The Vital Earth News

Agricultural Edition

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Thoughts on Tillage from *Plowman's Folly*

Introduction

So many things in our lives we take for granted, simply because they are traditional: "It has always been done that way." So is the case for the moldboard plow, an implement used by pioneers to break the sod but used continually by many farmers up to the present. Things are changing now, however, as more and more farmers move towards chisel plowing and forms of minimum or zero tillage. Perhaps* Plowman's Folly *had a lot to do with this tillage revolution. The now deceased author, a former county agent, teacher, and private soil and crop researcher, lays the issues on the line in this most provocative chapter.

The moldboard plow has reached mammoth size with high-powered tractors in recent years, but has also caused some high-powered troubles with our soils.

by Edward H. Faulkner

Briefly, [I wish to] show that the moldboard plow which is in use on farms throughout the civilized world, is the least satisfactory implement for the preparation of land for the production of crops. This sounds like a paradox, perhaps, in view of the fact that for nearly a century there has been a science of agriculture, and that agricultural scientists almost to a man have used and approved the use of the moldboard plow. Nevertheless, the statement made above is true, and capable of proof. Much of the proof, as a matter of fact, has come in left-handed manner from scientists themselves. The truth is that no one has ever advanced a scientific reason for plowing. Many learned teachers have had embarrassing moments before classes of students demanding to be shown why it would not be better to introduce all organic matter into the surface of the soil than to bury it, as is done by the plow.

The entire body of "reasoning" about the management of the soil has been based upon the axiomatic assumption of the correctness of plowing. But plowing is not correct. Hence, the main premise being untenable, we may rightly question the validity of every popularly accepted theory concerned with the production of

See Let's Think, page 2

How Important Is Soil Organic Matter? Just Ask GPS!

by Paul W. Syltie, Ph.D.

It came as quite a surprise during the 1997 harvest when combine yield monitors began to show a distinct pattern of yields across fields. The collective wisdom of conventional agribusiness said that yields should vary with the degree of N-P-K fertilization as related to the soil test grid.

Global positioning systems (GPS) — connecting satellites with ground equipment — have been promoted by major corporations in recent years in an effort to fine-tune fertility programs in fields, and of course to fine-tune their profits as well. Soils in fields are sampled according to a grid pattern, and fertility recommendations are then translated to a sophisticated fertilizer spreader that varies the application rate throughout the field according to individual grid "needs." Theoretically the system should produce a bumper crop throughout the field and thus spur the Green Revolution yet one more step on the road towards global food self-sufficiency.

Reality, however, has a way of catching our attention. According to Don Larson, president of Larson Systems Inc., Ames,

See Poor Soil, page 3

See Vitazyme Results for 1997 in This Issue!

Let's Think Twice About Plowing!

Continued from page 1

any crop, when the land has been plowed in preparation for its growth. That brings virtually all of our soil theories up for critical examination; so, in this book, the whole gamut of theory we have evolved concerning the growing of crops will be brought into focus for examination in the light of the discovery that plowing is wrong.

The discussion will be undertaken in language common to the layman, so far as this is possible, and throughout the text footnotes will be introduced to explain whatever may be perhaps out of range of the thinking of the average reader. The nature of the reasoning upon which this entire study is based makes it unnecessary to resort to any but the simplest of scientific terms. Moreover, there are few ideas which are not common knowledge — strange as that may seem. The vast amount of technical language created by scientific agriculture, as a result of an early and fundamental mistake, has produced its own confusions. Indeed, the mistake originally made might justly be called the basis for most, if not all, of the technology connected with present-day agronomy.

Perhaps sod-breaking on the prairie was the one legitimate use of a moldboard plow. After that, however, its value must be questioned.

An agricultural experiment station has its uses, but these obviously would not have embraced the problem presented in this book, if those who work the soil had not got off to a false start in the matter of plowing. In brief, if a way had been found to mix into the surface of the soil everything that the farmer now plows under; if the implements used in planting and cultivating the crop had been designed to operate in the trashy surface that would have resulted from mixing rough straw, leaves, stalks, stubble, weeds, and briars into the surface — crop production would have been so automatic, so spontaneous that there might not have developed what we now know as agricultural science. Actually, we would scarcely have needed one. From one point of view, we have been creating our own soil problems merely for the doubtful pleasure of solving them. Had we not originally gone contrary to the laws of nature by plowing the land, we would have avoided the problems as well as the expensive and time-consuming efforts to solve them.

See A Closer Look, page 10

Compost Boosts Soil Organic Matter at the Birkenfelds

by Paul W. Syltie, Ph.D.

Success stories on the farm seem hard to come by these days. Yet, for the three Birkenfeld brothers — Keith, Bob, and Greg — who farm west of Tulia, Texas, in the southern panhandle of Texas, success has been sweet. Compost — and plenty of it — has boosted soil organic matter levels greatly in just a few years.

Their soils tested the usual for the area, about 1.0 to 1.5% organic matter. Recognizing that organic production systems were the wave of the future, Bob and his brothers decided to embark on a program to boost soil organic matter levels in a concerted way, and theoretically improve the chances for higher long-term crop productivity.

