Residuals and Biosolids 2017

The Future of Biosolids and Bioenergy

USING LIME TO BENEFICIALLY MANAGE WASTEWATER TREATMENT PLANT RESIDUALS: A REVIEW AND ASSESSMENT OF THE PRACTICE FOR PRODUCING AN EXCEPTIONAL QUALITY PRODUCT

By

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This conference is presented by

Water Environment Federation the water quality people

NORTHWEST BIOSOLIDS

WHY LIME TO PREPARE EQ BIOSOLIDS?

Untreated Sludge   Calcium Oxide   Lime treated biosolids supporting grass growth

EQ PRODUCTS

	Commercial Fertilizer %	Revinu %
N	4.5	4.1
P	.38	.33
K	1.8	1.7
Ca	0.5	0.5
Mg	.37	.38
crude protein	28.1	25.4

Physical Properties:
pH..............................11.5-12.0
Percent Solids..................50-65%
Bulk Density....................40-50 lbs/cubic ft.

"Raleig h-Plus"

Calcium Supplement Fertilizer 0-0-0

Guaranteed Analysis:
Calcium.................................15%

Derived from: Calcium Oxide, Calcium Hydroxide, and Calcium Carbonate.

This product provides essential calcium for plant growth. ***RALEIGH-PLUS*** also reacts in soils to gradually improve soil, tilth, and structure.
RALEIGH-PLUS is produced by the City of Raleigh using a pasteurization process by stabilizing biosolids. Dewatered biosolids are blended with alkaline by-products such as limekiln dust to manufacture this product. This process produces "Class A Exceptional Quality" biosolids.

Where does lime come from?

- Limestone ($CaCO_3$) Heated to Temperatures in Excess of 1650°F
- Limestone + Heat -> Quicklime + CO_2
- $CaCO_3$ + Heat -> CaO + CO_2

How does Lime react with Sludge Cake?

- **Quicklime Reacts with Water in a strongly Exothermic Reaction, Heat is Generated, and Hydrated Lime is Produced**
- **Quicklime + H_2O -> Hydrated Lime + Heat**
- **$CaO + H_2O \rightarrow Ca(OH)_2$ + 27,500 BTU/lb mole**

Note: **1. Theoretical Temperatures in Excess of 575°F can be Generated & 2. The pH of a Saturated Lime Slurry is 12.4 @ 25°C.**

Illustration of Heat Released with Reaction

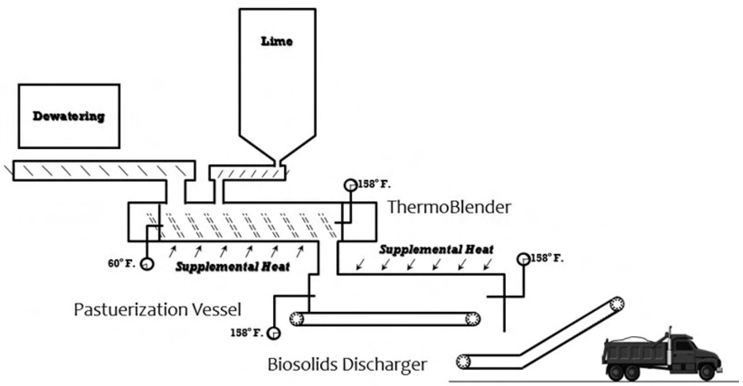
Presentation

- Relevant regulatory requirements
  - Pathogen Reduction
  - Vector Attraction Reduction
- Look at practices used by utilities to accomplish lime / alkaline treatment
- Discussion of what was learned from the assessment
- Experience(s) with Beneficial Use of the Biosolids

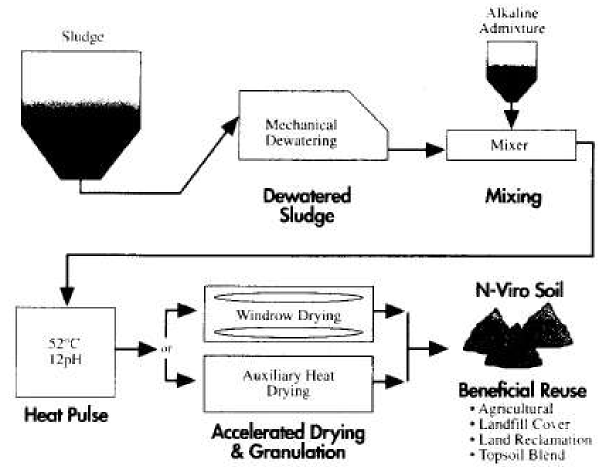
Relevant Regulatory Requirements (40CFR503)

