Using the new lime recommendations in Wisconsin

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History of lime recs. in WI

- 1963 Keeney & Corey 1st evaluated SMP & Woodruff buffers
  - SMP vs. LR (r = 0.949)
  - Woodruff vs. LR (r=0.818)
  - ΔpH x OM vs. LR (r=0.884)
- Concluded SMP is the best predictor, BUT
  - ΔpH x OM will work without adding a test
  - LR (T/a) = 1.6 x ΔpH x %OM
    - Included field liming factor of 2

Justification

- In 1998 lime recs., SMP buffer pH does not contribute much to lime requirement (LR)
  - SMP contributes < 10% of LR
    - SMP is the single best predictor of LR but does not strongly influence LR
  - Soil pH and OM most influential
  - Questioned about significance of SMP

- Example: Target pH = 6.8 OM = 3.5
  soil pH = 6.2 buffer pH = 6.4

LR=2.0*[1.64*(6.8-pH)*(OM-0.07)-0.046*(SMP)]

LR = 6.2 T/a
LR w/o SMP = 6.8 T/a

Justification

- 1998 equations produce large unnecessary lime recs. in some situations

- Example:
  - Target pH = 6.8
  - OM = 7.0%
  - SMP buffer pH = 6.7
  - soil pH = 5.9
  - Lime rec. = 20 T/a

Justification

- SMP buffer contains hazardous materials
  - Paranitrophenol
  - Chromium
- SMP is a health risk for lab workers
- SMP buffer requires hazardous waste disposal

WI buffer and LR revision goals

- Evaluate buffers as alternatives to SMP
- Develop the simplest equation that will produce the best lime recommendations in Wisconsin

Soils were collected from around the state

ID	Soil Name	Soil	OM	Sand	Clay
		pH 1:1	%	%	%
1	Loyal	4.9	3.7	14	18
2	Roscommon	5.6	9.1	52	15
3	Plainfield	5.5	0.9	86	8
4	Plainfield	5.5	0.8	72	8
5	Loyal	5.0	3.8	16	20
6	Plainfield	5.0	0.8	86	10
7	Plainfield	5.4	0.9	90	8
8	Withee	4.4	3.2	12	19
9	Marshfield	4.6	3.8	10	23
10	Vesper	4.9	3.6	18	17
11	Fayette	5.5	2.7	4	15
12	Rietbrock	5.2	3	28	17

