Phosphorus Availability from Swine and Dairy Slurries

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Issues

- Concerned about surface water quality
  - P losses causing eutrophication
- Manure management becoming P based
- Liquid manure injection is a BMP
  - Shown to create a unique chemical environment for N, what about P?

Manure P availability

- Relatively little known compared to N
- 50 – 80 % of Pt is credited from manure
  - 35 – 90 % of Pt is Pi
  - Same availability coefficient/index for all species
- Past research has shown P to be less, equally, or more available than fertilizer P

Objectives

- Evaluate the relative availability of manure P compared to fertilizer P
- Determine if differences in P availability exist between manure from different species
- Determine if previous manure applications impact the P availability of subsequent manure or fertilizer applications

Materials & Methods

- 2 incubation studies
  - Minnesota – swine slurry, soils with & without manure histories
  - Michigan – swine & dairy slurries, soils without manure histories

Minnesota Soils

Soil ID	Soil Map Unit	Manure History	Bray P	Olsen P
PB1	Port Byron	-	34	24
PB2	Port Byron	Dairy + Swine	98	57
Wa1	Waukegan	-	26	19
Wa2	Waukegan	Swine	162	126
Sa1	Sanburn	-	35	20
Sa2	Sanburn	Beef	53	25
Vd1	Verndale	-	16	8
Vd2	Verndale	Turkey	67	41
Ni1	Nicollet	-	32	26
Ni2	Nicollet	Dairy + Swine	64	49
Ni3	Nicollet	Dairy + Swine	152	114
Vs1	Ves	-	3	3
Vs2	Ves	Beef + Swine	50	44
Ba1	Barnes	-	18	17
Ba2	Barnes	Dairy	138	97

Michigan Soils

Soil ID	Soil Map Unit	Manure History	Bray P	Olsen P
Co1	Colwood	-	15	14
Co2	Colwood	-	8	12
Pr	Parkhill	-	4	7
Os	Oshtemo	-	11	12
Sk	Spinks	-	14	14

Manures

Manure	Moisture	Pt (P_2O_5)	Pi	Nt	K_2O
	%	---------- Lb/1000 gal ----------			
MINNESOTA					
Swine	95.1	9.95 (22.8)	-	42.3	24.9
MICHIGAN					
Dairy	95.3	4.42 (10.1)	3.5	27.3	22.4
Swine	94.8	10.5 (23.9)	9.2	54.6	38.3

Incubation – Minnesota

- Swine slurry or KH_2PO_4 (fertilizer) applied at 0, 144, or 288 ppm Pt
  - 3,600 and 7,200 gal/a injected rate
  - 3 replications
- Soil remained “loose” in bag
- Incubated for 9 months at 77 °F
  - Sampled at 1, 2, 3, 6, & 9 mo.
- Moisture maintained at 70 – 90 % of field capacity

Incubation – Michigan

- Swine slurry, dairy slurry or fertilizer applied at 0 or 100 ppm Pt (117 ppm for swine)
  - Dairy – 5,600 gal/a injected rate
  - Swine – 2,800 gal/a injected rate
  - 2 replications
- Soil packed to bulk density of 1.2 g/cm^3
- Incubated for 6 weeks at 72 °F
- Moisture maintained at 70 – 85 % of field capacity

