REDUCING RUNOFF VOLUME AND CONCENTRATIONS OF PHOSPHOROUS AND ATRAZINE WITH GYPSUM AMENDMENT

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Erosion/Runoff Control with Structures

The Problem

- Phosphorus (P) is one of the more problematic plant nutrients causing offsite eutrophication which upsets ecosystem balance in downstream areas.
- Atrazine is a pre-emergent herbicide used to control annual broad leaf weeds in corn, sorghum, sugarcane, and other crops, and is among the most widely used herbicides in the US.
- It is considered highly toxic and has an MCL of 3 ppb for drinking water.

Runoff Causing Soil Erosion and Removal of Chemicals

Rainwater is Natural Distilled and Low in Electrolytes

Both Physical and Chemical Processes Occur at the Time Scale of Raindrop Impact

Other Considerations

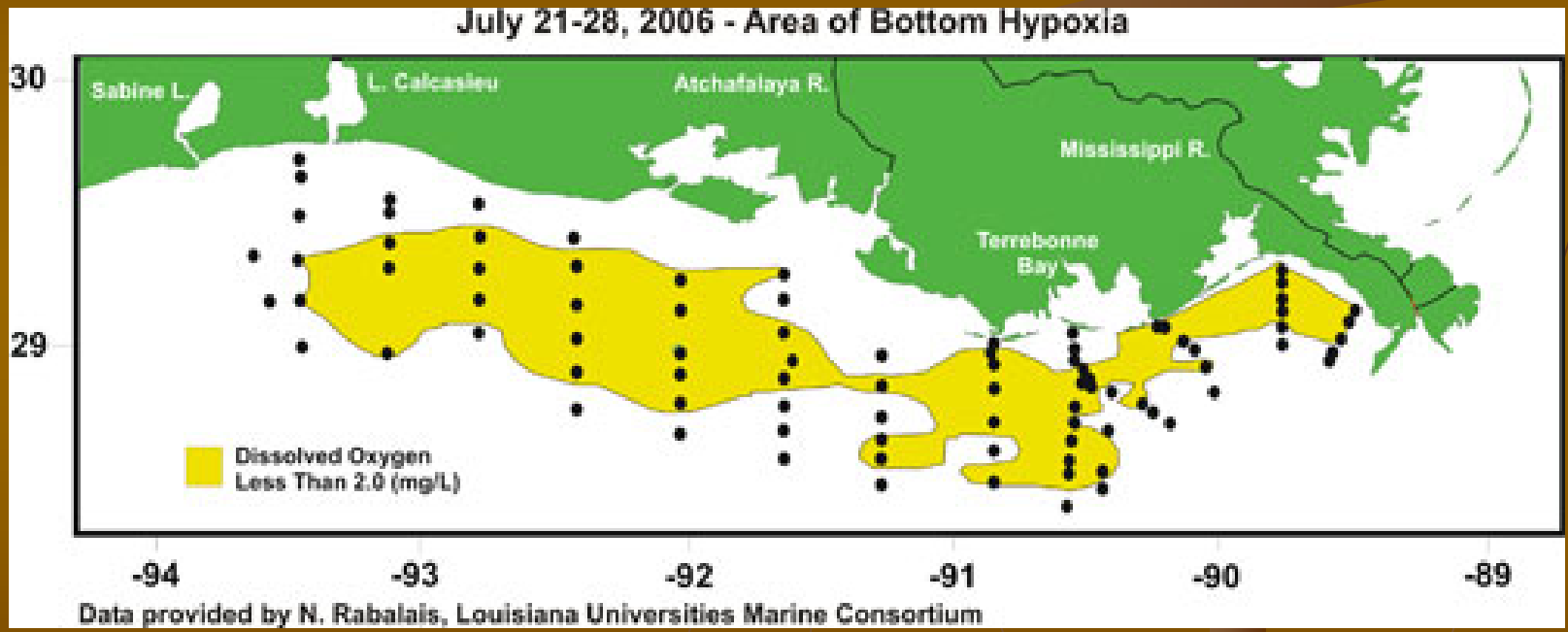
- No-tillage has been promoted as the preferred environmentally friendly method for soil and water conservation by the USDA-NRCS and other organizations.
- The development of glyphosate resistant crops has greatly increased the popularity of no-tillage in the US and other countries.
- Glyphosate is much less toxic than atrazine and has an MCL of 700 ppb in drinking waters.

