

## Managing Soil Fertility in Organic Systems

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## Overview

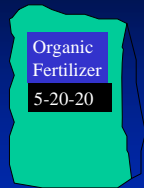
- Calculating fertilizer rates
- Match Soil Amendments to crop needs
  - What can be used?
  - Economics

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## Fertilizer Analyses?

- What is the analysis?



=

5 % N  
20% P<sub>2</sub>O<sub>5</sub> = 8.75% P  
20% K<sub>2</sub>O = 16.5% K

- Convert to lbs per 50 lb bag or per ton

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## Fertilizer Analyses?

- 5% N = 5% / 100 x 50 lb  
= 2.5 lb / 50 lb bag  
= 100 lb per ton
- 20% P<sub>2</sub>O<sub>5</sub> = 10 lb / 50 lb bag  
– or 400 lb per ton
- 20% K<sub>2</sub>O = 10 lb / 50 lb bag  
– or 400 lb per ton

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## What Soil Amendments Can Be Used?\*

- Aquatic plant extracts
- Elemental sulfur
- Humic acids
- Magnesium sulfate (Gypsum) – mined only
- Micronutrients - nitrates or chlorides are not allowed
- Soluble boron products
- Sulfates, carbonates, oxides, or silicates of zinc, copper, iron, manganese, molybdenum, selenium, and cobalt

\*\* USDA National Organic Program

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## What Soil Amendments Can Be Used?\*

- Liquid fish products — can be pH adjusted with sulfuric, citric or phosphoric acid
- Potassium chloride — derived from a mined source
- Sodium nitrate (Chilean Nitrate) — no more than 20% of the crop's total nitrogen requirement

\*\* USDA National Organic Program

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## Sources of Nitrogen

- Manure
- Cover Crops
- Plant Products
- Animal Byproducts
- Seaweeds
- Mined nitrate (Chilean Nitrate)

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## Nitrogen: Manure

- Content depends on animal type, age, feed and manure management
- Losses of ammonia ( $\text{NH}_3$ ) from volatilization ~ typically 50% if surface applied, less if incorporated
- Broiler litter – most common source in TN  
– 60 lbs total N per ton (also  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$ )
- Dairy manure – depends on how much water is mixed, expensive to transport
- Beef manure

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## Nitrogen: Cover Crops

- Leguminous cover crops fix atmospheric nitrogen
- Amount of N depends on the plant species, the stage of growth, soil factors, and the effectiveness of the rhizobial association
- 50 to 200 lbs N per acre possible
  - How much is available to plant?
  - How quickly does it decompose?



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## Nitrogen: Plant Products

- Alfalfa meal (4% N)
- Cottonseed meal (6% N), West Tennessee
- Corn gluten (9% N), Tate & Lyle, Loudon
- Soybean meal (7% N)
  - Some weed inhibition reported
- Check other nutrients
  - Soybean meal (7% N; 2%  $\text{P}_2\text{O}_5$ ; 1%  $\text{K}_2\text{O}$ )



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## Nitrogen: Animal Byproducts

- Blood Meal (derived from slaughterhouse waste, usually cattle), dried powdered blood contains approximately 12% N
- Guano: Seabird guano (8 to 12% N)
- Feather Meal: (14 to 16% N)
- Fish Meal and Fish Emulsion: Fish meal (10 to 14% N); fish emulsion (2 to 5% N)



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## Nitrogen: Seaweed

- Usually derived from kelp species (*Ascophyllum*)
- Dried kelp ~ 1% N and 2% K



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## Nitrogen: Mined

- Chilean Nitrate – mined in Chile and Peru
- Sodium nitrate ( $\text{NaNO}_3$ , 16% N)



- Note: In the U.S.A., the use of  $\text{NaNO}_3$  is limited to no more than 20% of the crop N requirement.

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## Sources of Phosphorus

- Manures and compost
- Rock phosphate
- Phosphatic clays
- Bone meal
- Guano

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## Phosphorus: Manure

- Content depends on animal type, age, feed and manure management
- Broiler litter – most common source in TN
  - 40-60 lbs total  $\text{P}_2\text{O}_5$  per ton (also N and  $\text{K}_2\text{O}$ )
  - More concentrated with age
- Dairy manure – depends on how much water is mixed
- Beef manure

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## Phosphorus: Rock Phosphate

- Apatite (calcium phosphate mineral)
- Sedimentary or igneous - widely varying mineralogy, texture, and chemical properties
- Total vs. citrate soluble P
- Florida, North Carolina, Idaho, Tennessee
- Influence of soil pH is dissolution

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## Phosphorus: Phosphatic Clays

- Calphos®
  - A soft, phosphatic clay originating in Florida
  - Contains a 17% total  $\text{P}_2\text{O}_5$ , with 3% available  $\text{P}_2\text{O}_5$
  - Available in a finely ground, powder-like form or granular form
- Tennessee Brown Rock Phosphate
  - 8.7% citrate sol.  $\text{P}_2\text{O}_5$ ; 2.4%  $\text{K}_2\text{O}$
  - Note: TN Dept. Ag. ~ 3.5%
  - Calcium Silicate Corporation, Columbia, (Tel: 931-381-1859)



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## Phosphorus: Bone Meal

- Prepared by grinding animal bones
- Primary P mineral in bone material is “calcium-deficient hydroxyapatite” – more soluble than rock phosphate
- Bones gleaned from Napoleonic battlefields in Europe in 19<sup>th</sup> Century
- Fish used by the Native Americans?



