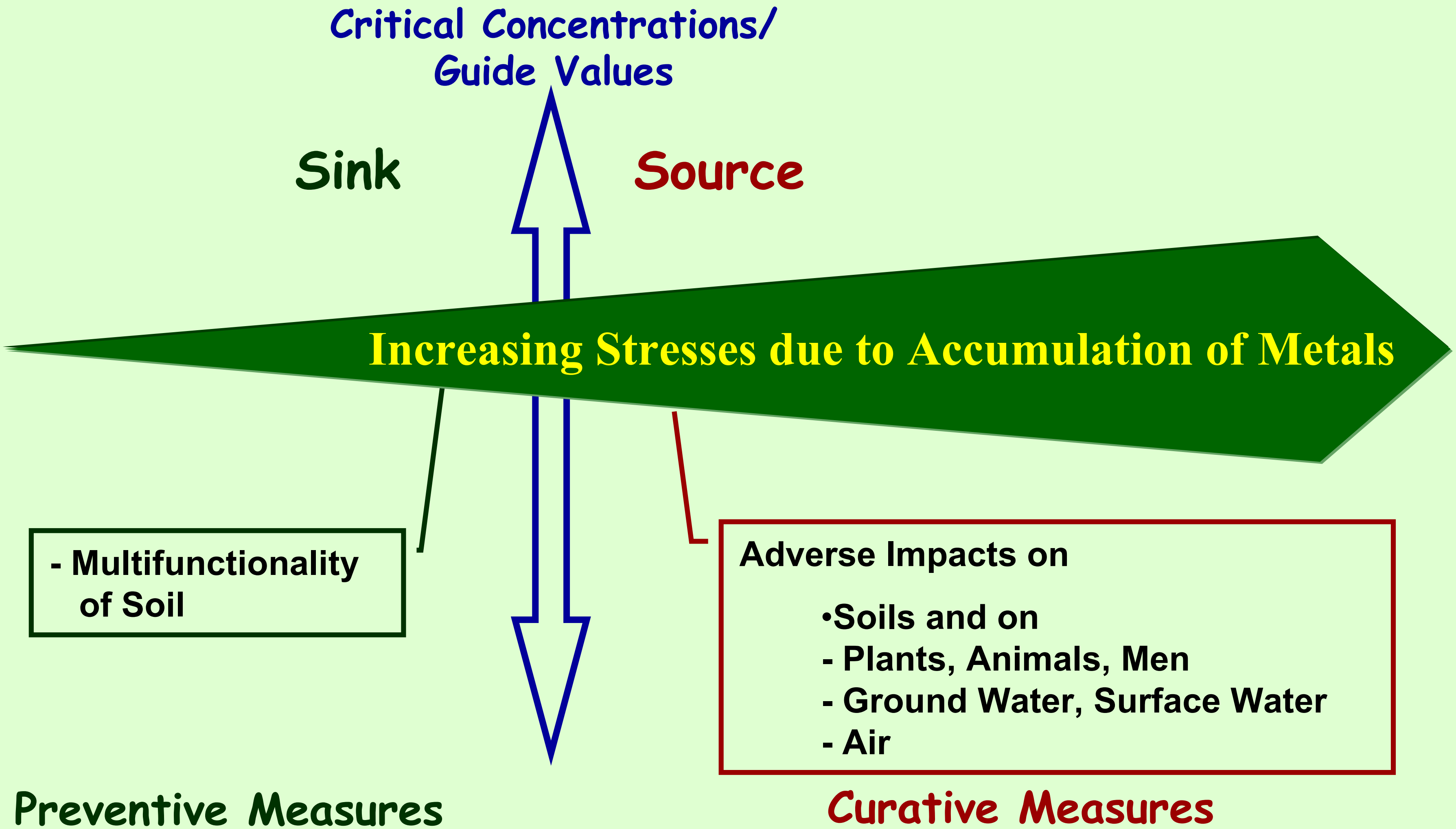
Heavy Metal Thresholds in Compost with a View to Soil Protection – what Approach for the Community?

Florian Amlinger

Applying Compost – Benefits & Needs

Soil as Sink or Source for Metals

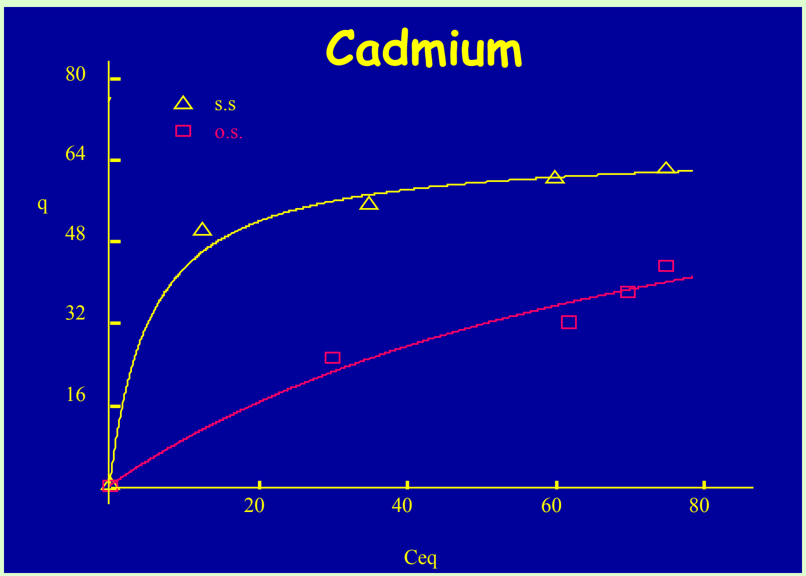
Source: Gupta (1999)

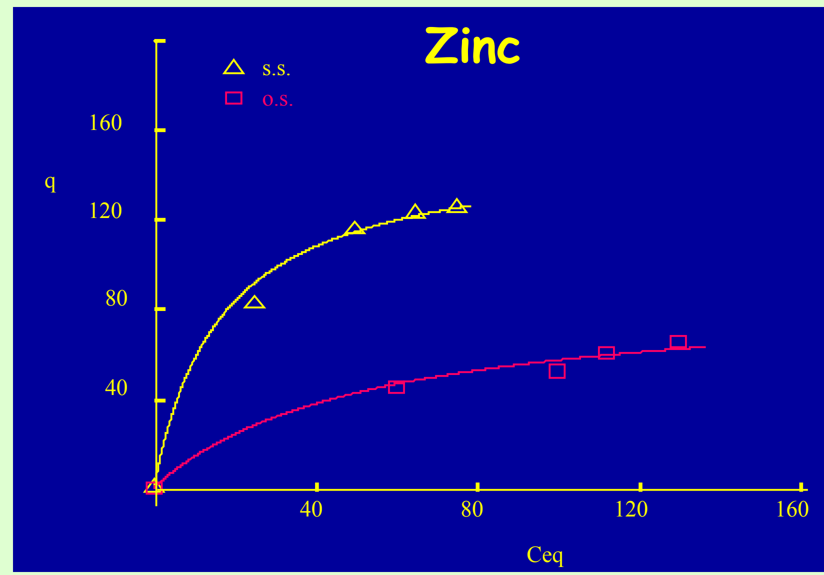


Sorption of Cd and Zn in a Compost Amended Soil .... 15 Years Later

Petruzzelli & Pezzarossa (2001)

Sorption isotherms





+ 27 %

+ 75 %

Heavy Metal Sorption and SOM

- Negative correlations between **solubility** of trace metals such as Cu, Hg and Cd, and **SOM**

- Correlation between **levels** of **Cd**, Cu, Zn, Pb and Ni and **SOM** (USA survey; Holmgren et al. 1993)

