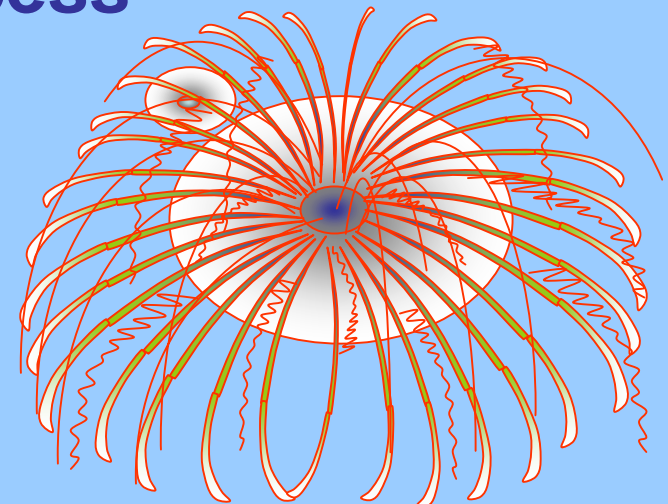


**Coming together is a beginning**

**Keeping together is progress**

**Working together is success**





## Current developments in remediation of contaminated sites

### Field Tested Soil Management Practices to Improve Contaminated Land

Gupta , S:K.

Agroscope FAL Reckenholz

Swiss Federal Research Station for Agroecology and Agriculture  
Zurich, Switzerland