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## Phosphorus: Guano

- Mined from aged deposits of bird or bat excrement in low rainfall environments.
- Struvite (magnesium ammonium phosphate) can be a major P mineral found in guano, dissolving slowly in soil
- Limited supply and high cost of guano generally restricts its use to small-scale applications.



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## Sources of Potassium

- Manures and compost
- Greensand
- Langbeinite (Potassium-magnesium sulfate)
- Potassium Sulfate
- Rock Powders
- Sylvinite (Potassium Chloride)
- Wood ash

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## Potassium: Manure

- Content depends on animal type, age, feed and manure management
- Found as  $K^+$  cation
- Broiler litter – most common source in TN
  - 40 to 60 lbs  $K_2O$  per ton (also N and  $P_2O_5$ )
  - More concentrated with age
- Dairy manure – depends on how much water is mixed
- Beef manure

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## Potassium: Greensand

- Sandy rock or sediment containing a high percentage of the green mineral glauconite
- Up to 5% K
- Very slow K release rate (soluble K is generally  $<0.1\%$  of the total K present) - too slow to provide any significant nutritional benefit to plants at realistic application rates?
- Deposits in AR and TX - only active mine in NJ



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## Potassium: Langbeinite

- Potassium-magnesium sulfate ( $K_2SO_4 \cdot MgSO_4$ )
- Contains 18% K, 11% Mg, and 22% S
- Allowed as a nutrient if used raw, crushed form without any further refinement or purification.
- The major source underground deposits in NM



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## Potassium: Potassium sulfate

- Must be derived from natural sources
- Typically contains approximately 40% K and 17% S
- Most  $K_2SO_4$  in USA from the Great Salt Lake in Utah
- May not undergo further processing or purification after mining or evaporation, other than crushing and sieving
- Product is not allowed in some European countries without special permission from the certifying agency

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## Potassium: Rock Powders

- Mined rocks, including ballast, biotite, mica, feldspars, granite and greensand allowed without restriction
- Lot of variability in the K release rate from different mineral sources
- Some unsuitable as K sources due to their limited solubility and their heavy and bulky nature

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## Potassium: Seaweed

- Sea water ~ 0.4 g K/L
- Seaweed ~ up to several % K
- Harvested seaweed biomass can be used directly as a K source (readily soluble, typically < 2% K), or the soluble K may be extracted

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## Potassium: Sylvinite

- Potassium Chloride (KCl) is restricted unless it is from a mined source (such as sylvinite) and undergoes no further processing
- Unprocessed sylvinite ~ 17% K
- Must be applied in a manner that minimizes Cl accumulation in the soil
- Should only be used after consultation with the certifying Agency
- The Canadian GSB has included KCl on the "Permitted Substances List" for organic food production systems.

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## Potassium: Wood Ash

- Ash (from hardwood trees) is one of the earliest sources of K for building soil fertility
- An alkaline material, pH 9 to 13, effective lime equivalence 8 and 90% of commercial limestone
- Typical wood ash ~ 0% N, 1% P, and 4% K
- Use of ash from manures, biosolids, coal, and some substances is prohibited for organic production
- Check with the certifying organization before applying!

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## Economics of Soil Amendment Selection

- Commercial fertilizer
  - N ~ \$1.00 per lb
  - P<sub>2</sub>O<sub>5</sub> ~ \$0.80 per lb
  - K<sub>2</sub>O ~ \$0.80 per lb
- How much do organic nutrients cost?
  - Bulk or bagged??

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## 2009 Prices\*\*

- |                            |   |
|----------------------------|---|
| • Blood meal (12-0-0)      | \$6.25 per lb N                             |
| • Feather meal (13-0-0)    | \$4.92 per lb N                             |
| • Chilean nitrate (13-0-0) | \$4.91 per lb N                             |
| • Bone meal (1-13-0)       | \$4.91 per lb P <sub>2</sub> O <sub>5</sub> |
| • ID Rock P (0-3-0)        | \$9.83 per lb P <sub>2</sub> O <sub>5</sub> |
| • Greensand (0-0-7.5)      | \$3.33 per lb K <sub>2</sub> O              |

\*\* From Seven Springs Farm, VA  
<http://www.7springsfarm.com/catalog.html>

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## Broiler Litter in Tennessee

- Excretion by broilers\*
  - 12,000 tons nitrogen
  - 8,000 tons phosphorus (as  $P_2O_5$ )
  - 8,000 tons potassium (as  $K_2O$ )
- How many tons litter?
  - Estimated 150 to 200,000 tons
- “Typical” nutrient content
  - 60 lbs N : 50 lbs  $P_2O_5$  : 50 lbs  $K_2O$
  - Approximately a 3 : 2.5 : 2.5 fertilizer
- \$40 per ton = \$0.25 per lb NPK
- \$100 per ton = \$0.64 per lb NPK



\*Based on ASAE Manure Production Characteristics; \*ASAE D384.2 March 2005

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## Summary

- Don't guess soil test!
- Don't guess have your organic amendments analyzed!
- Match soil amendments with UT soil test recommendations
- Do not over-apply nutrients

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