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ALTERNATIVE SOIL AMENDMENTS

HORTICULTURE TECHNICAL NOTE

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ABSTRACT: *This publication covers soil amendments that are not standard agricultural fertilizers. These include plant and animal by-products, rock powders, seaweed, inoculants, conditioners and others. Much of the information is taken from research reports by Iowa State University and the Rodale Institute Research Center, which cover the material in greater detail (2, 9). The reader is referred to these works for additional information. Another ATTRA publication, Sources for Organic Fertilizers and Amendments, serves as a companion piece to this document. It provides sources for the materials discussed herein.*

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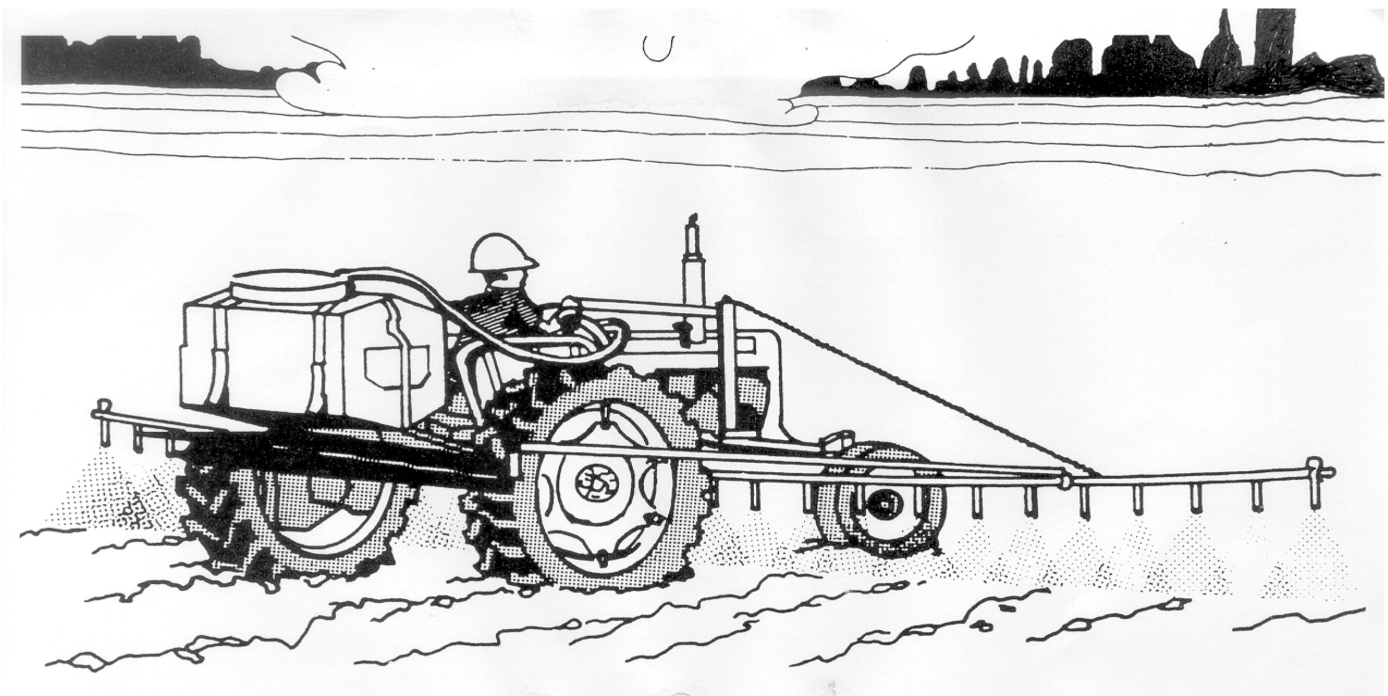

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Amendments In Proper Context

The *sustainability* of a farm system is only marginally related to fertilizer and other inputs. Intrinsic soil factors such as slope, texture, and local rainfall, along with management-related factors such as a forage-based rotation, soil organic matter, aggregate stability, and tillage practices, have a much greater influence on the sustainability of any given farm than does the type or amount of soil amendments. Shifting from conventional inputs to alternative ones does little to increase overall sustainability.