Well-made compost is hard to beat as both a fertility amendment and a soil conditioner to encourage excellent yields and high soil organic matter.

In late 1990 they began producing their own compost from cattle manure (80%) mixed with cotton burrs (20%) under the title of KBG Composters. The mix was allowed to compost for 7 to 8 months and then spread on fields using their own trucks. No material less then 6 months old was spread, since their analyses showed that older compost contained more nutrients to the load, a direct benefit to farmers. Presently they obtain manure

See Compost, page 5

Poor Soil Can't Be Improved By More N-P-K!

Continued from page 1

Iowa, who is one of the nation's top global positioning specialists, "We could not show any linkage between fertility levels and crop production levels on a site-specific basis. If anything, the highest yields tend to come on the areas testing the lowest in standard soil analysis" (*Pro Farmer*, 1997).

If standard N-P-K fertility treatments did not correlate with yields, then what did? Larson went on to explain.

"Three factors show a correlation between soils and yield:

1. Organic matter, not neccesarily the amount but its biological activity.

2. Water holding capacity and the proper amount of moisture.

3. Calcium levels and pH."

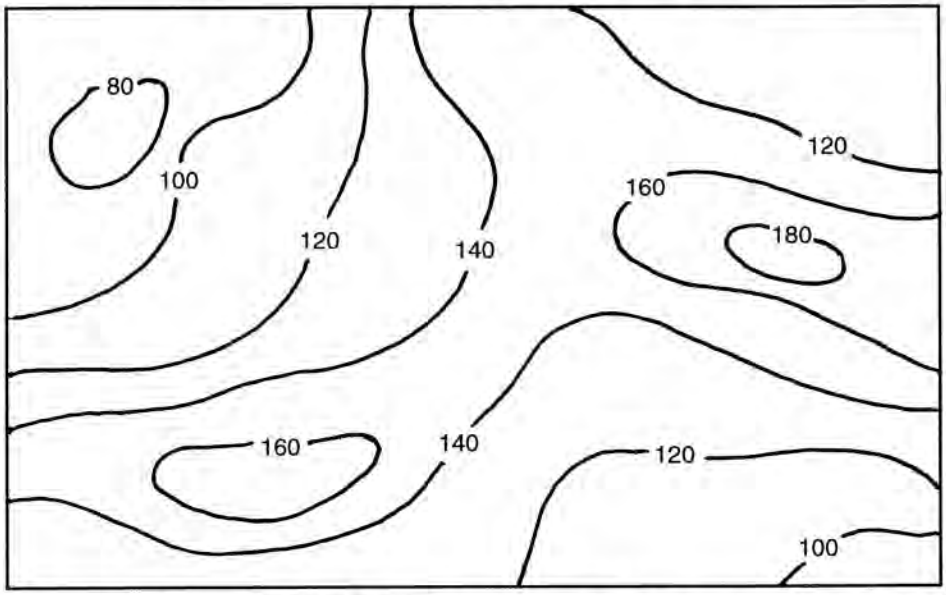
"If you don't have those three parameters, you won't raise top yields. These are the only three issues where we've found a correlation between computerized soil maps and field maps from GPS yield monitors. You cannot find that correlation with conventional fertility."

Larson continued by saying that management of fields for top yields should vary according to *soil types.* Such an approach is far more profitable than using a grid-type system based on N-P-K analysis alone.

"These are the only three issues where we've found a correlation between computerized soil maps and field maps from GPS yield monitors. You cannot find that correlation with conventional fertility."

These facts again point towards the great importance of organic matter in soils, an issue so frequently addressed in *The Vital Earth News.* Organic matter *quality* is an equally important issue, for a certain amount of fresh, raw organic material added regularly is crucial to supply digestible food for soil microorganisms ... which are the major instigators of nutrient release.

This release is expedited throughout the entire soil mass by fresh additions, but especially so in the immediate vicinity of plant roots where bacteria, fungi, actinomycetes, and other microbes live on excreted carbon compounds from the roots.



A typical GPS combine yield monitor might provide a yield picture in an 80-acre corn field such as the above, where yields vary widely, mostly according to soil type. Fertilizer applications have a minimal effect on yield variations.

Of course, soil calcium levels are highly important to crop growth. It is calcium balance more than soil pH that should be addressed, even though a low pH usually indicates a calcium deficiency. However, too high magnesium or potassium levels can raise the pH and give rise to a shortage of available calcium, causing soil compaction and reduced yields despite an acceptable pH.

Interestingly, both organic matter and calcium are strongly tied to soil tilth, porosity, and air and water exchange. Thus, the impact of soil humus, water holding capacity, and calcium should be viewed as a co-dependent unity. Standard N-P-K fertilizers cannot substitute for the basic full-spectrum fertility a plant requires for optimum growth ... where soil microorganisms play such a vital role. They feed upon the fresh organic residues and live symbiotically with plant roots, but any organism requires fresh oxygen and adequate moisture. Nearly all of the conversions of nutrients from unavailable to available forms require microorganisms as mediators. A highly productive soil requires a vigorous microbial population.