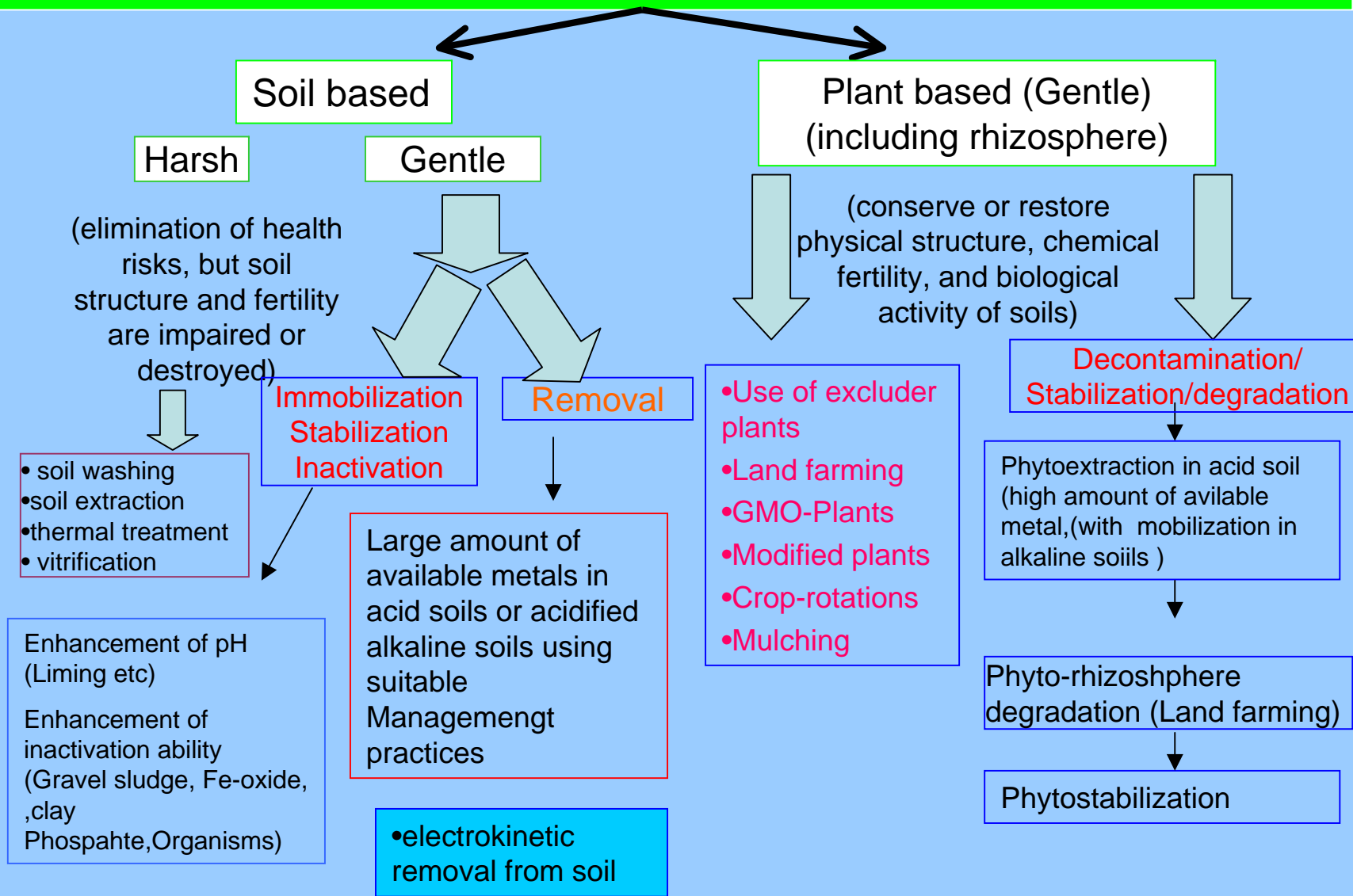
# Contents

## Field Tested Soil Management Practices to Improve Contaminated Land : Example Zinc

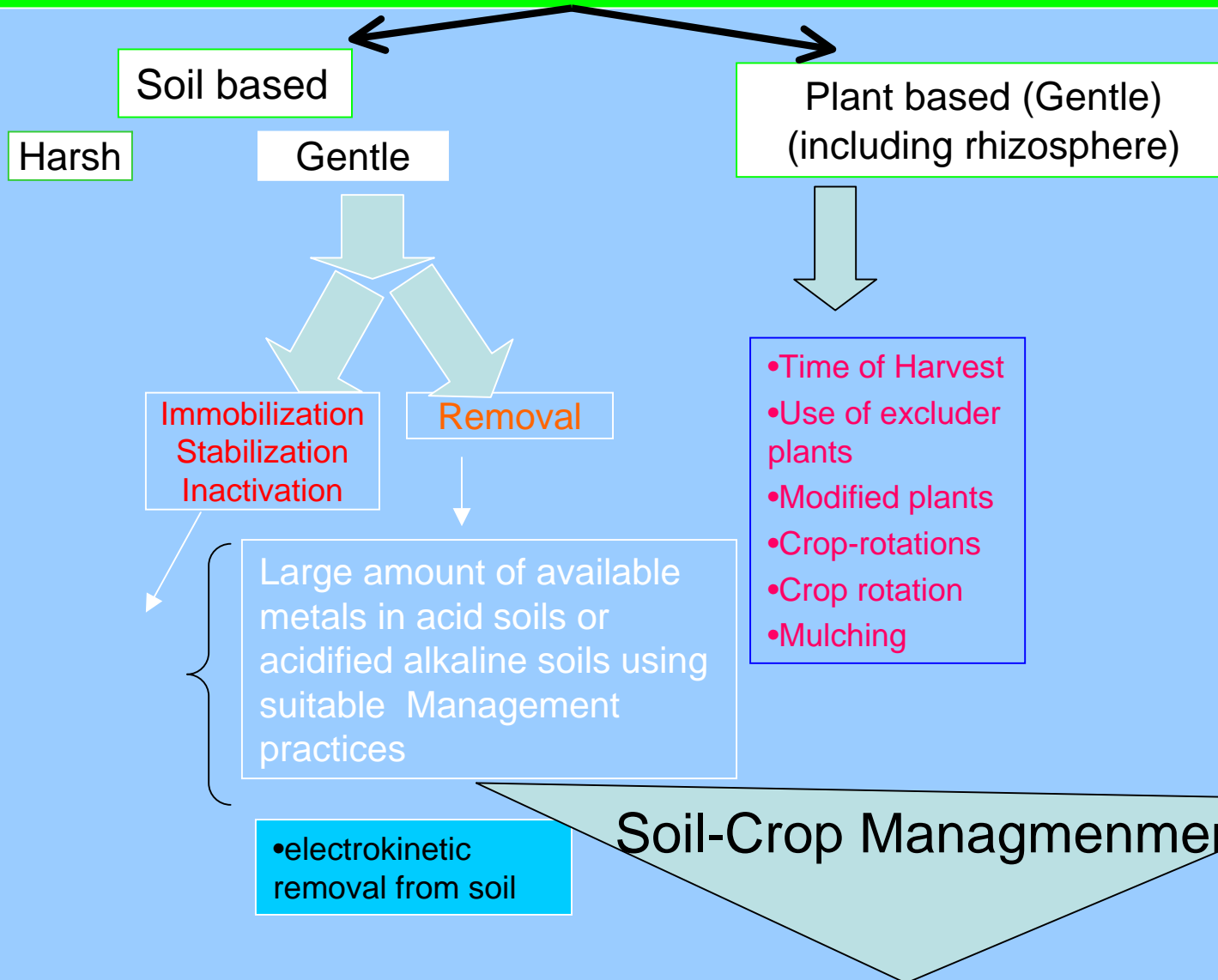
- Introduction
- Experimental Lay out, History of Experiment
- Zn in Soils
- Zn in Plants, Zn distribution in plant parts
- Zn Removal in years
- Summary / Conclusions , consequences