For example, yields of most crops will be reduced in soils with poor or excessive drainage, and when soil pH is too acidic or alkaline for the crop's needs. Only if soil moisture, air, and acidity regimes are generally correct do the major nutrients—nitrogen, phosphate, and potash—begin to exert significant influence on yields. In other words, if a soil is excessively acid and poorly drained it doesn't really matter how much fertilizer (conventional or alternative) is applied; yields will still be disappointing.

In most cases, alternative products are appropriate and effective as minor components of a highly developed system of whole-farm management. They are most effective in fine-tuning a system that already functions relatively well. This fact is well worth remembering when talking with vendors at a trade show or planning a product purchase. It is wise to evaluate their potential usefulness in view of other use for the same money.

Farmers for whom organic certification is an important element of marketing should check carefully with their certification program before buying any product that they do not positively know is approved on a brand-name basis.

Organic certification programs and their field inspectors have reported persistent problems with alternative soil amendments other than the better-known alternative fertilizer materials. Some farmers have been refused certification because they took the word of a product promoter and applied an alternative soil amendment without ensuring that it was approved by the program under which they sought certification. Some alternative soil amendments either contain ingredients that disqualify them from use in certified production, or contain "secret" ingredients that prevent a certification program from evaluating whether or not that specific brand can be approved.

ATTRA has additional information on organic certification, plus a list of certifiers, available upon request. ATTRA has some good introductory material on sustainable soil management; ask for ATTRA publications *Overview of Cover Crops & Green Manures* and *Sustainable Soil Management.*

Plant & Animal By-Products

Assorted by-products of the food and fiber industries are occasionally used as soil amendments, returning to the land nutrients that might otherwise be wasted.
Many of these products are far too expensive to justify their use in other than very specialized horticultural applications.

Plant by-products

<u>Alfalfa meal</u> (or pellets) contains around 3% nitrogen and is commonly used as an animal feed. It is an excellent fertilizer material in horticulture, and is said to contain unknown growth factors which make its mineral content more effective as plant nutrients.

<u>Cottonseed meal</u> is a rich source of nitrogen (7%). Unfortunately, a substantial percentage of the insecticides used in the U.S. are applied to cotton, and some of these tend to leave residues in the seeds. Most organic certification programs restrict or prohibit the use of cottonseed meal.

<u>Fruit pomaces</u> are what remain after the juice is extracted. They are heavy, wet products normally available only locally, and best composted before use.

<u>Leaf compost</u> is increasingly available as more and more municipalities compost urban and

suburban leaves. In principle, the product is a good one, but it is often contaminated with "impurities" ranging from transmission fluid to trash bags.

Soybean meal is, like alfalfa, most commonly used as a protein supplement for animal feeds. With about 7% nitrogen it can be a useful, but expensive, fertilizer material.

Wood ash contains about 2% phosphate and 6% potash, but may be contaminated with heavy metals or plastic and typically has a high salt content. Wood ash is rather alkaline, and excessive use can be quite damaging to many soils. Some organic programs restrict its use.

Animal by-products

Blood meal is dried slaughterhouse waste containing about 12% nitrogen. Unless used carefully, it can burn plants with ammonia, lose much of its nitrogen through volatilization, or encourage fungal growth. In view of the extremely high cost of blood meal, farmers should be sure that it really is the best source of nitrogen in a given situation.

Bone meal is discussed under phosphate sources, in the section titled "Rock and Mineral Powders."

Feather meal is a common by-product of the poultry slaughter industry. Although total nitrogen levels are fairly high (7 to 10%), the nature of feathers is such that they break down and release their nitrogen much more slowly than many products of similar price.