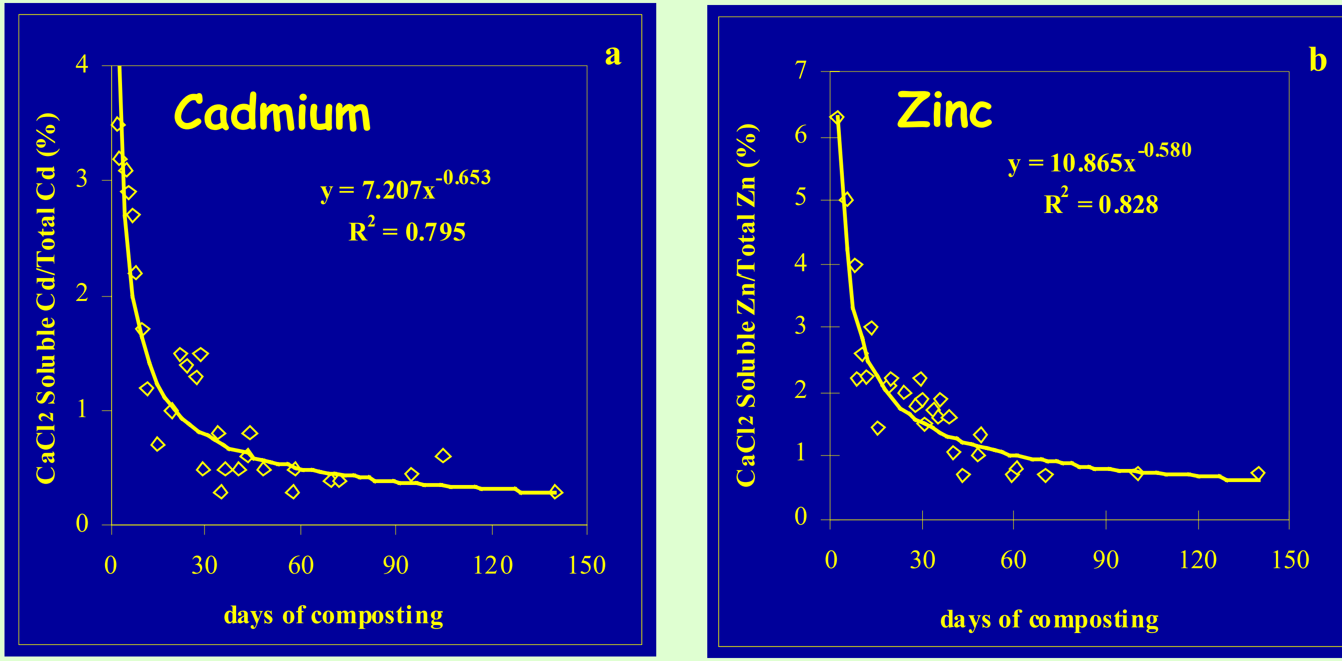
$$Cd_T = 0.10 + 0.0094\ SOM \qquad r = 0.51 \qquad (P<0.01)$$

- Soil sorption capacity is inversely related to the amount of metal sorbed

- Low-metal composts are more suitable to provide new sorbing sites

- Soil organic matter has probably the **greatest capacity and strength of bonding** with most trace metals of any soil component

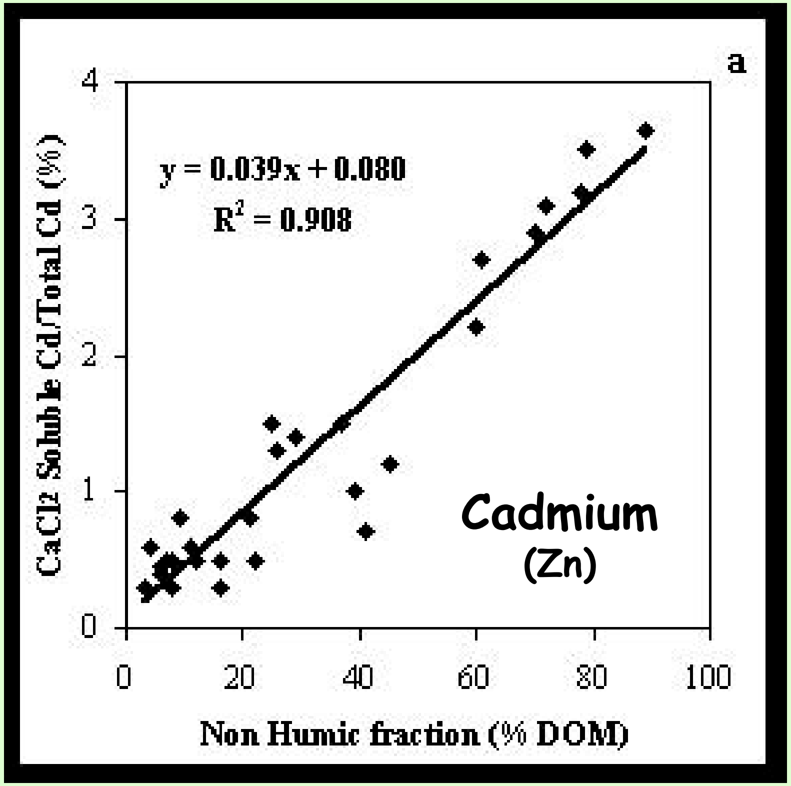
Soluble fraction of Cd and Zn during composting

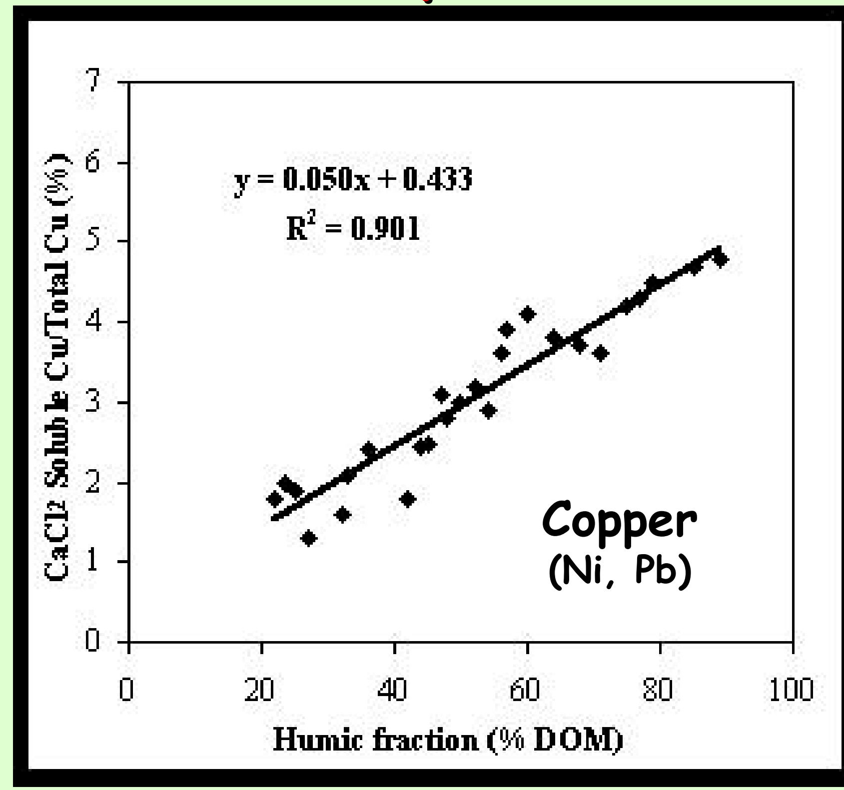


Leita et al. (2001)

- Desolved organic carbon (DOC) declines
- Non-humic fraction of DOC decreases 90 → 8 %,
- Humuc fractions increase 72 % of DOC
- Soluble fraction of Cd and Zn decreased significantly

Correlation of soluble Cd and Cu with non humic or humic fraction of DOC in composts