Don Larson encourages that a farmer get a sensor system for his combine. That instrument will pinpoint where yields are high or low, and indicate whether his management practices are good or bad. For example, a combine monitor in one field showed a 15 bushel per acre drop in corn yield midway between tile lines. The farmer immediately installed new tile lines midway between the existing tile lines.

A consistent-looking field will typically show 100 bu/acre variations from one area to another nearby area. A flat, black 80-acre field may vary in yield from 80 to 280 bu/acre, differences that cannot be detected by soil sampling. The greatest consistency in yields is across the same soil type. Soil types tend to be uniform in organic matter, drainage, and mineralogy (calcium levels in particular).

Is GPS merely another high-tech bill of goods that modern agribusiness is attempting to sell farmers to tie them in with the corporate paradigm? It is time for farmers everywhere to examine closely the laws of nature and strive to emulate them in their farming practices. Humus, porosity, and mineral balance are three major keys to top crop production now and on into the future, which no industrial or governmental dictates will ever circumvent. ■

One of France's greatest thinkers, Voltaire, once said that in 100 years the Bible would be a forgotten book, found only in museums. When the 100 years were up, Voltaire's house was occupied by the Geneva Bible Society.

Bits and Pieces, June, 1972.

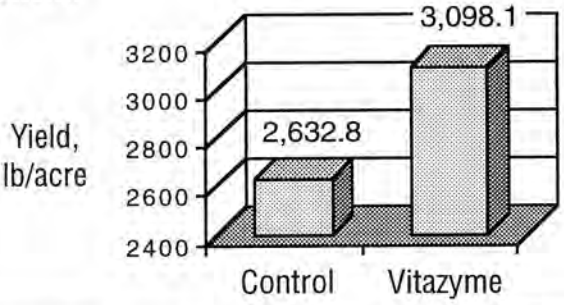
Special Feature: Vitazyme on Almonds

A test on almonds near Madera, California, in the San Joaquin Valley proved highly successful for Chip Rogers and his sons. In the spring of 1997 they took 10 acres of a 45-acre mature almond grove and treated it twice with Vitazyme, running 13 oz/acre through the sprinkler irrigation system in mid-April and again in mid-July.

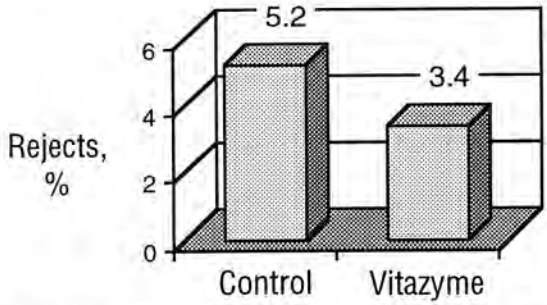
All areas were treated the same throughout the grove during the growing season, Vitazyme being the only variable. A special electronic water treatment, in which "programmed electrons" were injected into the irrigation water, was used throughout the year. The fertilization program was as follows:

- 50 lb/acre N as "can 17" the previous October
- 50 lb/acre N as "un 32" in April
- Rhizone, an "organic cocktail", applied foliar in the summer
- K_2SO_4 applied foliar in the summer

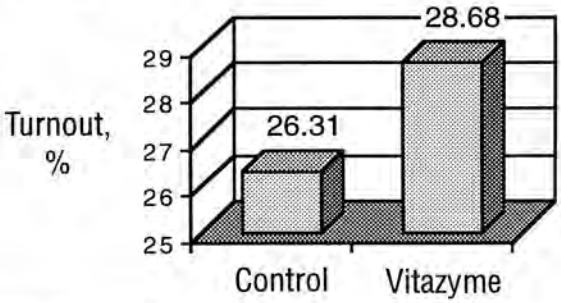
Results of the August 20 harvest were most excellent.



Yield increase: 17.7 %



Reduction in rejects: 1.8 percentage points



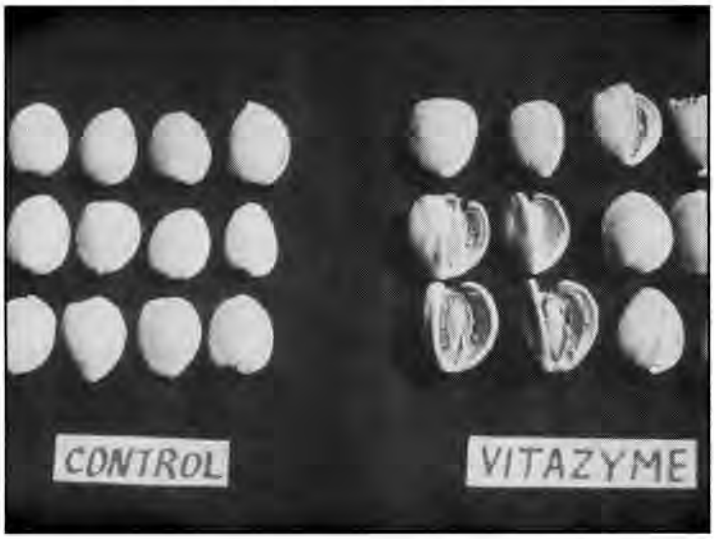
Increase in turnout: 2.37 percentage points

Note the excellent conformation of these almonds at the Rogers orchard. Trees are vigorous and nut production is prolific.