Fish meal and fish emulsion are, like most animal by-products, rich in nitrogen. Fish *meal* contains about 10% nitrogen, along with about 6% phosphate. It is most frequently used as a feed additive, but can be used as a fertilizer. The fertilizer analysis of fish *emulsion* varies with preparation method. Whole fish and fish parts must be digested to form a slurry, a process accomplished with the aid of either phosphoric acid or special enzymes. Acid-digested fish emulsion usually has an analysis around 4-4-1, while enzyme-digested fish emulsion is usually measured as 4-1-1. Fish emulsion may be fortified with chemical fertilizer, so organic farmers should be suspicious of any product with a nitrogen content in excess of 5%.

Leather meal is ground tannery waste with 10% nitrogen. Unfortunately, most leather meal also contains about 3% added chromium (a toxic heavy metal), and is thus prohibited in organic agriculture.

Manure and Compost Based Products

One of the most common types of prepackaged alternative soil amendments is the manure- or compost-based blended fertilizer. Several of these products have national distribution, and many more enjoy a loyal regional following. Such products are typically analyzed at 2 to 5% for each nutrient. Dried compost is used as a bulking agent, source of nutrients, and organic matter. It is blended with several of the materials discussed in this publication, including rock minerals and plant and animal by-products. Nearly all products of this class sell for prices about three times greater than their conventional fertilizer value, but may be quite effective in farm situations. However, farmers with access to other sources of manure or compost can realize substantial savings by relying on local manure resources. Some manure-based, blended fertilizers contain ingredients prohibited by one or more organic certification programs and may not be used in certified production; others may be disqualified because the manufacturer refuses to reveal the "secret" ingredients.

Composted sewage sludge is marketed as a fertilizer and soil amendment. This compost provides organic matter and a number of nutrients, and as marketed, is solid with little odor. The greatest potential problems with using composted sludge are heavy metals from industrial waste, along with assorted chemical contaminants (from household cleaners, latex paint, and other things people flush down their drains). Pathogens are controlled fairly easily through proper composting, which raises the temperature of the composting material sufficiently to kill many microorganisms. The U.S. Environmental Protection Agency has established strict guidelines for pathogen control, which most sewage composting facilities follow.

Heavy metal contamination is a significant risk wherever industrial facilities contribute to sewage. Contamination by heavy metals and many other chemicals is limited as much as possible with current technology, but composted sludge often contains levels that make it unsuitable for use on food crops. Before using any composted sludge or other treated municipal waste product in crop production, the grower must know the chemical composition of the product and whether it is safe to apply to food crops. Have the sludge tested. It is important to note that at least 38 states regulate the production of sewage compost. Its use is prohibited in all certified organic production.

Rock And Mineral Powders

Phosphate sources

There are a number of alternative phosphate sources on the market, but it can be difficult for growers to determine which is the most appropriate for their operation. Much of the difficulty stems from confusion about the difference between "total" and "available" phosphate. Chemical phosphate fertilizer is sold on the basis of available phosphate expressed as P_2O_5. In fact, "available phosphate" is the only allowable claim for fertilizer value.

Available phosphate designations are determined by measuring the amount of phosphate that dissolves in a weak citric acid solution believed to imitate conditions near plant roots. This test provides a standard means of comparing different phosphate sources. Unconventional phosphates, because of their slow release, are often promoted on the basis of total phosphate content. Neither available nor total phosphate analyses give a particularly accurate picture of how different phosphate materials will perform in natural systems, hence the importance of developing good powers of observation through on-farm experimentation. A general understanding of the principal phosphate products, however, will give some indication of how they are likely to act in different circumstances. Of particular importance is soil pH; phosphates will be released more quickly in moderately acid soils than in neutral or alkaline soils.