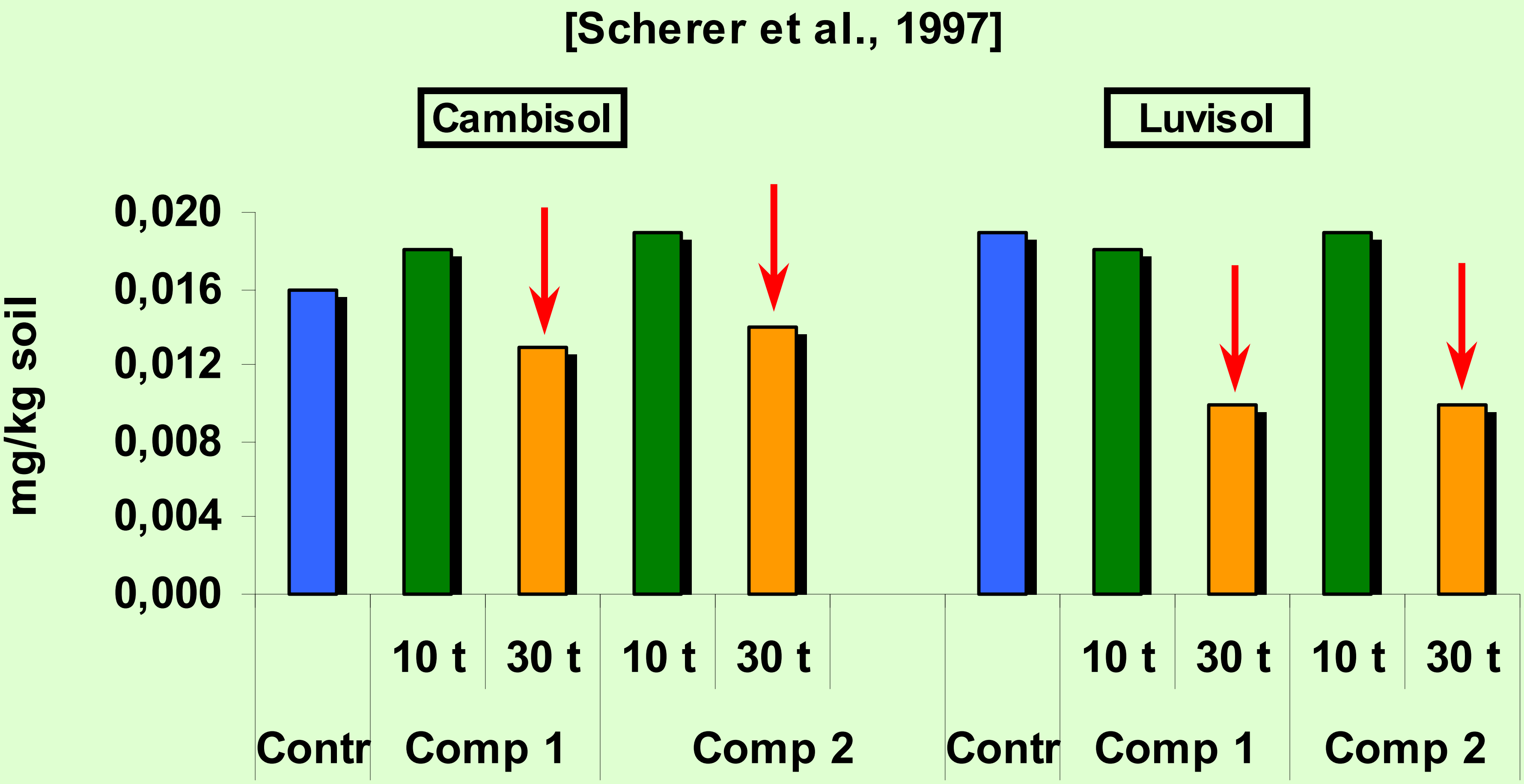




➢The humic fraction of DOC and the insoluble organic complexes play an essential role for the removal of metals from soluble phase of soil.

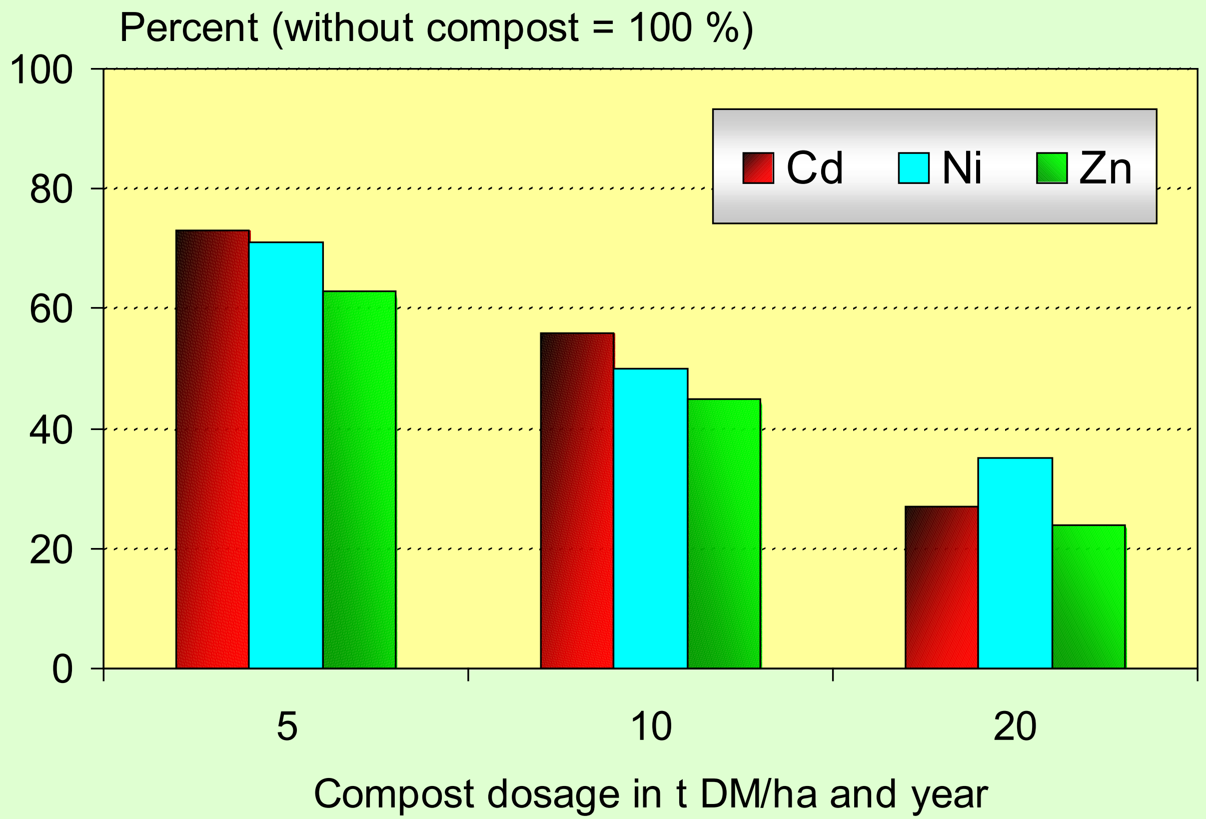
Leita et al. (2001)