Income increase: $697.95/acre

Return per dollar of product cost: Over $70.00/acre

Vitazyme Improves Yield and Quality



The Vitazyme treated almonds are not only larger, but they have already begun to open on July 21, 1997, when this picture was taken.

Comments on the Study

- The **percent turnout** was improved for Vitazyme due to fuller nut meats.
- The **percent rejects** was reduced for Vitazyme due to less insect (worm) damage, even though a neighboring almond grove was not well tended and in past seasons would increase worm damage on that side of the grove. Thus, Vitazyme provided some insect protection.
- In spite of a nitrogen application of only 100 lb of N/acre, versus the usual recommended 200 to 300 lb/acre, **yields** were maintained at high levels.
- The Carmel variety, though not analyzed in this study, provided about the same yield increase with Vitazyme as did the Non Pareil variety.

Compost Boosts Soil Organic Matter Quickly!

Continued from page 2

from three commercial lots.

They initially treated all of their land heavily: 2.5 tons/acre for cotton and 3 to 4 tons/acre for corn and sorghum. Later applications were usually cut back to 2 tons/acre on irrigated land or 1.5 tons/acre on dryland areas. With a three-year rotation of cotton, wheat, corn, or sorghum on irrigated land, yields have improved over the years. So have they on dryland areas. On 2,500 total acres, half of the total under irrigation, their net income figures have benefited substantially. Typical costs are $26/acre for 1.5 tons/acre, or $34/acre for 2 tons/acre, including compost, trucking, and application fees.

Their own soil, and that of nearby farmers who receive the benefits of KBG compost, have noted a surprisingly rapid improvement in soil organic matter. Careful monitoring of their fields has revealed that, at present, a 3.2 to 3.3% soil organic matter level is common in their fields ... at least a doubling of the original organic composition. This marked increase has occurred over only six years.

With organic matter being so imperative for the proper functioning of the soil-plant systems, it is no wonder that crops are responding so well to compost for the Birkenfelds and their clients. Rainfall is usually very deficient in the summer in west Texas — if not year-long in recent years — and the improved soil water-holding capacity and rooting enhancement imparted by the added organic matter enables plants to perform better in both dryland and irrigated environments.

This Canadian dairy farm utilizes manure piling on a long-term basis to convert fresh dairy manure to high-quality compost. Crop yields and quality have responded excellently.

Recent tests with Vitazyme, a biostimulant produced by Vital Earth, on cotton at the Birkenfelds revealed in 1996 that a soil application at planting, and a foliar spray at early bloom, boosted yields by 10% for either low or high irrigation frequency. In 1997, the Vitazyme was applied to the seed at planting rather than to the entire soil mass, and a 25% yield increase was produced. By coupling the improved soil organic matter content with Vitazyme, the improved root development greatly boosted cotton yield and profits.

Compost has proven its worth for the Birkenfelds and their neighbors in west Texas. Once again the value of enhanced soil organic content has been illustrated in on-farm situations, as will continue to be shown during the coming years as biological agriculture points the way towards tomorrow's methods on the farm. ■

15-Minute Soils Course

Lesson 6:
A Closer Look at Organic Matter

We ought to look at the soil as a whole, much like an organic body complete with its integral parts. As the human body contains many systems — circulatory, digestive, skeletal, endocrine, nervous, reproductive, and so forth — so the soil contains its counterparts: air and water (circulatory and respiratory), microorganisms (digestive), minerals (skeletal), hormone producers (endocrine), and so on.

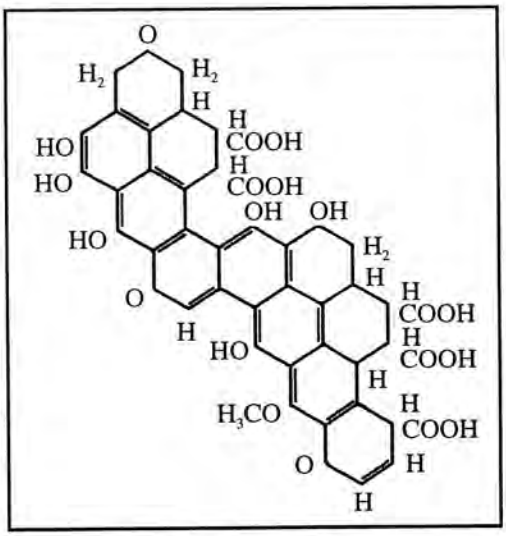
If we were to point towards one particular part of the soil upon which all other parts center, it would be the organic fraction. Let us take a close look at this vital soil fraction one might term the "heartbeat" of the soil.

