Processed Fertilizer from Animal Waste

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Southern Plant Nutrient Management Conference

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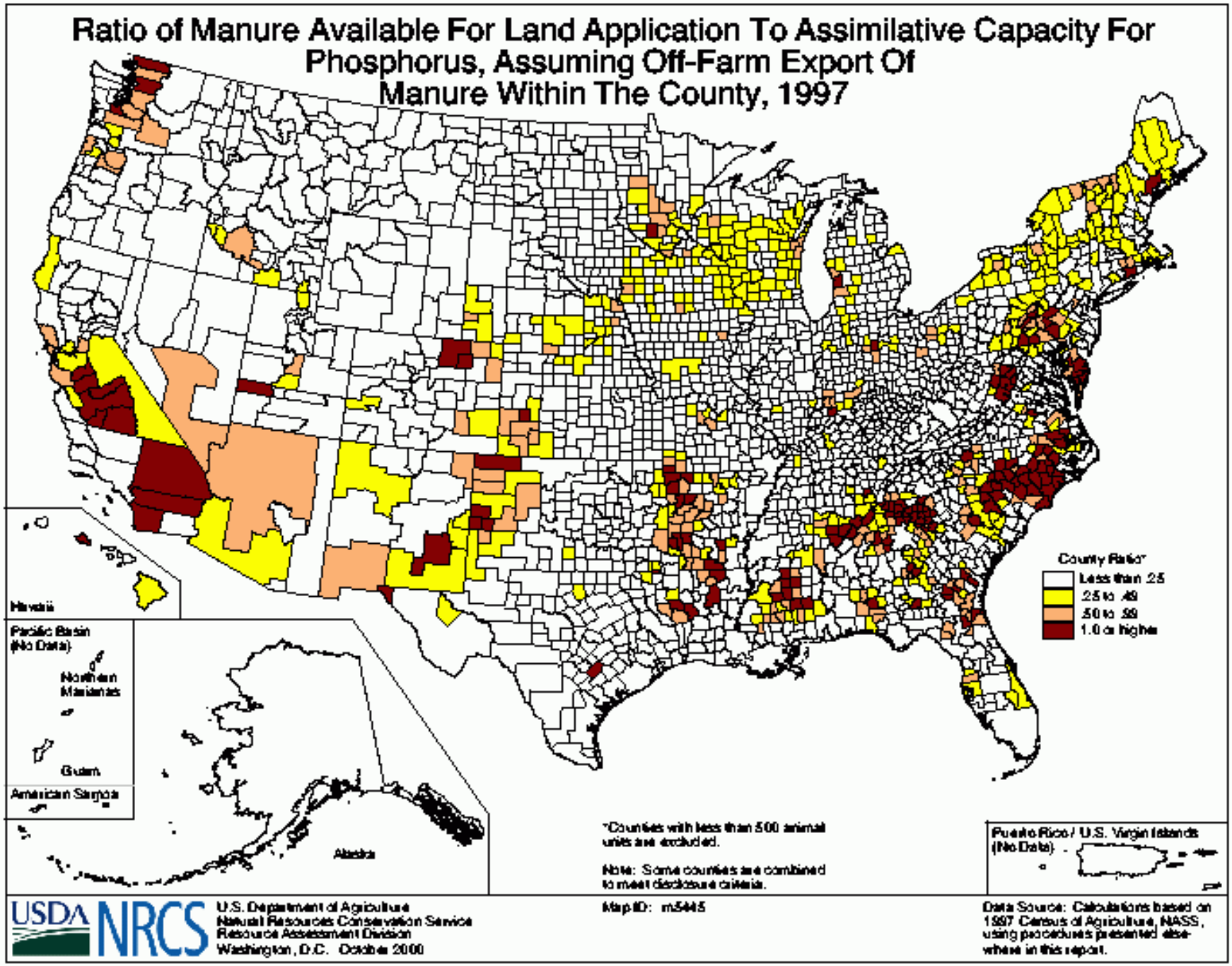

Ratio of Manure Available For Land Application To Assimilative Capacity For Phosphorus, Assuming Off-Farm Export Of Manure Within The County, 1997
County Ratio*
Less than 25
25 to .49
.50 to .99
1.0 or higher
Hawaii
Pacific Basin (No Data)
Northern Marianas
Guam
American Samoa
Alaska
Puerto Rico / U.S. 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.