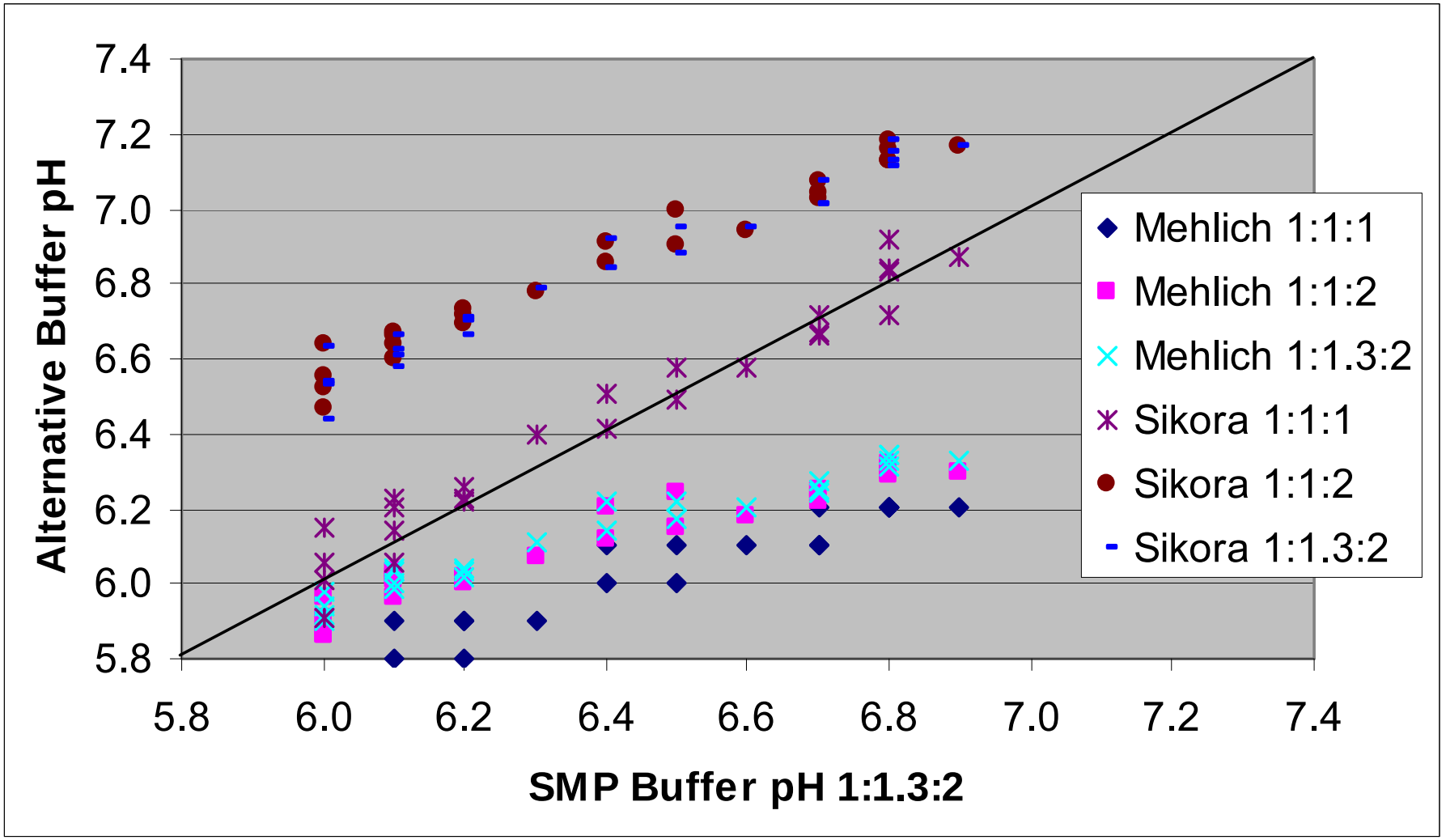
ID	Soil Name	Soil	OM	Sand	Clay
		pH 1:1	%	%	%
14	Pence	5.1	1.2	80	9
15	Silt loam	4.9	2.6	7	14
16	Freeon	5.0	2.8	51	10
17	Pence	5.0	3.6	67	8
18	Plainfield	5.4	1.9	75	6
19	Wyocena	5.1	1.2	67	10
20	Elburn	6.0	2.2	9	22
21	Plano	4.6	3.1	1	26
23	Freeon	6.1	6.8	9	10
24	Ontonagon	5.2	5.7	33	24
25	Santiago	5.6	3.3	17	12
26	Goodman	5.4	7	23	12

Incubation to determine lime requirement

1. 5 to 10 rates of reagent grade $CaCO_3$ added to each soil (3x)
2. Soil and $CaCO_3$ were thoroughly mixed
3. Water added
4. Soil pH measured at end of 3-month incubation
   - Both 1:1 and 1:1.3