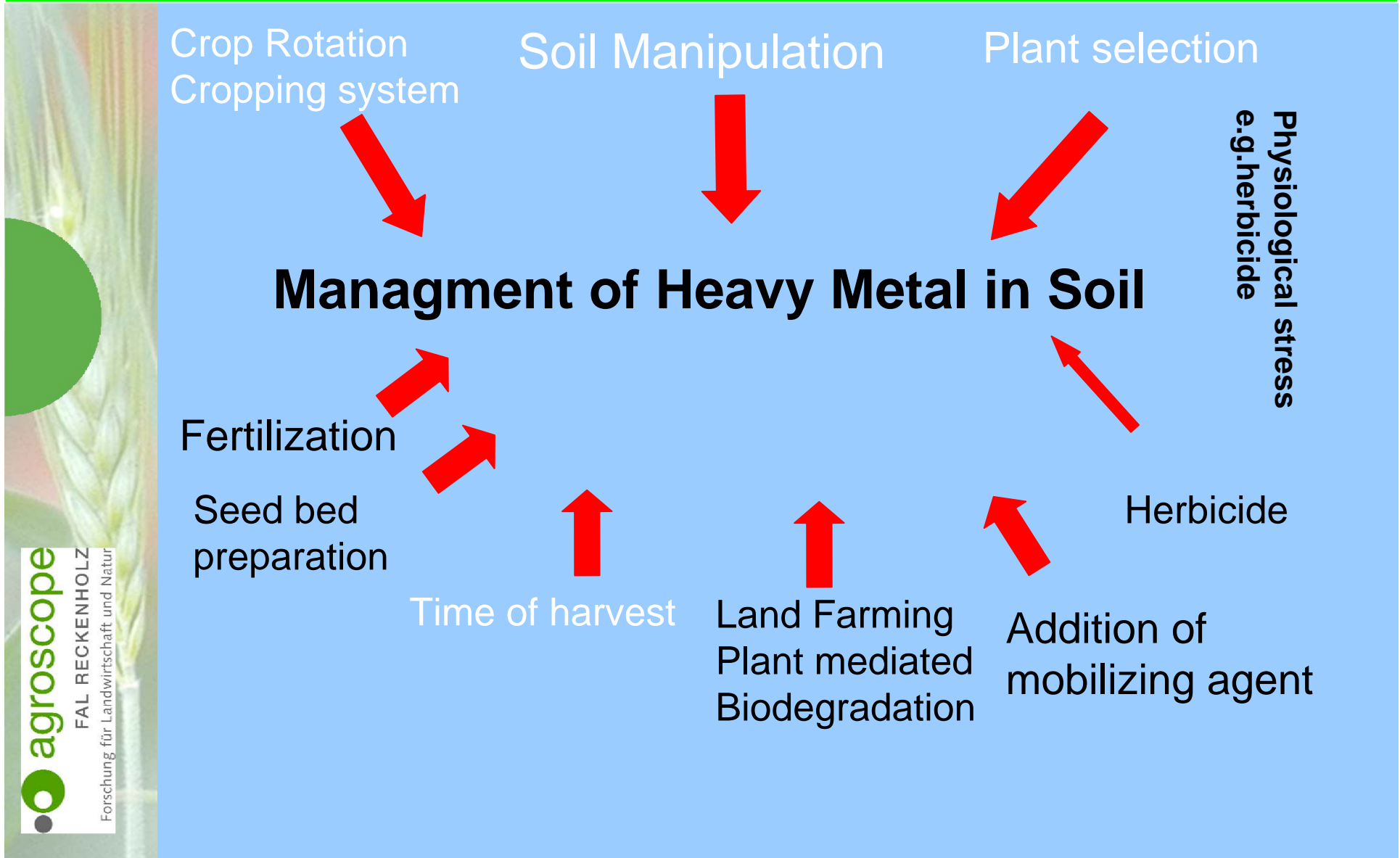
# Techniques to regulate the nutrients and pollutants concentration



# Techniques to regulate the nutrients and pollutants concentration



# Effect of Soil Crop Management Practices on Phytoextraction



# Contents

## Field Tested Soil Management Practices to Improve Contaminated Land

- Introduction
- Experimental Lay out, History of Experiment
- Zn in Soils
- Zn in Plants Zn distribution in plant parts
- Zn Removal in years
- Summary / Conclusions , consequences



## Effect of increasing Zn in soil on Growth of maize





# Experimental Layout 1988-2004



			Total Zn 1988	Soluble Zn 1988 2002	
Tobacco 4	Tobacco 5	Tobacco 6	1550	51.4	52.42
Maize 4	Maize 5	Maize 6			
Tobacco 10	Tobacco 11	Tobacco 12	750	44.8	48.1
Maize 10	Maize 11	Maize 12			
Tobacco 16	Tobacco 17	Tobacco 18	350	25.6	23.6
Maize 16	Maize 16	Maize 16			
Tobacco 22	Tobacco 23	Tobacco 24	150	13.2	14.73
Maize 22	Maize 23	Maize 24			
Tobacco 28	Tobacco 29	Tobacco 30	50	5.6	7.36
Maize 28	Maize 29	Maize 30			
Tobacco 34	Tobacco 35	Tobacco 36	Control	1.7	1.23
Maize 34	Maize 35	Maize 36			

2.8 m

2.8 m

# Zinc- Field Experiment

## *Phase I (1988 – 1996) : Swiss ordinance on soil impacts*

- to test Guide Values
- to estimate clean up value for Zinc in soils

## *Phase II (1998 – 2001): Site Clean up with plants*

- to estimate best time of harvest
- to assess metal concentration in different plant parts (food & fodder quality)
- to estimate time required for clean up of soil by phytoextraction or mining time

## *2004: Liebefeld Res Station moved to Zuerich (save money) so site must be cleaned before handing over to authorities*

- to find distribution of metals in soil profile
- to save deponie room and
- to find cost effective and ecological safe incineration of polluted soil