NH_4NO_3 Extractable Cd in the Soil



NH_4NO_3 Extractable Cd in the Soil

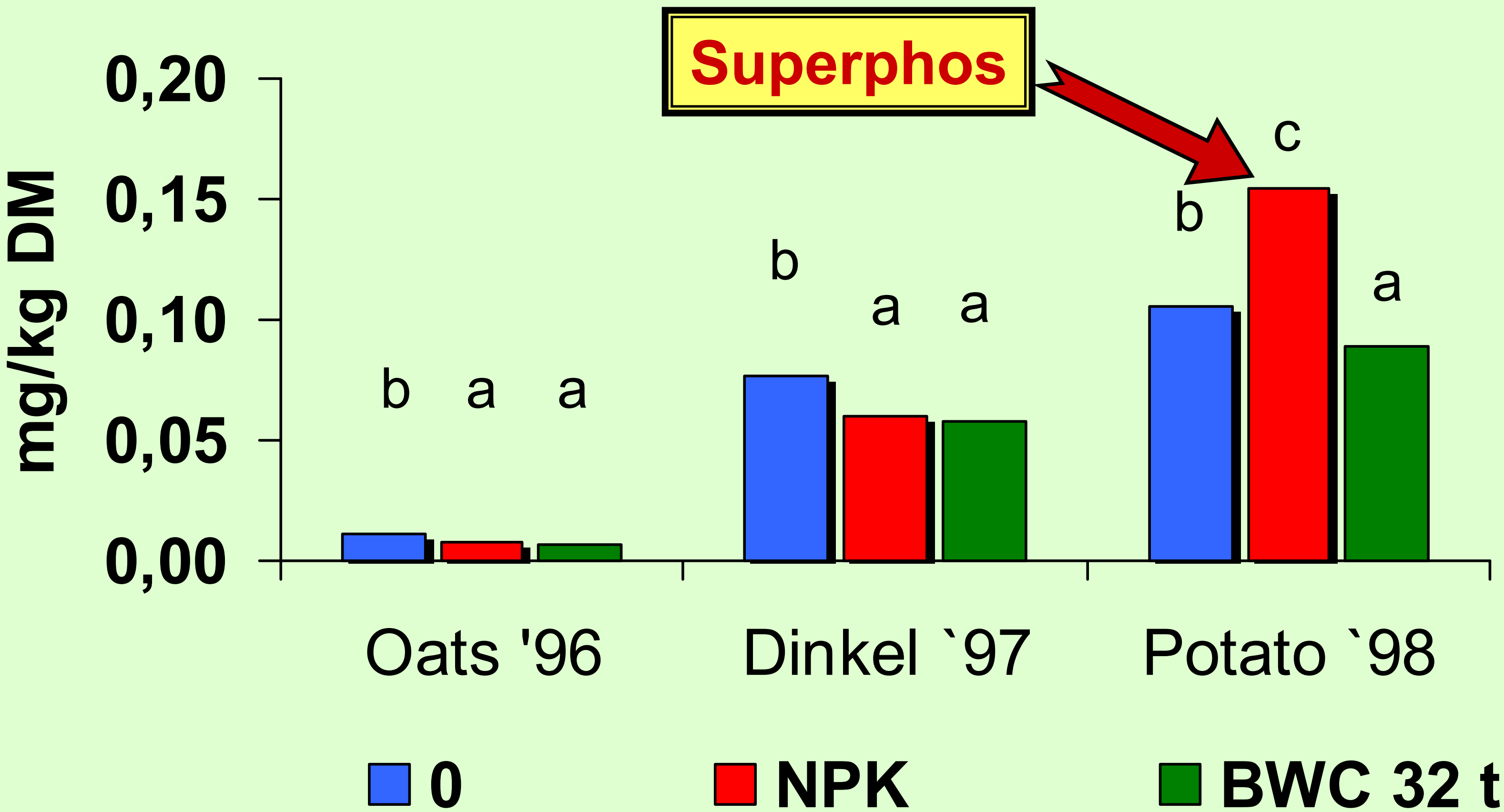
Kluge (2001)



- 6 years, six locations; 5 t, 10 t, and 20 t d.m. ha^{-1} $year^{-1}$
- No effect on heavy metal contents of the products
- Mobile heavy metal contents of Cd, Ni and Zn decreased with rising applications of composts.

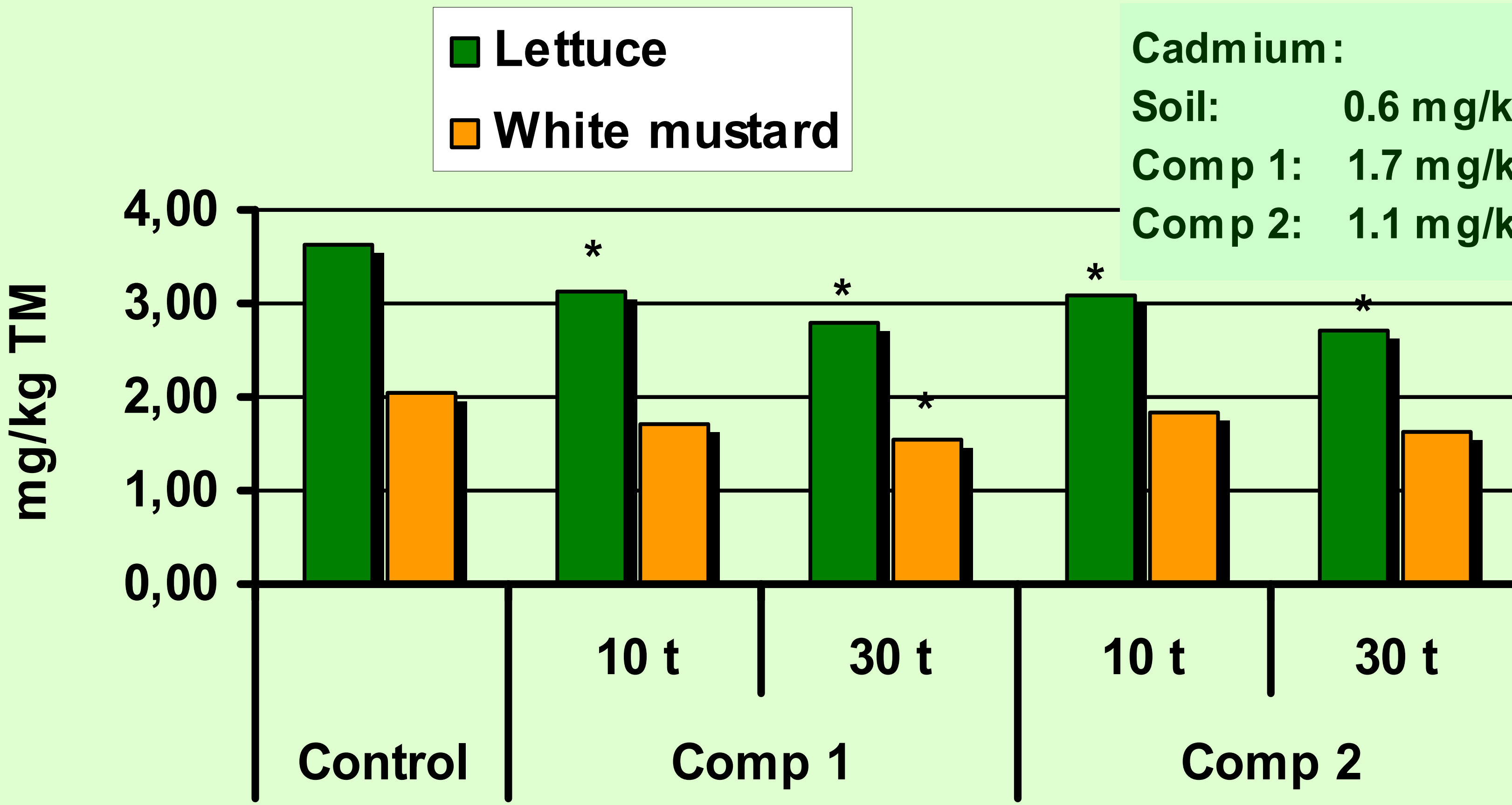
Cadmium in Grain & Potato

[Bartl et al. 1999]



Cadmium Concentration in Lettuce & White Mustard

[Luvisol; Scherer et al., 1997]



Cadmium:

Soil: 0.6 mg/kg

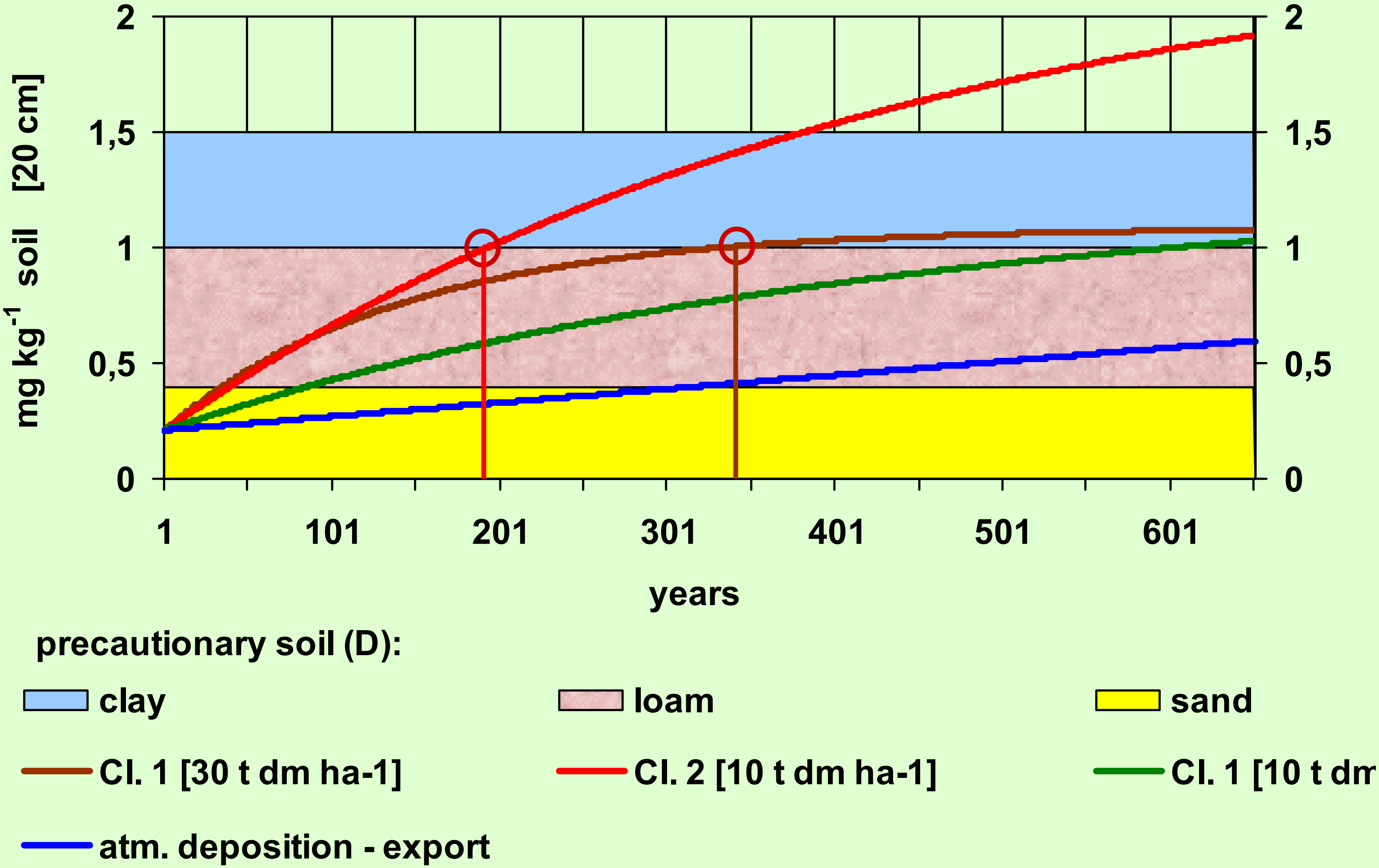
Comp 1: 1.7 mg/kg

Comp 2: 1.1 mg/kg

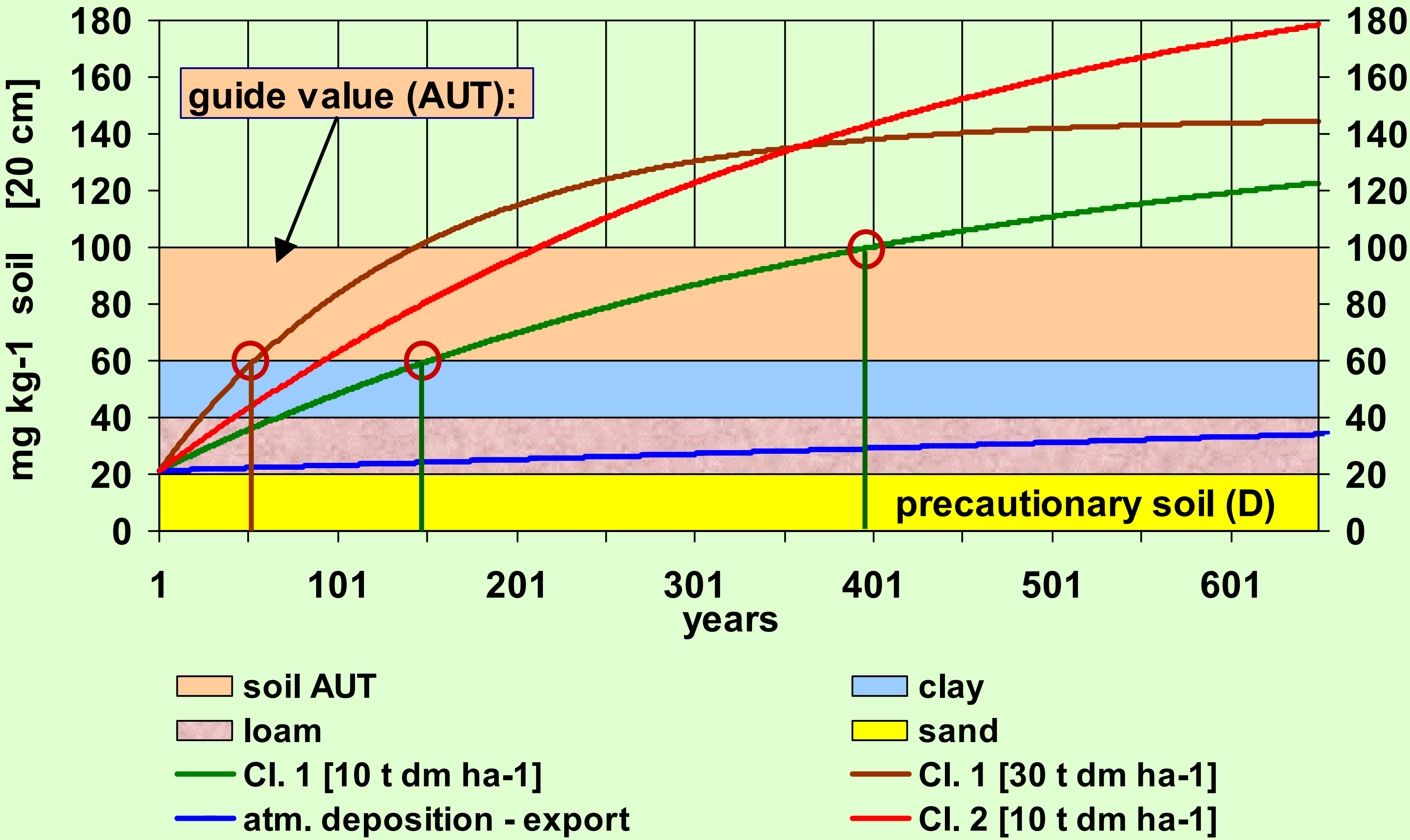
Heavy metal limits
- Soil vs Compost -

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
				mg kg^{-1} dm			
Sand	0.4	30	20	0.1	15	40	60
Silt/loam	1.0	60	40	0.5	50	70	150
Clay	1.5	100	60	1.0	70	100	200
Compost heavy metal concentration Class 1 & 2 [mineralised to 0 % organinc matter)							
Class 1	1.0	143	143	0.71	71	143	286
Class 2	2.14	214	214	1.43	107	214	571