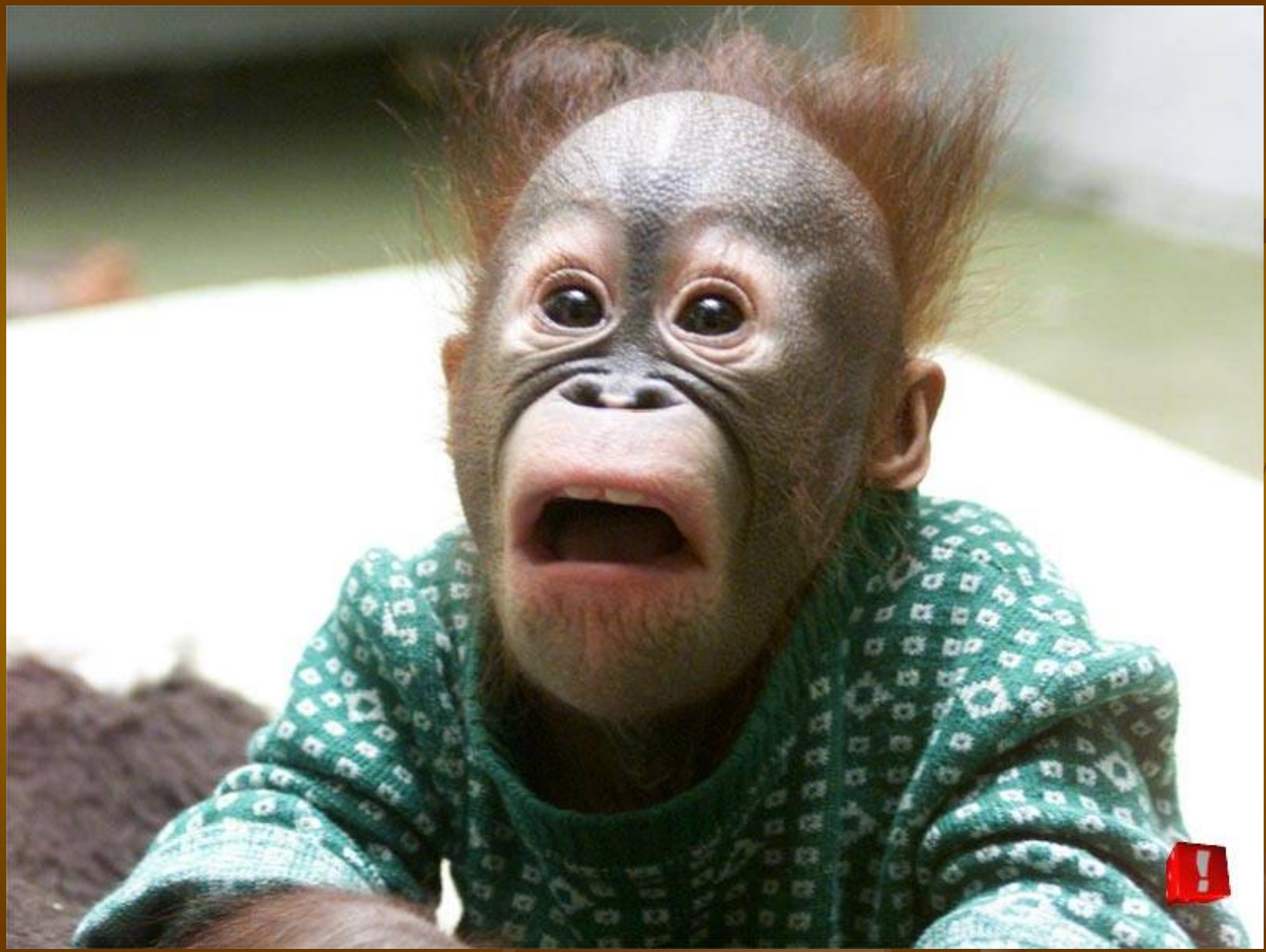
No-tillage Leaves Residue to Protect from Erosion but all Chemicals are Surface Applied

Other Considerations

- In No-tillage systems all the chemicals are surface applied in soluble forms and susceptible to transport to water bodies.
- The hypoxia zone which is increasing is just one example of nutrient runoff being a problem.
- Atrazine is still found in levels greater than the MCL in drinking waters of many major cities.