Colloidal phosphate consists of clay particles surrounded by natural phosphate. Total phosphate is around 20% and "available" phosphate about 2–3%. An efficient use of colloidal phosphate is to add it directly to livestock manure in the barn or lot, where the manure acids dissolve much of the total phosphate and the phosphate stabilizes the nitrogen in the manure. Many of the same advantages can be had by adding 20–50 pounds of colloidal phosphate to one ton (two cubic yards) of manure when composting. The ATTRA publication *Farm-scale Composting Resource List* directs the reader to many useful resources on composting. When direct land application of rock phosphate is the only possibility, spreading rates between 500 and 2,000 pounds per acre are appropriate, depending on phosphorus status, soil acidity, and finances.

Rock phosphates are usually derived from ancient marine deposits. They have a different composition than collodial phosphate, generally making them less available. Total phosphate is around 30% and available phosphate 1–2%. They are best used in the same manner as colloidal phosphate, and it is worth paying for several tests to determine how effectively this phosphate moves into manure and soil. It may or may not be a better buy than colloidal, depending greatly on conditions and circumstances.

Hard-rock phosphates are usually derived from igneous volcanic deposits and consist almost totally of the mineral apatite. Although apatite contains about 40% total phosphate, because of the mineral's composition, this phosphate is largely unavailable. In most circumstances it is not a good buy, but in some situations is the ideal product; again, trial and observation are the keys to a wise purchase.

Bone meal is so well known, especially in horticulture, that it can hardly be considered an alternative product. Typically it contains about 27% total phosphate, and nearly all of that is available. There is a great deal of confusion about the phosphate content of bone meal because much of it is sold as a feed additive. In the feed industry, phosphorus is expressed on the label as elemental phosphorus, while in the fertilizer industry it is expressed as phosphate. Phosphate gives a much bigger number (2.3 times as big) for the same actual phosphorus content. Twelve percent phosphorus is the same as 27% phosphate, and bone meal is sold under either of those (or similar) numbers; it's the same good, but expensive, product in either case.

A by-product of the smelting industry, basic slag may, if finely ground, be a source of phosphorus and minor elements. Use of basic slag in organic production is restricted.

Potassium from rock and mineral powders

Alternative potash (potassium) sources are similar to alternative phosphates in that there are a variety of sources, with differing availability and fertility value. As with phosphate, there is a difference between available potash and total potash; similarly, there is a difference between pure potassium and potash, with the potash number being 1.2 times higher than potassium for the same amount of nutrient.

Two sources of potash, potassium sulfate and potassium magnesium sulfate (langbeinite), are commonly enough used in conventional agriculture that they can hardly be considered alternative, save for the fact that both are regularly used in certified organic agriculture. There are two forms of potassium sulfate on the market. One is derived by reacting sulfuric acid with potassium chloride. It is a good fertilizer, but not acceptable in certified organic production. Natural potassium sulfate, from Great Salt Lake, is extracted by a differential evaporation process lasting three years. It can be used in organic farming. Langbeinite goes from mine to field with minimal processing. Sulpomag® and K-Mag® are two brand names for langbeinite.

The salt content and solubility of potassium-bearing sulfates dictate well-considered use, but their high potash content (22% for langbeinite and 50% for potassium sulfate) does allow for good plant response from relatively modest application rates. Although soluble salts, these products are considerably less salty and less soluble than either kainite (a mixture of potassium sulfates and common salt) or muriate of potash, the most common conventional potassium fertilizer.

Granite dust is often sold as a "slowly available" potash source for organic production. Total potash contents in granite dust typically vary from 1 to 5%, depending on overall mineral composition of the rock, but granite is mostly feldspar, a mineral with low solubility. Therefore, little potash fertility is derived from this material.

Another source of slowly available potash, popular in alternative agriculture, is the clay-type mineral, glauconite, commonly sold as greensand. Total potash content of greensand is around 7%, all of which is deeply locked into the mineral and only slowly available. Greensand is also said to have desirable effects on soil structure. Its high price, however, limits its use solely to high-value horticultural applications.

Feldspar is one of the major potassium-bearing minerals of granite. Feldspar powder is fairly easily obtained through the ceramics trade. Unfortunately, most feldspar potash is as tightly bound within its mineral structure as is the potash in greensand. Unless particular circumstances provide a clear indication that feldspar is the most appropriate source of potash, it is proabably not cost-effective.