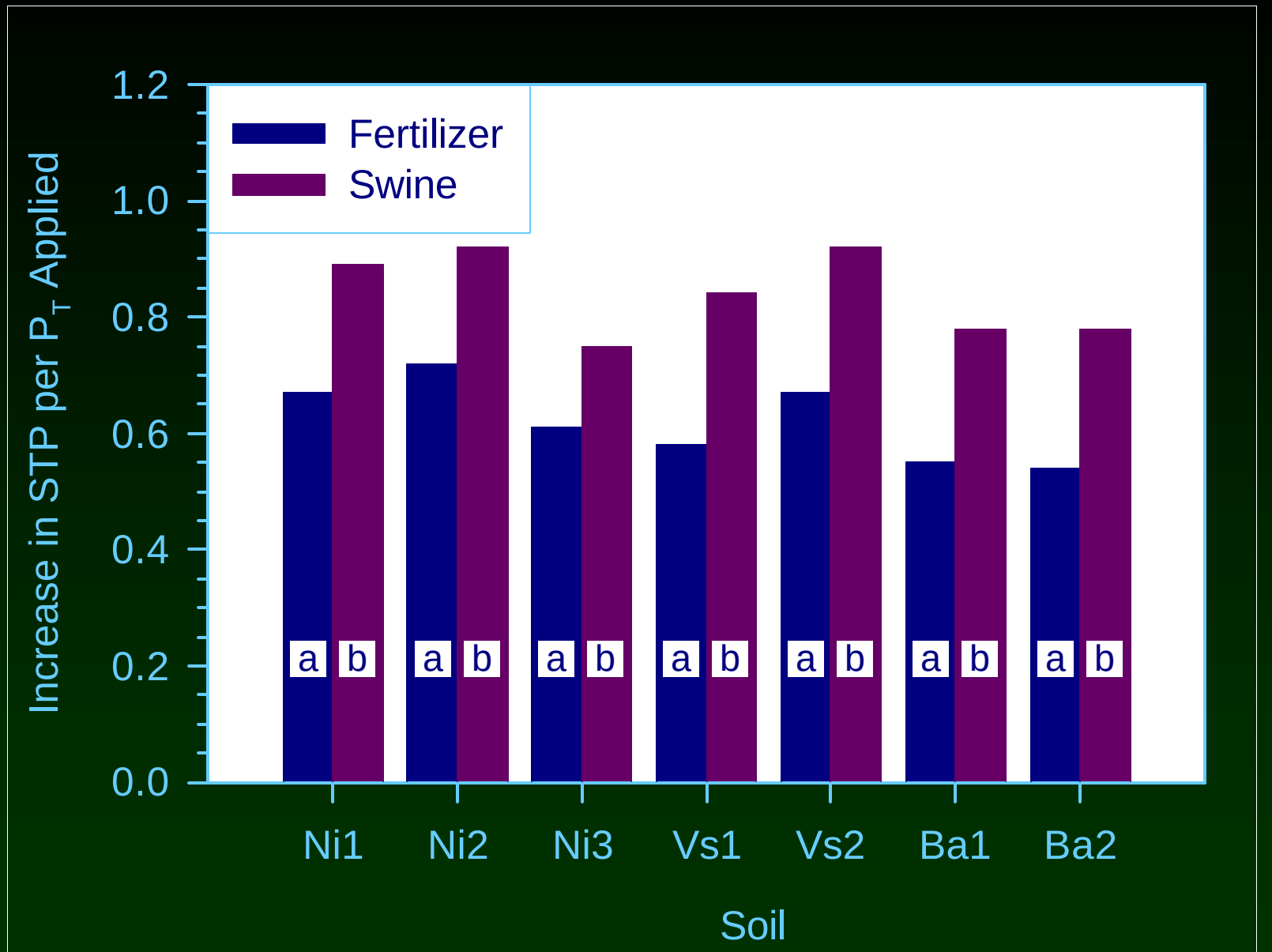
Data Analysis

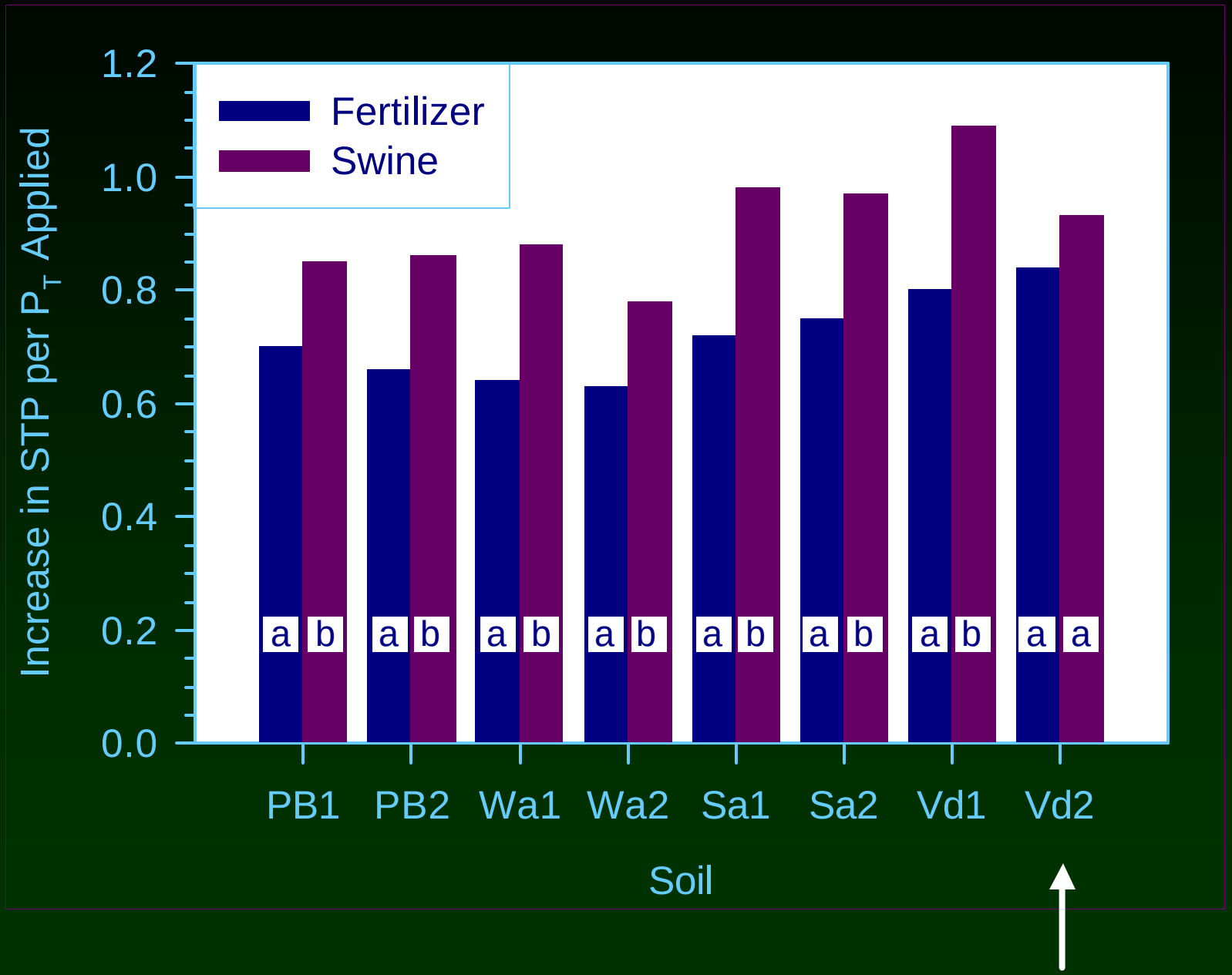
- Bray P measured at the end of each incubation period

- Bray P in the control (0 P applied) subtracted from other samples
  - P mineralization
  - $\underline{\text{Increase in STP}}$

    P applied

Results – Minnesota


Fertilizer
Swine
Increase in STP per P_T Applied
1.2
1.0
0.8
0.6
0.4
0.2
0.0
a
b
Ni1
Ni2
Ni3
Vs1
Vs2
Ba1
Ba2
Soil