CADMIUM: Accumulation in the SOIL



COPPER: Accumulation in the SOIL



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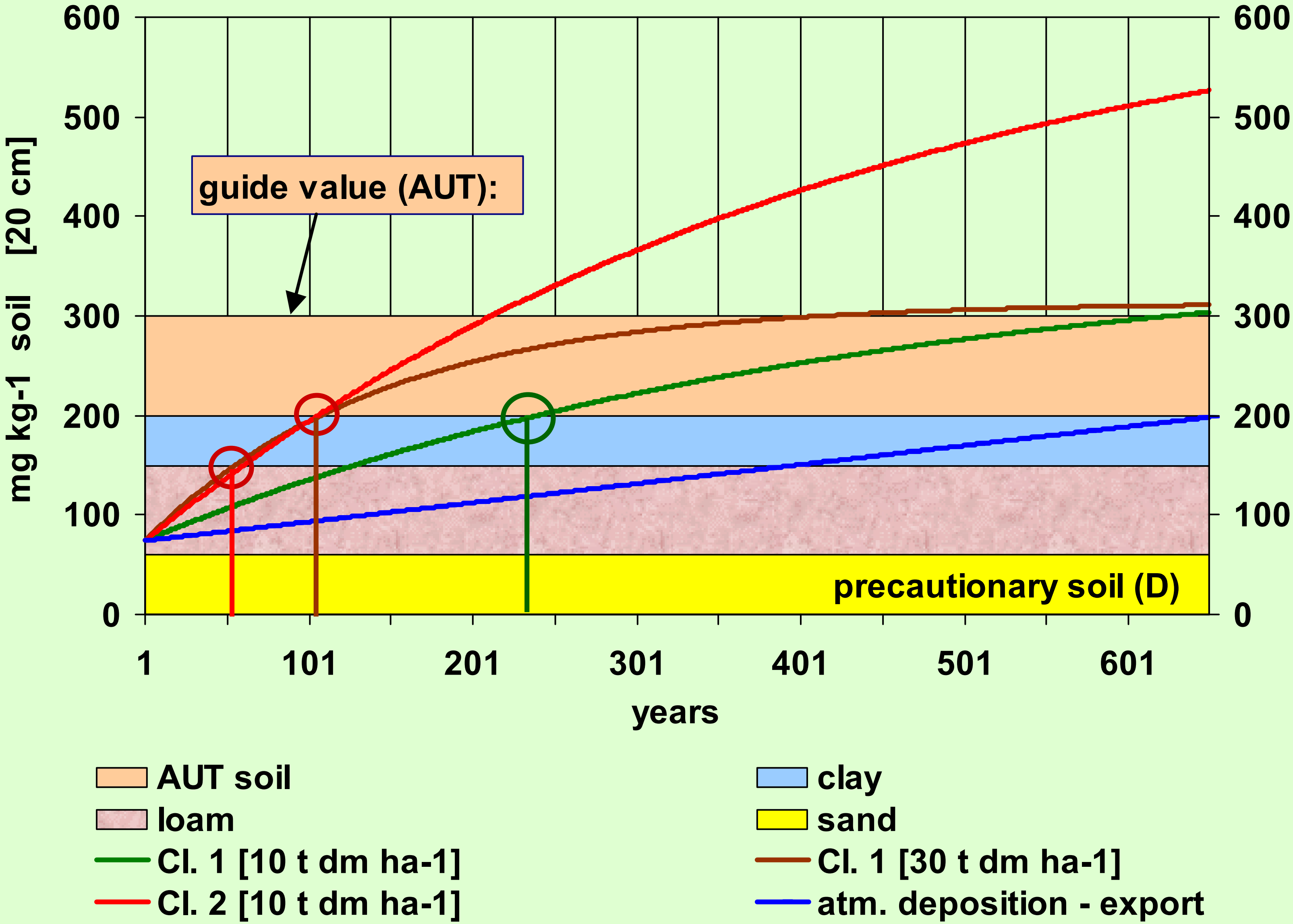
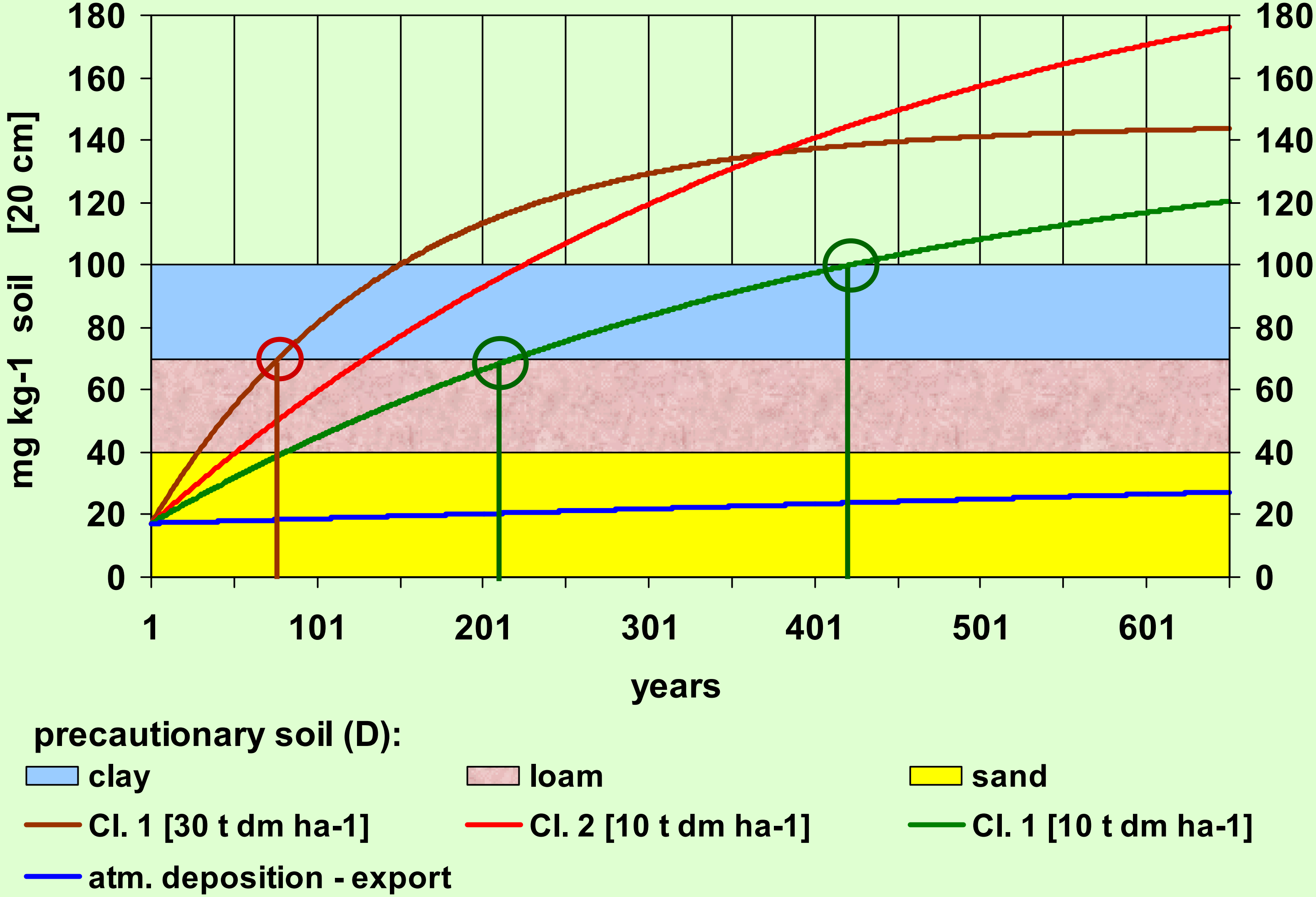
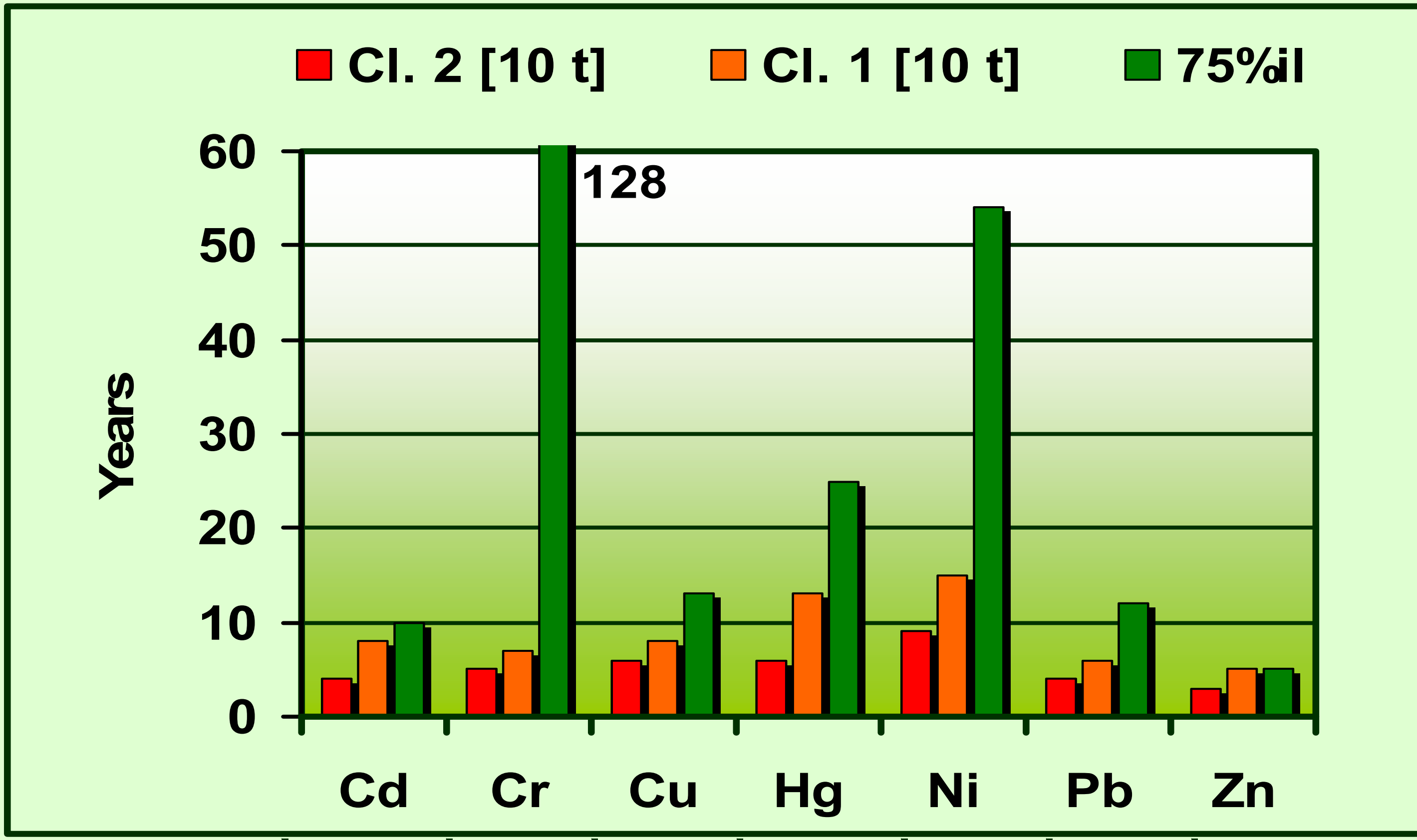
ZINC: Accumulation in the SOIL