# Contents

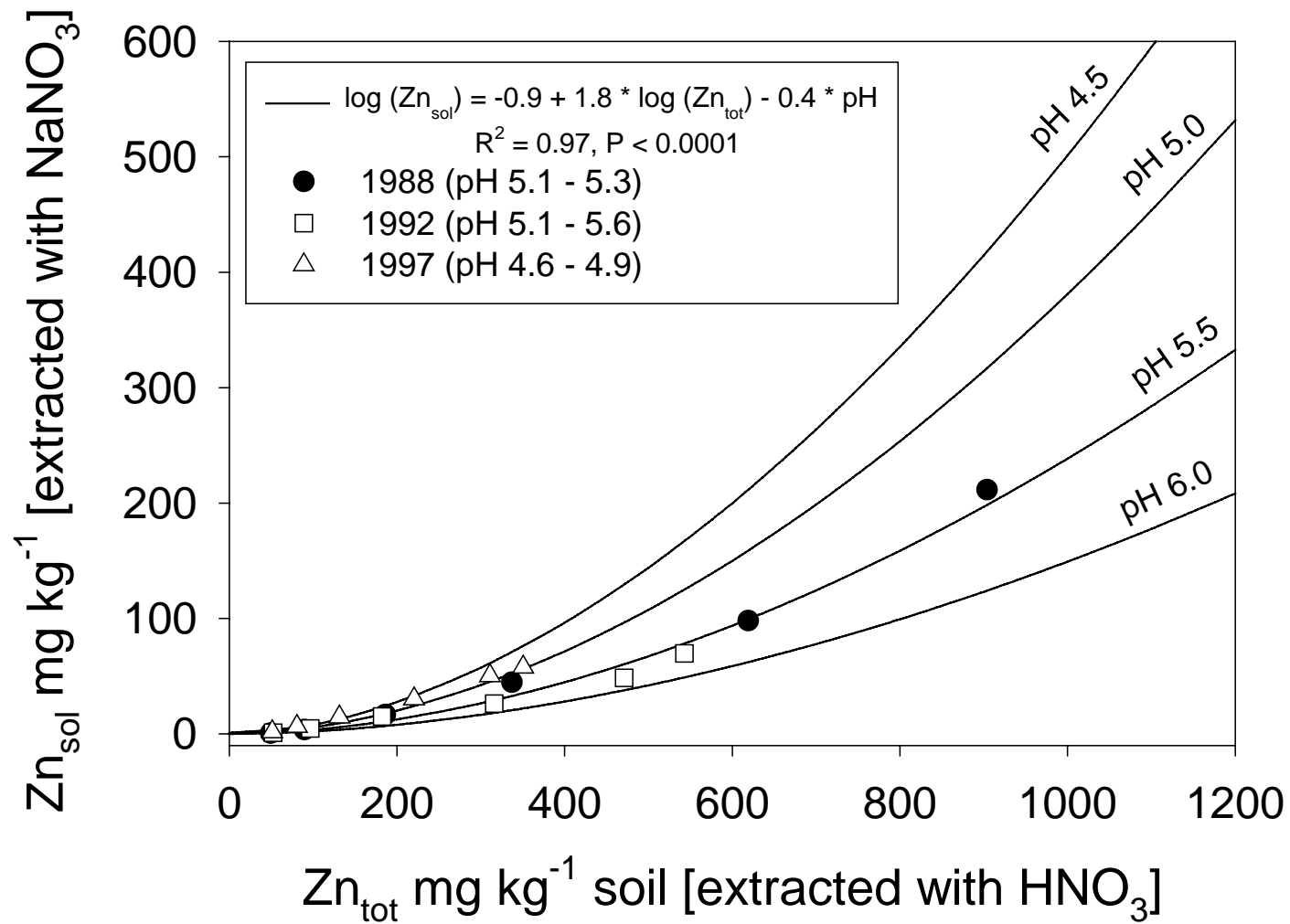
## Field Tested Soil Management Practices to Improve Contaminated Land

- Introduction
- Experimental Lay out, History of Experiment
- Zn in Soils
- Zn in Plants Zn distribution in plant parts
- Zn Removal in years
- Summary / Conclusions , consequences