July 2006 Hypoxia Zone in the Gulf of Mexico





Other Considerations

- Water quality concerns and no-tillage has been shown to have considerable losses of pesticides even though runoff volume was significantly reduced because of the increased concentrations in runoff water
- In order to make US agriculture more sustainable with respect to environmental concerns of the public new approaches to reducing both nutrient and pesticide loadings to surface waters must be found.

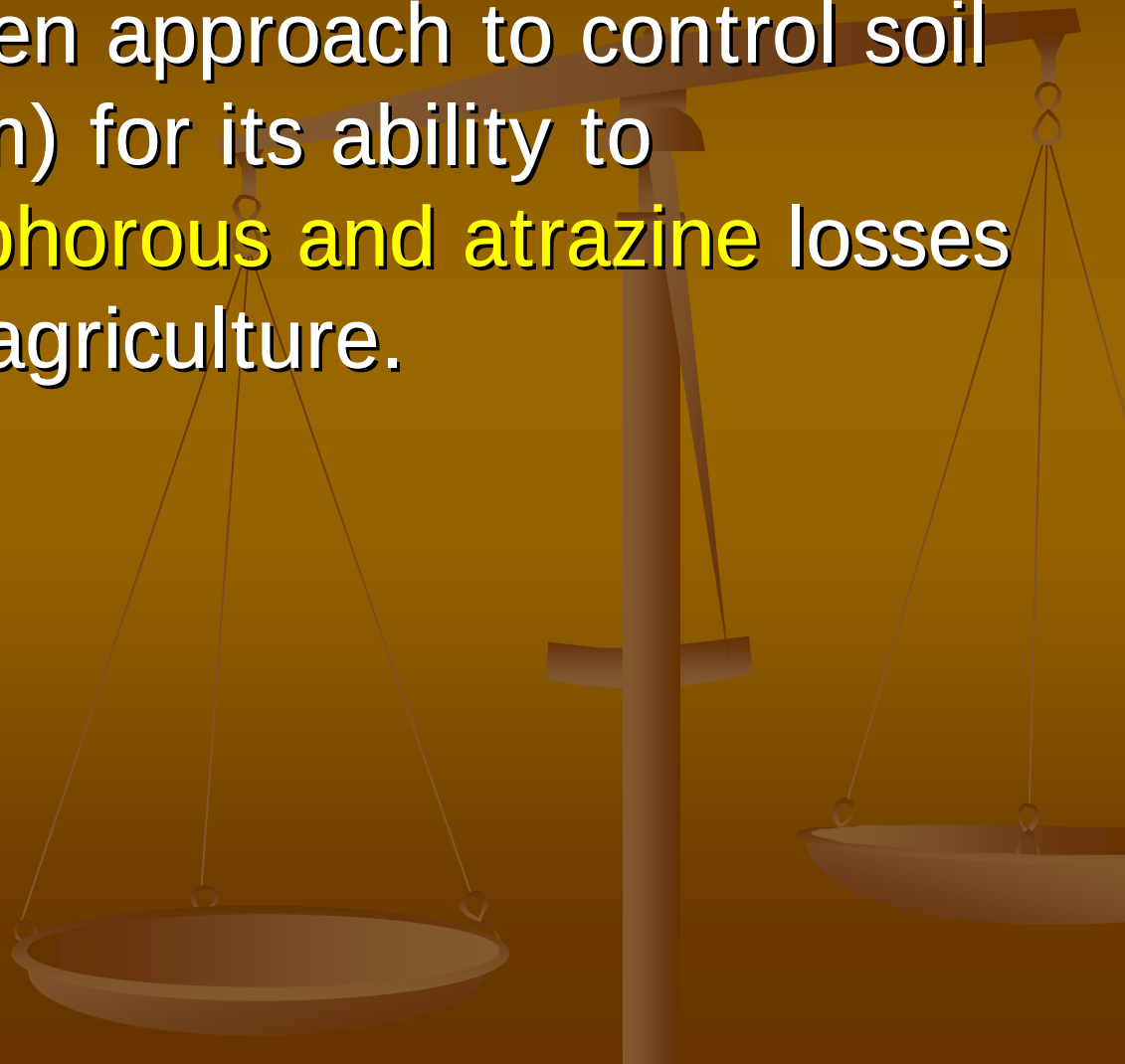
Other Considerations

- Soil amendments including gypsum and gypsum like materials have been shown to have the potential to reduce erosion by improving infiltration and reducing surface runoff even in no-tillage.
- Surface application of gypsum reduced runoff and erosion but also the concentrations of soluble reactive P (SRP) in runoff from high soil test P fields.