- **Pathogen Reduction**
  - **Class A, Alternative 1, Time & Temperature, e.g. 70°C for 30 minutes**
  - **Class A, Alternative 2, pH > 12 for 72 hours with a 12-hour period where temperature > 52°C & air drying to a solids content > 50 %.**
  - **Class A, Alternative 6 PFRP Equivalent Process**
    - **N-Viro Energy Systems, Ltd.**
    - **Schwing Bioset**
- **Vector Attraction Reduction (VAR)**
  - **Add sufficient alkali to raise pH to ≥12 & maintain pH of ≥ 12 for 2 hours, and a pH of ≥ 11.5 for 22 more hours.**

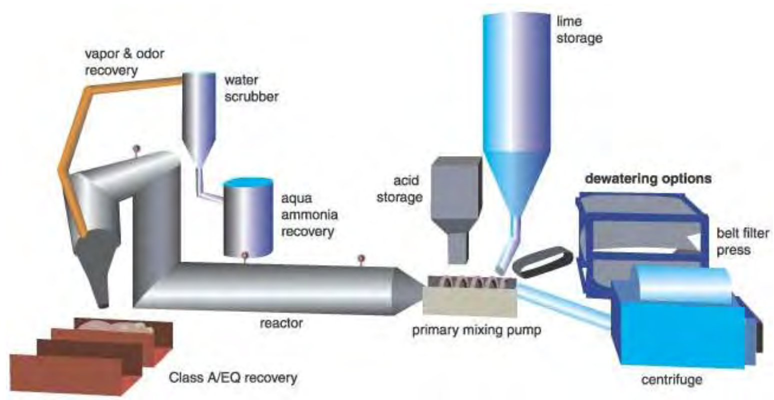
Proprietary Process Examples



RDP Evessel Pasteurization



N-Viro Energy Systems



Schwing Bioset Process

Facility Practices

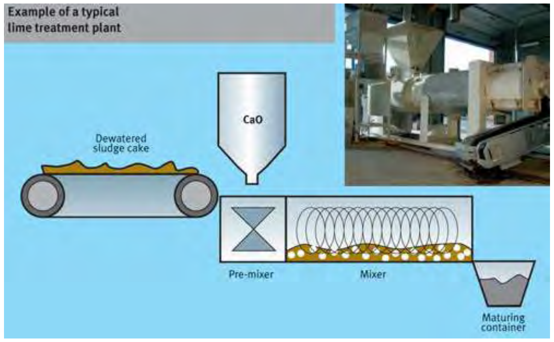
- Facility Size
- Sludge Dewatering
- Feed Conveyance
- Alkaline Additive
- Manner of Mixing
- Curing Practiced
- Storage
- Odor Control
- Beneficial Use

Observations made during Facility Tours/Inquiries

- **All were regulated at EQB**
- **Facilities regulated under Class A, Alternative 2 often used LKD, and sometimes CKD and flyash in various combinations.**
- **Facilities regulated as a PFRP or PFRP Equivalent used CaO**
- **Concerns/Issues**
  - **Coming together of alkaline material and sludge cake.**
  - **Mixing – method and time.**
  - **pH and <u>temperature</u> monitoring throughout and with time**
  - **Dust**
  - **Market**

Lime Addition

- How much lime was needed?
  - Needed for pH & temperature elevation
  - Varied with type of sludge & solids concentration
- Some Examples
  - To pasteurize & meet VAR: 13-20 % CaO on WWB
  - RDP-EVP Process: ~ 7 % CaO on WWB
  - Bioset Process: 9-18 % CaO on WWB
  - N-Viro (Alt 2) 12-20 % CaO on WWB
    - May add other materials, eg. CKD, LKD