Certain micas, particularly biotite (black mica), contain several percent total potash, which, because of mica's physical structure (quite different than feldspar or glauconite), is relatively available in microbially active environments. If pure biotite can be obtained at a reasonable price, it may be cost-effective and useful.

A by-product of the cement industry, kiln dust can be an affordable limestone substitute and potash (about 6% soluble) source in areas where it is available. Some cement kilns are fired using assorted industrial wastes, sometimes including hazardous wastes. Dust from these kilns may itself be a hazardous product, and in several states is legally treated as such. Sources should be verified carefully, and state regulations checked. To date, the product is sold only in bulk. It is generally prohibited in certified organic production.

Secondary and minor nutrients from rock powders

A number of other rock dusts and powders are occasionally available in various parts of the country; sometimes the results from local trials are reported in national or international publications, but it is important to remember that what applies in one region may not be pertinent in another. Additionally, when dealing with natural materials like rock, there is very little product consistency from one batch to another; results from one trial may not be transferable to other situations.

Basalt dust, if available at a reasonable cost, can provide a wide range of trace minerals to agricultural systems over a period of several years; as with most rock powders, transportation costs are a major factor in determining cost-effectiveness. Most of the rich volcanic soils of the world are derived from basalt, which gives some indication of basalt's agronomic value, and even when too expensive for land application, basalt dust can benefit farm systems when mixed with manure in the composting process.

Any rock, of course, can be ground into powder, if the price is right. Various people have proposed additions to the soil of assorted rock dusts, or even powdered gravel. One rationale for this is the paramagnetic property that some rock minerals add to the soil—a factor believed to be associated with high fertility. ATTRA has additional information on paramagnetism in soils for those interested.

Zeolites

Zeolites are mined alumino-silicate materials, containing only insignificant levels of plant nutrients. Their use in crop production stems primarily from high nutrient-exchange capacities, which allow them to absorb and release plant nutrients and moisture without any change in the nature of the zeolite. This action results from the mineral's porous-but-stable chemical structure.

Zeolites enhance the performance of fertilizers by making them resistant to leaching, immobilization, and gaseous losses. They are of particular use in reducing leaching in sandy soils. In one study, 4 to 8 tons of zeolite per acre was applied (1). Yield increases were reported for wheat (14%), eggplant (19–55%), carrots (63%), and apples (13–38%). Zeolites are widely used in eastern European and Japanese agriculture, but their use in the U.S. at this time is very limited.

Humates

Humates are commercial products usually prepared from leonardite, an oxidized form of lignite coal and clay. Leonardite may contain up to 60% humic and fulvic acids, which mimic the "active" part of soil humus. Soil scientists use very broad definitions to describe soil organic matter components; "fulvic acids" and "humic acids" are terms lumping complex families of organic compounds together on the basis of how they can be most easily extracted from soil. For the most part, however, the organic acids extracted from leonardite bear little resemblance to the humic or fulvic acids in soils. Although extremely useful and cost-efficient in certain situations—as nutrient substrates in soilless greenhouse production for example—humates and similar products are less clearly helpful in many field situations.

The sheer volume of organic matter in even moderately rich soils suggests that agronomically affordable applications of humates may not produce significant improvements. The top six inches of soil weigh approximately 1,000 tons per acre; each percent of organic matter, therefore, weighs ten tons. Even assuming that the organic matter in humate products actually is similar to that in soil, it requires two tons of humates per acre to increase soil organic matter by 0.1%.

Research by the Rodale Institute determined that:

> commercial humates...are not products that can substitute for adequate mineral nutrients.... Humates do contain high percentages of humic acids and organic matter, but at their recommended, or economically feasible rates it is likely they may not significantly increase soil organic matter. Likewise, the humic acids in commercial humates may have the ability to...provide growth-stimulating effects, but in the soil they comprise only a minute fraction of the total soil humic acid content (2).