Synthetic Gypsum as Soil Amendment

Objective

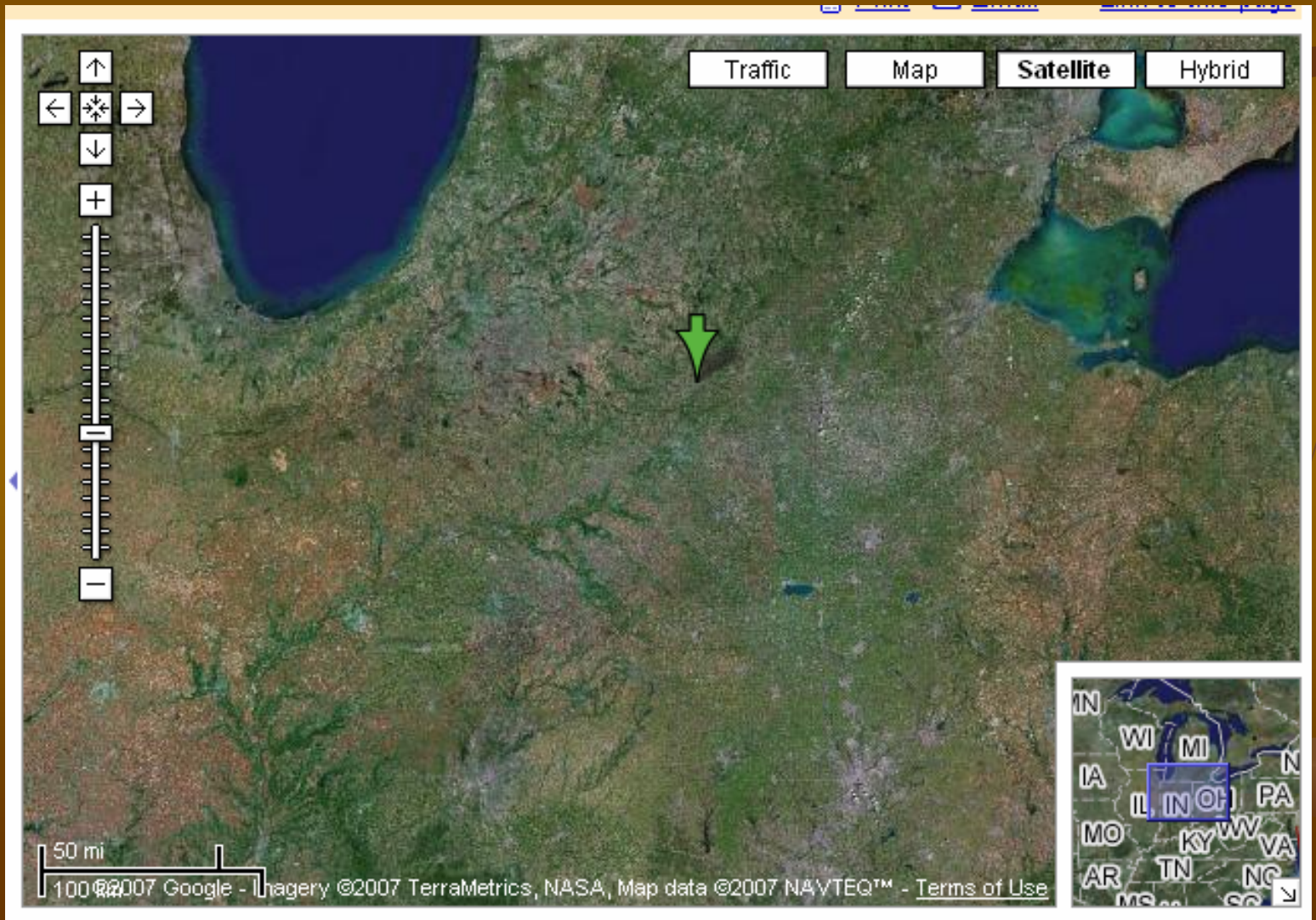
- Evaluate a proven approach to control soil erosion (gypsum) for its ability to attenuate phosphorous and atrazine losses from no-tillage agriculture.