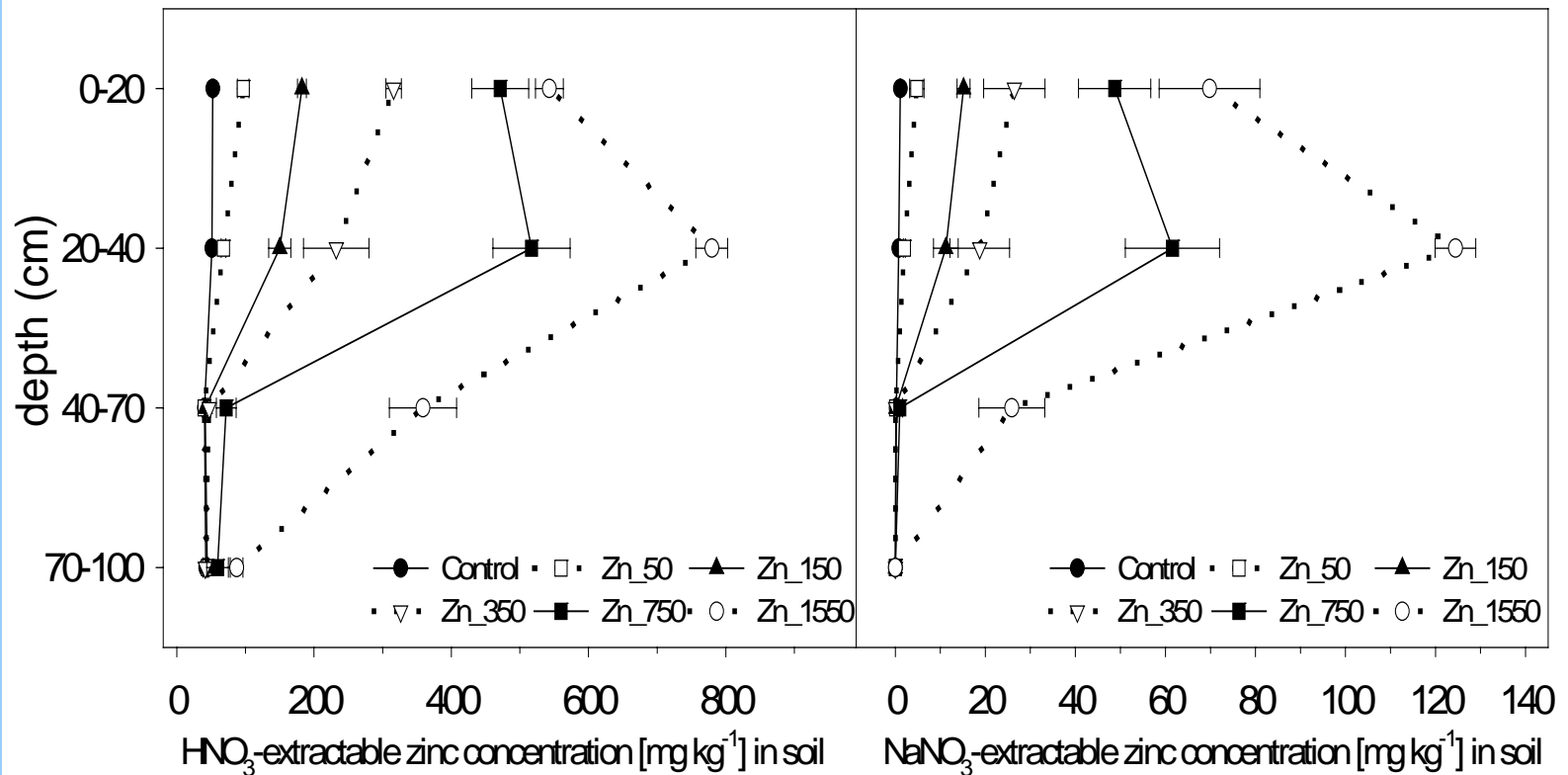
# Soil pH

Mean “soluble” Zn ( $Zn_{sol}$ ) concentration in topsoil (0-20 cm) in relation to “total” Zn ( $Zn_{tot}$ ) and soil pH in the years 1988, 1992 and 1997.



# Movement of Zinc in Soil Profile

“Total” ( $\text{HNO}_3$ -extraction) and “soluble” ( $\text{NaNO}_3$ -extraction) Zn concentration of the different treatments at different soil depths in the year 1992.



# Contents

## Field Tested Soil Management Practices to Improve Contaminated Land

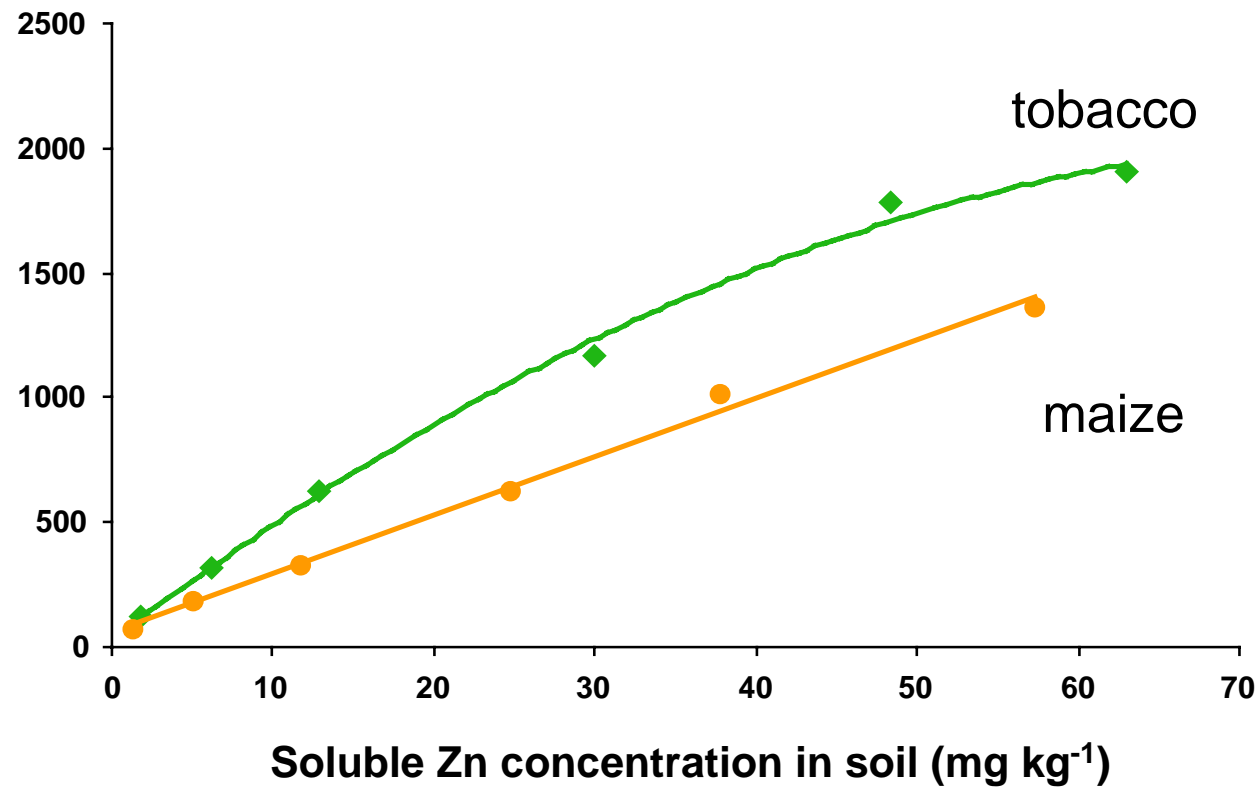
- Introduction
- Experimental Lay out, History of Experiment
- Zn in Soils
- Zn in Plants, Zn distribution in plant parts
- Zn Removal in years
- Summary / Conclusions , consequences