Courtesy of British Lime

Additon, Mixing, & Reaction Processes

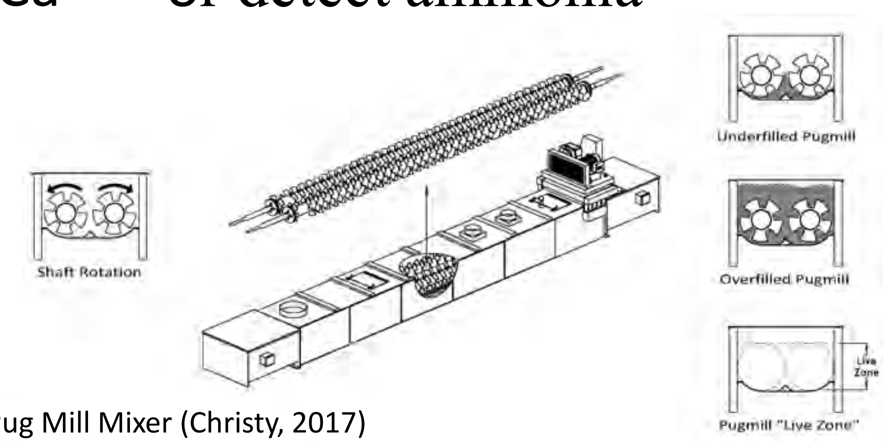
Sludge cake & alkaline material entering mixer and getting mixed.

Mixed materials getting conveyed to windrow pile.

Windrowed material continuing to react with temperature measurement.

Mixing!

- Heart of Process
- Short Reaction Time Between Quicklime and Cake Biosolid Necessitates Optimum (Small) Particle Size to Maximize Heat Rise
- Moisture is important, ideally 80 – 85 %.
- Need ≥60 seconds of mixing in live zone
- Operating speed ~ 30 rpm
- Measure Ca^{+2} or detect ammonia



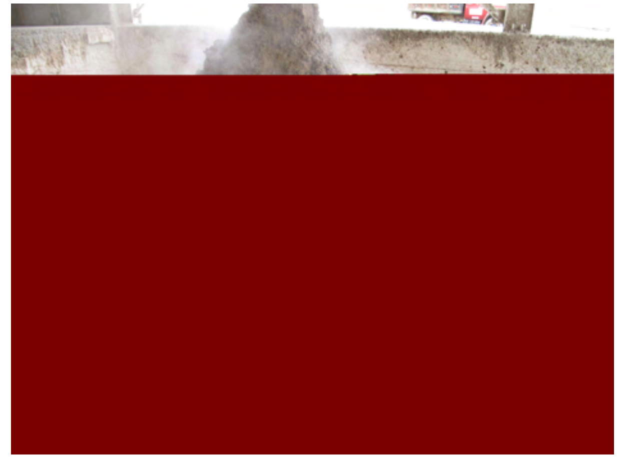
Dual Screw Pug Mill Mixer (Christy, 2017)

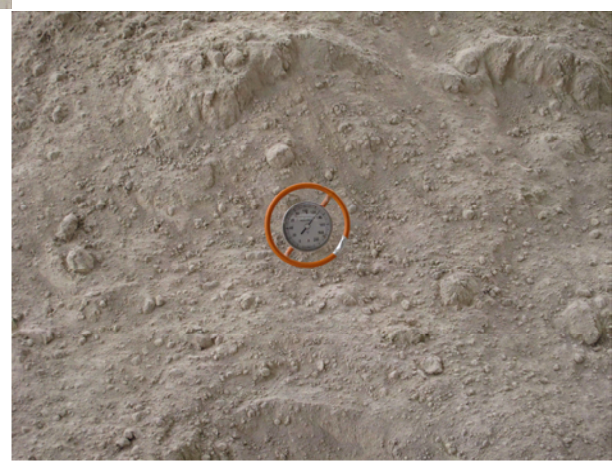
Idiosyncrasies of Alkaline pH Measurements

- Solubility of lime is inversely proportional to temperature
- At cold temperatures, meter reads a high pH, while at high temperatures, meter reads a low pH.
- So reading must either be made at 25^0C or corrected to 25^0C using the below formula

Correction factor = [0.03 pH units x ($T_{measured}$ – 25 ^{0}C)]/1.0^{0}C where T is in °C.
Actual pH = Measured pH + correction factor (factor can be + or -)

