# Chicken Soup for the Soil

*by Jerry Brunetti*

I've always been a fan of foliar nutrition, especially on forages. However, I don't advocate the application of foliar fertilizers as a replacement for sound agronomic practices involving comprehensive soil analysis (including multiple trace elements), tissue testing, and an evaluation of the soil ecology. A soil test can be quite easy to interpret and recommendations can just as easily be made based on the results of the test. Since many articles on soil fertility appear in *Acres U.S.A.*, suffice this article to provide the reader with an "ideal" test based upon a Mellick III Extraction (Table 1).

Forage tests generally determine whether or not you are on target with adequate feeding of the crop and are becoming considerably more revealing than in the past. This is especially true in the measurement of total digestibility and fiber digestibility, protein quality, and the various fractions of energy such as sugars, starches, digestible NDF, etc.

Relative to measuring biology, I like to poke around in the soil and dung to observe which organisms are present. One of my favorite instruments is a soil penetrometer, which measures soil compaction by disclosing the pounds per square inch (psi) every several inches of depth in the soil. When exceeding 200 psi, your ground is tightening up, which means it's becoming less aerobic and thus more anaerobic. Like livestock and humans, soil ecosystems need free oxygen in order to breathe. A lack of pore space indicates a lack of oxygen, which results in the disappearance of aerobic life forms.

In anaerobic soils, nitrate ($NO_3$-) is denitrified into nitrite ($NO_2$-), nitric oxide (NO), nitrous oxide ($N_2O$) and nitrogen ($N_2$). This is a wasteful loss of the raw material that creates plant proteins. Adequate oxygen creates adequate aerobic organisms, which exhale carbon dioxide ($CO_2$) gas at 3,000-4,000 ppm in the soil atmosphere. $CO_2$ is absorbed by the plant stomata to combine with water ($H_2O$) and sunlight inside the chloroplast to create plant sugars (CHO).

## Table 1: Soil Report Analysis

| | ***Ideal*** |
|---|---|
| TEC (ME) 1 | 2+ |
| pH | 6.3-6.5 |
| Organic matter (%) | 3-5% |
| Sulfur | 25-50 ppm |
| Phosphate p2o5 (lbs/acre) | 250-350 lbs/acre |
| Calcium (lbs/acre) | 1,904 (68%) |
| Magnesium (lbs/acre) | 192 (12%) |
| Potassium (lbs/acre) | 208 (3-5%) |
| Sodium (lbs/acre) | <100 lbs/acre (.5-3%) |
| Hydrogen (%) | 10% |
| Boron | 1-2 ppm |
| Iron | 100-300 ppm |
| Manganese | 20-45 ppm |
| Copper | 2-5 ppm |
| Zinc | 5-10 ppm |
| Aluminum | <1400 ppm |
| Silica | 80-100 ppm |
| Molybdenum | 0.4-0.7 ppm |
| Cobalt | 0.1-0.5 ppm |
| Selenium | 1(+) ppm |
| Chromium | 1-3(+) ppm |

## Table 2: Estimated Numbers of Common Micro-Organisms Found in Healthy Agricultural Soils

| | |
|---|---|
| Bacteria | 3,000,000 to 500,000,000 in 1 g. |
| Actinomycetes | 1,000,000 to 20,000,000 in 1 g. |
| Fungi | 5,000 to 1,000,000 in 1 g. |
| Protozoa | 1,000 to 500,000 in 1 g. |
| Algae | 1,000 to 500,000 in 1 g. |
| Yeasts | 1,000 to 100,000 in 1 g. |
| Nematodes | 10 to 5,000 in 1 g. |

Granulated soil, two to three feet deep, is ideal because it allows plant roots to burrow into the subsoil, which weather-proofs the crop from both excess flooding and drought. If the soil is compacted, do what the golf course industry regularly does — aerate! Subsoiling a couple of inches below the hardpan or plowpan when the soil is moist (not dry, not waterlogged) can perform wonders in allowing root systems to expand. Additionally, an aerification appliance such as the Aeraway is extremely helpful in maintaining the aerobic zone in the top 6 to 8 inches. Cattle are heavy animals, and unless you are a mob grazer and won't return the herd to paddocks for a number of months, they will compact soils quite substantially.

