

Framework of Risk Assessment in Relation to FGD-Gypsum use as an Agricultural Amendment

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Alternative Beneficial Uses: FGD-Gypsum

- Calcium fertilizer for peanuts, etc.
- Sulfate fertilizer for many crops.
- Improve water infiltration.
 - Reduce soil erosion/crusting.
- Reduce P runoff by Ca precipitation.
- Other fertilizer benefits for old FGD-Gypsum:
 - Boron fertilizer rate.
 - Selenium fertilizer for low Se soils.

Old vs. New FDG-Gypsum

- **Old** FGD Gypsum products contained much of the elements in fly ash, such that B, As, Se, etc. were a source of concern depending on the coal source used.
- **New** FGD-Gypsum produced post fly ash removal contains very low levels of all trace elements.

Need to Know the Potential Risk of using FGD-Gypsum in Agriculture

Risk assessments were developed for both biosolids and foundry sand considering high end risk (e.g.95th percentile of exposure).

- **Humans**
- **Soil organisms and function**
- **Plants and Food-Chain**
- **Water**
- **Livestock and Wildlife**

Evaluation Steps

- Obtain FGD-specific data
 - Trace elements at low detection limits.
 - Nutrients.
- Review FGD-specific data
 - Constituents, properties
 - Environmental behavior (e.g. plant survival/uptake)
- Develop/Choose Conceptual Model
- Screen out exposure pathways, constituents
- Model remaining pathways, constituents
- Characterize risk w/in context of soil science
- Conclusions

Pathways for Risk Assessment of Elements in Soils, and Highly Exposed Individuals-1.

Pathway	Highly Exposed Individual
1. Soil → Plant → Human	Farm markets; 2.5% of food.
2. Soil → Plant → Human	Home gardens; 60% of garden foods for lifetime; 100 t/ha
3. Soil → Human	200 mg/day soil/dust ingestion; 100 t/ha
4. Soil → Plant → Animal → Human	Farms; 45% home-grown meat; 100 t/ha
5. Soil → Animal → Human	Grazing ruminants; soil is 2.5% of annual diet; 45% home-grown meat.
6. Soil → Plant → Animal	100% of livestock feeds grown on soils; 100 t/ha
7. Soil → Animal	Grazing ruminants; 2.5% soil in diet.

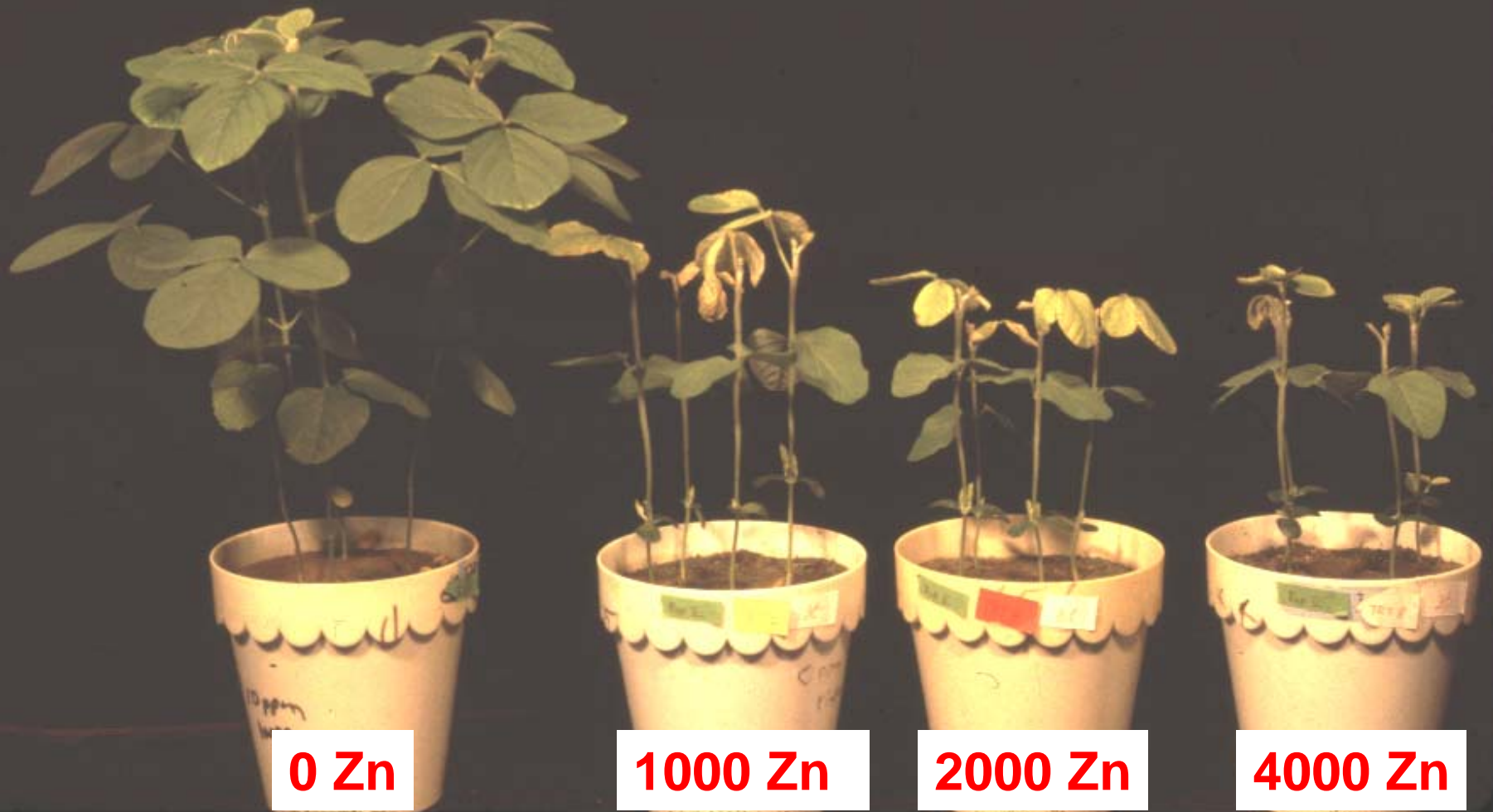
Pathways for Risk Assessment of Elements in Soils and Highly Exposed Individuals-2.