MATERIALS AND METHODS

- Rainfall simulations studies of different management systems.
- The site was located in DeKalb County, IN near the village of Waterloo.
- Treatments included:
- conventional tilled (CT) or no-tillage control (NC)
- to: precision tillage (PT),
- no-tillage with 1MT/ha surface applied recycled wall-board gypsum (GP),
- 1 MT/ha surface applied dry poultry manure (M),
- 1MT/ha GP plus 1MT/ha (MG) using rainfall simulation.

Location of Study Area



Precision Tillage or Strip Tillage

MATERIALS AND METHODS

- Fertilizer and pesticide additions were the same across all plots.
- These included a fall spray application of 1kg/ha glyphosate (Gly)
- followed by spring spray application of 1kg/ha ATz and 1kg/ha Gly.
- The GP was recycled wall board gypsum (~70% $CaSO_4$ x $2H_20$) from a manufactured housing recycled waste wall-board facility in Bremen, IN.

MATERIALS AND METHODS

- The poultry litter was from a broiler operation and consisted of dried bottom droppings.
- The GP and manure was surface applied by broadcast dry immediate before the rainfall experiment by broadcast.
- Blount soil (fine-loamy, mixed, mesic Typic Hapludalf) that had been in long-term no-tillage agriculture for over 20 years.

Rainfall Simulation

- Constant intensity with a target rate of 50 mm/hr.
- de-ionized water applied with a programmable simulator equipped with 80-100 Vee-jet nozzles.
- Actual rainfall amount was measured with gauges.
- Soil loss and runoff samples were collected at 5-minute intervals following initiation of runoff until four samples of steady state runoff were collected.
- Soil and water loss was measured gravimetrically from a 1-liter sediment sample taken and runoff rate was calculated.

Deionized Water to Simulate Rainwater Quality

Portable Rainfall Simulator to Apply Constant Rainfall

Runoff Collected to Measure Sediment, Nutrients and Pesticides

Laboratory Analyses

- Nutrients were measured colorimetrically using a Kone-Lab auto-analyzer for soluble reactive P (SRP), ammonia nitrogen (AN) and nitrate nitrogen (NN).
- A separate sample including sediment was digested and N and P measured by the Kone-Lab for total Kjeldahl nitrogen (TKN) and total phosphorous (TP).