Additionally, the results indicated that humates containing unrefined leonardite can immobilize soil phosphorus under some conditions, creating a negative effect on plant performance.

The Rodale report also concluded that:

> [while] humate products are based on sound principles and the potential for their beneficial action does exist...the economics and time involved to increase organic matter through commercial products, rather than through more traditional organic-matter-building programs, should be seriously considered (2).

Despite such determinations, many farmers report significant benefits from the use of humates and related products. Where humates have shown the most promise is as natural soil amendments in areas with alkaline, low-organic-matter soils. Such soils are common across a wide range of agricultural production zones in the southern and western U.S. Leonardite and similar products are generally consistent with organic production practices, given that they are natural products with proven benefit in certain situations. Some extracts, however, are not acceptable in certified organic production, depending on the extraction process used.

Seaweed Products

Most seaweed fertilizers come from kelp that has been harvested, dried, and ground. Kelp meal is suitable for application directly to the soil, or for addition to the compost pile. It flows easily and is readily applied with most dry fertilizer applicators. It is easily mixed with other dry fertilizers and amendments.

Soil application rates for kelp meal commonly range from 150 to 250 lbs/acre for pastures, forages and small grains. Two hundred to 400 lbs/acre are advised for corn, horticultural crops, and gardens. Since it is expensive, kelp meal is most commonly used only on high-value crops.

Dried raw seaweed tends to contain about 1% nitrogen, a trace of phosphorus, and 2% potash, along with magnesium, sulfur, and numerous trace elements. Raw seaweeds are prepared by various methods and sold under a number of brand names.

More often, compounds from kelp and other seaweeds are extracted by various methods in order to concentrate both micronutrients and naturally occurring plant hormones into a soluble, easily transported form. Such kelp extracts are sometimes applied as a foliar spray by farmers seeking a natural source of micronutrients. For the most part, none of the micronutrient levels in kelp extracts is high enough to correct a deficiency, but as a "tonic" providing a broad array of micronutrients and other trace elements, seaweed extracts have won a measure of acceptance among organic farmers. Note that while most kelp products are allowed in certified production, a few have been supplemented with commercial forms of potash and other nutrients and are prohibited.

Microbial Inoculants

Inoculants, which are dry or liquid preparations of one or more species of microorganism, fall into three broad groups: 1) those that inoculate individual plants with symbiotic organisms (chiefly *Rhizobia* spp.), 2) those that inoculate the soil with desirable organisms, and 3) those that are used as "cover crops" (algae).

Rhizobia

The most clearly beneficial microbial preparations for agricultural use are the different strains of *Rhizobia* used to inoculate legumes. Specific strains of these bacteria live in a mutually beneficial (symbiotic) relationship with specific species of legumes. The bacteria penetrate the plant roots, causing the formation of root nodules containing both plant tissue and bacteria. In very simple terms, the plant supplies the physical environment and certain nutrients to the bacteria; the bacteria "fix" nitrogen from the air into compounds that then become available to the plant. Typical nitrogen fixation rates vary from 50 lbs/acre to over 300 lbs/acre, depending on climate, species, and soil conditions. On most farms these rates make it possible to harvest good crops without purchasing additional nitrogen.

Mycorrhizae

The mycorrhizae (my-cor-ry-'zee) group of fungi live either on or in plant roots and act to extend the reach of root hairs into the soil. Mycorrhizae increase the plant's uptake of water and nutrients, especially in less fertile soils. The superfine, root-like structures of these fungi are more extensive and more effective than plant root hairs at absorbing phosphorus, and other nutrients as well. Phosphorus moves slowly in soils but the fungi can absorb it much faster than the plant alone can. This enhanced root feeding makes it possible to reduce fertilizer rates for plants having a healthy colony of mychorrhizae. Some plants including citrus, grapes, avocados, and bananas, are dependent on mycorrhiza fungi. Others that benefit from having them are artichokes, melons, tomatoes, peppers, and squash.