What is it?

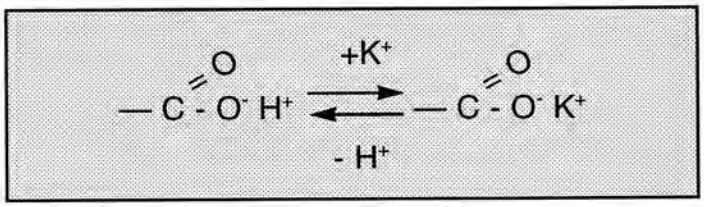
Soil organic matter is a complex array of carbon-based compounds that have originated from newly deposited plant and animal remains, or highly decomposed organic remains ... as well as various stages between these extremes.

Humus, as contrasted to organic matter, is the complex, rather resistant mixture of dark-colored amorphous and colloidal substance modified from original tissues, or synthesized by soil microbes. Changing raw, undecomposed organic matter to humus is called **humification.**

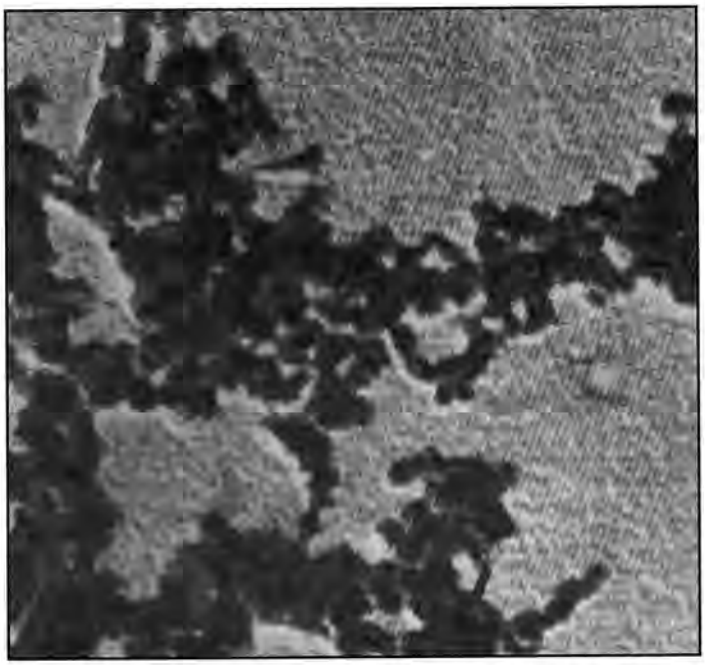
It is almost impossible to draw a single chemical structure for soil organic matter, since it is so diverse. Here is one attempt to construct a humic acid molecule.



As can be seen from this figure, there are many - OH (hydroxy) and - COOH (carboxylic acid) groups that can ionize and provide negatively charged ion-capturing sites. Especially important are carboxylic acid groups.



Thus, it can be understood how soil organic matter can contribute so greatly to cation exchange capacity, or the ability of a soil to hold nutrient cations (see Lesson 4). An electron micrograph of humus from a grassland soil shows the following microscopic view.



This electron microscope photograph of humic acids shows their gross structure at 105,000 magnifications.

Soil organic matter is continually changing, affected by plant and animal imports and microbial activity. It is mostly carbohydrates (sugars, starches, and cellulose), lignin, tannin, fats, oils, waxes, resins, proteins, pigments, and minerals. However, it also contains the myriads of organisms found in the soil. Ranges may be as follows.

Continued on next page

15-Minute Soils Course

Organism	Estimated number/gram
Bacteria	3,000,000 - 500,000,000
Actinomycetes	1,000,000 - 20,000,000
Fungi	5,000 - 9,000,000
Yeasts	1,000 - 100,000
Algae	1,000 - 500,000
Protozoa	1,000 - 500,000
Nematodes	50 - 200

Because of its extremely high cation exchange capacity, its ability to bind with nutrient elements (some compose its structure), and even minerals (forming clay-organic complexes), its support of soil organisms (they feed on it), its ability to "buffer" chemical reactions, and its high water-holding capacity, organic matter plays a vital role in determining the soil's physical, chemical, and microbiological properties. Here are some benefits of soil organic matter:

1 Coarse organic matter on the surface reduces the impact of raindrops, and allows clear water to seep into the soil. It also reduces wind erosion.

2 Decomposing organic matter produces polysaccarides and "glues" that produce a stable, strong soil structure for rapid air and water movement.

3 Live roots decay and provide channels for further root growth and air and water movement.

4 Fresh organic matter provides food for earthworms, microbes, and other soil creatures that increase pore space and release nutrients.

5 Surface mulches moderate soil temperature like a blanket. A straw mulch can lower the temperature at 0.5 inch by 10° F, while a clear plastic mulch may increase it by 10° F.

6 Evaporation losses are reduced by surface residues.

7 Nutrients are supplied by decomposition, especially nitrogen (15 to 110 lb/acre), and cations (positively charged nutrients) are held by its high cation exchange capacity.