# Effect of different Plant

## Effect of soluble metal in soil on zinc uptake

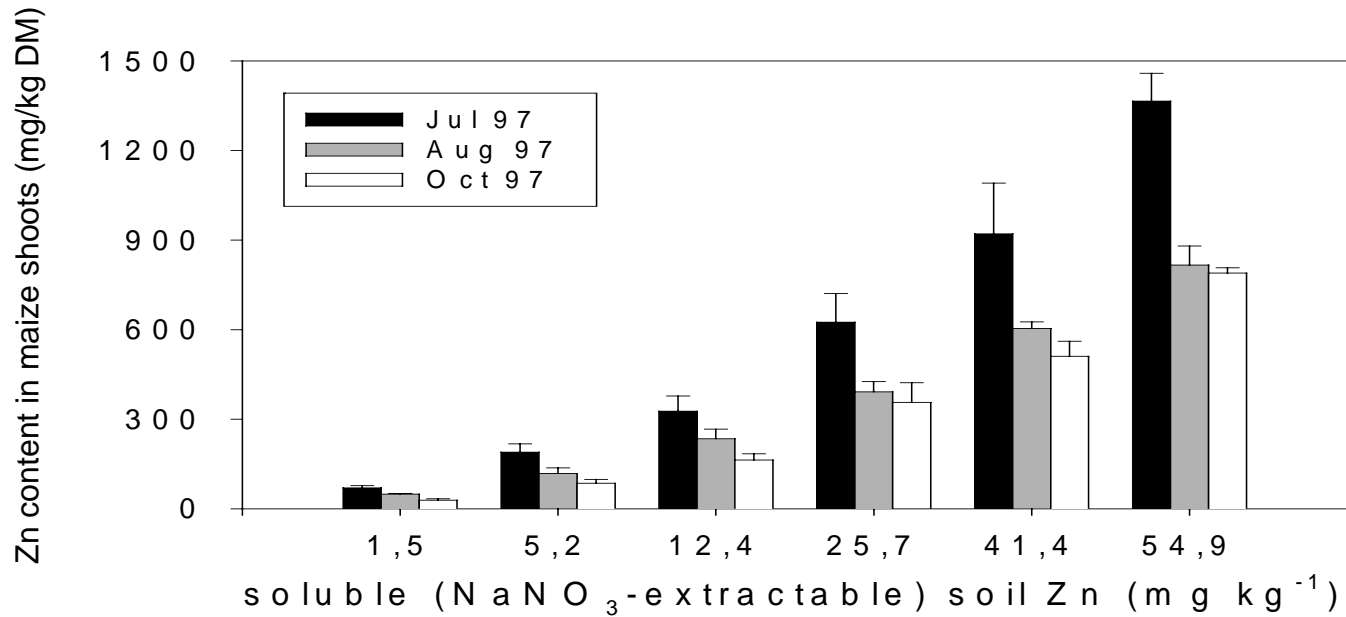
Zn concentration in plant shoots  
(mg kg<sup>-1</sup>)



Zinc (Zn) uptake by crop plants from a field soil (pH approx. 4.8) 10 years after experimental contamination with various dosages of ZnSO<sub>4</sub>