Results

SMP 1:1.3:2 vs. Alternative Buffers



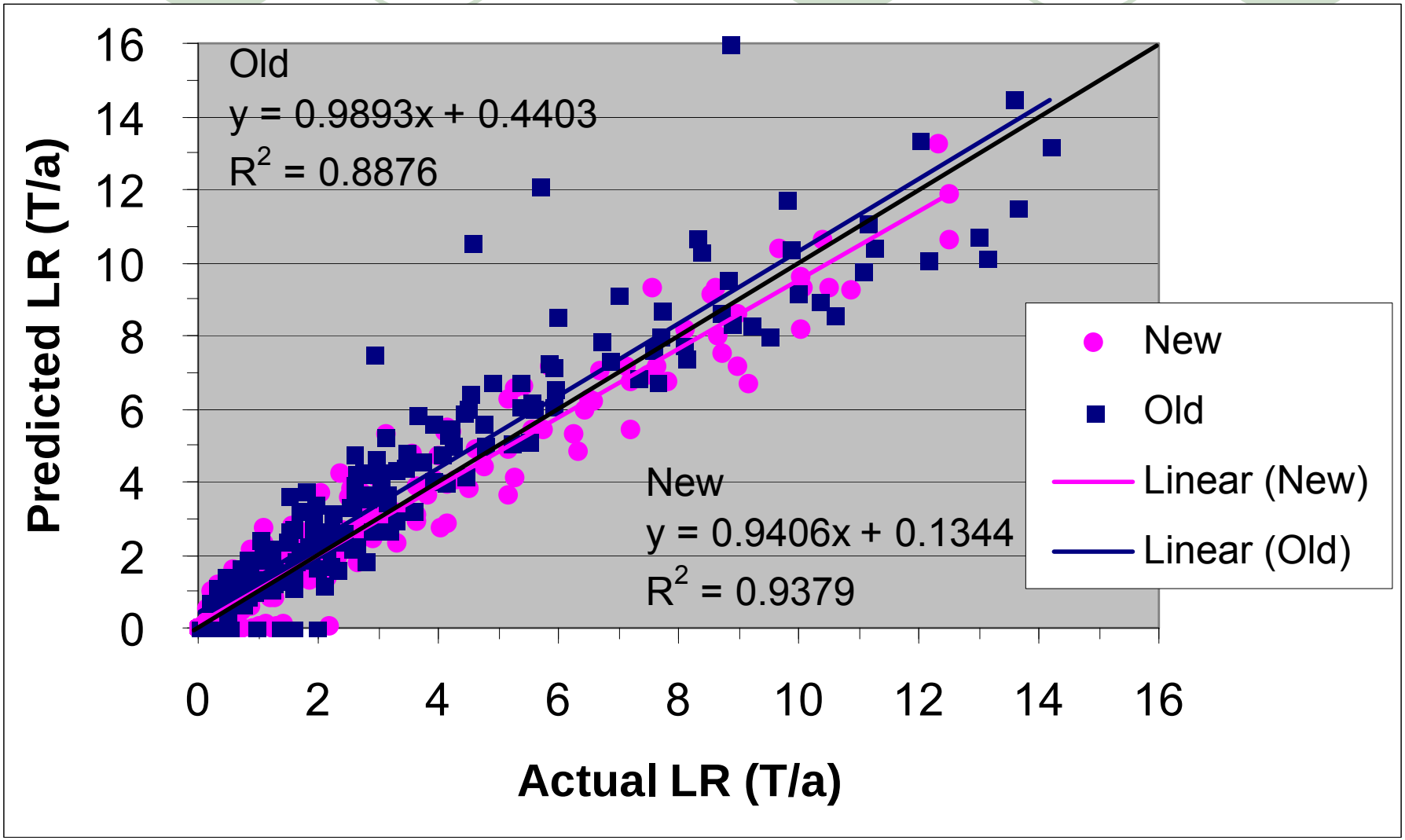
Choosing a buffer method

- Mehlich and Sikora buffers are well correlated to LR
- Mehlich had a short shelf life, ~4 week
  - Remove from further consideration

Which factors were used in the model

- First term will be Sikora 1:1:1
  - Most often single best predictor of LR
  - Sikora 1:1:1 closest to 1:1 correlation with SMP 1:1.3:2 & 1:1:2
  - Uses less buffer & costs less than 1:1:2
- Second term will be pH
  - Most often second best term to add to model
  - Already measured, thus no additional cost
- R^2 ranged from 0.737 to 0.901 at target pH 5.2 to 6.8