8 Fresh organic matter makes soil phosphorus more available in acid soils.

9 Organic matter buffers the soil against rapid chemical changes.

10 Some plant diseases can be controlled by organic matter additions.

11 Organic matter provides a buffer against rapid chemical changes, such as when lime and fertilizers are added.

12 Available water for growth is increased.

We have just touched the surface of soil organic matter — its nature and importance.

See How Much You Learned

1. What is the most important fraction of the soil?

2. How does humus differ from organic soil? (This is a trick question.)

3. Name three major soil organism classes or types in the soil.

4. Coarse organic matter on the surface helps reduce erosion by absorbing the impact of_____.

5. Is soil organic matter a single, uniform type of complex molecule?____Yes____No

6. Which is the most important functional group of organic matter that contributes to cation exchange capacity?

7. Name five of the many valuable functions of soil organic matter.

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1. organic matter; 2. humus is a *part* of the organic matter that is colloidal, highly broken down, and resistant to further breakdown; 3. bacteria, actinomycetes, fungi, yeast, algae, protozoa, nematodes; 4. raindrops; 5. no; 6. carboxylic acid group; 7. see the text.

Vitazyme Test Results for 1997

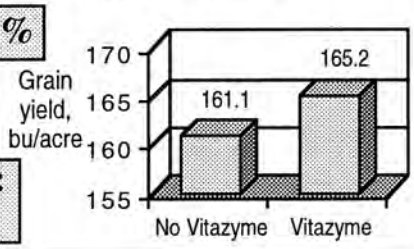
The third year of testing for Vitazyme has just been completed, and results have been very good. Notice this brief sampling of those results and judge for yourself.

Corn

Iowa State University, Ames, Iowa

Yield increase: 3%

*Significant at P=0.09

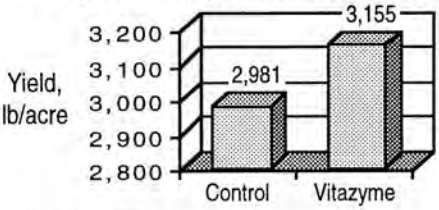


Income increase: $12.30/acre

Peanuts

Brownfield, Texas • Organically grown, irrigated

Yield increase: 6%



Treated plants, typical of the one on the right, produced more nuts, Rhizobium nodules, and roots.

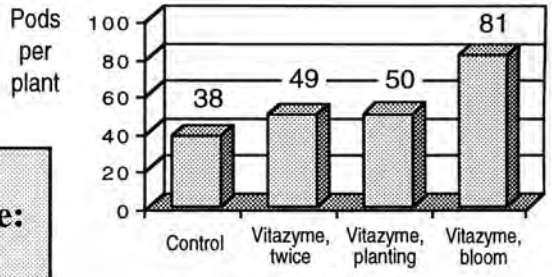
Income increase: $57.04/acre

The Vitazyme treated peanuts to the left show leafier plants with decidedly darker green color.

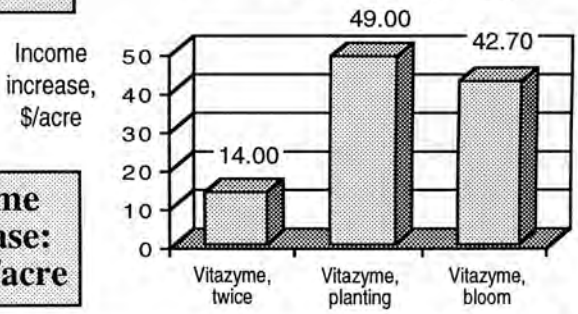
Soybeans

Easton Agri-Consulting • Bagley, Iowa

Pod increase: 113%



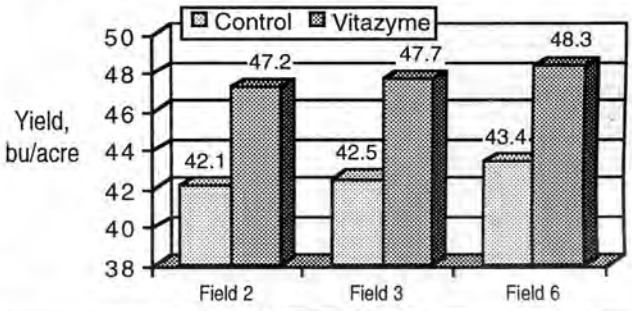
Income increase: $49.00/acre



Soybeans

Olivia, Minnesota • Organically grown, dryland

Larger leaves and more total leaf area with Vitazyme treatment indicate great photosynthetic capacity, which translates into greater yields.



Yield increase
Field 2: 12%
Field 3: 12%
Field 6: 11%

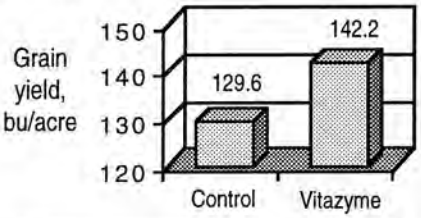
Income increase
Field 2: $35.70/acre
Field 3: $36.40/acre
Field 6: $34.30/acre

Vitazyme Test Results for 1997

Corn

Shortsville, New York

Yield increase: 10%



Test weight increase: 2 lb/bu

In spite of reduced nitrogen applications, the Vitazyme treated corn shown here performed extremely well.