Pathway	Highly Exposed Individual
8. Soil→Plant	Sensitive crops; strongly acidic; 100 t/ha.
9. Soil→Soil Biota	Earthworms; microbes; metabolic function of soil; 100 t/ha.
10. Soil Biota→Soil Biota Predator	Shrews; 1/3 of diet presumed to be earthworms full of Soil; 100 t/ha.
11. Soil→Airborne Dust→Human	Tractor operator; 100 t/ha.
12. Soil→Surface water→Human	Subsistence fishers.
13. Soil→Air→Human	Farm households
14. Soil→groundwater→Human	Well water on farms.

SOIL-PLANT BARRIER

Processes in soils or plants which prevent excessive food-chain transfer of elements

- **Insolubility or adsorption in soil or plants roots:**
 - Cr, Pb, Fe, Hg, Sn, Au, Ag, Zr, Al, F, Ti, etc.
- **Phytotoxicity limits plant yield at levels which are not toxic for lifetime consumption by livestock:**
 - Zn, Cu, Ni, **As**, Mn, **B**, etc.
- **Exceptions to Soil-Plant Barrier:**
 - Cd, Se possible risk to humans
 - Mo**, **Se**, (Co) possible risk to livestock
- **Barrier can be circumvented by direct ingestion of soil; Volatilization of Hg is separate risk.**
 - Fe, F, Pb, **As**, **Hg** may comprise risk in high on surface.



0 Zn

1000 Zn

2000 Zn

4000 Zn

Low Zn Phytotoxicity Resistance of 'Williams' Soybean; at Harvest. Sassafras sandy loam amended with 5% Zn biosolids, adjusted to pH 5.5.

FGD-Gypsum Data Collection for Risk Assessment -1

- Samples should be collected and stored using chain of custody.
- Samples should be analyzed using the appropriate methods (duplicate or triplicates, certified standards, spike and blanks) should be included in all analysis.
- Instrument detection limits should be low enough to meet drinking water and soil standards.

FGD-Gypsum Data Collection for Risk Assessment-2

- Leaching Study
 - water soluble
 - synthetic precipitation leaching procedure (SPLP)
- Plant uptake
- Biota - earthworms full of Soil
- Mercury Volatilization
 - cold-hot
 - light-dark
 - canopy-non-canopy
 - winter-summer
 - aerobic-anaerobic

Conclusion

A high ended Risk Assessment for FDG-Gypsum will provide:

- **A scientific document summarizing the beneficial use of new low contaminant FGD-Gypsum in agriculture.**
- **A summary of risk assessment research and estimation of potential risks to highly exposed individuals (humans, livestock, plants, soil organisms and wildlife) after long periods of application at beneficial rates.**