LEAD: Accumulation in the SOIL



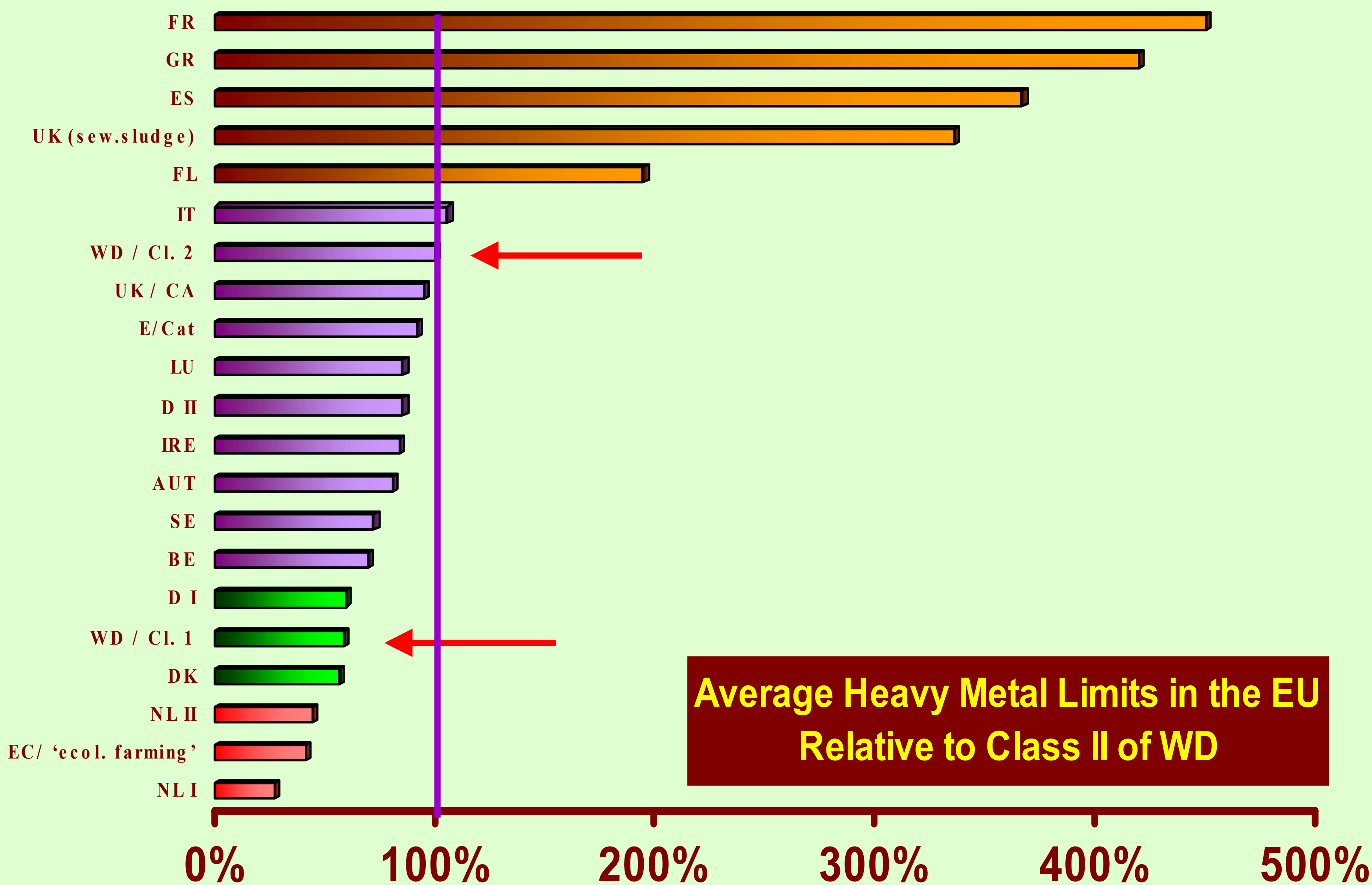
Measurable changes in the soil ?



background soil	0.21	38	21	0.16	24	17	74
measurable increase	0.02	1.5	2.0	0.02	1.5	1.5	2.5
75%il BW C/AUT	0,51	31	61	0.29	26	49	211

The reality of Compost Quality ?