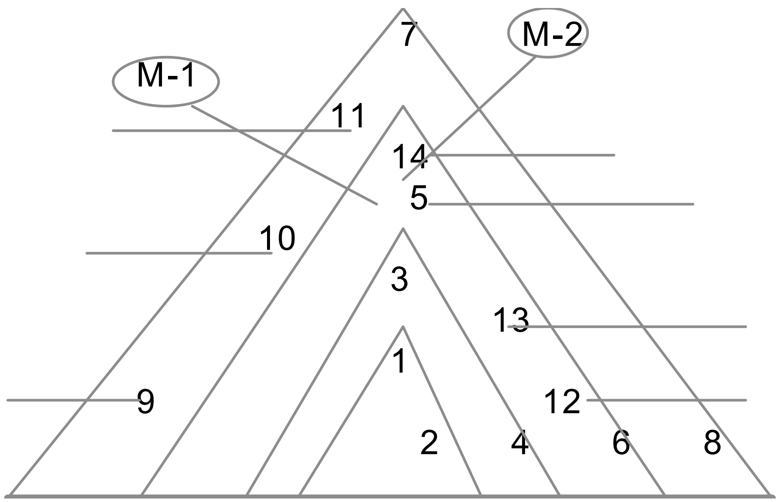
Meeting Temperature Requirements

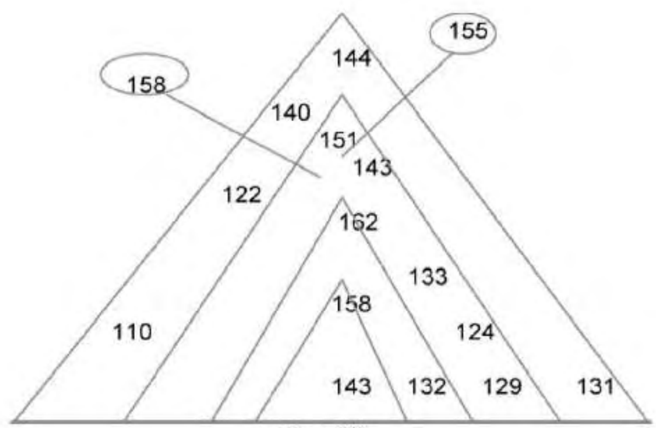




Case 1: ≥ 70°C for ≥ 30 minutes
Case 2: ≥ 52°C for 72 hours

Temperature Variance in a Windrow





Approach of One Processor

ThermoBlender

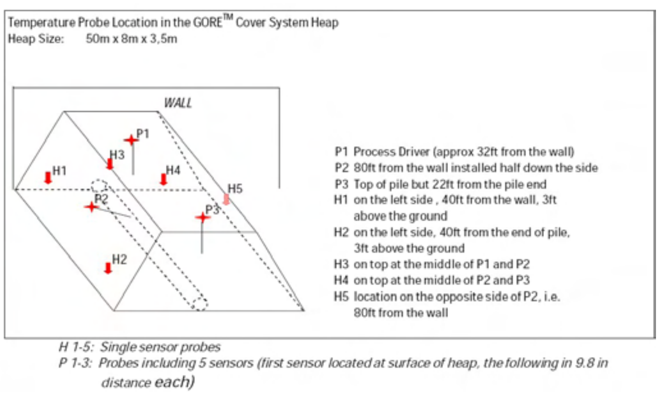
Insulated Vessel

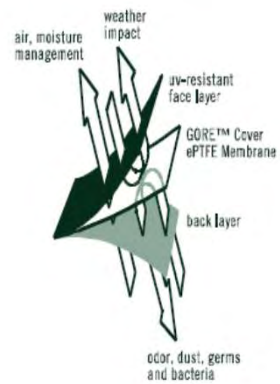
Another Approach

Here sludge cake is mixed with CaO and a little Sulfamic acid and sent to a pressurized vessel to be held at 55°C for 40 minutes.

Still One More to Attack Concerns

Courtesy of GORE





Beneficial Use Planning: Storage

A GUIDE TO RECOMMENDED PRACTICES FOR

FIELD STORAGE OF BIOSOLIDS

AND OTHER ORGANIC BY-PRODUCTS

USED IN AGRICULTURE

AND

SOIL RESOURCE MANAGEMENT

2000

U.S. ENVIRONMENTAL PROTECTION AGENCY

U.S. DEPARTMENT OF AGRICULTURE

Our Changing View of Beneficial Use

1991:

"Beneficial Use means any application of sludge on land specifically designed to take advantage of the nutrient and other characteristics of this material to improve soil fertility or structure and thereby further some natural resource management objective."

Source: NEBRA, 2007

December 2011:

"The Water Environment Federation (WEF) supports a comprehensive approach to wastewater treatment and solids management that ensures the recycling and recovery of valuable resources including water, nutrients, organic matter, and energy."

