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

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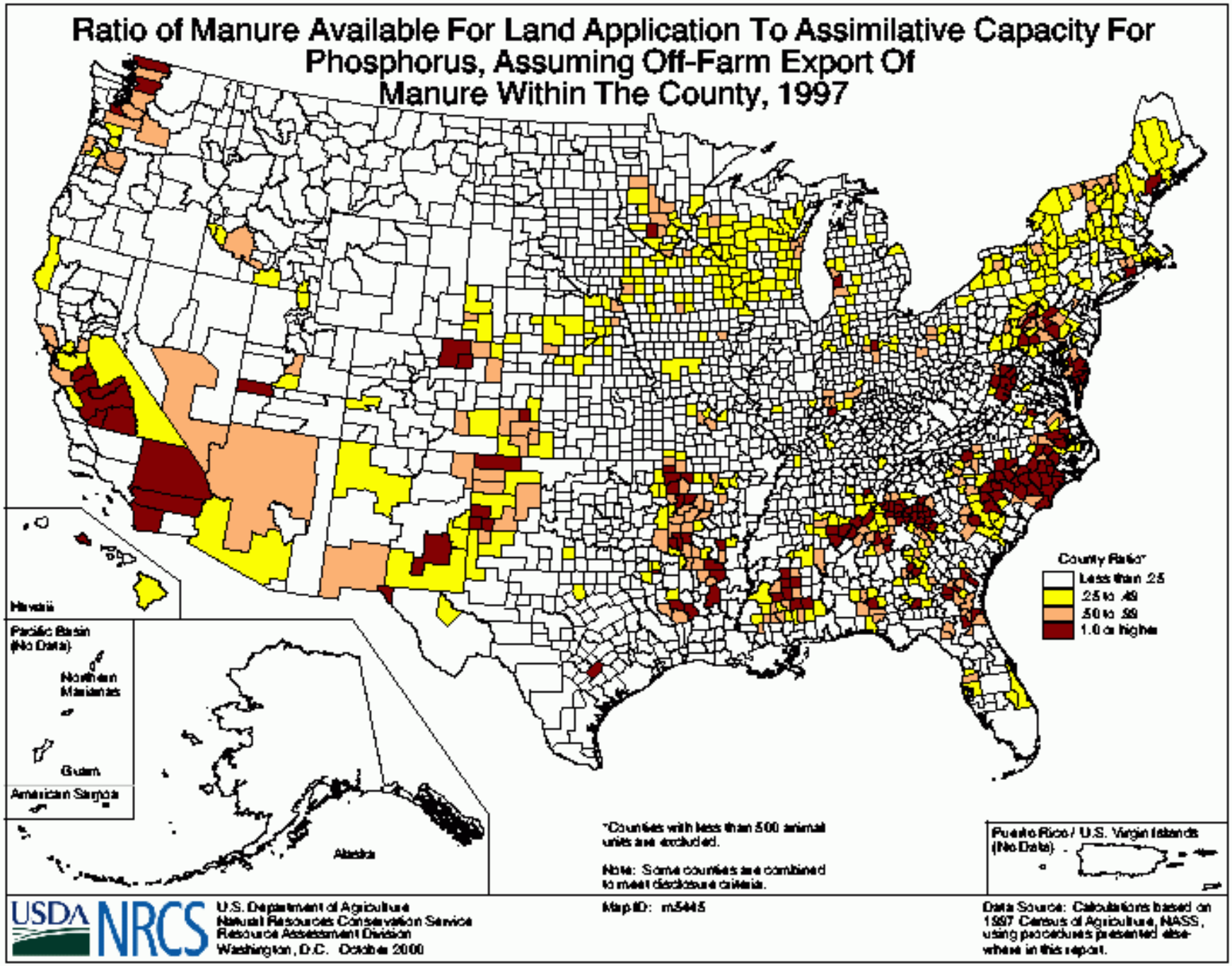
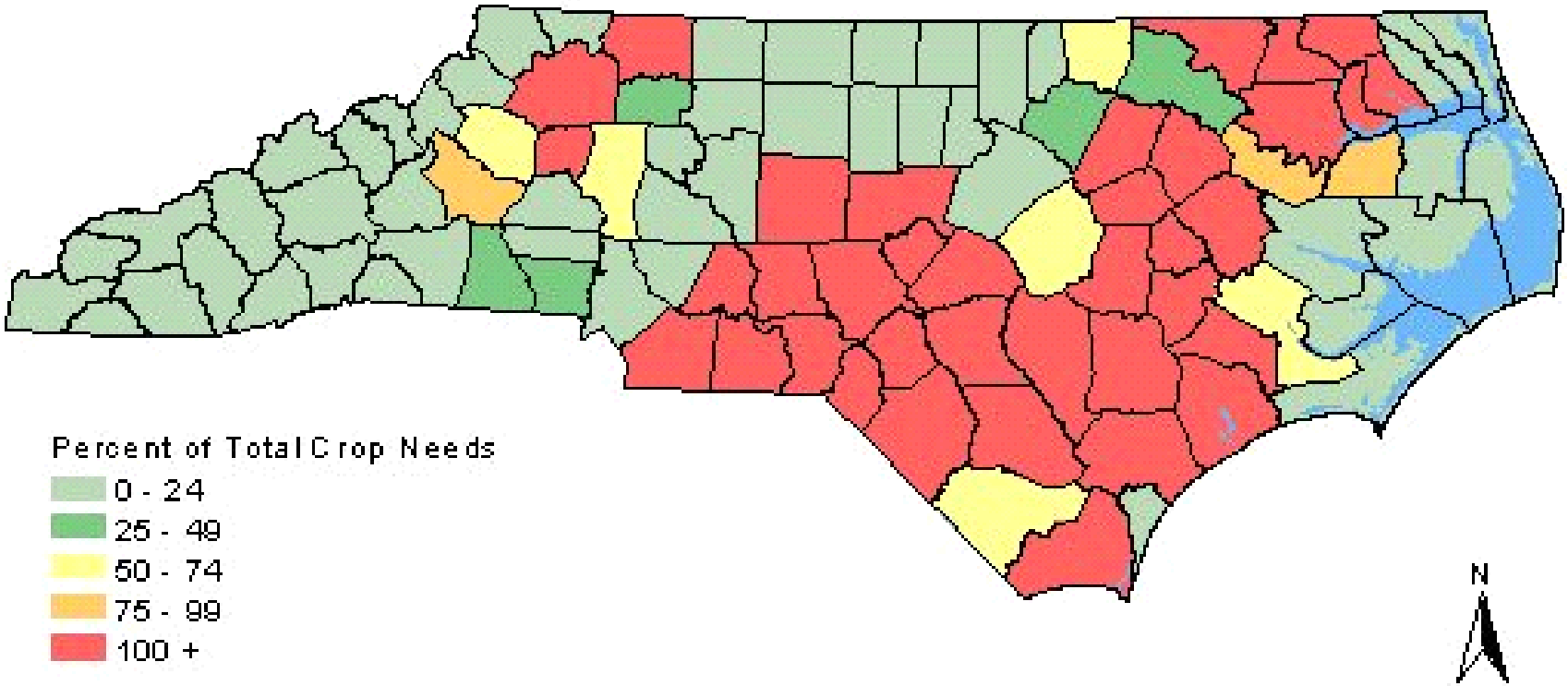
Objectives: Overall Project

- Refine and demonstrate fluidized bed combustion of turkey litter and mixtures of turkey litter and swine solids on a pilot-plant scale
- 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: existing NPK granulation plants outside regional P surplus areas


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

Participants

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

Granulation Goals

- Co-granulate ash with standard fertilizer inputs that provide plant nutrients plus do the following:
  - Serve as the “binder”
  - Neutralize ash alkalinity and reduce ash pH
  - Convert all the ash P and K to soluble forms that can be claimed on a fertilizer label
  - Control dustiness of ash, especially baghouse ash
- 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)

General Process

- Inputs: ~½ ash, ½ phosphoric acid + ammonia
- Combine cyclone and baghouse ash with 40% P_2O_5 phosphoric acid to form pumpable slurry
- Inject ash-acid slurry onto bed of undersize granules in drum granulator
- Inject ammonia under the granule bed to neutralize unreacted phosphoric acid
- Dry granules exiting the drum granulator
- Screen granules exiting the dryer
- Recycle undersized granules to granulator for further enlargement (~2:1 recycle to product ratio)

Projected Product Analysis and Use

- ~5 N – 40 P_2O_5 – 5 K_2O; BL ash with low Si
  ~5 N – 36 P_2O_5 – 5 K_2O; TL/SS ash with med Si
  - N from ammonia
  - P from ash and phosphoric acid
    - ~3/4 of P water soluble
    - ~1/4 of P citrate soluble
  - K from ash
- Starter fertilizer
- Ingredient for bulk blends

Ash Nutrient and Silica Content

	Demonstration		Survey Means	
	SS	TL	TL-SENC	BL-Delmarva
	%			
K_2O	8.3	8.3	12.4	16.3
P_2O_5	27.4	17.6	23.4	24.4
SiO_2	8.3	47.3	26.5	8.1

Apparent Effect of Ash Silica Content on Solubility of Ash P

	% of ash P that can be claimed on a fertilizer label
NC ash (high SiO_2):	
Before granulation	42
After granulation	42
Delmarva ash (low SiO_2):	
Before granulation	41
After granulation	75-95

Comparison of tons SiO_2 in litter, bedding, and soil

Tons litter/ house	% ash in litter	% SiO_2 in litter ash	Tons SiO_2 in litter
200.00	27.00	48.00	25.9
Tons bedding/ house	% ash in bedding	% SiO_2 in bedding ash	Tons SiO_2 from bedding
20.00	5.00	50.00	0.5
Assumed tons dry soil in litter/ house		% SiO_2 in dry soil	Tons SiO_2 from soil
30.00		85.00	25.5
Depth (inches) of soil mixed with litter			
0.56			

TL Ash Fertilizer Value: FOB Energy Plant

Ash SiO_2=26.5%		Wholesale price	
	%	**$/20 lb nutrient**	**$/ton**
Total P_2O_5	23.5		
Avail. P_2O_5	17.6	4.00	70.40
Soluble K_2O	12.4	2.25	27.90
Total			98.30
30% discount			29.50
Ash trans.			15.00
Net			53.80

TL Ash Fertilizer Value: FOB Energy Plant

Ash SiO_2, %	26.5	16.5	16.5
Total P_2O_5,%	23.5	26.1	26.1
Avail. P_2O_5, %	17.6	19.6	26.1
Soluble K_2O, %	12.4	13.8	13.8
Net ash value, $/ton	53.80	61.60	79.80

SS Ash Fertilizer Value: FOB Energy Plant

Ash SiO_2, %	8.3	8.3
Total P_2O_5,%	27.4	27.4
Avail. P_2O_5, %	20.6	27.4
Soluble K_2O, %	8.3	8.3
Net ash value, $/ton	55.80	74.80

TL/SS 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

Requirements for Favorable Economics of Fluidized Bed Combustion of TL/SS

- Ash revenues ~ offset cost of delivered TL/SS feedstock (ash projected to offset~ $8-10/ton TL/SS)
- 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/MBtu

Summary

- Co-granulating TL/SS ash with standard fertilizer inputs on a pilot-plant scale produced granules with excellent physical properties
- High silica levels in TL ash prevented conversion of the insoluble fraction of ash P to soluble forms that can be claimed on a fertilizer label
- Bench-scale tests indicated that the granulation process can solubilize most of the P in TL/SS ash if ash silica levels are medium to low
- Medium-to-low TL ash silica levels appear achievable with modified TL rototilling practices
- Co-granulation of TL/SS 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 continuous operation, if the TL/SS ash value ~ offsets TL/SS feedstock costs (i.e., if the delivered cost of TL/SS ≤ $8-10/ton)

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