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Soil Sampling

- Soil sampling is more than putting soil in a jar.
- Management decisions are made on the results. Make sure they are correct. (Are they representative ?)
- Develop a plan & follow the plan.
 - Correct sample method, sample handling, analytical method





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Sampling Plan

- Sampling: Numbers, What, Where, When, How ...
 - Number of samples to collect (statistically viable for your field ~10 or more)
 - What - composite from depths of 0'-1' & 1'-2' & 2'-3'
 - Where - Random locations
 - When - After the harvest





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Sample Handling

- Thoroughly homogenize the sample
- Fill laboratory supplied containers
- Label the jars
- Date & time
- Place in cooler with ice (double bagged)
- Get it to the lab ASAP!



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Laboratory

- Analytes: Total Kjeldahl Nitrogen (TKN), ammonia, nitrate & nitrite
- Results: dry weight vs. lbs/ac
- Others:
 - Inorganics: (Arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc)
 - Nutrients: Phosphorus (P), Potassium (K)
 - pH
 - Cation exchange capacity



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Annual Biosolids Reports

“Just the facts ma’am”

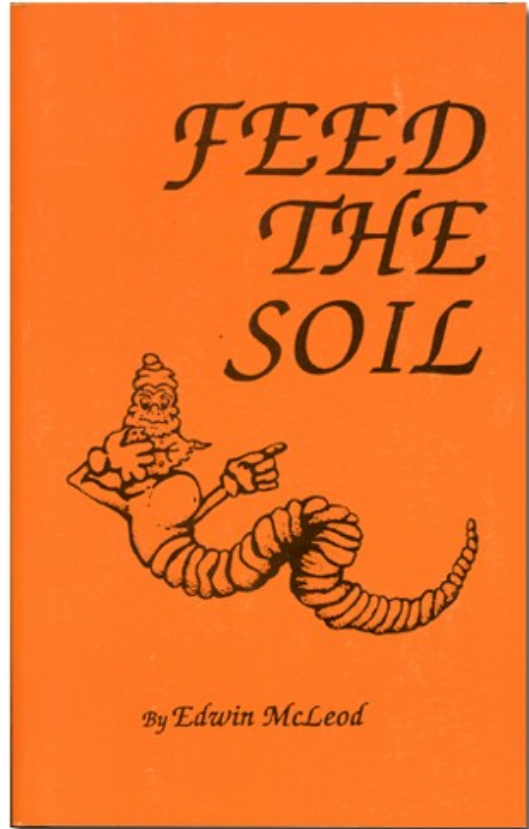
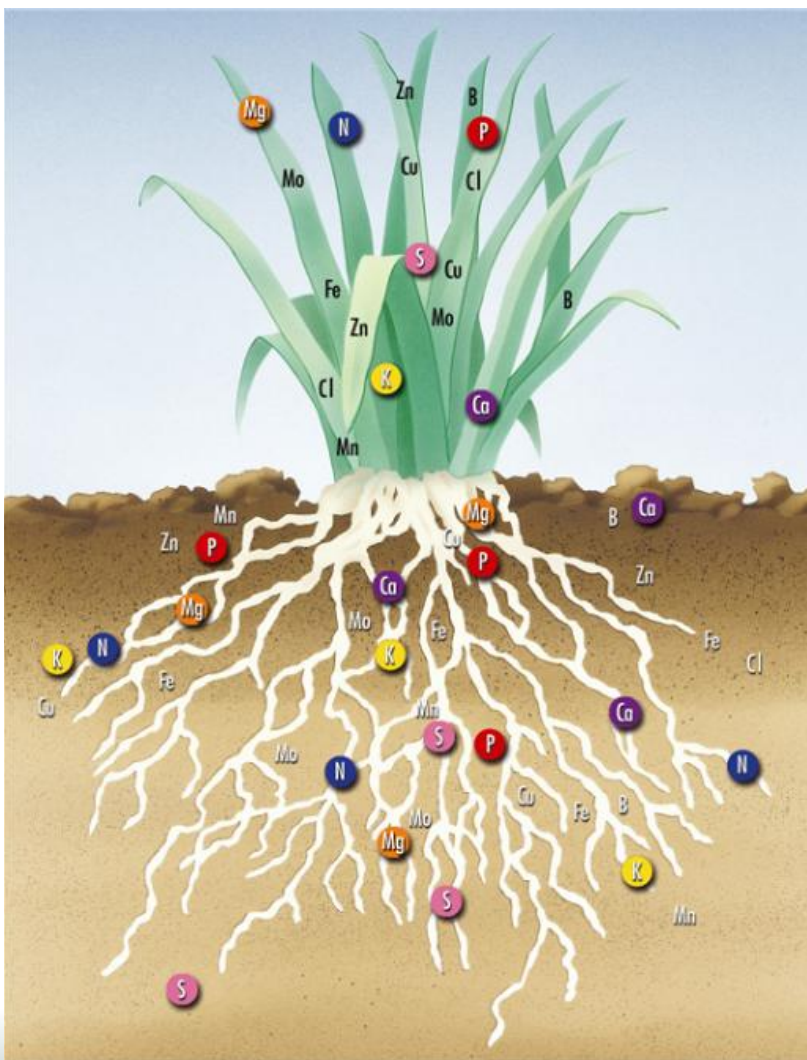
- Don't need all the paper or fancy covers
- EPA - Electronic reporting only. Major facilities (have a design flow equal to or greater than one Million GPD and/or you serve 10,000 people or more) **Does not meet DEQ reporting requirements.**
- Copies sent to: Regional DEQ biosolids staff contact and to the DEQ biosolids program coordinator at HQ.