Actual vs Predicted Lime Requirement

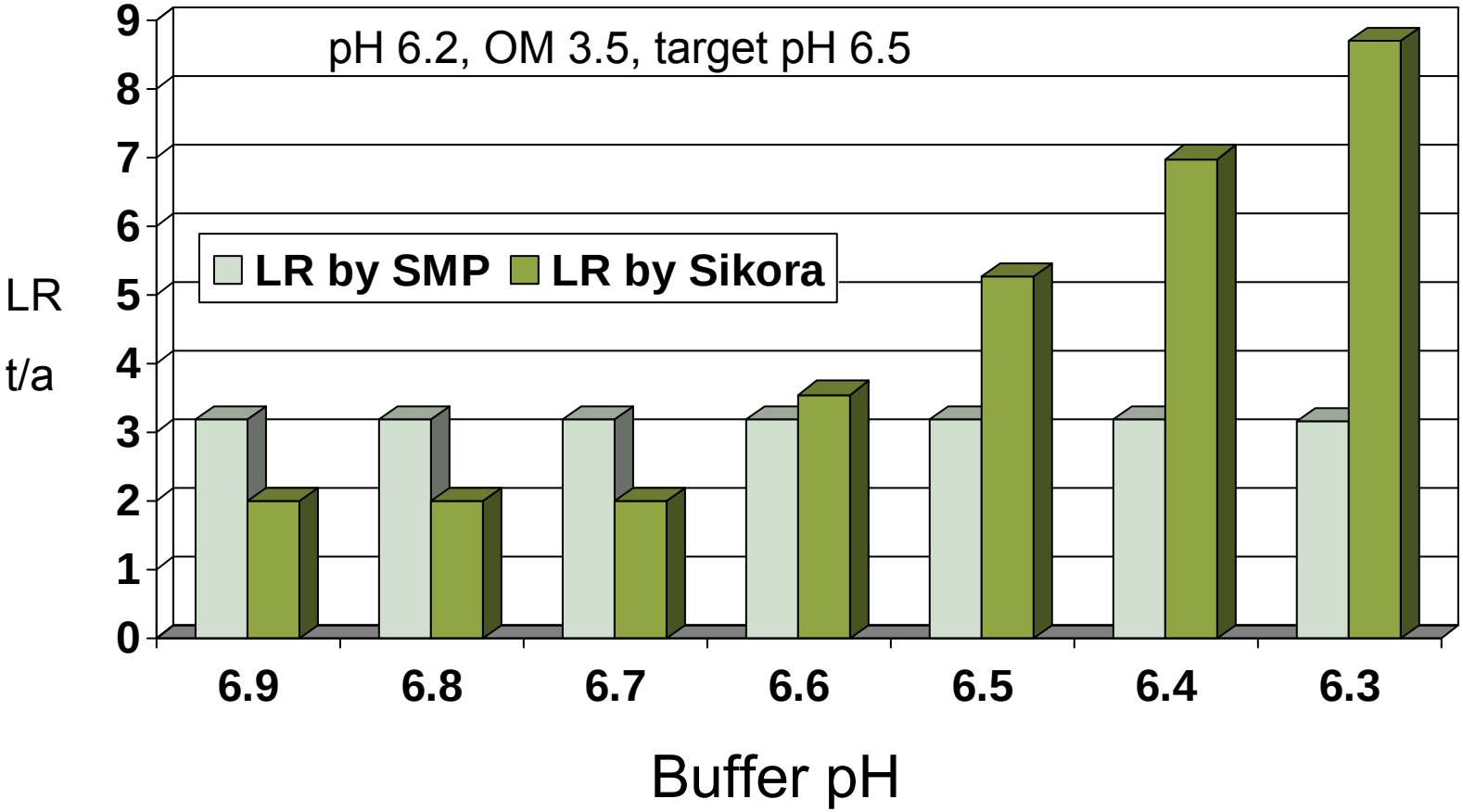


New Lime Recommendation Equations

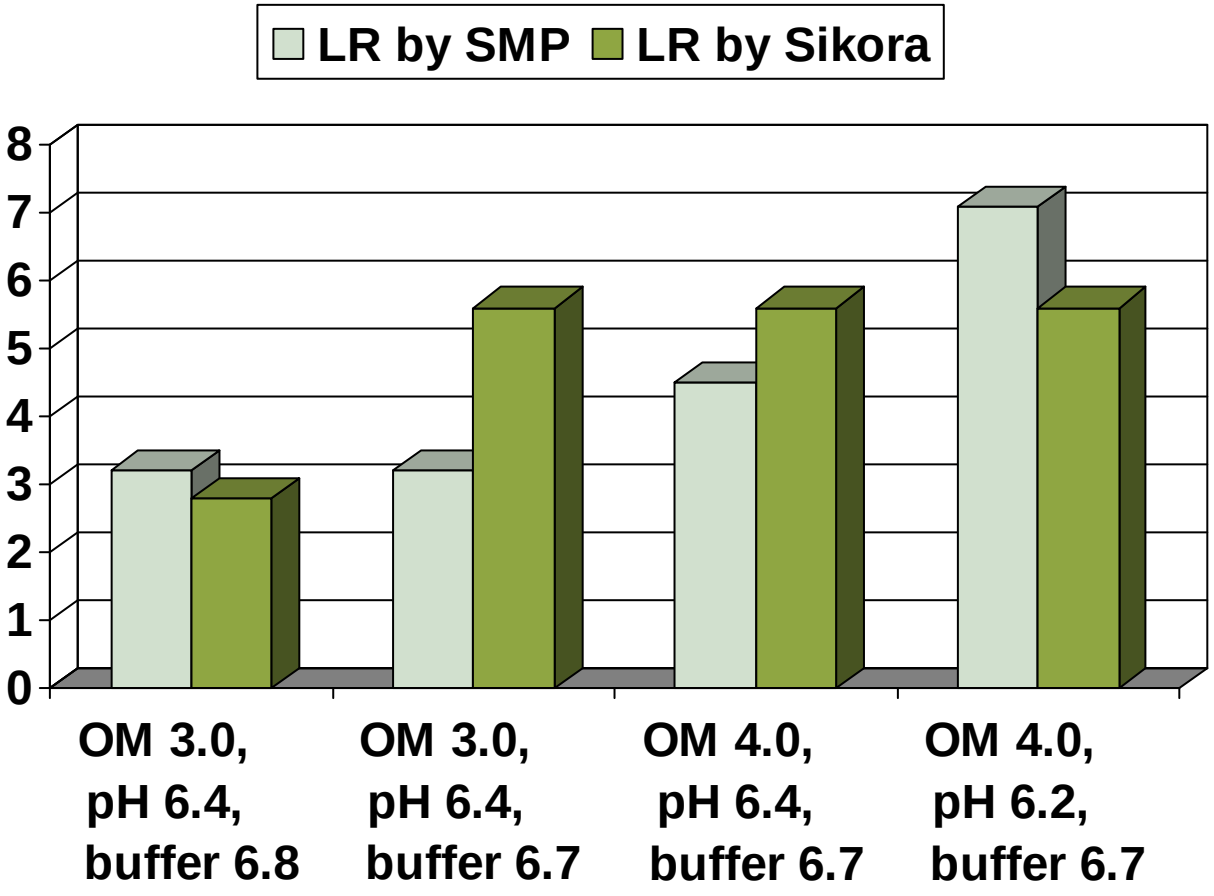
Target pH	Lime recommendation equation
	T/a of 60-69 lime to apply
5.2	36.1 – (3.29 x BpH) – (2.67 x pH)
5.4	48.2 – (4.84 x BpH) – (3.03 x pH)
5.6	51.0 – (5.40 x BpH) – (2.67 x pH)
5.8	57.2 – (5.55 x BpH) – (3.50 x pH)
6.0	72. 7 – (7.59 x BpH) – (3.78 x pH)
6.3	103 – (12. 6 x BpH) – (3.18 x pH)
6.5	134 – (17.2 x BpH) – (2.73 x pH)
6.6	152 – (20. 3 x BpH) – (2.17 x pH)
6.8	195 – (28.4 x BpH) + (0.144 x pH)