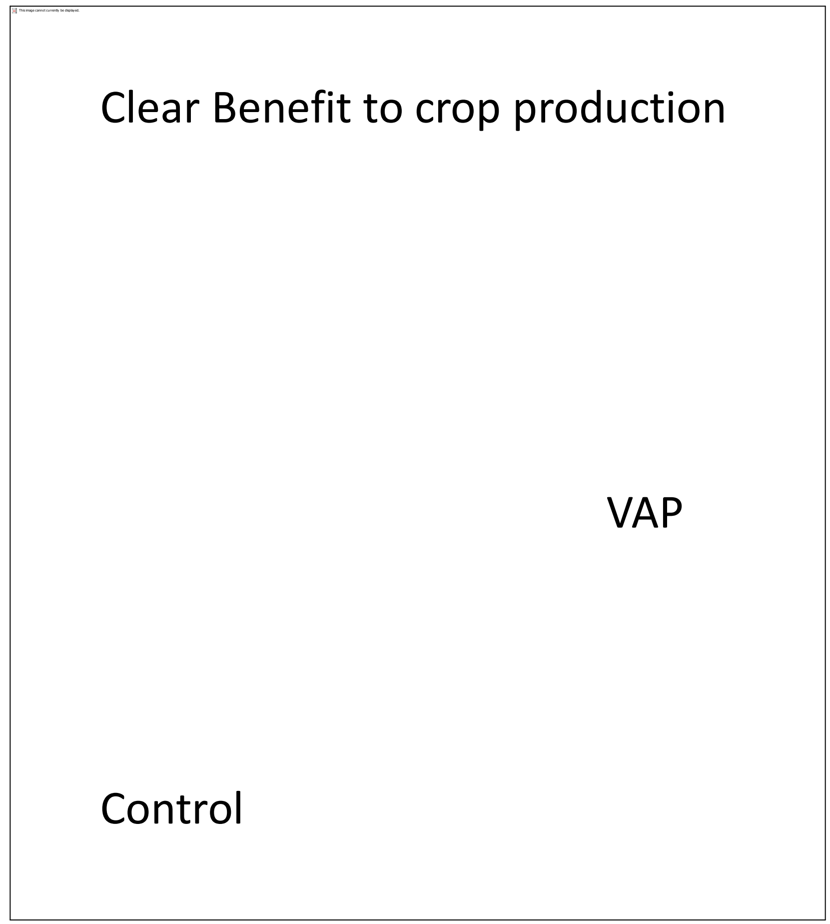
Source: WEF, 2011

What Influences Beneficial Use of Value-Added Products

1. What are the local agriculture, silvicultural and horticultural markets for a biosolids derived product? Are these general agriculture or specialty crop operations with special product quality needs? Has the generator developed GIS or GOOGLE maps showing potential users?
2. What are the product qualities required by those various markets and can the biosolids material (and potentially other local materials) be commingled to produce those VA materials?
3. Does the generator have samples of product to be generated or have access to product from potential sister operations, does it exhibit adverse odor?
4. Can potential users see, smell, touch product and evaluate nutrients levels in the product?
5. Will the product be supplied in bulk loads, 0.5 to 1 ton super sacks or bags? Is product easily managed in the field?
6. What does the user community desire (niche markets)? This could be related to energy saving from production of biofuels.

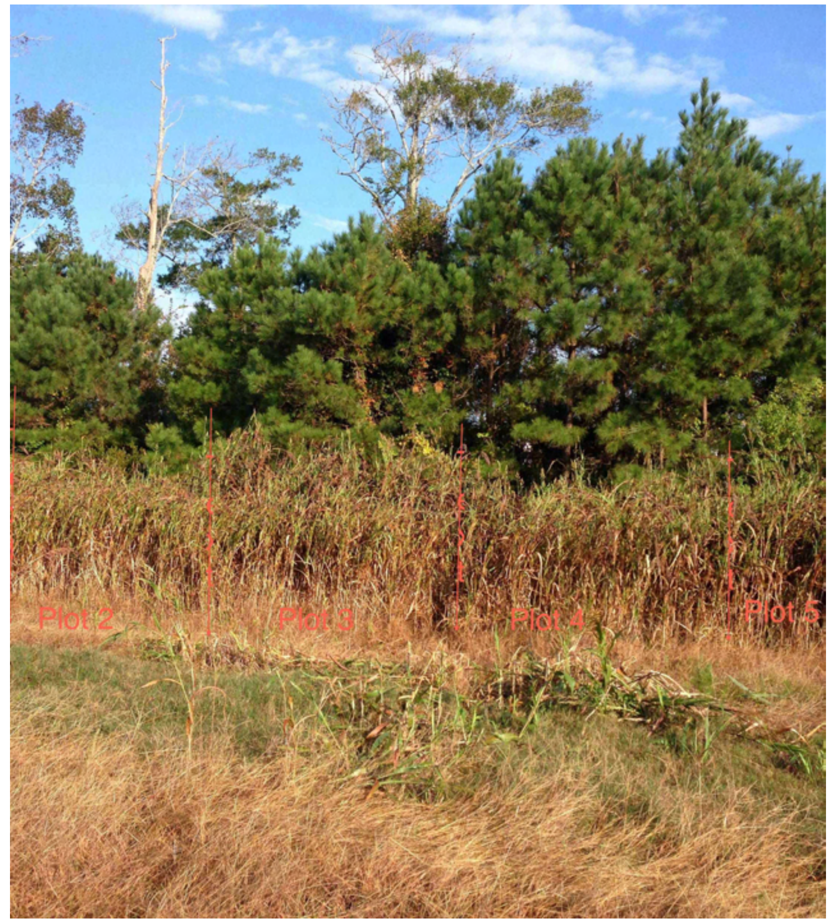
Nutrient Source

- What is it and how will it be applied?
- What are nutrient levels (essential)
  - All plant nutrients
  - Additional materials
    - Metals
    - Salts
    - Liming potential
- Reliable estimate of nutrient mineralization must be developed.



Field Test Results

- Commingled materials yield balanced nutrient source
- Positive impact on yield and quality



Beneficial Use *Results*

- Morehead City, North Carolina & EPP
- Looked at LSP, EPP, LSP+Compost, EPP+Compost

Biosolid Product Quality by Commingling

Product	pH	CCE	N	P	K	Ca	Mg
LSP only	11.5	43	1.7	.3	.3	18	0.4
LSP+comp	10.2	35	2.1	.4	.9	12	0.4
EPP only	11	24	3.2	.8	.5	12	0.6
EPP+comp	9.8	21	3.0	.8	1.5	8	0.6

Soil Test Results

Site	CEC	pH	PI	KI	Ca%	MG%	ZnI	CuI
LSP	16.8	7.4	79	67	92	7	189	101
LSP+Comp	24.2	7.1	113	115	90	6	172	90
EPP only	20.0	7.0	91	86	91	6	198	115
EPP+Comp	26.8	6.9	126	131	91	8	180	105
Control	13.6	5.5	57	41	80	9	129	72
Background	9.2	5.7	57	41	81	9	118	67

Sorghum Quality and Yield with Biosolid Application

Site	Yield	N %	P %	K %
LSP only	7	2.3	.25	1.8
Lime+Comp	12	2.8	.3	2.3
EPP only	12	2.9	.3	1.7
EPP+Comp	15	3.1	.35	2.6
Control	5	1.9	.22	1.2

CNMP

A. **Balance productive agricultural land with environmental protection**
B. **590 Standard and NRCS nutrient management policies available at:**

- **http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/npm**

Nitrogen Needs of Crop

- Based on realistic yield expectations (R.Y.E)
  - For specific crops
  - On specific fields or soil types

Realistic Yields for CfB: ***Cecil fine sandy loam, 2 to 6 percent slopes*** **in Orange County**

Crop	Yield	Nitrogen Factor	Realistic Nitrogen Rate (lbs/acre)	Estimated Phosphorus Removal (lbs P_2O_5/acre)
Barley (Grain)	79 Bushels	1.49	118	30
Corn (Grain)	123 Bushels	1.11	136	54
Corn (Silage)	22.5 Tons	10.9	246	77
Cotton	735 Pounds	0.081	60	21
Sorghum (Silage)	19.2 Tons	7.6	146	58
Oats (Grain)	100 Bushels	1.13	113	25
Peanuts	0 Pounds	0	0	0
Rye (Grain)	59 Bushels	2.01	118	19
Small Grain (Silage)	10.8 Tons	11.1	120	58
Sorghum (Grain)	59 CWT	1.72	101	44

Soil and Site Resources

- Are the proposed crops adapted to the soils and climate?
- What is a reasonable expected crop yield?
- What do soil test results show?
- What nutrient deficiencies or excesses are reported
- What is optimum EQP loading
- What are specific site control measures?
  - Leaching potential
  - Erosion Control

Why Lime

- Proven, accepted process
- Suited to variety of raw feedstocks
- Easily monitored and must be operated properly
- Provides essential nutrients to plants and soil
- Potential to commingle variety of feedstocks to create value added products

- Jim, Harry, the other Bob R and I thank you.