Land Application More Specifically, Agronomy





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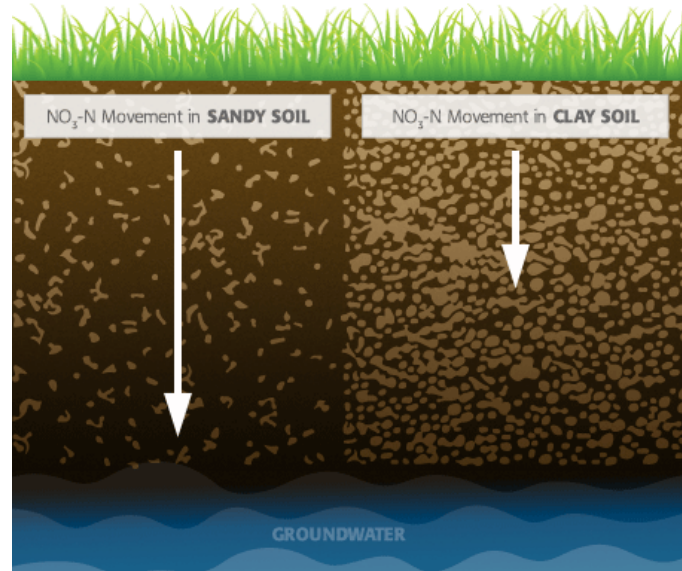
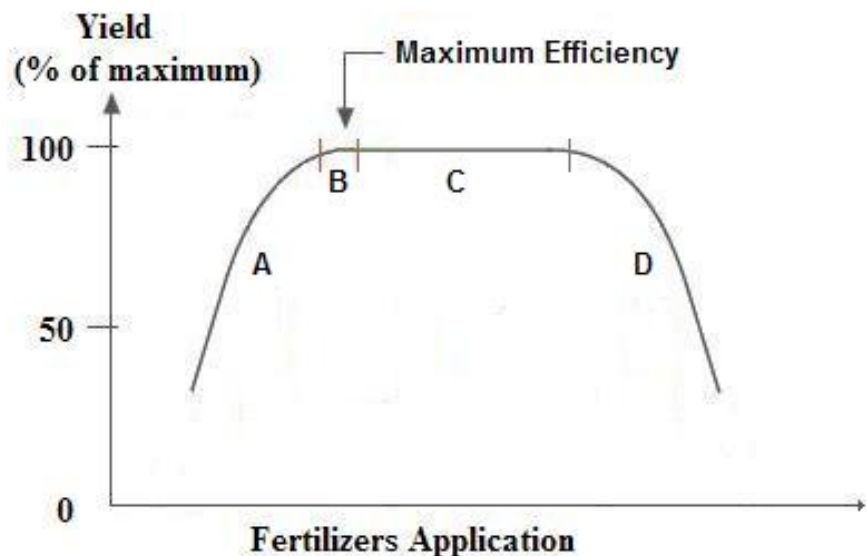