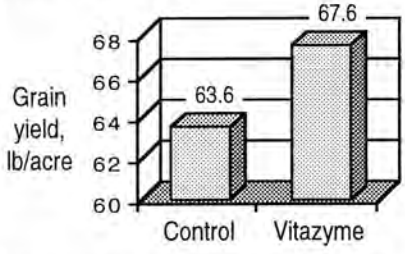
Income increase: $59.40/acre

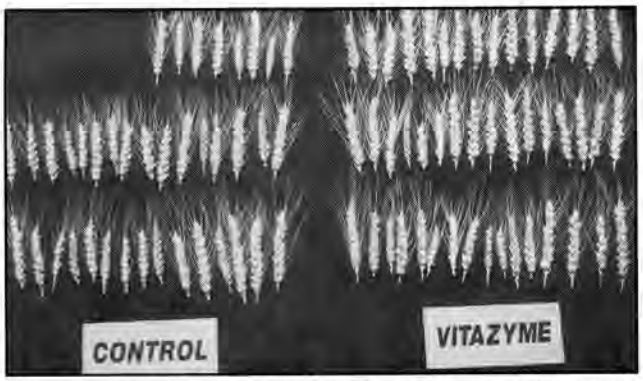
Winter Wheat

Rushville, New York

Yield increase: 6%

Income increase: $24.00/acre



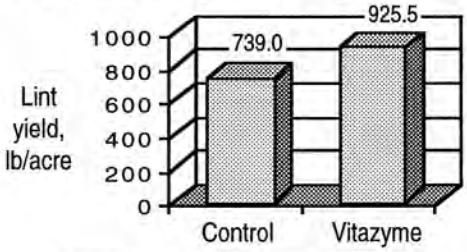


Vitazyme treated wheat produced more heads, with excellent grain filling. These heads were taken from the same number of plants for each treatment.

Cotton

Tulia, Texas • Organically grown, irrigated

Yield increase: 25%



Income increase: $103.01

Note the thicker, stronger stems and greater root mass of the Vitazyme treated cotton plants.

Tests with Vitazyme in 1997 on field and orchard crops in the United States were conducted in several states, including the following:

California: Almonds, pistachios, plums, grapes, tomatoes, sorghum-sudangrass

Georgia: Cotton, peanuts, ornamentals

Iowa: Corn, soybeans

Louisiana: Sugar cane

Maine: Potatoes, wheat, barley, other crops

Minnesota: Soybeans

Nebraska: Corn, soybeans

New York: Corn, soybeans, apples, other crops

Oregon: Alfalfa

Pennsylvania: Corn, wheat, other crops

South Carolina: Cotton

South Dakota: Corn, soybeans

Tennessee: Tomatoes

Texas: Cotton, peanuts, sorghum-sudangrass, bermudagrass

A Closer Look At the Folly of Plowing

That we would also have missed all of the erosion, the sour soils, the mounting floods, the lowering water table, the vanishing wild life, the compact and impervious soil surfaces is scarcely an incidental consideration. We have really had a fling at scientific agriculture. The fling, in fact, appears to be the scientific counterpart of what our grandfathers used to call "sowing wild oats." It is time we sobered up and began to apply to the growing of farm crops the same basic science we have for so long been using in the factories, mills, and workshops of our reasonably progressive civilization.

We have equipped our farmers with a greater tonnage of machinery per man than any other nation. Our agricultural population has proceeded to use that machinery to the end of destroying the soil in less time than any other people has been known to do in recorded history. This is hardly a record to be proud of. It gains nothing in attractiveness, moreover, when we consider that our Chinese friends and the often despised peasantry of the so-called backward countries of the world can produce more per acre without machinery than the American farmer can with all his fine equipment. Any reasonably well-traveled person will confirm this statement.

One of the persistent puzzles has been the fact that an ignorant, poverty-stricken Egyptian who stirs his land with the ancient crooked stick can produce more per acre than his British neighbor whose equipment is right up to the minute. The explanation is that the poor farmer can't afford the equipment that would make it impossible for him to continue growing such high yields per acre. The full import of all this will be explained in due course.

"The government is merely an expensive organization to regulate evildoers and tax those who behave; government does little for fairly respectable people except annoy them."

Edgar W. Howe

The disk harrow incorporates residues in a shallow layer, and according to Faulkner is an appropriate tool to emulate natural laws in many situations. It is a step up from the plow.

There is a double meaning in the statement that all of the trouble in producing crops seems to lie in the farmer's fields. The uncultivated fields and woodlands surrounding his land do not show any signs of trouble. Even the crops growing in the fence rows seem to thrive through droughts as well as in fine weather. Would that observation justify us in wondering whether the manner in which farmers handle their land might be responsible for the way crops grow under tillage? Certainly we should not overlook the possibility that a clue to the farmer's trouble might be found by a comparative study of cultivated and virgin soils.