Includes field mixing factor of 2.15; BpH = Sikora 1:1:1

Calculated LR using SMP and Sikora



SMP vs Sikora – Impact of OM, water pH and buffer pH



Target pH = 6.8

Comparing buffer pH values for SMP and Sikora

Comparison of SMP 1:1.3:2 and Sikora 1:1:1 buffer pH

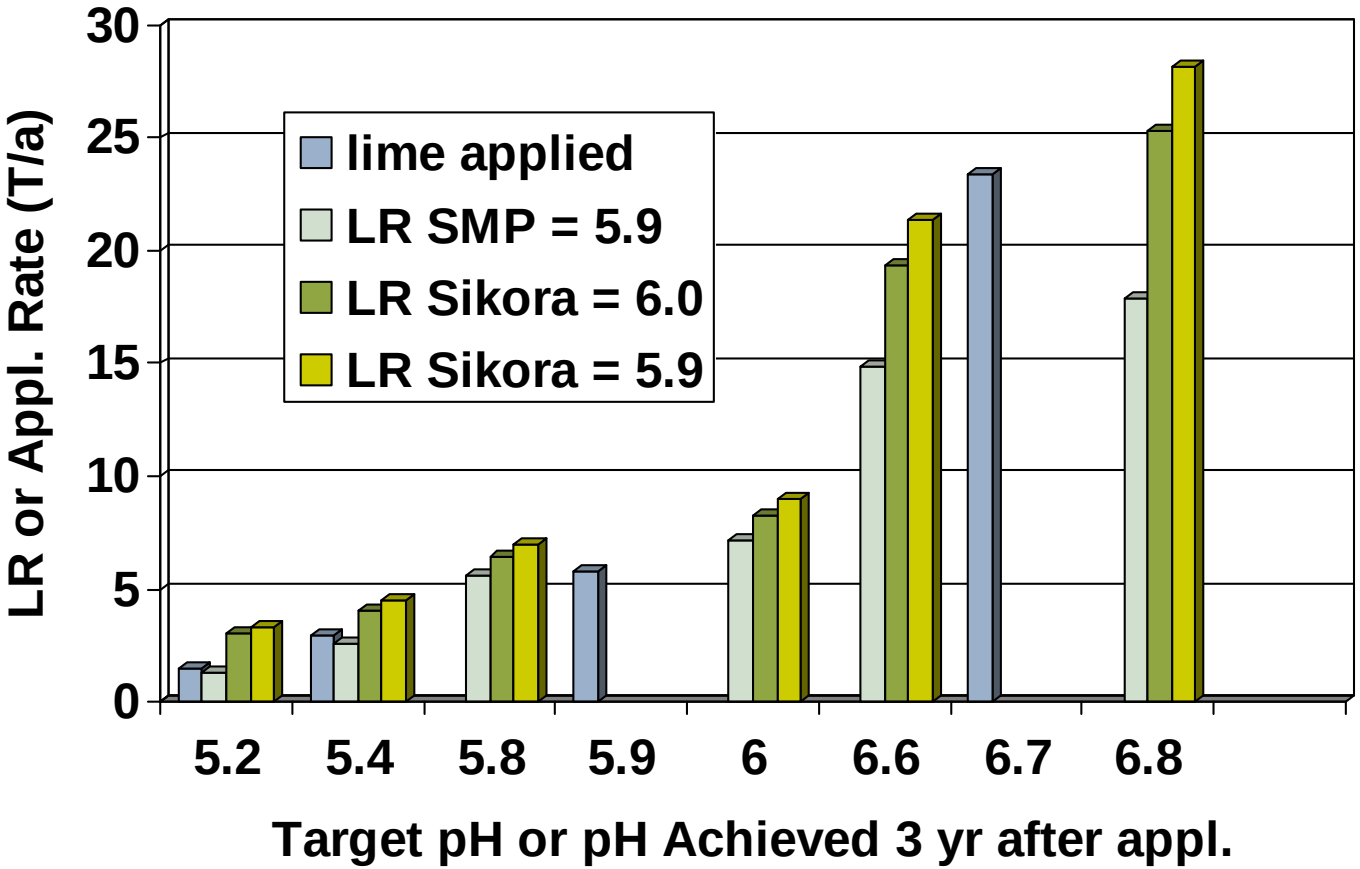
	SMP 1:1.3:2	Sikora 1:1:1	SMP – Sikora †
Sample	Mean ± Std dev	Mean ± Std dev	Difference
	Buffer pH		
1	6.46 ± 0.05	6.46 ± 0.11	0.00 NS
2	6.68 ± 0.08	6.66 ± 0.05	0.02 NS
3	6.74 ± 0.09	6.86 ± 0.05	-0.12
4	6.78 ± 0.08	6.86 ± 0.06	-0.08 NS
5	6.96 ± 0.05	7.00 ± 0.10	-0.04 NS