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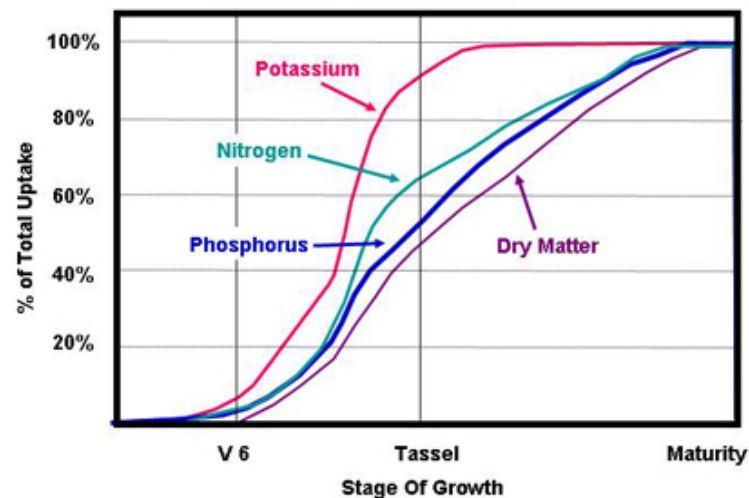
- **Maximum Agronomic rate**

Expected yield vs Agronomic Rate

Crop Response To Fertilizers Application



Corn Nutrient Uptake And Dry Matter Accumulation





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Waste Management

What's in the waste
being land applied?

TABLE 36.1

Mineral Elements Required by Plants

ELEMENT	ABSORBED FORM	MAJOR FUNCTIONS
MACRONUTRIENTS		
Nitrogen (N)	NO_3^- and NH_4^+	In proteins, nucleic acids, etc.
Phosphorus (P)	H_2PO_4^- and HPO_4^{2-}	In nucleic acids, ATP, phospholipids, etc.
Potassium (K)	K^+	Enzyme activation; water balance; ion balance; stomatal opening
Sulfur (S)	SO_4^{2-}	In proteins and coenzymes
Calcium (Ca)	Ca^{2+}	Affects the cytoskeleton, membranes, and many enzymes; second messenger
Magnesium (Mg)	Mg^{2+}	In chlorophyll; required by many enzymes; stabilizes ribosomes
MICRONUTRIENTS		
Iron (Fe)	Fe^{2+} and Fe^{3+}	In active site of many redox enzymes and electron carriers; chlorophyll synthesis
Chlorine (Cl)	Cl^-	Photosynthesis; ion balance
Manganese (Mn)	Mn^{2+}	Activation of many enzymes
Boron (B)	$\text{B}(\text{OH})_3$	Possibly carbohydrate transport (poorly understood)
Zinc (Zn)	Zn^{2+}	Enzyme activation; auxin synthesis
Copper (Cu)	Cu^{2+}	In active site of many redox enzymes and electron carriers
Nickel (Ni)	Ni^{2+}	Activation of one enzyme
Molybdenum (Mo)	MoO_4^{2-}	Nitrate reduction

LIFE 8e, Table 36.1

LIFE: THE SCIENCE OF BIOLOGY, Eighth Edition © 2007 Sinauer Associates, Inc. and W. H. Freeman & Co.