Roots colonized by mycorrhizae are less likely to be penetrated by root-feeding nematodes since the pest cannot pierce the thick fungal network.

Mycorrhizae also produce hormones and antibiotics, which enhance root growth and provide disease suppression. The fungi benefit from plant association by taking nutrients and carbohydrates from the plant roots they live in.

In soils where mychorrhizae have been killed off, an inoculation may be beneficial. In healthy soils where they already exist there will be little or no benefit to adding more. There are dozens of mychorrizae species in nature. Additionally, the species found on plant roots may change as the plant matures. If those that are available are of the correct species, and are handled properly at all stages, they offer interesting potential benefits to farmers in well-managed systems. Generally it is preferred to inoculate with several species rather than a single one. For information on rhizobial and mycorrhizal inoculation for disease suppression, request the ATTRA publication *Sustainable Management of Soil-borne Plant Diseases*.

Free-living soil organisms

A great many of the products in this category are designed to be sprayed on the soil surface or on crop residues in order to inoculate the topsoil with desirable microorganisms. Manufacturers of these products make numerous and varying claims about their beneficial effects, which fall into three broad categories:

- The microbes will fix enough nitrogen from the air to allow the farmer to eliminate much or all fertilizer.
- The product improves soil organic matter and "releases" soil nutrients to the crop.
- The product produces better yields, especially during times of drought.

Many microbial products do indeed contain free-living (as opposed to symbiotic) microbes that are known to fix nitrogen in certain circumstances. Those species, however, work best in wet, oxygen-poor conditions that most farmers and their crops would prefer to avoid. Rice paddies are a notable exception. In the vast majority of cropping situations other than rice production, the amount of nitrogen fixed by such free-living microbes is not generally considered economically significant (3). In other words, the value of any fixed nitrogen may be less than the cost of the product. Far greater nitrogen fixation, for example, can be obtained via symbiotic *Rhizobia* on a legume sod or cover crop, for much lower cost.

Soil microbes, like all living things, will thrive only in the presence of their preferred environmental conditions—moisture, oxygen, temperature, pH, food, and shelter. When conditions are not within favorable ranges, the microbes cease reproduction or die. Natural microbial populations will be abundant if soil conditions are right. Adding a microbial amendment in such circumstances may not be cost-efficient, because the naturally occurring individuals will typically outnumber the same species supplied in a product by 10,000 to 1, or more (4).

If soil conditions are *not* right, inoculant organisms will reproduce just as slowly as their naturally occurring colleagues, which is to say, not at all. The consensus among agronomists appears to be that these products perform best when the soil is at or near optimum conditions to begin with.

Algal mats

Another group of inoculants, sold as "cover crops," are commercial preparations of soil-inhabiting algae advertised as providing many benefits, including reduced soil crusting, improved soil structure, increased soil organic matter, improved drainage, and better moisture retention. A solution of the algae mixed with water is sprayed on the soil surface. In theory it then establishes itself to form a continuous mat over the soil surface. If natural algae populations have not been observed to populate a particular soil already, management practices will have to be adjusted to get successful growth of an algal cover crop.

Algae are susceptible to the vast majority of herbicides in use today and would therefore be essentially incompatible in a conventional row crop system. Mat establishment could only occur in the absence of soil disturbance. Therefore, application would need to be made only after a final cultivation. Lastly, a continuously moist surface is necessary. On most soils this would require irrigation.

Where weed management is a concern, a traditional cover crop will be more effective than algae. The algal mat is very thin and will not suppress weeds adequately. The constant surface moisture required by the algae tends to encourage weed seeds to sprout. It can also encourage disease problems in the crop.

Enzyme-Based Amendments

Enzymes are involved in a number of soil reactions, particularly as catalysts in the microbial breakdown of organic matter, but very little research has been done on the effects of adding enzyme products to the soil. Nevertheless, commercial enzyme treatments for soils are often advertised as having a large number of beneficial effects, including improved soil structure, nutrient "activation," greater nutrient availability, "detoxification" of the soil, better drainage, better water retention, and greater microbial activity.