While we're on the subject of biology, how many of you farming folk who have livestock would consider yourselves "manurologists," especially on dung from large livestock? The cowpie is its own eco-system, harboring wonderful livestock friends that not only help control face, horn, stable and house flies, but also consist of dung decomposers that eliminate the patty as a future habitat for parasites. A single dung pat may contain *more than 1,000 insects*, most of them beneficial if you have a pesticide-free, parasiticide-free farm. Mites, spiders, parasitoid wasps, and predator beetles such as rove, ground and carcinops, prey on livestock pests' eggs, larvae and pupae, while earthworms, dung beetles and eventually ants consume and bury the pat.

Dung beetles have shown to reduce nematodes (parasite) larvae by as much as 90 percent and hornfly larvae by 95 percent! There are roughly a dozen important species of dung

beetles in the United States that aggressively attack manure so that it doesn't smother the forages. Dung beetles recycle nitrogen, aerate the soil, and reduce 90 percent of the pasture manure in one week. Millions of acres of pasture are lost annually in the United States due to a lack of manure decomposers.

Table 2 illustrates the sheer number of microorganisms found in a given gram of fertile soil. There are virtually 1.5 to 2 million species of soil microorganisms, yet fewer than 5 percent have been identified, and it's still unknown how many types dwell in the guts of the larger life forms such as beetles, springtails, mites, earthworms, etc. Leonardo da Vinci was right in the 16th century when he said we know more about the movements of celestial bodies than we know about soil life. Little has changed in 500 years.

Earthworms (*Lumbricus terrestris*) at a count of only 25 worms per square foot and a spade deep would provide about one million worms per acre, which in turn would excrete 62,000 pounds of worm castings per acre per year. While aerating and tilling the soil they are capable of burrowing eight feet deep. Worm castings are not only rich in nitrogen, phosphorus, potassium, calcium, magnesium and micro-nutrients, but are also rich in microbes and microbe stimulants. What's best about worm manure is that the worms produce a product that isn't phytotoxic, i.e., too high in salts, ammonia, nitrite, etc. Therefore, by incorporating vermicompost, either by making your own or by purchasing it, you'll supply the *crème de la crème* of a compost tea.

## Table 3: Optimum Parameters for Forage Nutrient Density

Nitrogen: 3.2-3.5% (20-22% CP) ADF insol/CP: < 90%
ADF: 28-30% NDF: 38-43%

| *Wet Chem.* | *Legumes* | *Grasses* |
|---|---|---|
| Ca | 1.5-2.0% | 1.2-2.0% |
| P | 0.35-0.50% | 0.25-0.40% |
| Mg | 0.35-0.50% | 0.30-0.50% |
| K | 2.0% (1:1 with Ca) | 2.0-3.0% |
| S | 0.32- 0.35% | 0.32-0.35% |
| (N:S Ratio = at least 1 part Sulfur: 10 parts Nitrogen) | | |
| Na | 0.20-0.50% | 0.20-0.50% |
| Cl | 0.40% | 0.40% |
| Si | 0.50-1.5% | 1.0%-3.0% |
| ***Trace Minerals*** | ***Legumes*** | ***Grasses*** |
| Boron | 40 ppm+ | 25 ppm+ |
| Cu | 15 ppm+ | 15 ppm |
| Mn | 35 ppm+ | 55 ppm |
| Zn | 30 ppm+ | 45 ppm |
| Fe | <200 ppm | <100 ppm |
| Al | <100 ppm | <100 ppm |
| Mb | | 3 ppm |
| Co | | 0.13 ppm |
| Se | | 0.20 ppm+ |
| I | | 0.50 ppm |
| Cr | | 1-3 ppm |

### NUTRITIOUS SOIL SOUP

Consider the following "soup mix." Start by brewing a tea using high-quality compost or vermicompost. Then "spike" a 40-50 gallon finished stock solution with the following ingredients and spray it on paddocks approximately ten days following a grazing or cutting:

- 2 gallons fish emulsion
- 1 quart seaweed extract
- 5 lbs dextrose sugar
- 1 quart humic acid extract
- 5 lbs Epsom salts
- 4 oz boric acid
- 2 gallons calcium nitrate (not for organic use)
- 1 quart 85 percent phosphoric acid (not for organic use)
- 1 pint of "Fusion," a fulvic extract with trace elements
- Wetting agent as per label