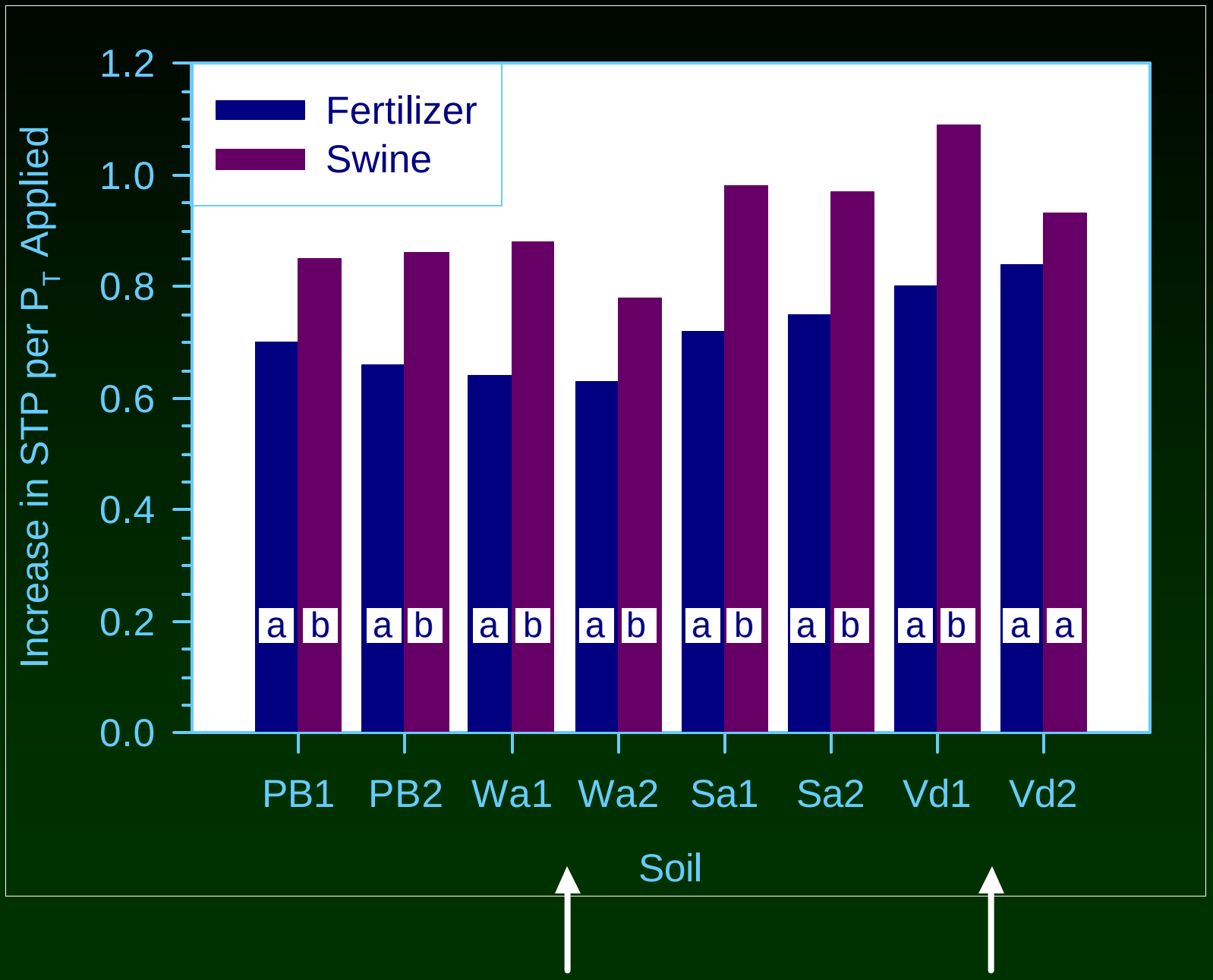

Fertilizer
Swine
Increase in STP per P_T Applied
1.2
1.0
0.8
0.6
0.4
0.2
0.0
a b
a b
a b
a b
a b
a b
a b
a a
PB1
PB2
Wa1
Wa2
Sa1
Sa2
Vd1
Vd2
Soil

