

A Whirlwind Introduction to Soil Fertility, From a Farmers Perspective



STRENGTHENING OUR COLLECTIVE ENDOWMENT (SOIL FERTILITY, KNOWLEDGE, AND SKILLS)

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NOFAMASS WINTER CONFERENCE

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Spinach... oxalic acid, nitrates and nutrition... the case for locally grown nutrient dense crops



Brix Bounty Farm



Growing Food with
Respect for the Earth
& Future Generations

Tomatoes – June 27th, 2010



Nutrient Dense Crops



- Food suitable for human consumption and nutrition
- Moving beyond process to focus on outcomes – brix yield and human & animal health
- Emphasis on outcomes focuses our work on soil and crop health
- Consumer demand for taste and nutrition
- New research developing (e.g. blood sugar with mineralized fruits)
- Value vs. cost/price

Our Soils as a Foundation of Health and Wealth



- Endow: to furnish with an income; *especially*: to make a grant of money providing for the continuing support or maintenance of <endow a hospital> (www.merriam-webster.com, dec 10)
- Soils are far too important to be neglected
- Aim should be to create and maintain soils which grow healthy crops and therefore can avoid expensive use of pesticides and herbicides (who profits in this scenario? Ideally the farmer if we focus on soils...)
- Human health and future financial implications (diabetes, etc.)
- Raw material or primary wealth production
- Soils are far too important to be neglected

Folks Who Provide Insight Into Fertility



- William Albrecht – Soil Scientist at U. of Missouri, focused on percent base saturation of nutrients
 - Neal Kinsey – follows Albrecht methods
- Eliot Coleman – “The New Organic Grower”
- Sir Albert Howard – “An Agricultural Testament”
- Carey Reams – Reams Biological Theory of Ionization
 - Arden Andersen, Dan Skow – building on Reams’s work
- Rudolf Steiner – Lectures formed foundation of Biodynamic Agriculture
- And... a growing network of growers, labs, and scientists

Natural Fertility and Climatic Impact on Soils



- The Big 3
 - Glaciers
 - Volcanoes
 - Siltation
- Weathering of parent material and climate impact on soils
- Soils in the Northeast > Acidic overtime (cation leaching)
 - Lower pH - fungally dominant soils vs. bacterially dominant soils (higher pH)
- Kansas and the breadbasket - Albrecht's work examining protein in wheat vs. rainfall amounts (West to East)

What is our Endowment? North Field – Feb. 8th, 2008



North Field – Feb. 8th, 2008



June 27th, 2010



June 27th, 2010



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- Agricultural Management of our Soils > Future Impact

Chemical, Physical, Biological



- Soil health is a function and result of interrelated processes including biological, chemical, and physical characteristics.
- Chemistry influences Biology and Physics
 - Ca vs. Mg and soil flocculation
- Physical influences Chemistry and Biology
 - Oxygen necessary for soil biology
- Biology influences Chemistry and Physics
 - Mycorrhizal fungi producing Glomalin and P availability

North Field March 31st, 2010



North Field April 30th, 2010



Tomatoes – July 14th, 2010



Valley Girl Tomatoes – July 14th, 2010



Industrial Ag vs. Biological/Organic Theory



- Industrial agriculture (often referred to as “conventional agriculture”) – focus on limiting cost of inputs, with an emphasis on “feeding the plant” – i.e. using water soluble fertilizers, reliance upon “fossil fuel” sourced fertility.
- Biological/Organic agriculture focus on the health of the soil; feed the soil and let the soil feed the plant. Focus on using “organic” materials and rock minerals to strengthen biology and physical attributes of soil.
- Trophobiosis (Francis Chaboussou) – crop health with a focus on protein synthesis, limiting “free amino acids”.

Why Simplify Complex Systems?



Nutrients for the soil, plant, animal, and human



- CALCIUM (Ca^{++})
- Magnesium (Mg^{++})
- Potassium (K^+)
- Sodium (Na^+)
- Nitrogen (N) – NH_4^+ and NO_3^-
- Phosphorous (P)
- Sulfur (S)
- Carbon (C) and Hydrogen (H)
- Trace Minerals: Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn)...Cobalt(Co), Iodine (I) Molybdenum(Mo), Nickel (Ni), Selenium (Se), Silica (S)...

Reviewing Soil Analysis



- Soil testing can be an important tool in determining fertility needs and making sound amendment choices.
- Strong Acid, Weak Acid and Saturated Paste Analysis
- Field Sampling Depth – 6'' if tilled, 4'' if pasture/hay.
- Soil pH: As pH goes down, soil becomes more acidic. More H⁺ ions in the soil; replacing Ca, Mg, K, etc. which are “cation” nutrients the plant needs. It's important to look at calcium and magnesium levels before using lime to amend the soil; otherwise may end up with Mg excess.

Real Time Soil/Crop Analysis



- Observation – Farmers Footsteps as Fertility
- Soil Conductivity – ERGS
- Brix levels of Sap, Fruit
- pH and Conductivity of Sap
- Tissue Analysis

Where are the Nutrients in the Soil? ... CEC and...