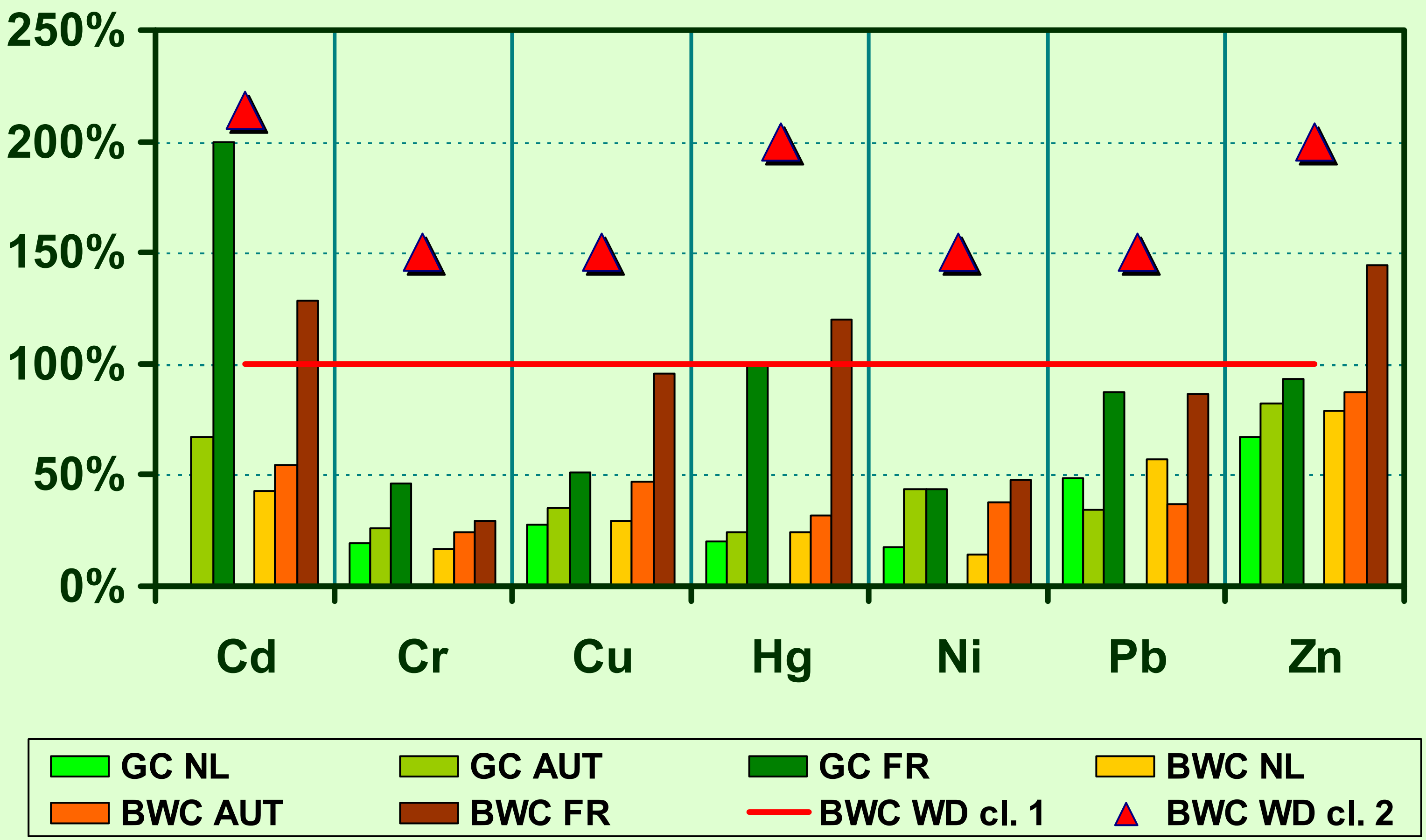
Biowaste Compost	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	mg/kg dm						
Austria: Med; n = 552 - 582	0.38	24	47	0.16	19	37	174
Belgium: Med; n = 195	0.82	22	45	0.15	12	69	229
France: Mean; n = 20 - 28	0.9	29	96	0.6	24	86	289
Germany: Med; n = 6414 - 6446	0.53	25	49	0.18	16	57	196
Catalunya (Spain): Mean; n = 9	< 1.5	30	123	0.4	30	77	239
The Netherlands: Med	0.3	17	29	0.12	7	57	157
United Kingdom: Med: n=60	0.51	16	50	0.20	18	102	186



Heavy Metals - Compost - Soil Protection

The reality of Compost Quality ?

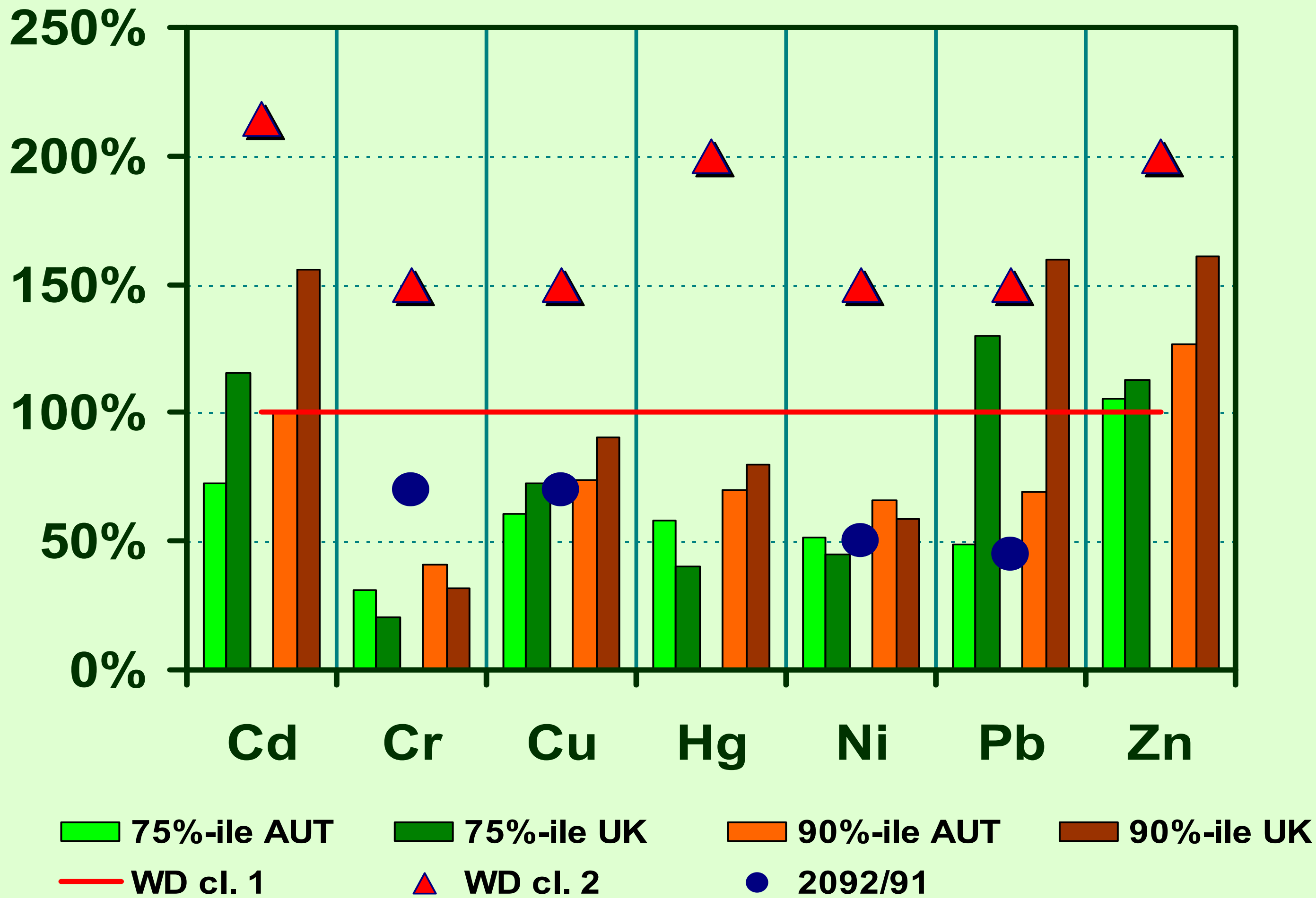
Median of GC & BWC relative to Cl. 1 WD 2nd draft



The reality of Compost Quality ?

75th and 90th %ile of AUT and UK Composts

relative to Cl. 1 WD 2nd draft



Heavy Metals - Compost - Soil Protection

Conclusions I

- Sorptive properties of compost can prevent the release of heavy metals and their excessive leaching or uptake by crops.
- Only clean / high quality compost guarantees the introduction sorptive surfaces for heavy metals in compost amended soils
- Soluble, exchangable fraction and plant uptake of H.M. decrease in compost amended soils
- H.M. accumulation has to be considered on the background of environmental standards for sustainable soil functions
- The critical concentration of H.M. in the soil varies with local climatic and soil conditions
- Thus: .... Precautionary soil values and compost application regimes should be established on MSt level

Conclusions II

- Quality classes → an important tool
- Class 1 in agreement with Organic Farming Regulation (adjustment at least of Ni, Pb and Zn)
- Class 2 → Agriculture and hobby gardening
- Class 1 & 2:
  - Limitations for the quantity to be applied on land on MSt level
  - Labelling: Recommendations for the safe use on MSt level
- Product - Class 3
  - non food
  - Limitations for the quantity to be applied on EU level
  - market for sewage sludge compost
  - MSt → may allow the use in Agriculture within waste regime; heavy metal loads in compliance with the Sludge Directive
- Stabilised Waste …. Not to be included in a Compost Directive

Proposal for an Environmental Compost Classification within an EU Compost Directive

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	----------------	----------------	----------------	mg kg^{-1} dm	----------------	----------------	----------------
class 1 org. farming	0.7	100	100	0.5	50	100	200
		70				80	250
class 2 agriculture	1.5	150	150	1	75	150	400
	1.0	100		0.7		120	500
class 3 non food	3	250	500	3	100	200	1 500