Laboratory Analyses

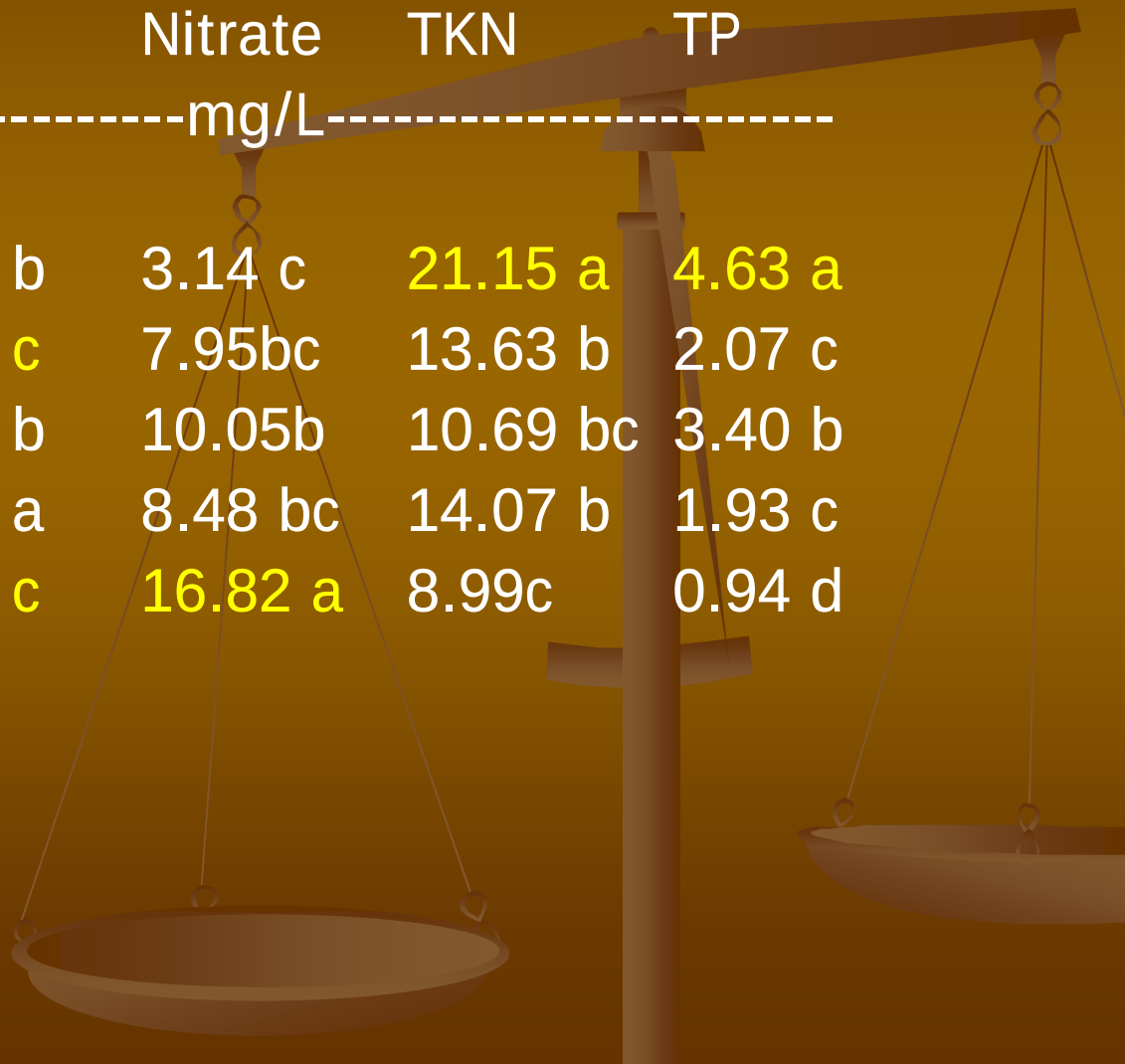
- Atrazine was measured on a filtered sample by solid phase micro-extraction and gas chromotography
- Glyphosate was measure by HPLC.
- Steady state mean differences were subjected to Tukey's Studentized Range Test at P=0.05.

Erosion Data

Treatment	Sed Conc g/L	Soil loss g/m2/min	Runoff g/s
2005			
CT	6.79 a	6.00 a	88.13 ab
PT	5.23 a	5.62 ab	103.67 a
MG	9.03 b	3.19 bc	89.32 ab
NM	2.83 b	2.37 c	78.57 b
NG	2.09 b	2.20 c	108.45 a
2006			
NC	3.07 c	2.30 c	74.86 b
PT	7.78 b	5.94 b	76.50 b
MG	4.76 bc	3.50 c	76.90 b
NM	11.07 a	8.85 a	79.02 ab
NG	3.28 c	2.89 c	89.88 a