Summary - Minnesota

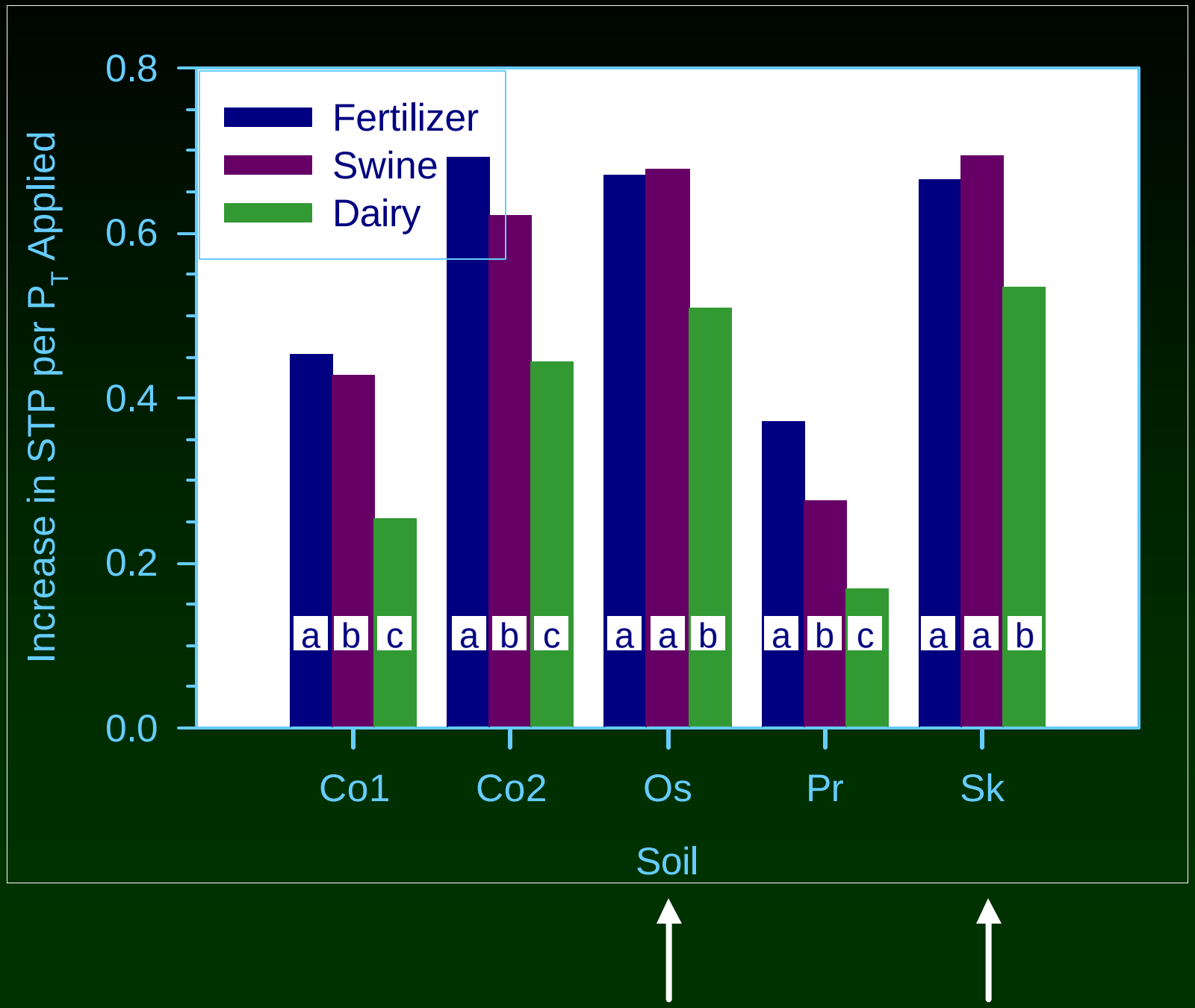
- Manure P increased STP more than fertilizer for 14 of 15 soils
  - Based on Pt applied
  - Same relationship at 1 and 9 months

