



# Farming Smart for a Sustainable Future

## Increasing profits by improving soil conditions Part I of 4-part Series

**W**ith input costs soaring and returns declining, problems on the farm seem to be getting out of hand. The business of farming is very complex and confusing at best. There are ways to reduce your input costs and increase your profits, while at the same time improving your soil conditions, plant and livestock health. It focuses on soil health and is called *biological farming*. It utilizes resources of both science and nature in a superior farming system. It works with natural laws, not against them, which is how things were designed to work. Biological farming improves the environment, reduces erosion, reduces disease and insect pressure, and alters weed pressure, and it accomplishes this while working in harmony with nature.

Let's share some ideas and suggestions for making farming more fun and **profitable**. Biological farming is a different type of farming – working with nature, feeding soil life, balancing soil minerals and tilling soils with a purpose. One can't credit any one thing for making biological farming successful – it is a whole-farm management *system*. There is no one right way; this is not an exact science.

No question about it, you can get high yields with lots of commercial fertilizers and synthetic chemicals for weed, insect and disease control. There are, however, some concerns and problems. Is this food production system *safe* and *sustainable*? At best we can only hope we are not creating more problems for the future. We do need to keep production up to help feed the people, however we can do that by working toward elimination of limiting factors to production. Once the soil's chemical (nutrients), physical and biological properties are in balance, you can expect optimum production, even in bad years.

*"The trouble with the world is not that people know too little, but that they know so many things that ain't so."*

Mark Twain

The main objectives are to provide a soil which is well drained, loose and crumbly, with lots of soil life, and mineralized with lots of essential elements. Select the proper sources of materials and manage the excesses as well as the deficiencies. That is what it takes to grow high-yielding, healthy crops/plants of any kind on all soils.

Building healthy mineralized soils takes time. The speed of correction has to do with soil types and present soil conditions. For most farms, it takes three to five years, which really is a short time considering how long it has

taken to get the land in the shape it is now. Observation can clue you in along the way during transformation to healthy soils. Feed quality and insect pressure usually change first.

The six main principles to achieving a balanced soil are:

1. Keep the soil covered by having a plant growing the year round (plant cover crops in the "off-season")
2. Grow as many different species of plants as practical (diversify the crop rotation and cover crops)
3. Manage plant residues (avoid burning)
4. Manage for active biological functions below the soil (earthworms)
5. Disturb the soil as little as possible (avoid excessive tillage)
6. Limit physical, chemical and biological disturbances (tillage, fertilizer, pesticides, overgrazing)

By altering cropping, grazing or pasture maintenance practices, soil health can be restored. By altering management practices and restoring soil health, the use of pesticides, herbicides and fertilizers can be greatly reduced and production yields will maintain if not increase due to a vital nutrient supply from the practice of continually building organic matter. A healthy soil will produce long term consistent yields at a lower cost. The two most powerful things you can do for your soil is to provide a living root the year round and manage for earthworm activity. By diversifying the species of plants growing you can better provide what the soil needs. Alternative practices such as cover crops, interseeding, compost, diverse crop rotation, manure application and reduced or no-tillage farming will all create additional organic matter and stabilize the soil structure for better drainage and improve water holding capacity.

Follow the four-part series for more tips and techniques for managing for improved soil health. NRCS will soon be offering financial assistance directed toward improving soil health. For more information, please contact your local NRCS office at (STREET and CITY address), (PHONE) or visit us online [www.mo.usda.gov](http://www.mo.usda.gov).

*In 1794, Thomas Jefferson was using vetch, turnips, peas and clover as cover crops to improve soil health on his Virginia plantation.*

*Thomas Jefferson's Garden Book,  
1774-1824*



# Farming Smart for a Sustainable Future

## Increasing profits by improving soil conditions Part II of 4-part Series

In Part I, you learned a little about the main thoughts and ideas behind changing the way we think about farming—from using conventional methods to turning our attention toward soil health. Let's build a little on that thought process and dive a little deeper into the mechanics of *biological farming* for improved soil health.

Skilled biological farmers learn how to take care of soil life—they nurture it, feed it a balanced diet, and use tillage tools and methods to enhance soil life. Farmers must understand proper use of livestock manure, compost and green manure crops. Learn how to evaluate soil for its health, tillage and soil life. Develop an understanding of fertilizers and soil fertility, the steps and methods to get soils in

balance, and the proper use of fertilizers. Learn the “when” and “how” of fertilizer use for soil correction, feeding soil life, balancing nutrients, and feeding the crop with the proper balance between soluble and slow-release materials.

Three important parts of your soil are (1) the organic particles that serve as a reservoir of plant foods, (2) the soil minerals, and (3) the living portion, consisting of bacteria, fungi, algae and larger organisms such as earthworms. These organisms are alive and need air, water and organic matter (food) and a safe place to live. Work with them, because the productivity of your farm is in direct proportion to the number, activity and balance of soil organisms. In many soils, a good measure is a minimum of 10-25 earthworms per cubic foot of soil. Some insecticides that are harmful to earthworms include, but are not limited to: Temik, Sevin, Furadan, Dursban, Mocap, Mesuroil, Lannate, Baygon, Thimet.

Sustainability is the key factor to becoming a biological farmer. Balance is the key, not only for economic, but ecological reasons as well. It is essential to provide all elements to your crops and to soil organisms in the proper balance. An excess of some nutrients can be as limiting as deficiencies of others. Agronomists and soil scientist have written that at least 16 elements are (essential) needed to grow plants. *The productivity of a soil can never be greater than the plant food elements in least supply.* You need to make these nutrients “exchangeable” or available to the roots of the plant. Because nutrients can interact, an excess of some elements can cause a shortage of others, even though it appears there is enough on a soil test. Managing your crops to produce large root systems that will recover the nutrients, plus working with soil organisms so they make nutrients available and exchangeable, can make farming fun and profitable.

Rules for biological farming:

1. Test and Balance Your Soil – plants need more than N, P and K. Test for the following 10 nutrients: phosphorus, potassium, calcium, magnesium, sulfur, zinc, manganese, iron, copper and boron. Adjust calcium first.
2. Use Fertilizers Which Are Life-Promoting and Non-Harmful – use natural, mined fertilizers and small amounts of the highest quality manufactured fertilizers (see part III for suggested products)
3. Use Pesticides and Herbicides in Minimum Amounts and Only when Absolutely Necessary – try non-toxic methods first, if they fail and if crop damage is above the economic threshold, toxic chemicals might be considered. Try reducing the concentration, banding or spot-spraying and adding humic acid to the tank to balance the pH of the tank mix
4. Use a Balanced Crop Rotation – rotate crops regularly and incorporate diverse species of cover crops
5. Use Tillage to Control Decay of Organic Materials and to Control Soil, Air and Water – till raw organic matter (plant residues and animal manures) into the upper layers of the soil. Avoid inverting (turning over) the soil, but rather use equipment that slices and uplifts it. Never till soil that is wet. Consider tillage radishes to break up a hardpan.
6. Feed Soil Life – adding rock phosphate or a little lime to compost piles will produce a more balanced fertilizer. Incorporate green manure crops, like rye, red clover, Australian field peas, alfalfa or buckwheat. Do not apply heavy applications of manure or other raw organic matter (it is better to apply a lighter coat over more acres). Consider biological stimulants like kelp (seaweed), humic acids, enzymes, vitamins and hormones.

### DID YOU KNOW?

Cornell University offers a *Soil Health Test* – which tests not only the traditional Chemical factors, but also Physical and Biological.

*The weight of all the bacteria in 1 acre of soil can equal the weight of one or two cows!*

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# Farming Smart for a Sustainable Future

## Increasing profits by improving soil conditions Part III of 4-part Series

In Part I, you learned a little about the main thoughts and ideas behind changing the way we think about farming from using conventional methods to turning our attention toward soil health. In Part II, you learned the six rules for biological farming. Let's build on those ideas and explain a little of the mechanics behind those *rules*.

**Rule 1 – Test and Balance Your Soil** - Test for the following 10 nutrients: phosphorus, potassium, calcium, magnesium, sulfur, zinc, manganese, iron, copper and boron. Adjust calcium first. Cornell University offers a Soil Health Test – which tests not only for the traditional chemical factors, but also the physical and biological factors and also provides clue to the limiting factors in your soil.

**Rule 2 – Use Fertilizers Which are Life-Promoting and Non-Harmful** – sometimes the cheapest source of an element is not the best source.

Highly soluble commercial

phosphorus fertilizers have a hardening effect on the soil. The most common potassium fertilizer, potassium chloride, is a strong salt containing 47% chloride (which can kill beneficial soil life and injure roots). The typical vicious circle – apply commercial fertilizer, the soil gets harder and erodes, water quality deteriorates, animal and human health problems increase, pests and weeds proliferate, and more fertilizers and chemicals are continually needed. Try the following natural, mined products:

- Phosphorus
  - Idaho phosphate – a natural marine shell deposit containing 30% calcium, 28% phosphorus, carbon and other trace elements. It provides a continuous slow-release supply of phosphorus.
  - North Carolina reactive rock phosphate – 33% calcium, 33% phosphorus and some trace elements. Provides phosphorus more readily than other rock phosphates yet contains slow-release phosphorus.
  - Monoammonium phosphate (MAP, 11-52-0) – a low pH soluble source of phosphorus (good on high pH soils)
- Potassium
  - Potassium sulfate (0-0-50) – high quality mined potassium source with a lower salt index and lower chloride content.
- Calcium
  - High-calcium lime (calcium carbonate) – recommended on low pH soil (pH 6.0 or under). Dolomitic lime (calcium magnesium carbonate) is not required on high magnesium soils.
  - Bio-Cal – highly soluble high-calcium source that also contains sulfur and boron (requires much less per acre application rate than typical lime products)
  - Gypsum (calcium sulfate) – calcium and sulfur source that works well where calcium is high and the pH is over 7.0.
- Essential Elements
  - Ammonium Sulfate (21-0-0-24S) – excellent source of nitrogen and sulfur. Helps reduce high magnesium levels.

- Ammonium Nitrate (28-0-0) – good source of nitrogen as a liquid (great for side-dressing corn)
- Calcium Nitrate – good source of nitrogen and calcium for foliar feeding and vegetables
- Trace elements – use the sulfate or chelated forms
- Unacceptable Fertilizer Materials
  - Dolomitic lime (calcium magnesium carbonate) – may be useful on low-magnesium soils, but use with caution as high-magnesium makes soils compact and tight
  - Potassium Chloride (0-0-60 or 0-0-62) – high percentage of chloride and is a strong salt (causes salt damage to seedlings and roots and can kill beneficial life) – may also cause nutrient imbalances and livestock health problems
  - Anhydrous ammonia – kills any life near the injection point, including crop roots. Hardening effect of the soil and causes soil to become acidic.
  - Diammonium phosphate (DAP, 18-46-0) and Urea – release considerable amounts of ammonia in the soil, harming seedlings or roots
  - Oxide-form trace elements – lacking sulfates and chelates

**Rule 3 - Use Pesticides and Herbicides in Minimum Amounts and Only when Absolutely Necessary** – try non-toxic methods first, if they fail and if crop damage is above the economic threshold, toxic chemicals might be considered. Try reducing the concentration, banding or spot-spraying and adding humic acid to the tank to balance the pH of the tank mix

**Rule 4 - Use a Balanced Crop Rotation** – rotate crops regularly and incorporate diverse species of cover crops

**Rule 5 - Use Tillage to Control Decay of Organic Materials and to Control Soil, Air and Water** – till raw organic matter (plant residues and animal manures) into the upper layers of the soil. Avoid inverting (turning over) the soil, but rather use equipment that slices and uplifts it. Never till soil that is wet. Consider tillage radishes to break up a hardpan.

**Rule 6 - Feed Soil Life** – adding rock phosphate or a little lime to compost piles will produce a more balanced fertilizer. Incorporate green manure crops, like rye, red clover, Australian field peas, alfalfa or buckwheat. Do not apply heavy applications of manure or other raw organic matter (it is better to apply a lighter coat over more acres). Consider biological stimulants like kelp (seaweed), humic acids, enzymes, vitamins and hormones.

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*The target level of organic matter in healthy soil is 3-5%. Potential yield could increase by about 12% for every 1% increase in organic matter. What is your soil organic matter?*

*It takes about 4,000 to 6,000 pounds of plant residue per year to maintain the content of organic matter in soil. How much are you leaving?*



# Farming Smart for a Sustainable Future

## Increasing profits by improving soil conditions Part IV of 4-part Series

In Part I, you learned a little about the main thoughts and ideas behind changing the way we think about farming from using conventional methods to turning our attention toward soil health. In Part II, you learned the six rules for biological farming. In Part III, you learned a little more about acceptable and unacceptable fertilizer materials. Let's re-iterate some of the main ideas.

The six main principles to achieving a balanced soil are:

1. Keep the soil covered by having a plant growing the year round (plant cover crops in the "off-season")
2. Grow as many different species of plants as practical (diversify the crop rotation and cover crops)
3. Manage plant residues (avoid burning)

4. Manage for active biological functions below the soil (earthworms)
5. Disturb the soil as little as possible (avoid excessive tillage)
6. Limit physical, chemical and biological disturbances (tillage, fertilizer, pesticides, overgrazing)

Rules of biological farming:

1. Test and Balance Your Soil
2. Use Fertilizers Which are Life-Promoting and Non-Harmful
3. Use Pesticides and Herbicides in Minimum Amounts and Only when Absolutely
4. Use a Balanced Crop Rotation
5. Use Tillage to Control Decay of Organic Materials and to Control Soil, Air and Water
6. Feed Soil Life

So the one piece to this puzzle that hasn't been discussed yet is the economics. We all know the underlying reason behind most decisions is economics. So how much is an inch of soil worth? 1 acre of soil equals 3,639 ft<sup>3</sup>. If you are purchasing bagged fertilizer (which cover approx. 2 ft<sup>3</sup>), you need 1,815 bags. The cheapest bag of fertilizer is approx \$2.50 per bag – that equals \$4,538 for one acre. However, the higher priced bag of fertilizer (Miracle Grow) is approx \$7.00 per bag – that equals \$12,705 for one acre. How much can you afford?

Some economic impacts of not building soil quality are also costly. On a field with a current erosion rate of 7.6 tons/acre/year, it costs \$40 per acre each year to replace the lost nutrients as fertilizer and \$17 per acre to pump well irrigation water to replace the lost water holding capacity of the soil. This equates to more than \$27 billion a year of lost soil and water on US cropland alone.

Plant residues left on a field after harvest are also a valuable resource. The value of removed nutrients is approx. \$26/ton (1 ton of corn residue has 17 pounds of nitrogen, 4 pounds of phosphorus, 50 pounds of potassium and 3 pounds of sulfur). These valuable nutrients must then be returned to the soil by some other means.

So what is the monetary value of:

- 1 ton of top soil
- 1 inch of water
- 1 ton of residue
- 1-2% increase in organic matter
- 9 billion microorganisms in one teaspoon of healthy soil
- Clean water and air
- Plant, human, and animal health

*Management, balance and efficiency are what make farming profitable.*

Do we really know? Can we put a price tag on soil quality or the capacity of the soil to function? There may not be any definitive answers, but the time has come to change our way of thinking and shift our farming systems to become more sustainable.

Biological farming is a program, not just adding a single product and hoping for a miracle. There are no pills, potions, powders or silver bullets. It takes time to change things, and there is no one single way to do things. But there are ways that make sense. To be successful in the long run, you must use an approach where you are working *with* and properly utilizing nature's biological systems.

Biological farming respects nature and realizes that man doesn't know it all. Plants and animals grow by natural laws, and they grow best when natural laws are followed, not overpowered. Life operates in natural cycles. One thing affects another. The way soil is fertilized controls the quality of the plants. Plant quality affects animal and human health and productivity. Healthy soils, healthy plants, healthy livestock and humans.

Open your mind and eyes and look around. Imagine new possibilities, try new things and be willing to be different from your neighbors. Many farmers are farming biologically right now. There are many books and printed materials that provide useful information. Visit the farms, read the books, and check it out for yourself. NRCS will soon be offering financial assistance directed toward improving soil health. For more information, please contact your local NRCS office at (STREET and CITY address), (PHONE) or visit us online [www.mo.usda.gov](http://www.mo.usda.gov).

*Don't just accept the farm situation the way it is. Biological farm will improve things.*