Our conventional ideas of growing processes are due for drastic revision. Much thought and experimental work have been devoted to studies of plant growth, but there has been comparatively little consideration of the part played in plant and animal growth by the actual transfer, more or less directly, of previously used plant food from a lifeless body to one that is living.

We often think and speak of growth as if it were a building process — which indeed it is — but we are likely to assume without sufficient thought that the best growth would result from the use of materials not previously used in organic tissues. We think of our farm crops as getting a mineral solution from the land; and we think of that solution as originating from soil minerals directly, or from the fertilizers the farmer applies. We do not give much consideration to the biochemistry of the matter. We know that anything covered up in the soil is subject to rather prompt decay, if it is at all decayable, but we do not reason from that point to acceptance of the decay products as choice building material for crops growing in the immediate vicinity.

In our material civilization we have rightly learned to be suspicious of anything constructed of cast-off materials. Few people would buy an automobile that was assembled from used parts. And a suit of clothes made of shoddy material would not bring a very high price. Our basic distrust carries over into our thinking about the materials essential to the development of a plant. This would not be true if we did some critical thinking on the subject; but we have not done so. We have left the whole subject to our scientific men. They have learned the facts, and in many instances have published their findings in books or pamphlets which anyone who cares to do so may read; but few have cared to wade through the technical language in which such studies usually have been expressed. Such writings seldom make the headlines or the front pages, so we don't bother to read them. This may be distinctly bad for us.

Much of our knowledge of nutritive relationship is what might be called academic: pigeonholed after discovery and never developed into practical usefulness. Particularly is this true of our knowledge concerning plant nutrition. We know, of course, that no animal can subsist solely on mineral solutions in simple, inorganic form. We do not take our lime as lime water, or our iron as tincture — at least not to any great extent as a matter of nutrition. Our present knowledge indicates that the human race and the whole animal

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Consider Using Green Manures

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kingdom would disappear completely from the earth if deprived of the organic storehouse known as the plant kingdom. That being true, it is highly important that we have a thoroughly practical understanding of the nutritive relationships between plants and the earth; for those relationships are necessarily fundamental to animal well-being, including, of course, the human race.

For purposes of this discussion, it will simplify our reasoning if we think of inorganic solutions, such as those that occur in the soil where water is in contact with mineral crystals, as new, or primary plant foods; and the inorganic solutions that originate in the decay of plant or animal tissues as used, or secondhand plant foods. These are distinctly not the technician's terms for such concepts, but it will be shown herein that they are useful for the layman in understanding how plants may be made to grow best. It should be said, too, that in practice we would almost never find in the soil any organic solution entirely devoid of inorganic compounds. This is because the water which assists in the decay of organic tissues already carries a load of inorganic compounds when it is absorbed into the organic material.

The chief trouble with our farming is that we have concerned ourselves increasingly with the difficult techniques of supplying our farm crops with new materials for growth, when we could easily take full advantage of the almost automatic provisions of nature for supplying plants with complete rations in secondhand form. We have made a difficult job of what should be an easy one.

Several circumstances have conspired to distort our point of view on the nutrition of plants. Thirty years ago, farmers had not become so familiar as they are now with the possibilities offered by inorganic minerals as fertilizers. But, as they have learned about them, and as the costs of such fertilizers have been reduced from time to time, it has been progressively easier to use mineral fertilizers. Meanwhile the means of restoring organic matter to the soil has seemed at the same time to become progressively more difficult. The net result is that technical attention to the inorganic mineral supply has been more and more necessary; and the organic possibilities have simply vanished from consideration.

The wisdom of following nature's ways and leaving residues on the soil surface, as with disking or chisel plowing — or no tillage at all — is obvious: reduced erosion and fertility additions from the surface, allowing microbes to do their job in a highly aerobic environment.

The last few paragraphs outline the basic nutritive concepts involved in this book. No new technical discoveries are to be aired here. The discussion is concerned wholly with reducing to practical terms, employable in anybody's back yard or on any farm, the scientific information possessed for decades but hitherto not put to any extensive use.

Green manures have been known and recommended for decades. For those to whom the idea is new, green manures are simply crops of any kind grown for use as decayable material in the soil where grown. Farmers have been advised for years to make frequent and regular use of green manures to supplement the always inadequate supply of animal manure. In keeping with this idea, county agents as early as thirty years ago urged farmers to make the plowing down of green manures the basis of their soil improvement program for very thin land. Then, when the results of those early attempts were reported, trouble loomed. Plowing down great masses of green manure proved such a colossal boomerang that subsequent attempts to improve growing conditions for plants have been cautious expedients rather than bold attempts to imitate the perfect example set by the natural landscape. It seems never to have occurred to anybody to question the effects of the universally approved moldboard plow. ■ *(to be continued)*

Like water, the man who is complacent follows the easiest course — downhill.

Statement of Purpose

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