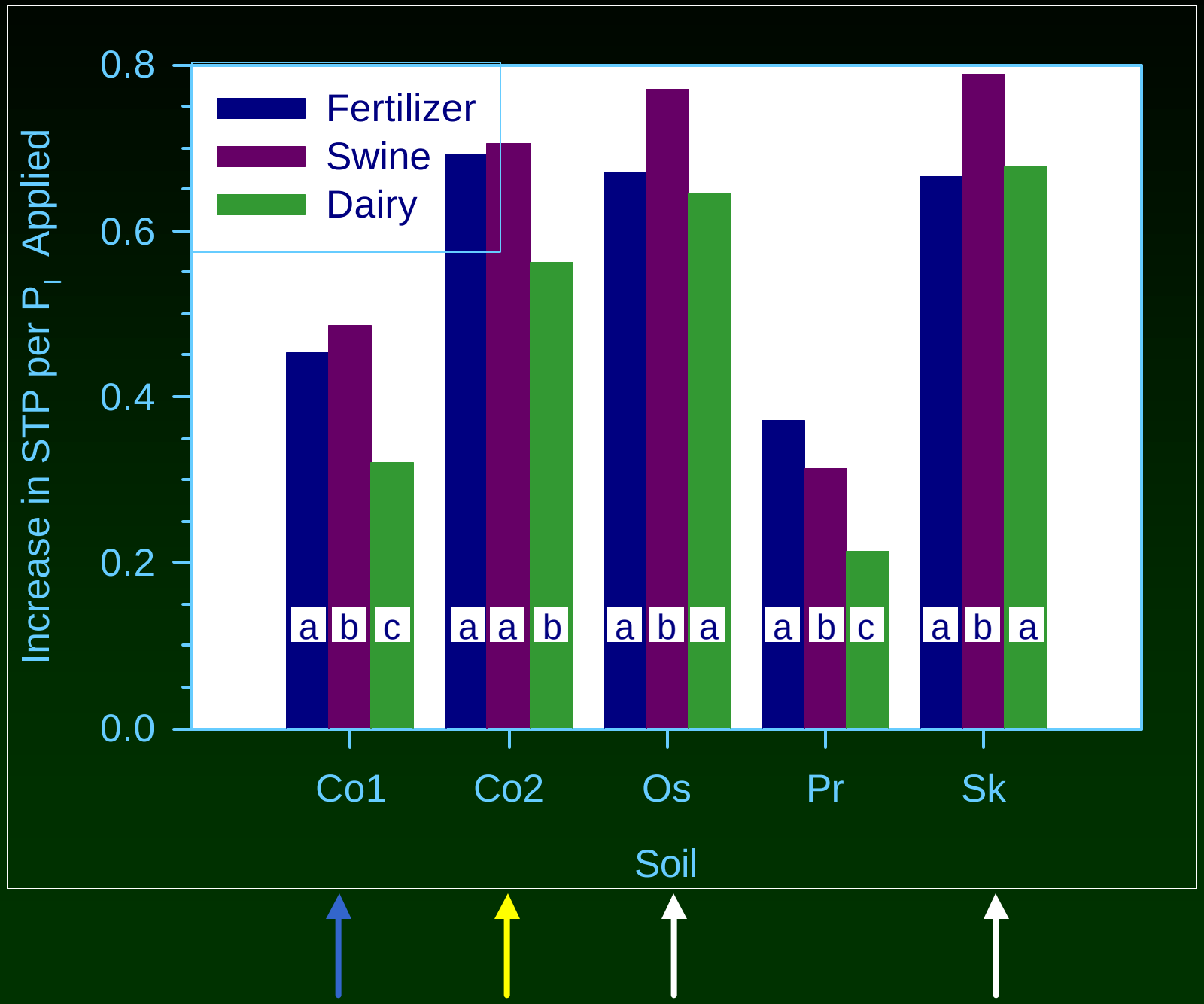
Summary - Minnesota

- Manure history effect
  - Does manure increase STP as much on a soil that was previously manured compared to unmanured?
- ~ 50% of the soils no difference
  - PB, Sa, Ni2/Ni1, & Ba
- When difference did occur
  - 75% (Wa, Vd, Ni3/Ni1) manure was not a effective at increasing STP when the soil had been previously manured


Fertilizer
Swine
Increase in STP per P_T Applied
1.2
1.0
0.8
0.6
0.4
0.2
0.0
a b
a b
a b
a b
a b
a b
a b
a a
PB1
PB2
Wa1
Wa2
Sa1
Sa2
Vd1
Vd2
Soil

Results – Michigan


0.8
0.6
0.4
0.2
0.0
Increase in STP per P_T Applied
Fertilizer
Swine
Dairy
a b c
a b c
a a b
a b c
a a b
Co1
Co2
Os
Pr
Sk
Soil


0.8
0.6
0.4
0.2
0.0
Increase in STP per P_I Applied
Fertilizer
Swine
Dairy
a b c
a a b
a b a
a b c
a b a
Co1
Co2
Os
Pr
Sk
Soil

Summary – Michigan

- On a Pt applied basis:
  - Dairy manure did not increase STP as much as fertilizer or swine manure
  - On 2 of 5 soils (sandy), swine manure increased STP as much as fertilizer
  - On 3 of 5 soils, swine manure did not increase STP as much as fertilizer

Summary – Michigan

- On a Pi applied basis:
  - Dairy manure did not increase STP as much as fertilizer or swine manure
  - On 3 of 5 soils, swine manure increased STP > fertilizer
  - On 1 of 5 soils, swine manure increased STP = fertilizer
  - On 1 of 5 soils, swine manure increased STP < fertilizer

Summary – Overall

- Differences in the ability of manure to increase STP is likely because of the composition of manure
  - Pi % of Pt
  - Amount and forms of Po
  - Amount and types of organic acids
- Suggests inherent differences in manure between monogastrics and ruminants
  - Animal physiology
  - Feeding strategies

Summary – Overall

- Cavets
  - High rates of P applied
    - Manure injection band
  - Closed container
  - Constant temperature and relatively constant moisture
- May not be exactly what happens in the field

Conclusions

- Swine manure increased STP >, =, and < fertilizer
- Dairy manure increased STP < fertilizer
- Past manure applications may change the way the soil responds to future manure applications

Conclusions

- Data suggest P availability coefficients for various manure sources should be developed
  - Better guidance on taking manure P credits
- Manure injection may create bands of high P availability
  - Need field studies