Types of “Organic” Fertilizers/Amendments



- Rock Minerals – i.e. lime, soft rock phosphate, sul-po-mag...
- Organic Fertilizers – soybean meal, alfalfa meal
- Assisting Products: e.g. Humates, Sugars (Molasses)
- Biologicals – Bacteria, Fungi, BD Preps, Inoculants, etc.
- Compost and Organic Matter
- Animal Manures – chicken, sheep, goat, cow, etc.
- Fish and Seaweed
- Cover Crops – green manures (legumes), bio-accumulators (oats, buckwheat)
- Air and atmospheric deposition...

Possible Shortfalls of Conventional Fertilizers



- Focus on a crop instead of overall soil health. A band-aid approach. Short-term response.
- Production of chemical fertilizers may be deemed unsustainable; reliance on fossil fuels.
- Concentrated industrial fertilizers can have a negative impact on soil biology; e.g. KCl impact on microbes. “Oversaturation” may lead to excessive nutrient leaching (nitrates and phosphates)

Biodynamics – Closing the Fertility Loop



- Among the tenets of Biodynamic Agriculture is the “individuality” of every farm or garden.
- Biodynamic growers attempt to make their farms self-sustaining fertility wise.
- Use of Biodynamic Preps to help stimulate the soil’s natural processes.
- Emphasis on the role cows, as ruminant, can play in concentrating energies and providing a balanced compost ingredient (manure).
- “Import” amendments to help balance system

Flavor, Nutrition, and Value



- “Superb Taste” as a critical component in developing healthy diets in our children.
- Soil Fertility > High Quality Flavor and High Yield



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Calcium(s) - Ca



- **Roles**

- Absolutely essential to consider; it's in every cell! The gatekeeper...
- Calcium plays an important role in the soil; often impacting the availability and transport of nutrients to the plant.

- **Notes**

- Calcium isn't generally mobile in the soil; mixing lime through the root zone is key (if plowed land). Also it's picked up at root tip (as opposed to entire root hair length). Location in the soil matters.
- Calcium can leave the soil with Nitrate; N doesn't take Mg only Ca
- Boron's influence on Calcium ...

- **Sources**

- Lime – Hi-Calcium or Calcitic (CaCO_3) vs. Dolomitic $\text{CaMg}(\text{CO}_3)_2$
- Soft Rock Phosphate: Calcium, Phosphorous, and trace minerals
- Gypsum (Calcium Sulfate, CaS)

Magnesium - Mg



- Roles
 - Needed for Photosynthesis – part of chlorophyll molecule
- Notes
 - Higher Mg levels (vs. Ca) will tighten soils
 - Excessive Mg will require higher levels of N to grow crops
 - Mg can be taken out of the soil with S
- Sources
 - Sul-Po-Mag – Langbeinite or K-Mag – Available Source
 - Dolomitic Lime – $\text{CaMg}(\text{CO}_3)_2$
 - Magnesium Sulfate – Epsom Salts

Potassium - K



- Roles

- Metabolic functions – including regulation of stomata
- Helps build stalk strength, fruit size, bulk of crop

- Notes

- Weaker bond than Ca and Mg
- Only builds up with pH below 6.5 (water) *(Kinsey)
- Compost and Manures may hold substantial levels of “avail” K

- Sources

- Sul-Po-Mag (Langbeinite) – K-Mag
- Potassium Sulfate
- Greensand – Glaucanite
- Wood Ash

Nitrogen – NH_4 and NO_3



- Roles

- Important for increasing yields (volume)
- Necessary to build proteins in the plant

- Notes

- Ammonium vs. Nitrate > Male vs Female Growth
- Excessive Nitrogen – Free Amino Acids > Food for Insects

- Sources

- Organic matter (Humus) in soil
- Soil microbes and biological activity
- Legumes
- Manures
- Alfalfa, Blood, and Soybean Meal, Fish Emulsion

Phosphorous



- **Roles**

- Plays critical role in development of sugars (photosynthesis) and plant metabolism
- Nutrients should enter into plant as phosphate ions

- **Notes**

- Spring – low P availability in most soils
- Not mobile in the soil; but will leave the soil through surface run-off
- P:K Ratio on Int'l Ag. Labs test (weak acid test)

- **Sources**

- Soft Rock Phosphate – Colloidal Phosphate
- Bone Meal or Bone Char
- Non-organic – MonoAmmonium Phosphate (MAP) – water soluble
- Phos. Acid Fish – Organic Gem

Sulfur



- Roles

- Helps plants build proteins – pest resistance
- Impacts flavor of crop

- Notes

- Sulfur levels will generally be low in well drained soils w/o supplementation
- Reduced atmospheric deposition with clean air act

- Sources

- Organic Matter in the soil
- Sul-Po-Mag
- Sulfate form of other nutrients – Ca. Sulfate, Pot. Sulfate, etc.
- Pastille Sulfur – Keg River Canada