# Time of Harvesing

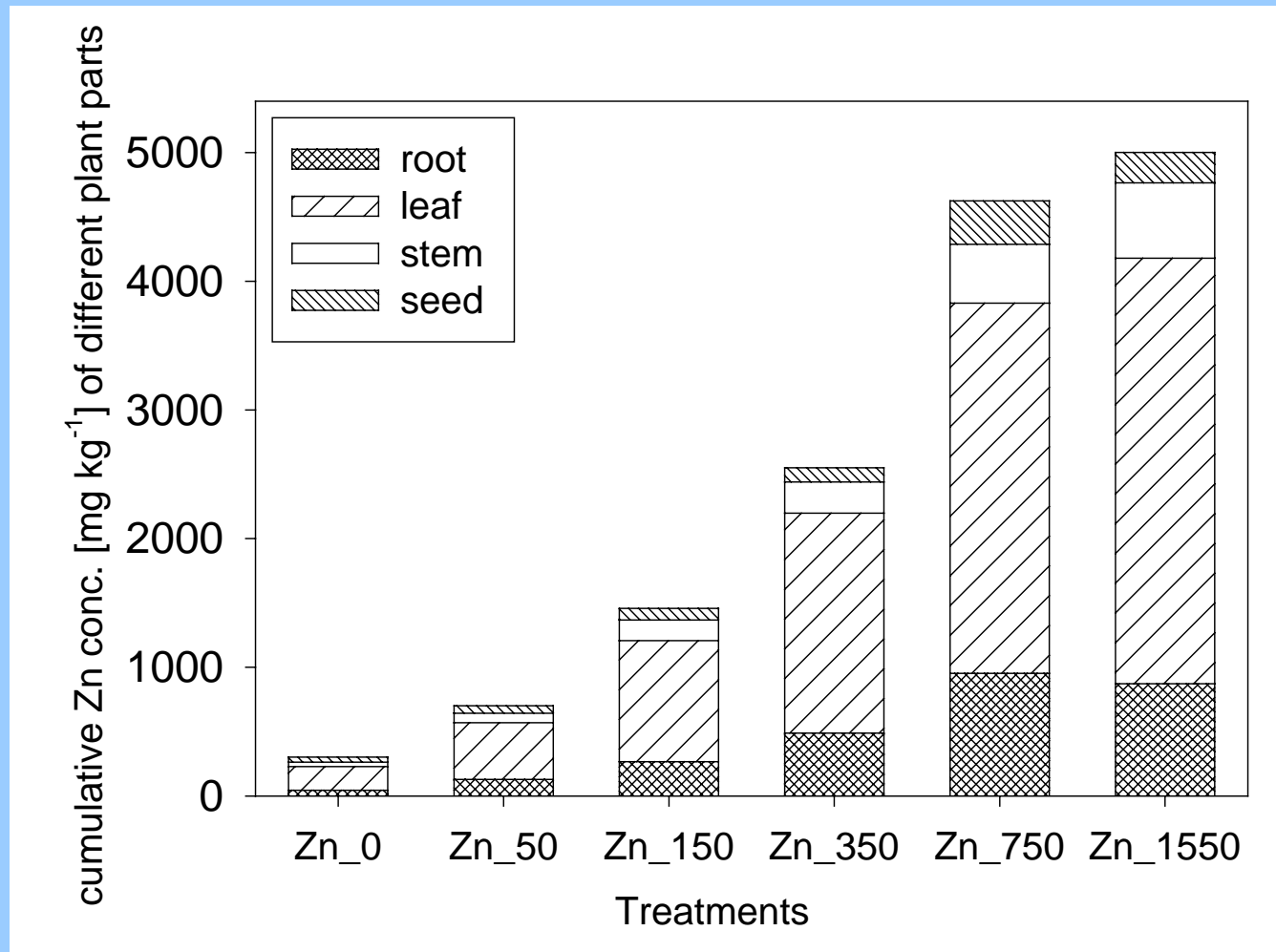
Effect of varying mobile zinc contents in soil on zinc concentrations in maize shoots at different growth stages





# Maximum Zn concentration in plant parts

## Distribution of Metal in different parts of Tobacco



# Contents

## Field Tested Soil Management Practices to Improve Contaminated Land

- Introduction
- Experimental Lay out, History of Experiment
- Zn in Soils,
- Zn in Plants , Zn distribution in plant parts
- Zn Removal in years (Zinc Harvesting)
- Summary / Conclusions , consequences