† 95 % confidence level

5 measurements were made for each buffer pH method for each sample

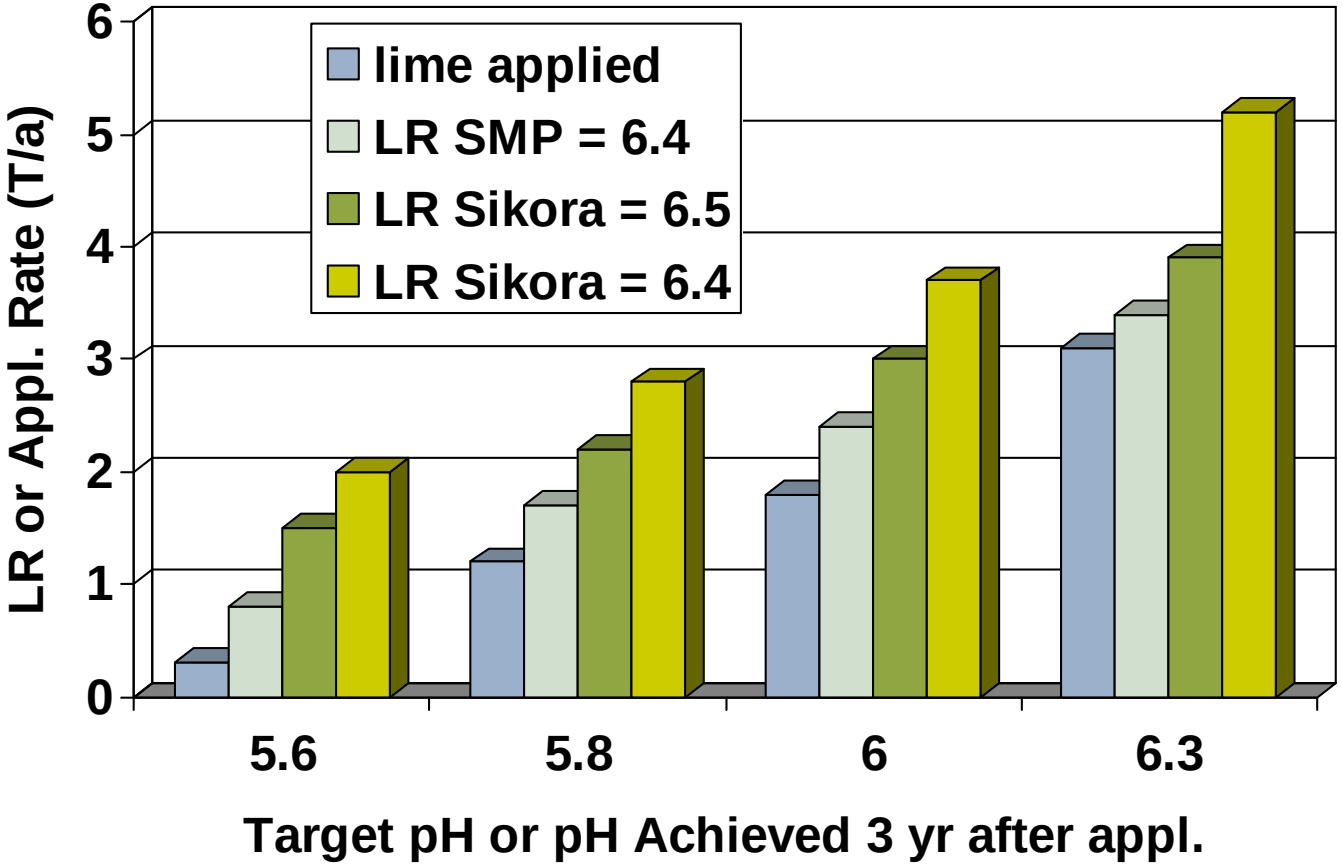
How do new LR compare to field results?

Actual vs. calculated LR – Withee sil



Soil pH = 5.0 SMP pH = 5.9 OM = 3.2

Actual vs. calculated LR – Plainfield sand



Soil pH = 5.4 SMP pH = 6.4 OM = 1.5

Adjustments made since introduction

- If soil pH is >0.2 pH units below the target for the rotation, a lime requirement is given. If the calculated value is very small, a 2 T/a recommendation is given for soil groups A-D, and O and 1 T/a for coarse-textured (Group E) soils.

- If more than 50% of the samples for one field have a 0 LR, no LR is given for the field. Comment given – “Some parts of field may benefit from liming. See unadjusted LR values”

- If 50% or more have a LR, the calculated LR is given along with comment – “Parts of this field may not benefit from liming, see unadjusted LR values”

Further work

- Field validation
  - Check field scaling factor
    - Coarse-textured soils
    - Medium-textured soils
- Continuing to monitor lab results with Sikora
- Critical to have a good Sikora lab value