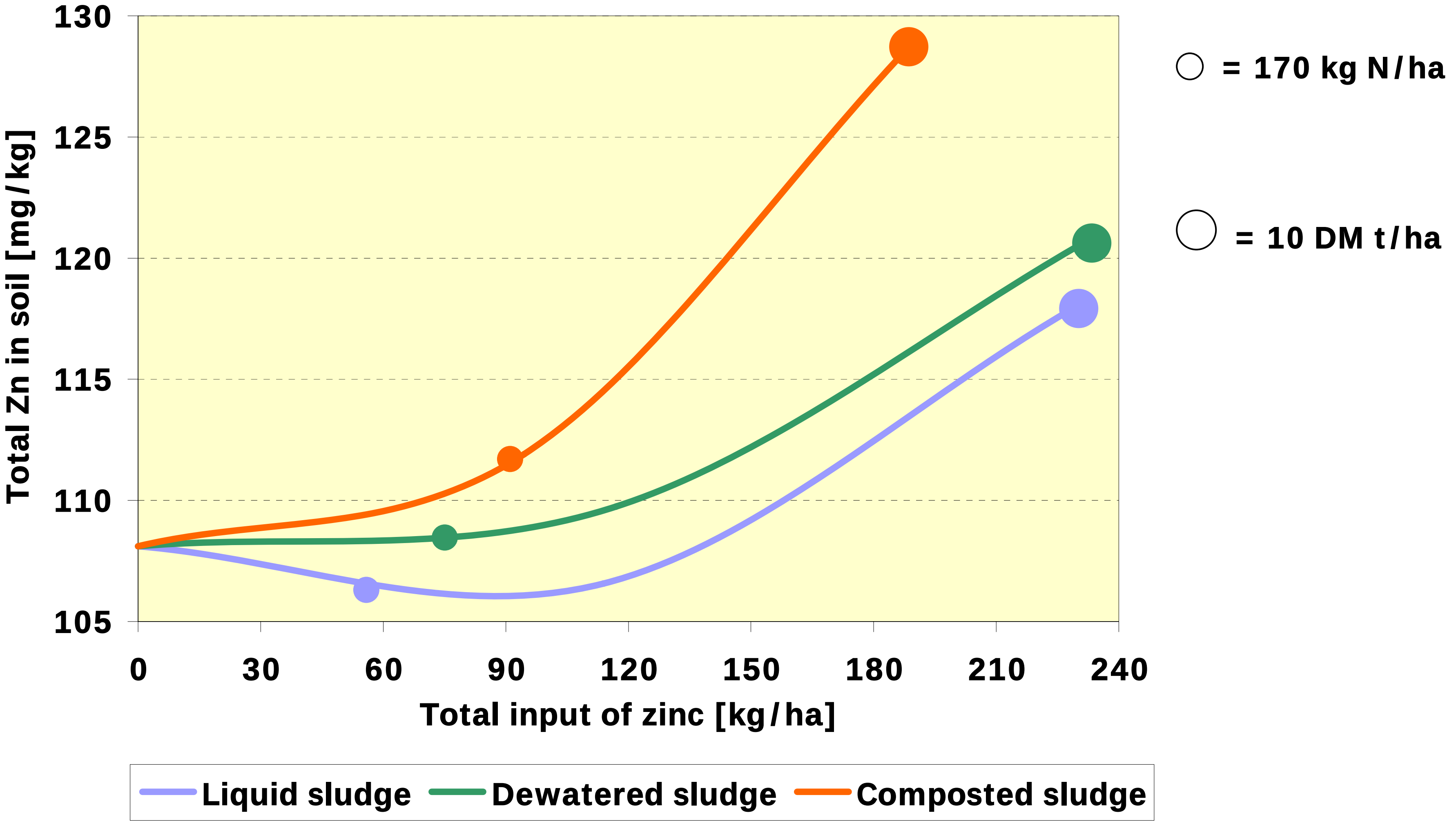


Results - Cu input vs. total Cu in soil

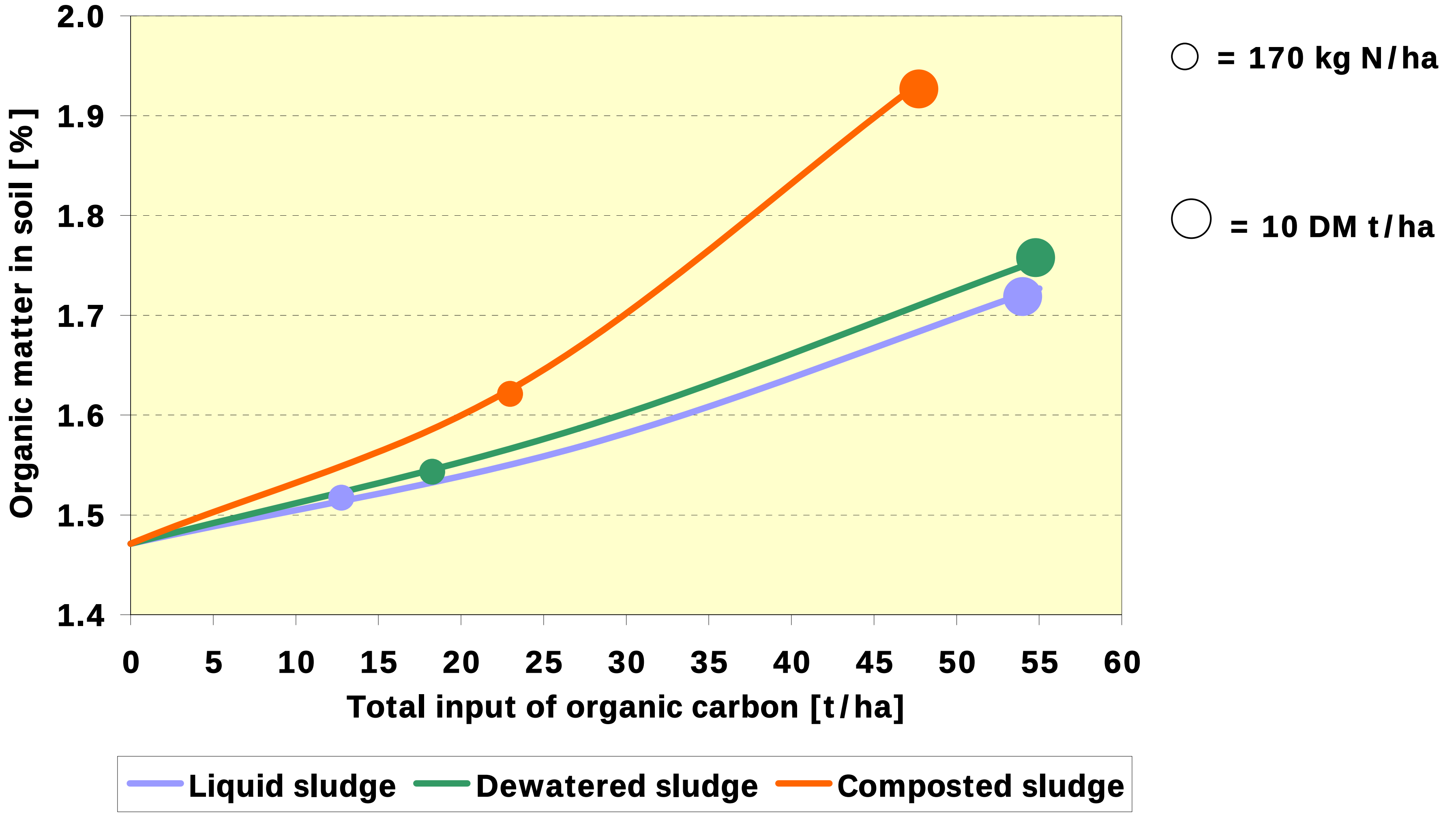


C.R.P.A.

Results - Zn input vs. total Zn in soil

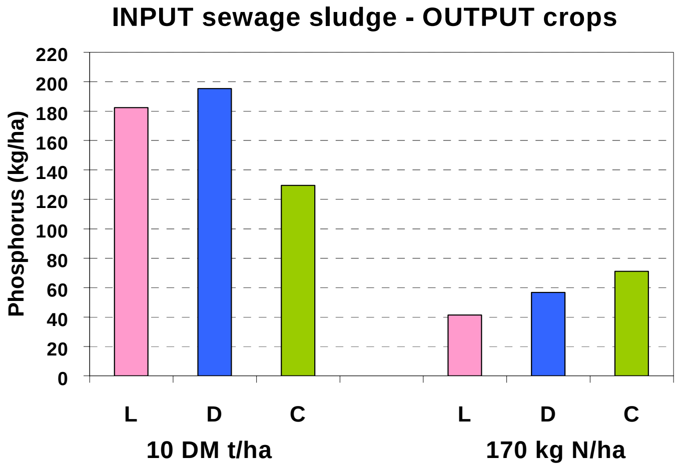


Results - C input vs. OM in soil



Results - Application standards comparison

Difference between the two approaches more evident when using liquid or dewatered sewage sludge



Sludge composting:

- ammonia volatilisation, concentrates P and HM with respect to N

- addition of “clean” materials (wheat straw), dilutes elements concentration on DM basis

Conclusions

The application standards set up by Sewage sludge Directive imply an excessive nutrients and contaminants surplus

Compulsory sewage sludge applications rates based on real crop nitrogen requirements, and in conformance with the Nitrate Directive, undoubtedly could guarantee increased sustainability in the application of sewage sludge in the long period

(already come into force in Emilia-Romagna region)

Final note

This research has been supported by the Department for Agriculture of the Emilia-Romagna Region

till the end of 2006... and after? No more funds!

There is an urgent need, for this field experiment, to become a part of a European network as a resource to researchers wanting to verify the long-term effects of exogenous organic matter inputs to soil

Many thanks for your attention!