Potential Solutions for P Surpluses

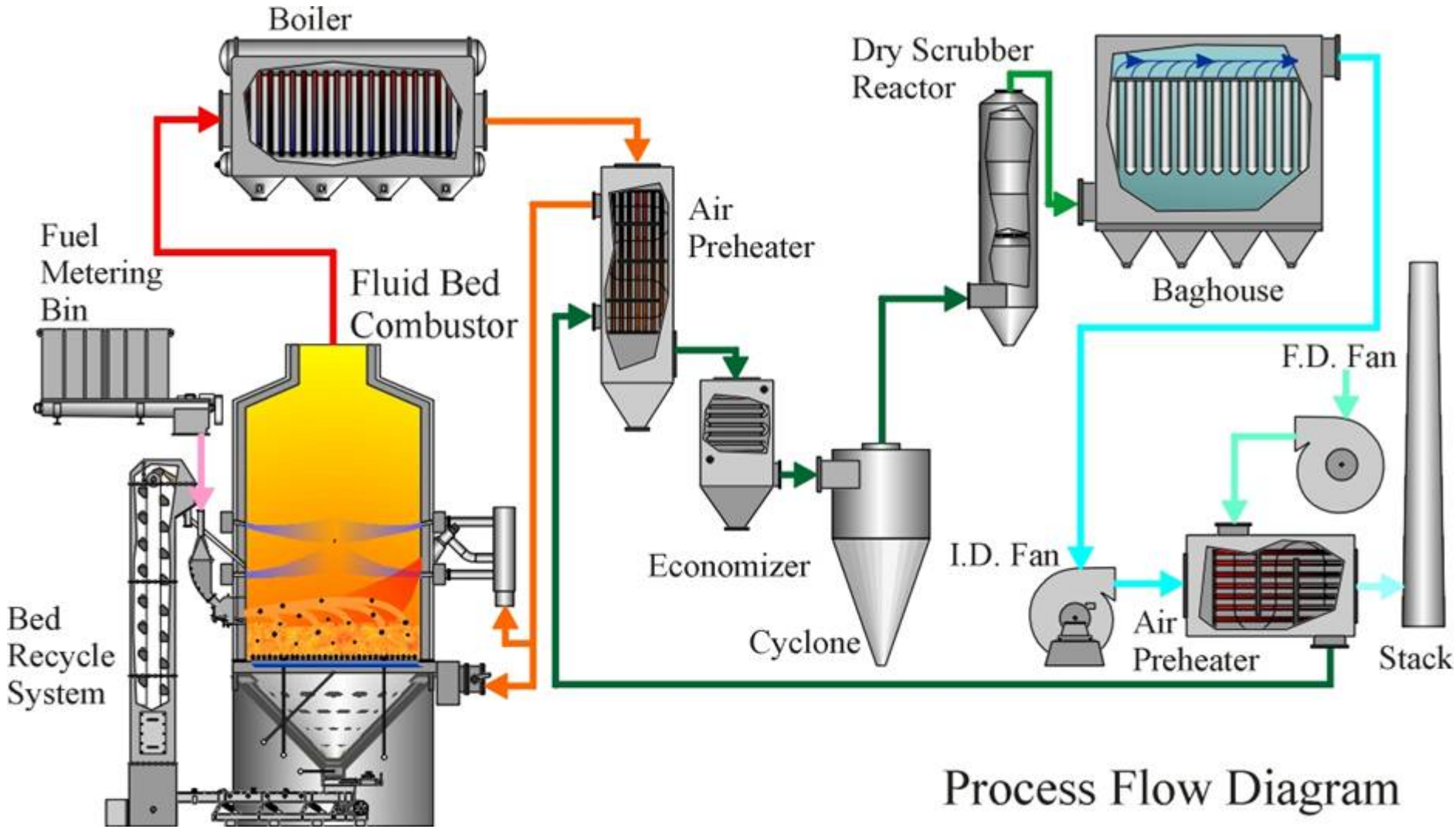
- Reduce P imports and excretion--feed management (partial solution)
- Export unprocessed poultry litter (requires subsidies; logistical limitations)
- Export value-added organic products (low-volume markets)
- Produce process heat and/or electricity
  - Export ash nutrients for use in fertilizers
  - Reduce P imports by using ash as P feed supplement
    (Large-vol., year-round, non-subsidized market for poultry litter; ➔staggered, year-round cleanout)