Table 2. Physicochemical parameters and metal concentration obtained for the water of three sources and point after discharge of industrial wastewaters into the Curupê River

Parameters	NS1	NS2	NS3	IR1
pH	5.30	5.40	6.10	2.60
T / °C	27.80	27.55	28.00	29.80
EC / ($\mu\text{s cm}^{-1}$)	17.9	15.2	40.3	2195.0
TDS / (mg L^{-1})	8.8	7.8	20.1	1091.0
SALT / (mg L^{-1})	0.00	0.00	0.00	1.22
TRB (NTU)	2	2	1	14
TSS / (mg L^{-1})	2	5	4	18
COLOR / (Pt L^{-1})	13	1	1	84
$\text{NO}_3\text{-N}$ / (mg L^{-1})	0.085	0.070	0.055	0.015
$\text{NO}_2\text{-N}$ / (mg L^{-1})	0.007	0.008	0.006	0.014
$\text{NH}_4\text{-N}$ / (mg L^{-1})	0.255	0.160	0.100	1.740
PO_4 / (mg L^{-1})	0.175	0.080	0.050	0.220
SO_4 / (mg L^{-1})	4.0	1.0	8.0	1900.0
S / (mg L^{-1})	0.003	0.002	0.001	0.014
Al / (mg L^{-1})	0.338	0.225	0.029	2.742
Ba / (mg L^{-1})	0.015	0.031	0.015	0.064
Cd / (mg L^{-1})	0.004	0.001	0.020	0.001
Co / (mg L^{-1})	0.001	0.001	0.001	0.001
Cr / (mg L^{-1})	0.001	0.001	0.001	0.001
Cu / (mg L^{-1})	0.001	0.001	0.001	0.001
Fe / (mg L^{-1})	0.341	0.158	0.337	10.687
Mn / (mg L^{-1})	0.002	0.002	0.002	0.343
Ni / (mg L^{-1})	0.012	0.001	0.001	0.001
Pb / (mg L^{-1})	0.025	0.002	0.001	0.001
V / (mg L^{-1})	0.002	0.002	0.002	0.002
Zn / (mg L^{-1})	0.005	0.014	0.005	0.398



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		Ac/in	Ac/in	Ac/in	Ac/in
Field #	Crop Grown	OSU Recommended Irrigation Amount	Amount of wastewater applied	Amount of supplemental water applied	Total Irrigation amounts applied
Reason for exceeding recommended irrigation amounts:					
ie: ET; moisture monitoring showing the need for additional amounts					



DEQ

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		lbs/A	lbs/A	lbs/A	lbs/A	lbs/A	Tons/A	Tons/A
Field #	Crop Grown	Agronomic Rate of Crop	Plant Available Nitrogen remaining in soil profile based on soil test	Amount of Nitrogen applied from wastewater	Amount of supplemental nitrogen applied	Total Nitrogen amounts	Expected Yield	Actual Yield
Reason for exceeding recommended nitrogen amounts:								
ie: Increased expected yield, CP showing removal, Petiole sampling showing the need								



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Annual Reports

- Analysis based on amount generated (metric tons per year). Samples pulled from sludge prior to land application.
- Results: ppm dry weight vs. lbs./ac
 - Nutrients: Total Kjeldahl Nitrogen (TKN), ammonia, nitrate & nitrite, Phosphorus (P), Potassium (K)
- Loading calculations, OSU WSO spreadsheet (typically you'd average the analysis results)



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Certification Statements

- Who signs these statements and how do they know?
- 40 CFR Part 503.14
- 40 CFR Part 503.32 Class B Alt 1 or Alt 2;
503.32(b) 5 site restrictions
- 40 CFR Part 503.33(b)1 or?
- Agronomic Loadings



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Land Application

- New sites and neighbor notifications, do you need a LUCS?
- Land application site access regress are there problems?
- Track out? Loading and offloading areas, spillage and ponding? Are your truck clean leaving the site? Are all the hoses and pipe openings capped with cam locks?
- Have things changed at an approved site? New neighbors? Different farming practices? Call before you go out...
- Land application during rain events and holidays.



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Contract Haulers

- What tanks are acceptable for hauling biosolids? What other materials could be hauled in the tanks? (farmer's truck , trucking company City owned truck)
- Open tanks with a tarp vs. closed self-contain tanks.
- What permits and licenses are required?
- Does the hauler have a permit or are they operating under your permit. Your biosolids your liability...



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Site logs

- Site map with table and clear delineation where biosolids were land applied (to scale readable).
- Does the log contain date, time, location, amount, and who spread?
- Are the all setbacks on the site map?