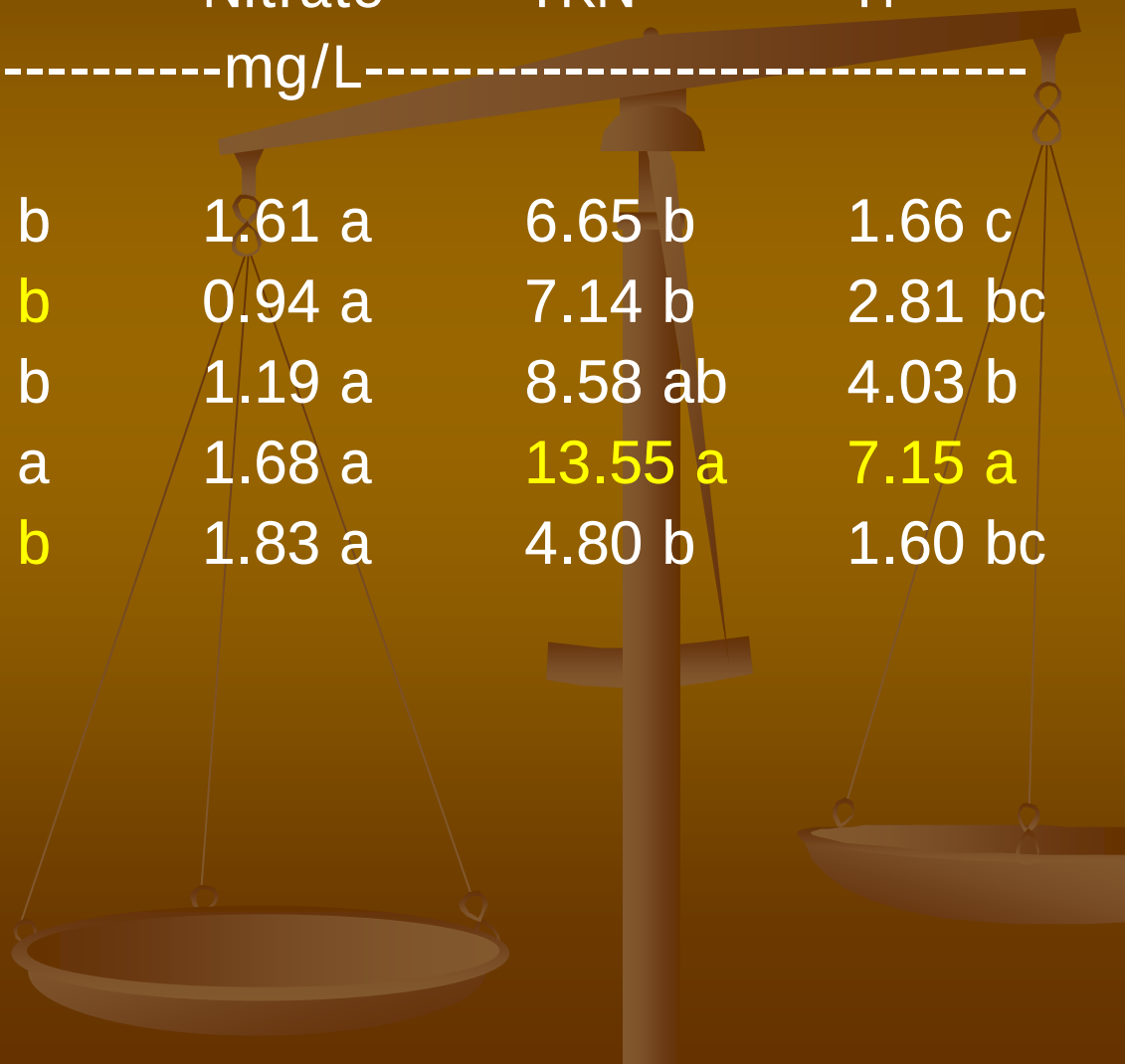
Nutrient Data 2005

TRT	NH_3	SRP	Nitrate	TKN	TP
	----------mg/L----------				
CT	1.03 a	0.49 b	3.14 c	21.15 a	4.63 a
PT	1.21 a	0.12 c	7.95bc	13.63 b	2.07 c
MG	2.11 a	0.76 b	10.05b	10.69 bc	3.40 b
NM	1.22 a	1.13 a	8.48 bc	14.07 b	1.93 c
NG	1.84 a	0.05 c	16.82 a	8.99c	0.94 d



Nutrient Data 2006

TRT	NH_3	SRP	Nitrate	TKN	TP
	----------	----------	mg/L	----------	----------
NC	0.19 bc	0.21 b	1.61 a	6.65 b	1.66 c
PT	0.14 c	0.07 b	0.94 a	7.14 b	2.81 bc
MG	0.67 ab	0.56 b	1.19 a	8.58 ab	4.03 b
NM	0.70 a	1.17 a	1.68 a	13.55 a	7.15 a
NG	0.15 c	0.08 b	1.83 a	4.80 b	1.60 bc



Pesticide Data

Treatment	Glyphosate		Atrazine	
2005	ppb		ppb	
CT	69.3	a	30.2	a
PT	17.0	b	10.4	c
MG	12.1	b	12.6	bc
NM	10.0	b	27.6	ab
NG	13.5	b	14.9	abc
2006				
NC	08.7	ab	27.7	a
PT	08.2	ab	22.8	a
MG	07.0	b	15.9	a
NM	15.2	a	16.5	a
NG	06.2	b	21.8	a

Conclusions

- Steady state concentrations and do not represent total loadings from the various treatments.
- These results do represent a directly comparison to the MCL for components.
- Atrazine is a risk of movement in all management systems.
- Gypsum application reduced SRP but not pesticides.
- Glyphosate in runoff does not appear to approach the MCL even in the most extreme scenario.

Questions