Potential Cost Savings: PL vs. Fertilizer (continuous corn)—Lichtenberg et al., 2002

Nutrient mgt. plan	Value of fert. nut. displaced	PL clean-out	PL testing	PL appln.	Savings before trans.
	$/ton poultry litter (PL)				
P based	32.26	4.00	0.20	14.63	13.43
N based	19.24	4.00	0.20	7.27	7.77

Long-Distance Litter Transport: Best-Case Scenario (Equal Basis with Fertilizer)

- Order from broker or dealer in advance
- No litter storage by crop producer*
- Custom application in narrow window*
- Guaranteed nutrient analysis
- One bill for brokering, transportation, handling, and application
- No supplemental commercial fertilizer*
- Option to supply 2- or 3-year P supply at one time
- Total cost ≤ commercial fertilizer



Courtesy of Energy Products of Idaho

SO_X Emission Control

--Fuel Ca forms $CaSO_4$ deposited with ash

--Added lime ($CaCO_3$), if required

Prevention of Ash Fusion due to K, Na, Cl

--Uniform air & fuel dist.

--Low temperatures

--Added lime ($CaCO_3$), if required

Complete C Burnout

--Bed mixing and fuel/ash abrasion

--Excess air vs. starved air for gasification

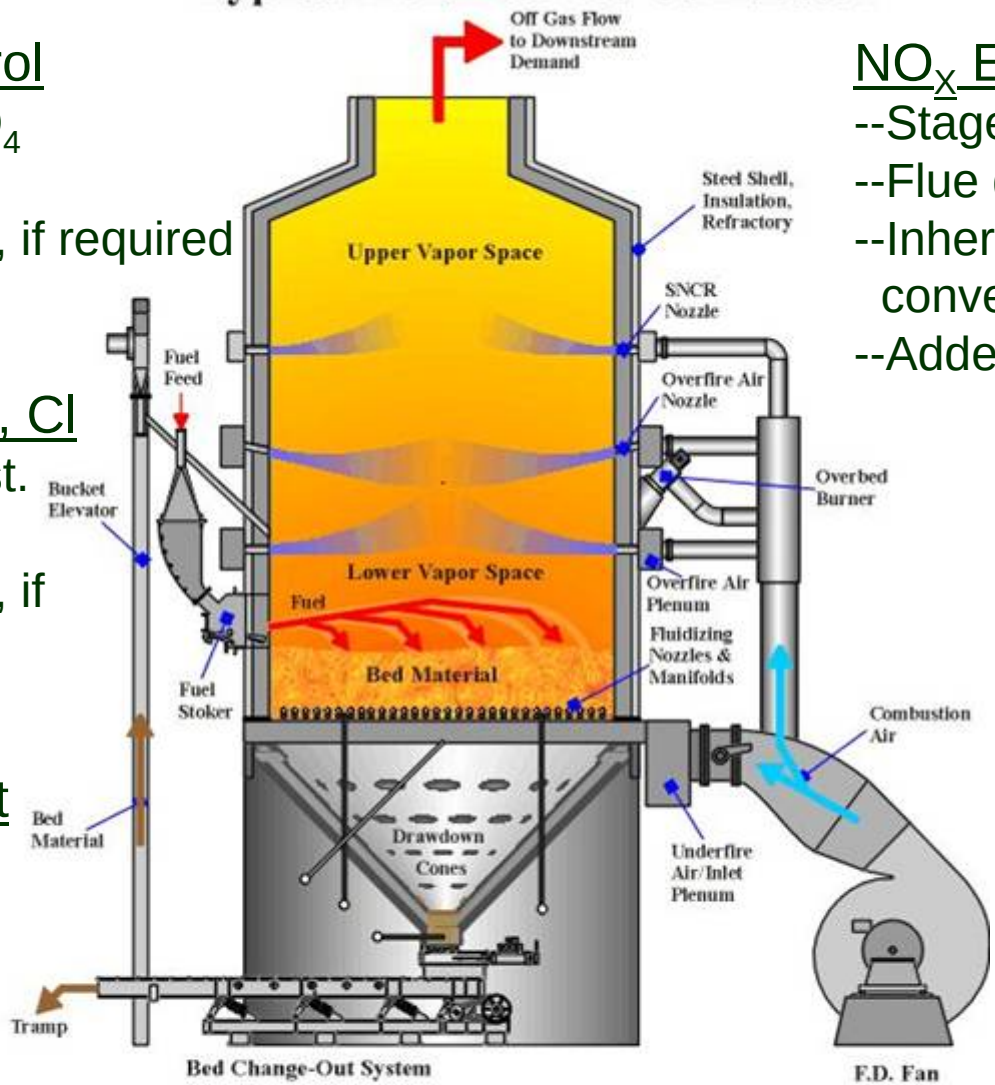
NO_X Emission Control

--Staged combustion

--Flue gas recirculation

--Inherent fuel NH_3 converts NO_X to N_2

--Added NH_3, if required



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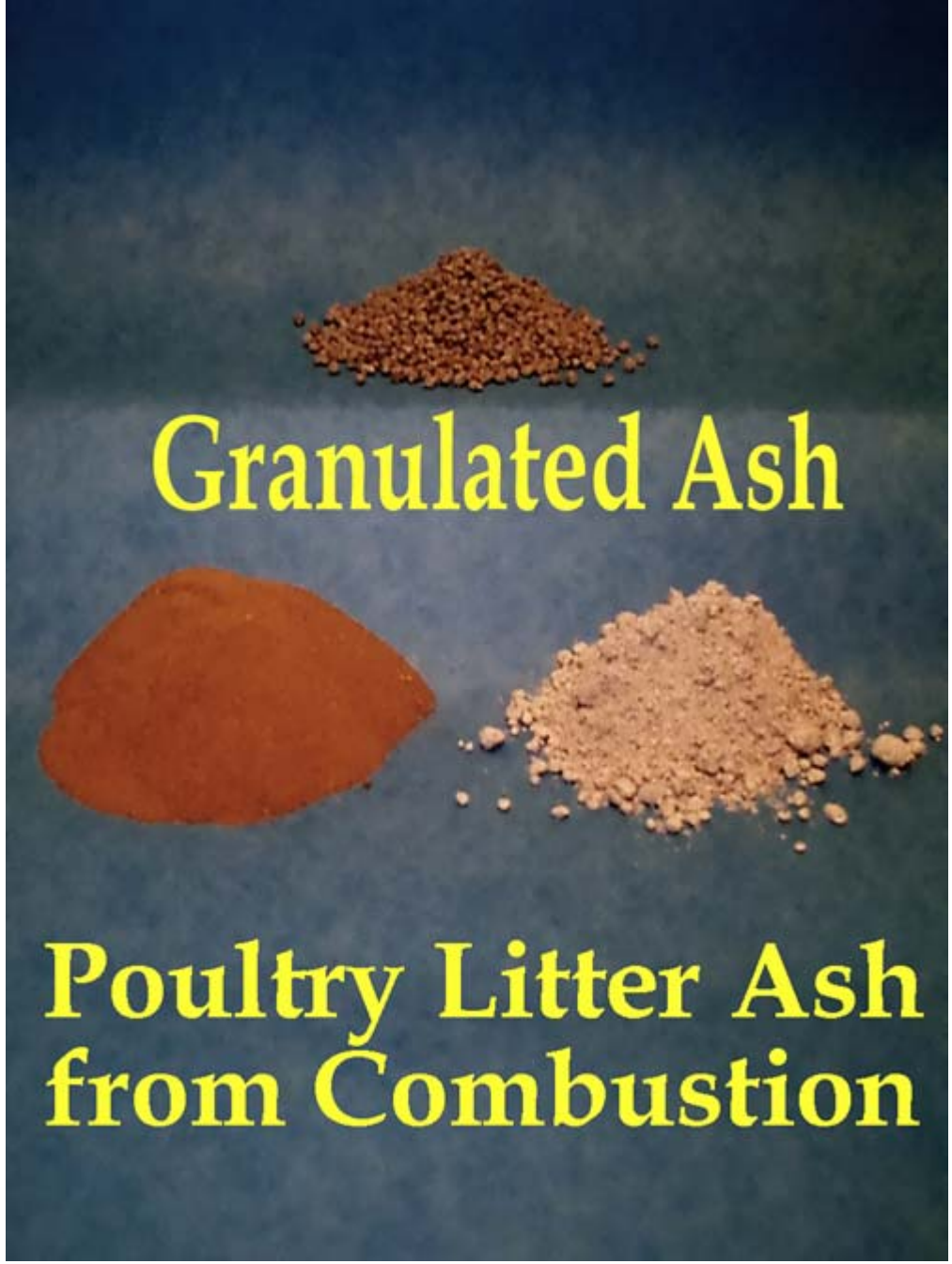
Granulated Ash
Poultry Litter Ash
from Combustion

Equivalent Values

Ash	Poultry Litter
$/ton	
50	7.50
100	15.00

Nutrients of Primary Value

Nutrient	PL Ash	DCP
Fertilizers		
Total P_2O_5, %	24.4	
Total K_2O, %	16.3	
Mineral Feed Supplements		
Total P, %	10.7	18.5
Total Ca, %	12.4	24.1

Ash Value and Cost Factors

Value Factors	**Fertilizers**	**P Feed Supp.**
% of P credited		
w/o further processing	50-70	100
w/ further processing	90-100	N/A
% of K credited	95-100	0
Value-add for low F	no	yes
Cost Factors		
Granulation required	yes	no
Transportation	Med to High	Low

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)

Fertilizer 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

Net Fertilizer Ash Value at 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.			12.00
Net			77.60

Net Ash Value as Mineral P Feed Supplement

	$\%P_2O_5$	%P	$/ton
DCP	42.4	18.5	250
PL Ash	24.4	10.7	145
Ash trans.			5
Net			140

Poultry Litter Management Factors

- Soil contamination 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

- 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

Energy Conversion Factors

- Unburned carbon: dilutes nutrients
  - Combustion vs. gasification
  - Operating conditions
- Fluidized bed sand contamination: inert, dilutes nutrients (normally minimal dilution)
- High temperatures: silica gel or glass formation
- Dioxin levels in ash, especially fly ash
- Lime ($CaCO_3$) addition with poultry litter
  - Dilutes P and K; increases Ca concentration
  - Replaces some of lime normally added to feeds
  - May enhance P and K segregation
    - More of P in bottom ash; more of K in fly ash

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

Summary

- PL ash is nutrient-rich (~40 units of P_2O_5 + K_2O)
- Good potential for energy plants to net:
  - $40 to 80/ton of PL ash used in fertilizers
  - $80 to 110/ton of PL ash used in mineral feed supplements
- Need to optimize PL management and energy conversion factors to realize these potentials
- With poor management of PL and energy conversion factors, PL ash will have minimal or perhaps even negative net value at energy plants
- Good potential for energy and nutrient recovery from PL to significantly reduce regional P surpluses