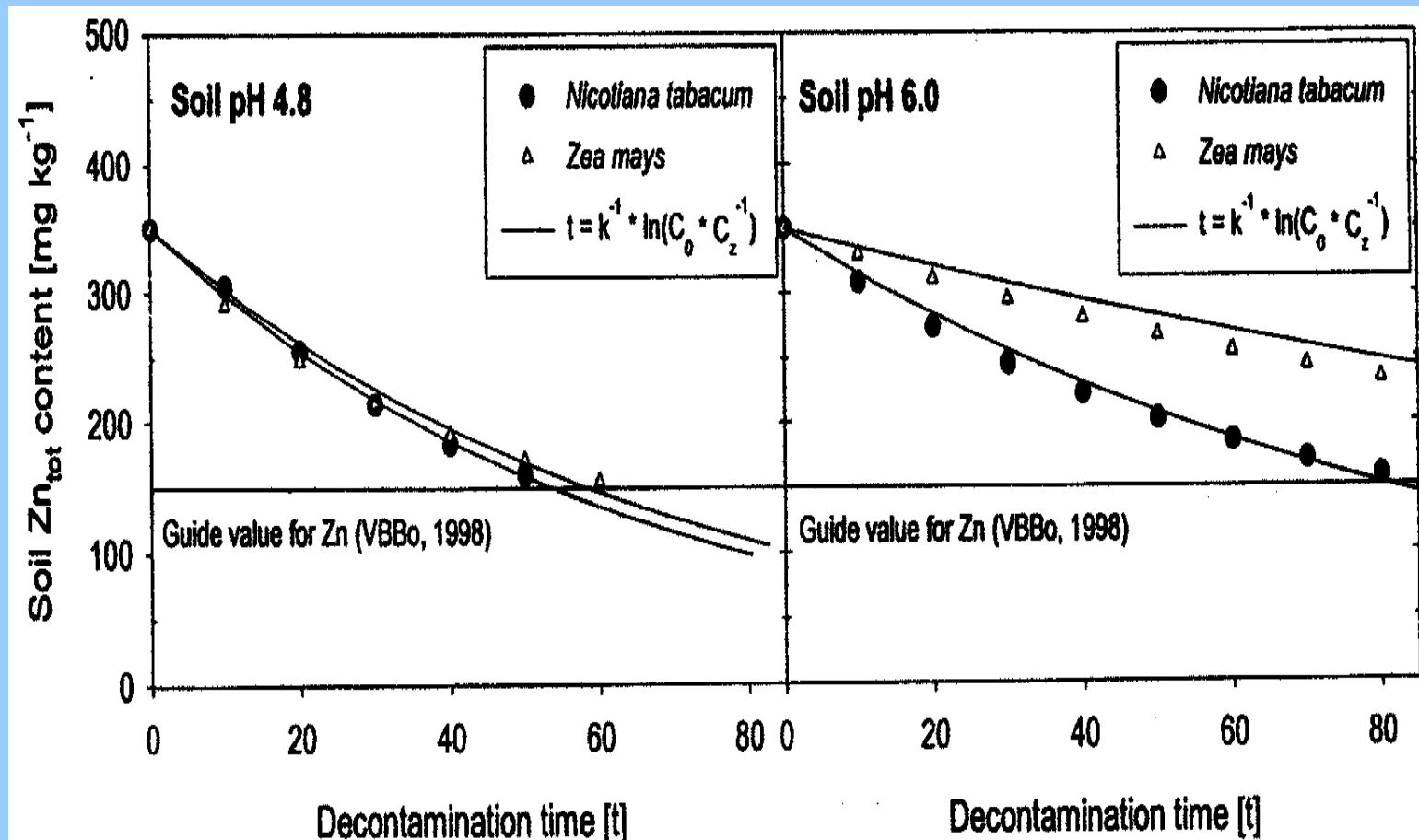
# Calculated time for removal of soluble Zn from Soil by plants (constant removal)

**Concentrations of Zn ( $\text{mg kg}^{-1}$  dry matter), yields ( $\text{t ha}^{-1}$ ) and removals ( $\text{kg ha}^{-1}$ ) during growth period of maize by varying mobile ( $\text{NaNO}_3$ -extractable) zinc contents in soil**

NaNO <sub>3</sub> extractabl zinc in soil (mg/kg DM)	Maize <b>55 days growth period</b>			Maize <b>82 days growth period</b>		
	Conc.	Yield	Removal Harvesting	Conc.	Yield	Metal harvesting
1.7(±0.1)	69.6(±7.9)	4.8(±0.4)	0.3	49.2(±1.5)	15.8(±1.9)	0.8
5.6(±1.0)	189.2±28.5)	4.8(±1.0)	0.9	118.2±18.9)	15.2(±1.4)	1.8
13.2(±2.7)	326.7±50.5)	3.9(±1.3)	1.3	234.7±32.0)	16.7(±1.1)	3.9
25.6(±5.1)	625.1±96.1)	4.4(±1.0)	<b>2.8</b>	391.7±34.1)	17.2(±3.0)	<b>6.7</b>
44.8(±8.3)	920.9±169.9)	3.9(±0.6)	<b>3.6</b>	603.6±22.2)	16(±2.0)	<b>9.7</b>
51.4(±8.3)	1365.7±93.2)	3.7(±0.5)	<b>5.1</b>	816.2±64.1)	14.3(±2.2)	<b>11.6</b>



# Calculated time for removal of total Zn from Soil by plants (constant removal)



# Is it possible to improve efficiency of Phytoextraction?

## Phytoextraction

for some metals requires long time span and for some metals it is in the range of economic viability

- **suitable plants**

Plant root system, metal tolerance , high metal uptake, high biomass

- **additives**

to facilitate enhanced uptake by metal accumulating and metal tolerant plant



# Contents

## Field Tested Soil Management Practices to Improve Contaminated Land

- Introduction
- Experimental Lay out, History of Experiment
- Zn in Soils,
- Zn in Plants , Zn distribution in plant parts
- Zn Removal in years
- Summary / Conclusions , consequences



## • Summary / Conclusions , consequences (1)

- The total zinc removal by maize at the 'early milk' growth stage corresponds to the average removal of zinc using the hyperaccumulator *Cardaminopsis halleri*.

- Maximum removal of Zn was

- maize 12 kg ha<sup>-1</sup> y<sup>-1</sup>

- Tobacco 13 kg ha<sup>-1</sup> y<sup>-1</sup>

- Only small amounts of Zn were translocated into the seeds of Tobacco and cobs of Maize

Corn cobs of *Z. mays* and seeds of *N. tabacum* are safe use.



## • Summary / Conclusions , consequences (2)

- **The Preventive measures to protect soil from pollutants should be given priority**

- Simple protocols for conducting phytoremediation experiment has to be prepared

- Phytoextraction : Efficiency of extraction can be improved

- **Legal basis should be formulated for gentle Remediation technique such as phyoremediation, immobilization, Land management practices**