In order to meet the optimum levels you want to accumulate in the plant tissue, based on the tissue test results, add small amounts (e.g., 1 ounce) of copper, zinc, manganese, iron, cobalt and/or molybdenum. If mixing Epsom salts and/or calcium nitrate with phosphoric acid, please know that these are incompatible cation/anionic ingredients and can only be blended together if you use a catalyst such as Fusion, a remarkable, humic/fulvic extraction containing fulvic acid and approximately several dozen trace elements. It performs like a catalyst in allowing incompatible anion and cations to be mixed without a reaction. It also acts as a chelating agent, a biostimulant and is a source of micronutrients. It has a pH of 2.5-3.0, so it will help adjust the tank mix pH to below pH 6, which is preferred in order to effect optimum absorption by plant stomata. *If you are organically certified, the use of calcium nitrate and phosphoric acid are*

*prohibited.* Shop around for micronized calcium and phosphate mineral sources, ideally below 5 microns, which approximates the diameter of the stomata opening. Spray when temperatures are below 80 F, again to increase absorption into the plant stomata.

This soup readily benefits the soil ecology as well as the plant tissue. Monitor the progress of this application by getting a comprehensive forage analysis.

Table 3 is an example of what amounts of nutrient density one should look for in legumes and grasses. On site, one can do relative hand meter measurements, using tools such as a brix refractomer, plant-sap pH test, and plant-sap nitrogen and plant-sap potassium. Supposedly, plant-sap pH should reflect ideal soil and saliva pH — about 6.4. Lower than 6.4 indicates a fungal susceptibility, and higher than 6.4 indicates a susceptibility to insects.

Note that the brix refractomer is a relative tool. For example, even though a "perfect world" brix of greater than 12 is the target, testing for brix after several days of cloudy weather will give you a reading substantially below what one would get after several days of sunshine. Measuring for brix late in the afternoon will yield higher readings than in the morning, for the simple reason that photosynthesis has been occurring for a longer period of time. Thus, to really know how you are progressing, measure a treated plot against a control plot on the same soil at the same time. Of course, this applies to measurements of plant-sap potassium and plant-sap nitrogen as well.

Ultimately, the results will be determined by the old adage, "the proof of the pudding is in the eating." Since livestock don't eat soil as a primary feedstock, have your forages thoroughly analyzed. Then watch your livestock. Are lactation and growth improving? Do the animals come in heat and settle more successfully? Are the young stocks thriftier? Is the herd or flock more immuno-competent, *i.e.*, less susceptibility to mastitis, respiratory challenges, parasite opportunism, etc.?

Foliar soup mixes work as part of a "systems approach" to farm productivity, health and performance. In other words, they appear to give the farmer the biggest return on their investment when soils are recognized as the foundation of a profitable farm, including soil fertility (minerals), soil ecology (biology) and soil structure/tilth, all of which influence one another.

The results from applying a foliar soup mix are especially dramatic when the extremes of weather pay a visit upon the landscape, namely drought and heat, or conversely, cold and wet spells. One thing for sure, we don't seem to have "climate" anymore — just vagaries of the weather.

We've also witnessed dramatic improvements on golf courses, a habitat where plant stress is at an extreme due to the fact that a monoculture is grown upon 90 percent sand and is force-fed nitrogen along with heavy applications of herbicides, insecticides and fungicides. Even in this stressful environment, we've discovered that disease and insect pressure are reduced due to a boost in the biological factors associated with microbes, microbial exudates, auxins, cytokinins, hormones and enzymes, which interrupt disease processes.

Foliar soup mixes contribute nutritionally and help build plant immunity which results in a decrease in pesticide use so there's less interference with enzyme systems necessary for plants to synthesize complete proteins and carbohydrates. Plants rich in complete proteins and carbohydrates are less than optimum substrates for insects and diseases because these primitive organisms produce unsophisticated digestive enzymes capable of breaking down simple "funny" proteins such as nitrate, free amino acids, NPN (vs. complete proteins) and simple sugars rather than polysaccharides, starches and pectins.

So, to stay healthy, eat nutrient-dense foods (minerals), maintain optimum digestion (soil micro-flora), and *eat your soup!*

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