Sodium



- Roles
 - Along with K regulates osmotic cell pressure
- Notes
 - Well drained, higher pH soils; sodium will often be low
 - Beets, Brassicas, Celery, Apples and Tomatoes (skin color) are a few crops which need adequate sodium...
- Sources
 - Sea Salts – Sea 90
 - Manure and Compost
 - Organic Matter and Fish Emulsion, Kelp Meal
 - Seaweed

Micro Nutrients and Trace Minerals – Full Spectrum Fertility



- Roles
 - Enzymes and Enzyme Activators
- Notes
 - Interactions with other minerals...
 - Boron- Relationship with Calcium and disease prevention
 - Manganese – Fruit Crops and Disease...
 - Cobalt, Molybdenum, Selenium
- Sources
 - Various – Sulfates and Chelated Forms
 - Solubor (boron)
 - Trace Mineral “Rocks” and “Salts” – Azomite, Planters II, Sea-90
 - Fish Fertilizer – Organic Gem, Neptune’s Harvest

Earthworms, Chickens, and Cows: Making Nutrients Available



Biologicals – Going Beyond NPK



- Humates – Improve efficiency of Carbon and N fertilizers; assist with chelation of minerals
- Sugars – Energy for soil biology
- Mycorrhizal Fungi – Most vegetable crops except brassicas and chenopods (beets, chard)
- Bacterial Inoculant – Rhizobia for legumes and more...
- Compost Tea –

Methods of Spreading Amendments/Fertilizers



- Broadcasting – using spreader, hand and bucket, etc.
- Synergy– amend a soil mix used for transplants
- Targeted Application (i.e. seed inoculation, in furrow at transplanting, banded in the row)
- Sidedressing – applied to root zone once crop is growing
- Field Sprays – broadcasting with liquids
- Foliar Sprays – foliar applications have been proven to be a highly effective way of getting nutrients into the crop
- Note on Chelation... and forms of nutrients: rocks v salts

Why Fertilize in the Fall? or February (its not too late)



- Fertilizing and Spreading Amendments in the fall (or ahead of the growing season) allows for the biological activity of the soil to begin to work to make minerals available for the next season's crop.
- Providing additional energy to the fields in the fall can help with crop breakdown (if crops aren't adequately broken down 'til the spring they may tie up nitrogen).
 - Consider use of BD 500 (horn manure)
 - Other "biologicals" available, balancing C:N ratios for breakdown

Resources: Websites/Organizations



- Books/Publications (just a few):
 - Acres USA
 - The Albrecht Papers – re-published by ACRES USA
 - Science in Agriculture – Arden Andersen
 - The New Organic Grower – Eliot Coleman
 - Biodynamics – Rudolf Steiner
 - Hands-on Agronomy – Neil Kinsey
- Websites:
 - Brix Bounty Farm & Garden Resource Page - <http://brixbounty.com>
 - ATTRA - <http://www.attra.ncat.org/>
 - MOFGA – Maine Organic Farmers & Gardeners Association Fact Sheets - <http://www.mofga.org/>

Resources: Amendment/Fertility Sources



- On the Farm... Green Manures and Composts
- The Atmosphere and Surrounding Environment (coastal fog)
 - Harnessing Photosynthetic Potential
- [Fedco – Organic Growers Supply](#) (Maine)
- [Lancaster Ag](#) (Pennsylvania)
- NOFA-MASS Bulk Order – postmark deadline Jan. 31
- Nutrient Density Supply Company – Dan Kittredge (MA)
- Conklin Limestone (Rhode Island) – Hi-Cal Lime
- [Crop Production Services](#) (South Deerfield, MA)
- Fieldworks (Westport, MA and CT)
- Zuber's Feed and Grain, Marvin Grain (Dartmouth)

You Can't Eat Dollar Bills – A More Delicious Endowment for Future Generations



Thank You for Strengthening our Endowment



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Real Food Campaign - www.realfoodcampaign.org

Nutrient Dense Crop Production Courses - 2011

Vermont

- **[Shelburne Farms](#) Shelburne, VT**
Saturdays: Dec 4, Mar 5, Apr 30, June 25, Aug 20
- **[The Mountain School](#) Vershire, VT**
Sundays: Jan 23, Mar 6, May 1, June 26, Aug 21

New York

- **[Hawthorne Valley Farm](#) Ghent, NY**
Sundays: Jan 16, Mar 20, May 22, July 17, Sep 18
- **[Stone Barns Center](#) Pocantico Hills, NY**
Saturdays: Dec 18, Mar 12, May 14, July 16, Sep 17

Connecticut

- **[White Gate Farm](#) East Lyme, CT**
Sundays: Dec 19, Mar 13, May 15, July 10, Sep 11

Massachusetts

- **[Simple Gifts Farm](#) Amherst, MA**
Saturdays: Nov 20, Feb 12, May 7, July 9, Sep 10
- **[Brix Bounty Farm](#) Dartmouth, MA**
Saturdays: Jan 8, Feb 19, Apr 16, June 18, Aug 27
- **[Jones Farm](#) Chelmsford, MA**
Sundays: Jan 9, Feb 20, Apr 17, June 19, Aug 28