In nature, the microorganisms that process soil organic matter produce the enzymes they need to do the job. Those enzymes, being proteins, are themselves broken down by microbial action (5). Enzymes added to the soil would probably suffer a similar fate in short order.

As with free-living soil organism products, the circumstances where enzyme products are likely to perform the best are in soils, that are already well-balanced and in good condition.

Vitamin products are also sold as soil treatments on occasion, but more often as sprays for the plants themselves. Plants might absorb some of the vitamin through leaves or roots, but much of the applied vitamin is broken down into simple components before being absorbed by the plant (6, 7). Generally, plants in favorable environments synthesize all the vitamins they need from the resources at hand. The most likely benefit of applying a vitamin product would be as a “quick fix” measure for plants grown under poor conditions, provided it is possible to determine just which vitamins happen to be deficient.

Soil Conditioners

Wetting agents and surfactants break the natural surface tension of water, overcoming its tendency to form droplets, and allowing it to penetrate a variety of materials. Common clothes-washing solutions, shampoos, and detergents rely on wetting agents or surfactants to function effectively. Similar compounds are also sold as soil conditioners and are heavily promoted as improving water penetration, drainage, and soil structure. They are also advertised as aids in controlling erosion and reducing compaction or hardpans as a result of increased water penetration of the soil.

In general, wetting agents are effective where a soil's water-repellency is caused by turf or grassland cover, by ash from the burning of organic matter, or by single-grain soil structure (soil particles all of one size and not aggregated, as occurs in some sands). Conditions in which wetting agents have little or no effect include poor drainage due to hardpans, compaction from tillage or traffic, and "tight" or fine-textured soils that have very small pores (such as some clays). In other words, wetting agents are likely to have some effect where water infiltrates a soil slowly because the soil surface repels water, but not where water penetrates slowly because there are no large pore spaces (8). Most soils with good structure have good infiltration rates. Soil structure can be maintained and improved by a good rotation, regular additions of organic matter, and normal conservation practices. Beneficial effects should not be expected on soils that are already wetable.

Commercial wetting agents can be quite expensive, especially when used to treat large areas, and any results may not justify the cost of the product. Some farmers attempt to economize by applying something like dishwashing soap or shampoo instead of commercial wetting agents, but caution is advised since other ingredients in household products may be detrimental to plant growth or may cause a breakdown of soil structure. Note, too, that many wetting agents are not acceptable in certified organic production.

Evaluate Products Carefully

Some non-traditional soil treatments are based on sound biological or scientific principles. Unfortunately, a number of studies cited in the *Compendium* (9, 10) and in the Rodale report *Novel Soil Amendments* (2) show that using many of the non-traditional products mentioned here results in ***negative net income*** for the farmer. The supposed beneficial effects of the products tested in these studies do not increase yields sufficiently to offset the cost of applying the product. In many studies, the product tested had no measurable effect on either the crop or the soil.

Advertisements for these products often cite studies which the sellers claim prove the effectiveness of their products. Those results, however, are usually taken out of context, obscuring the fact that the claimed yield increase is due not to the tested product, but to normal random fluctuations in yield caused by environmental conditions within the study. In other words, the product doesn't really do what the vendors claim it does. Though governments do require companies to guarantee analyses and to back up sales claims for conventional fertilizers, alternative products are, for the most part, unregulated and uncontrolled.

At the same time, prejudice against alternative products and practices has often resulted in testing that has been less than honest, and some off-the-cuff rejections by researchers and Extension. As a result, farmers benefit the most by evaluations done within the context of their own farm operations. On-farm research trials take some effort but are not difficult to perform. Contact ATTRA for a copy of the Sustainable Agriculture Network's publication entitled *How to Conduct Research on Your Farm or Ranch.*

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The electronic version of Alternative Soil Amendments is located at:
http://www.attra.org/attra-pub/altsoil.html

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Notes: