Demonstrating Co-Granulation of Turkey Litter Ash and Swine Solids Ash with Standard Fertilizer Inputs

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FPPC 2005 Technology Summit

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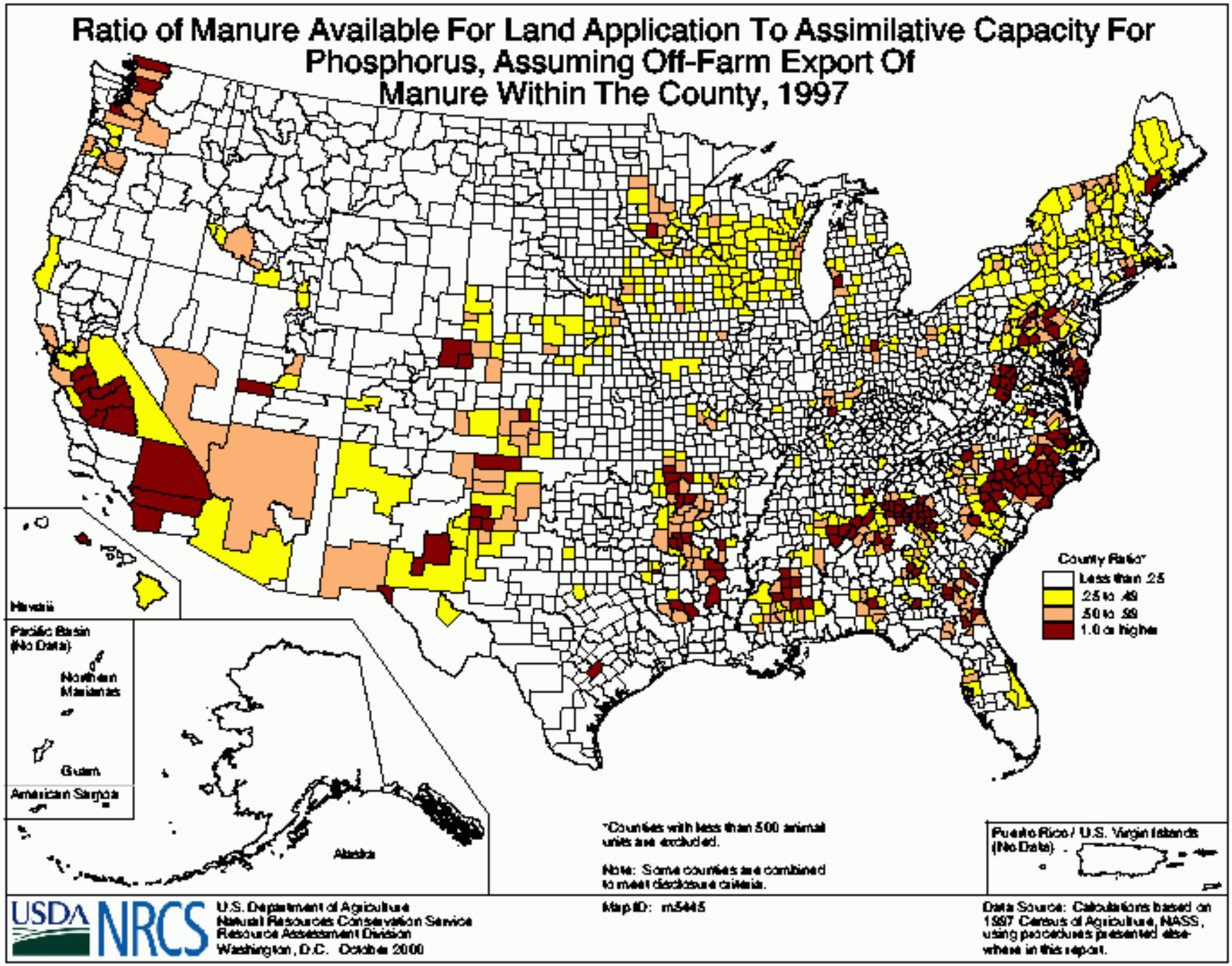
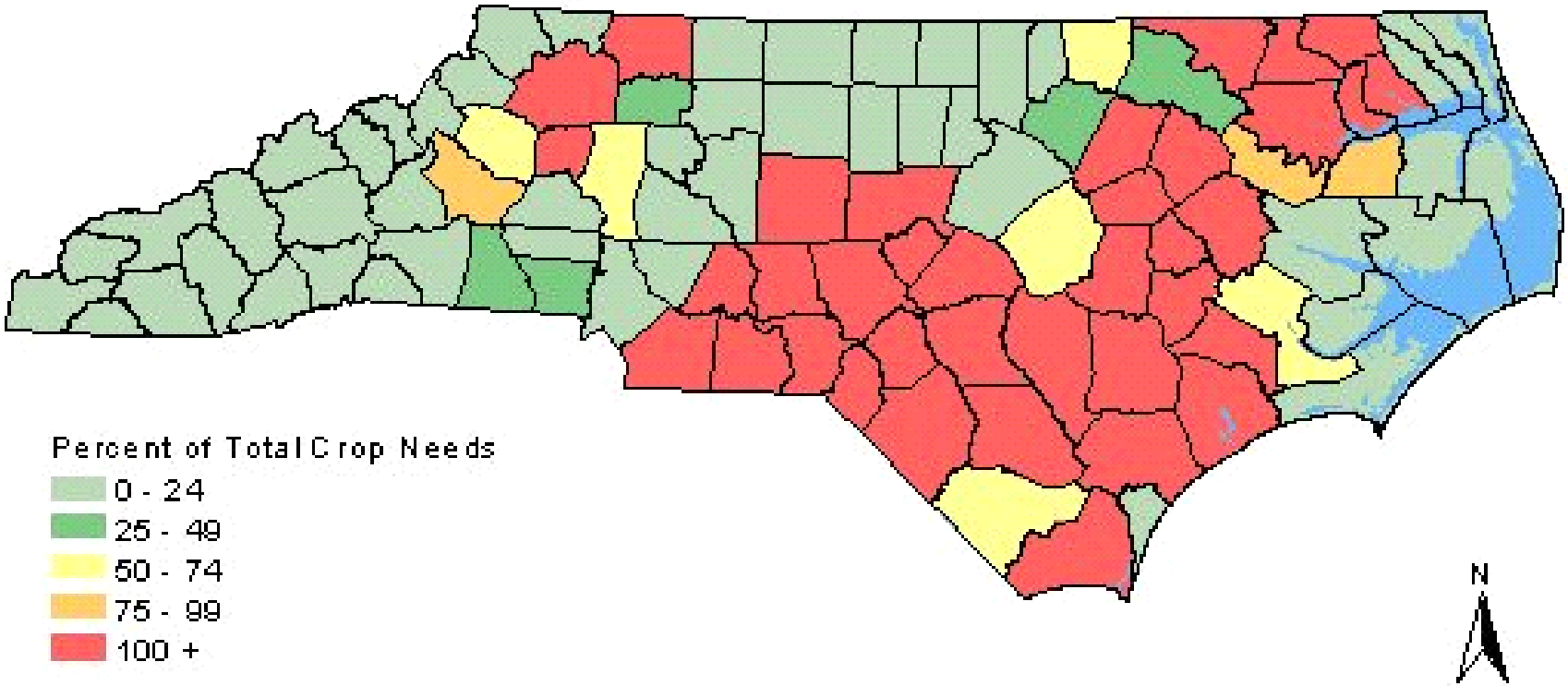
Goal: Overall Project

- Refine and demonstrate an economical system for exporting P from P surplus regions


Ratio of Manure Available For Land Application To Assimilative Capacity For Phosphorus, Assuming Off-Farm Export Of Manure Within The County, 1997
County Ratio*
Less than 25
25 to .49
.50 to .99
1.0 or higher
Hawaii
Pacific Basin (No Data)
Northern Marianas
Guam
American Samoa
Alaska
Puerto Rico / U.S. Virgin Islands (No Data)
*Counties with less than 500 animal units are excluded.
Note: Some counties are combined to meet disclosure criteria.
Map ID: m5445
USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service
Resource Assessment Division
Washington, D.C. October 2000
Data Source: Calculations based on 1997 Census of Agriculture, NASS, using procedures presented elsewhere in this report.


Percent of Total Crop Needs
0 - 24
25 - 49
50 - 74
75 - 99
100 +
N

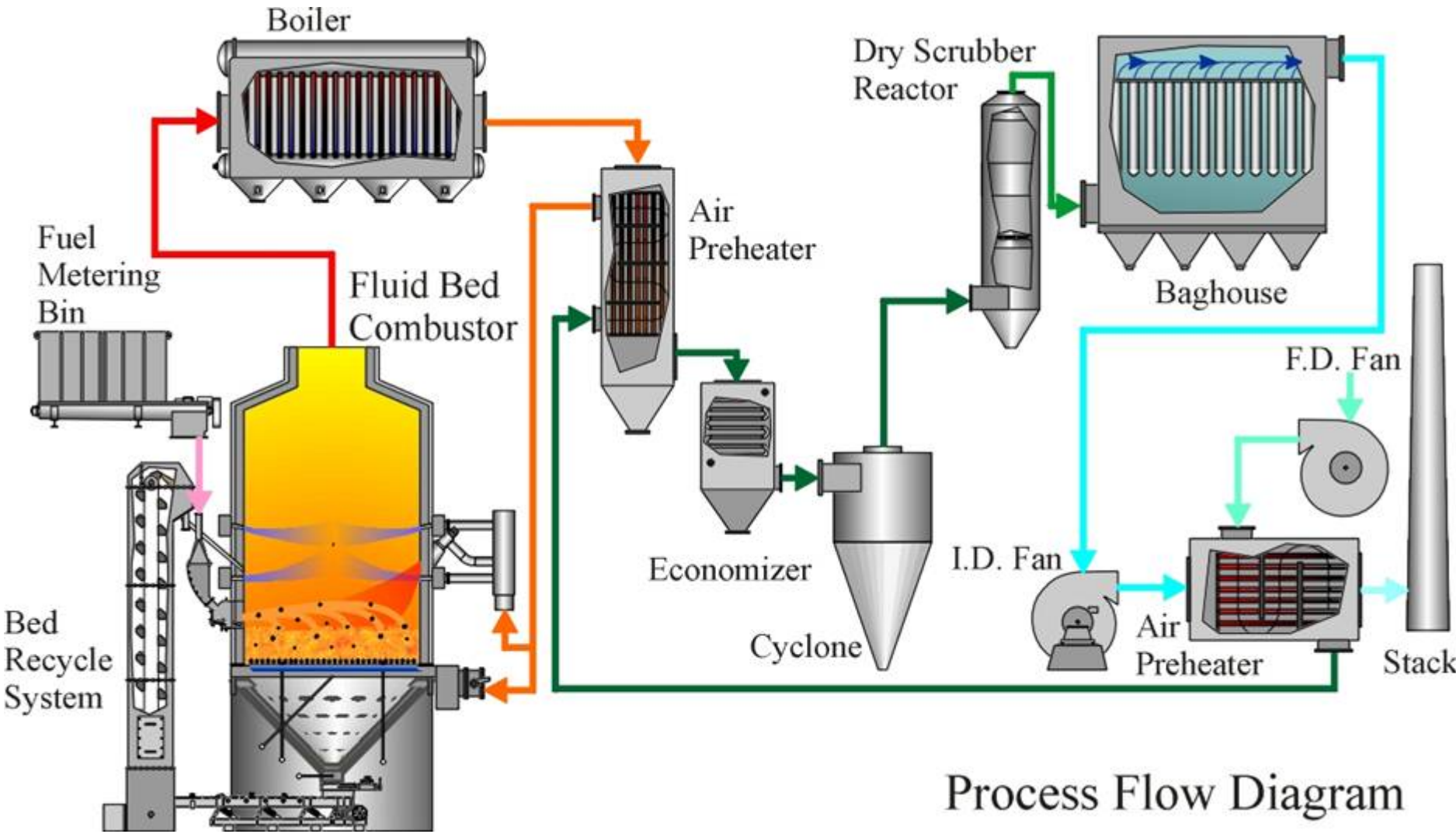
Objectives: Overall Project

- Refine and demonstrate fluidized bed combustion of turkey litter and mixtures of turkey litter and swine solids on a pilot-plant scale
  - All turkey litter nutrients removed from farm
  - 1 to 4% of N and P removed from farm with swine solids (no chemicals added in solid/liquid separation process)
  - All fuel nutrients except N concentrated in ash
  - Intended commercial implementation—regional scale
- Refine and demonstrate co-granulation of ash from turkey litter and swine solids with standard fertilizer inputs on a pilot-plant scale
  - Intended commercial implementation—regional scale, existing NPK granulation plants

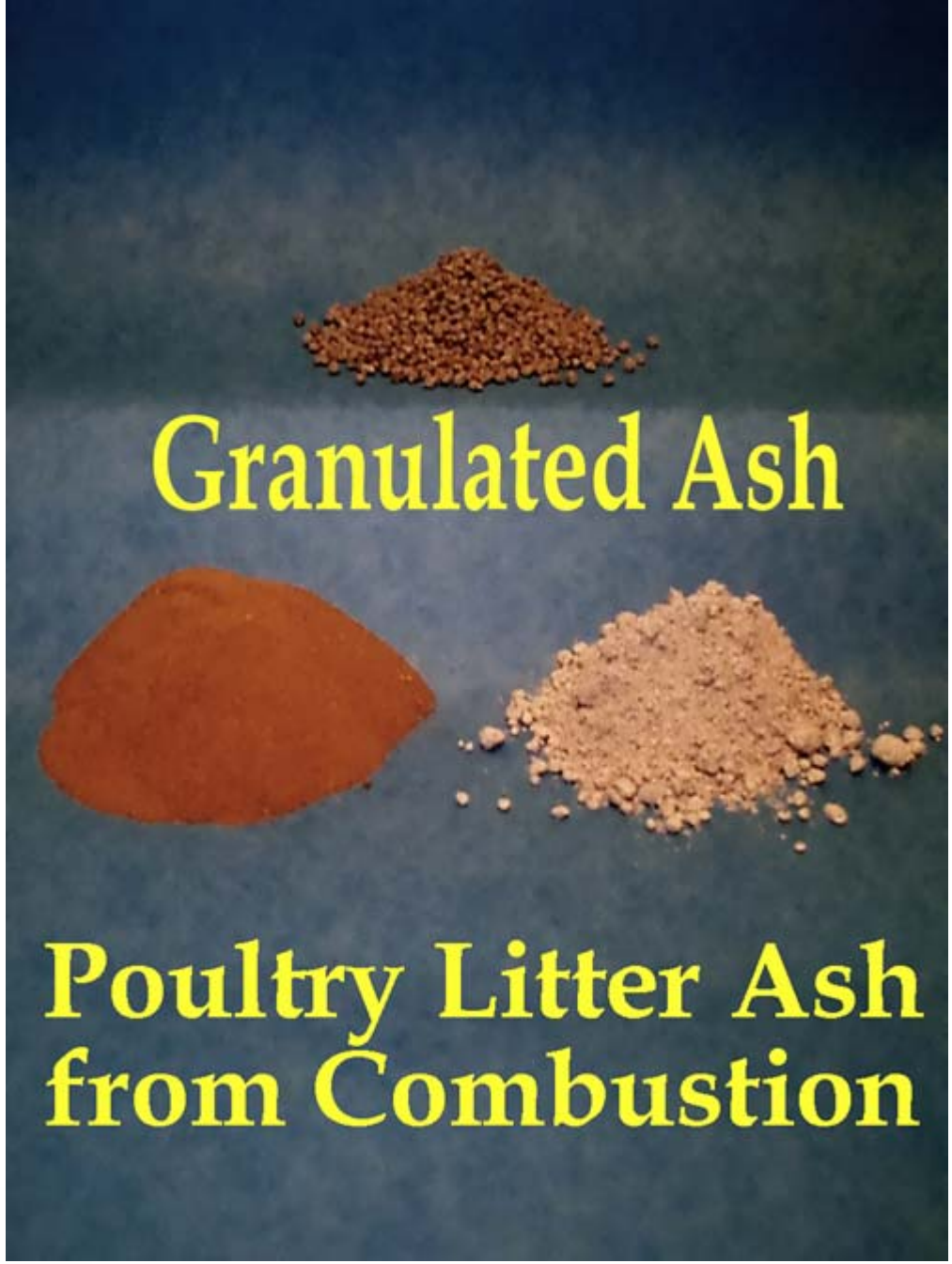
Participants

- Cape Fear RC&D (SE NC)—prime contractor
- FPPC—Co-funder
- Smithfield Foods
  - Co-funder
  - Technical participant (swine solid/liquid separation)
- TVA PPI, B.R. Bock Consulting, Inc.—technical coordination
- Energy Products of Idaho—pilot-scale fluidized bed combustion
- Applied Chemical Technologies—pilot-scale ash co-granulation
- T.R. Miles Technical Consultants, Inc.—combustion consultant

Elements of a Commercial FB System for Energy and Nutrient Recovery



Courtesy Energy Products of Idaho


Granulated Ash
Poultry Litter Ash
from Combustion

Granulation Goals

- Neutralize alkalinity, high pH
- Convert all the P and K to soluble forms that can be claimed on a fertilizer label
- Control dustiness of ash, especially baghouse ash
- Co-granulate ash with standard fertilizer inputs
- Use standard fertilizer inputs as “binder”
- Produce granules with hardness, bulk density, and size comparable to commercial fertilizers
- Do all of above in existing NPK granulation plants without adding to cost of granulation
  (simply substitute ash for some of the standard fertilizer inputs in existing NPK granulation plants)

Granule Inputs and Properties

- ~½ PL ash, ½ phosphoric acid + ammonia
- Final product analysis ~5 N - 40 P_2O_5 - 5 K_2O
  - ~¾ of P_2O_5 water-soluble
  - ~¼ of P_2O_5 citrate-soluble
- Granule hardness ≥ current commercial fertilizers
- Bulk density ≥ current commercial fertilizers

Fertilizer Ash Value: FOB Energy Plant

		Wholesale price	
	%	**$/20 lb nutrient**	**$/ton**
P_2O_5	24	4.00	96.00
K_2O	16	2.00	32.00
Total			128.00
30% discount			38.40
Ash trans.			17.00
Net			72.60

Poultry Litter Management Factors Affecting Ash Value

- Soil contamination (mainly silica and aluminum) during clean out, rototilling poultry litter
  - Dilutes nutrients
  - Silica gel formation: reduced P solubility
- Bedding material: wood vs. rice hulls
  - Rice hulls much higher in silica; affects similar to soil
- Frequency of whole-house cleanout
- Alum (aluminum sulfate) amendment of PL
  - Dilutes nutrients in ash
  - Reduces P solubility in PL; likely more important in fertilizers than feed supplements

Phytase Enzyme Addition to Poultry Feed: Effects on Ash Value

- Enhances availability of P in corn and soybeans to poultry
- Enables reduction of mineral P supplement
- Reduces excretion of manure P=>less P in PL ash

Fertilizer Ash Value: FOB Energy Plant

		Wholesale price	
	%	**$/20 lb nutrient**	**$/ton**
P_2O_5	12	4.00	48.00
K_2O	13	2.00	26.00
Total			74.00
30% discount			22.20
Ash trans.			17.00
Net			34.80

Poultry Litter Ash in Fertilizers: Environmental Considerations

- Trace metals: As, Cd, Co, Hg, Mo, Ni, Pb, Se, Zn Cu, Cr
- Trace metals comply with following standards:
  - American Association of Plant Food Control Officials
  - CFR 503 for sewage sludge
  - Canadian Food Inspection Agency
- Dioxins/Furans
  - Very low, mostly below detection limits
  - No national standards

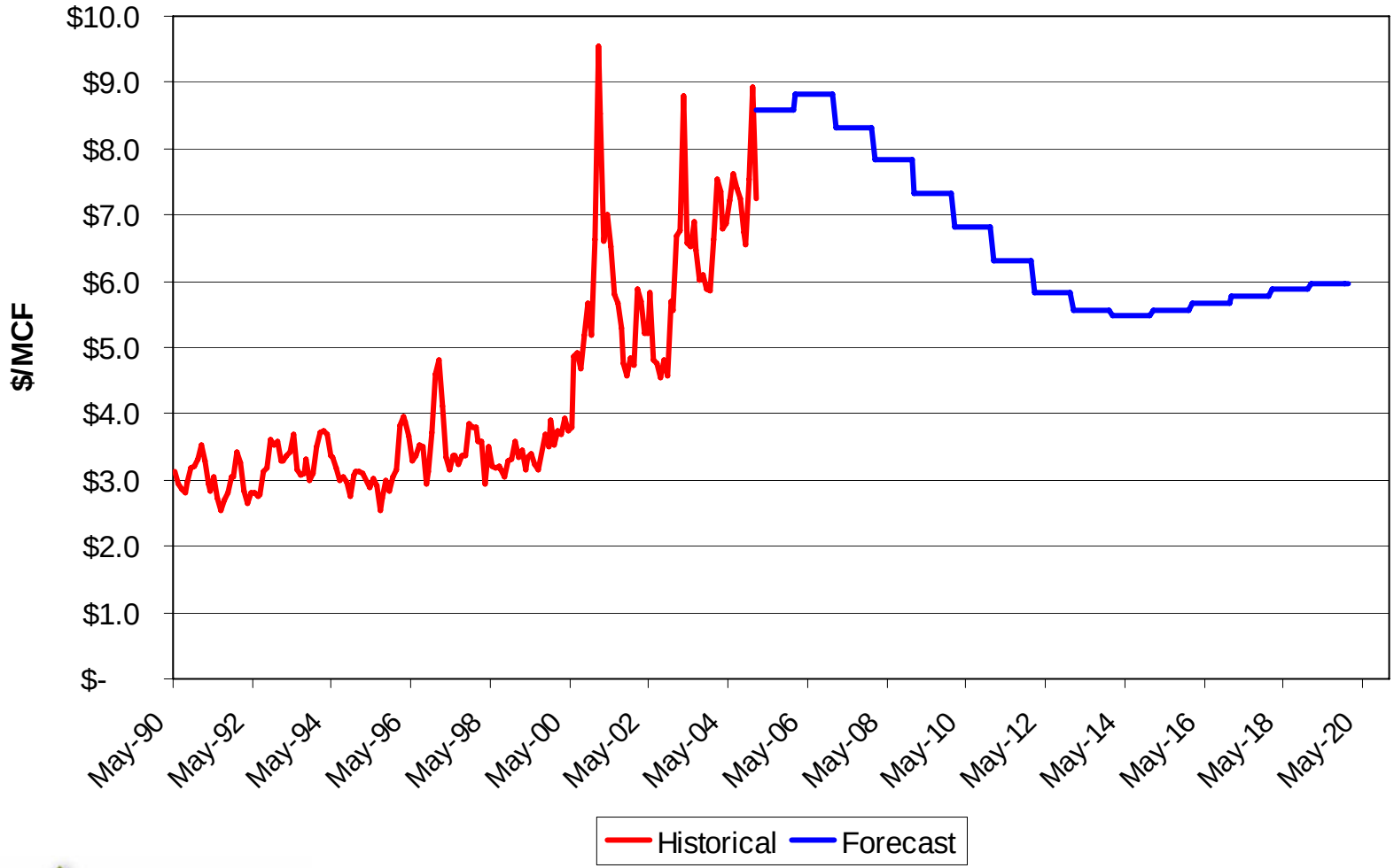
Equivalent Values

Ash	Poultry Litter
$/ton	
50	7.50
100	15.00

Requirements for Favorable Economics of Fluidized Bed Combustion of Poultry Litter

- Ash revenues ~ offset cost of delivered poultry litter feedstock (cleanout and hauling costs ~ $8-10/ton)
- Providing process heat rather than electricity (i.e., displacing high-priced natural gas)
- Supply large user of process heat (e.g., rendering plant)
- Preferably supply large, 24/7 user of process heat
- Can supply process steam at a natural gas equivalent price of $3.50 to $4.50/MCF

Alabama Industrial Natural Gas Prices/Projections



Summary

- Co-granulating poultry litter ash with standard fertilizer inputs on a pilot-plant scale produced granules with excellent physical properties
- High silica levels in poultry litter ash prevented conversion of insoluble P to soluble forms that can be claimed on a fertilizer label
- Bench-scale tests indicated that insoluble P in poultry litter ash with normal levels of silica can be converted to available forms
- Co-granulation of poultry litter ash with standard fertilizer inputs is projected to be commercially viable in NPK granulation plants

Summary

- A fluidized bed combustion plant is projected to be commercially viable for providing process steam to a large operation, if poultry litter can be obtained for cleanout and hauling costs
- Other requirements for maximizing return
  - Minimizing soil contamination of poultry litter
  - Limiting ammonia control additives to poultry litter
  - Limiting phytase use in poultry feeds
  - Switching to a staggered year-round clean-out schedule

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Waste, Energy and Nutrient Solutions for a Better Tomorrow

SO_X Emission Control

--Fuel Ca forms $CaSO_4$ deposited with ash

--Added lime (CaO), if required

Prevention of Ash Fusion due to K, Na, Cl

--Uniform air & fuel dist.

--Low temperatures

--Added lime (CaO), if required

Complete C Burnout

--Bed mixing and fuel/ash abrasion

--Excess air vs. starved air for gasification

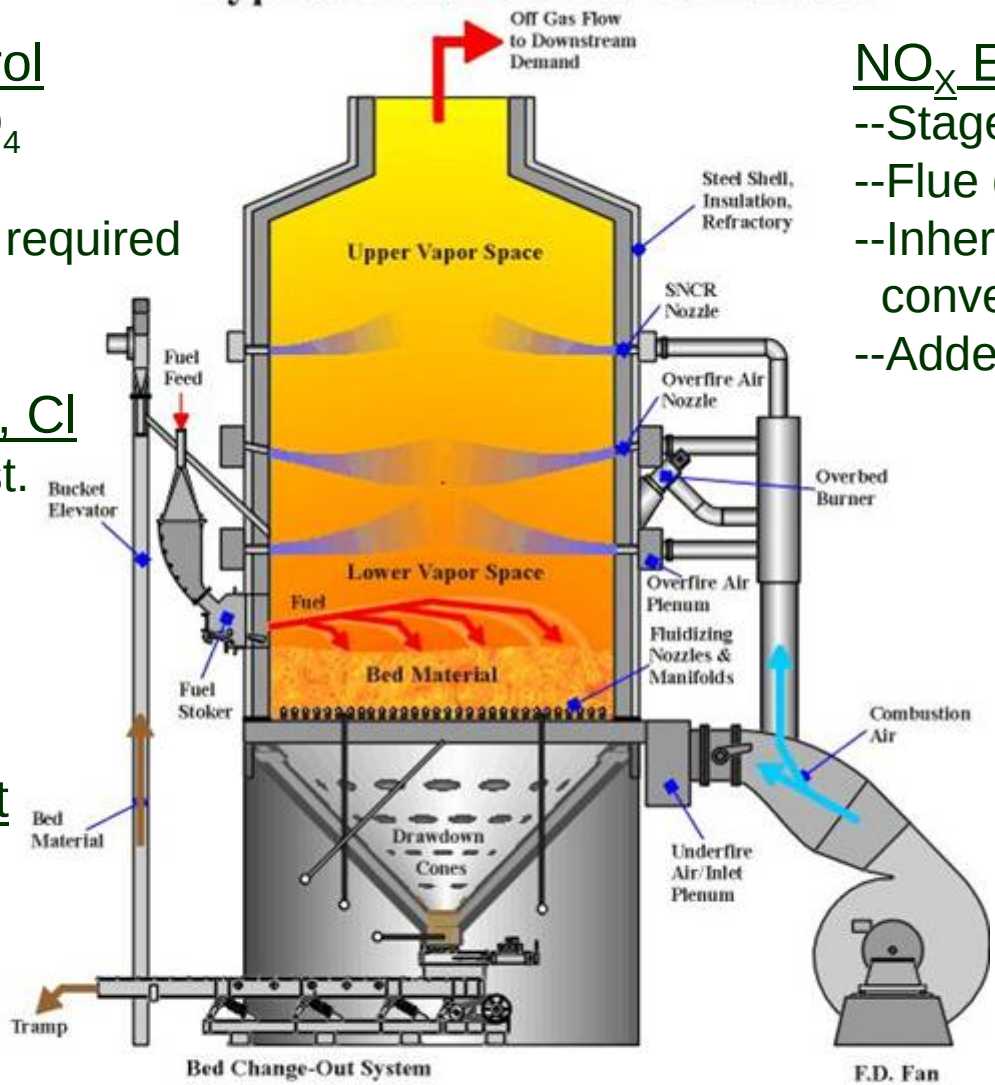
NO_X Emission Control

--Staged combustion

--Flue gas recirculation

--Inherent fuel NH_3 converts NO_X to N_2

--Added NH_3, if required



Courtesy of Energy Products of Idaho