Let's Live Magazine, January, 1956

Trace Elements and Agricultural Production

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

We are slowly realizing that the essential chemical elements contributed by the soil in only "trace" amounts--for the support of microbes, plants, animals, and man--are no less essential than those taken from the soil in larger amounts.

It seems most logical to view the "trace" elements, not as parts or constituents of the masses grown, but rather as tools in the process of growing them. "Trace" elements are possibly rendering repeated or recurring services. They are very probably entering into a reaction to bring it about, then coming out to repeat the reaction on another mass, just as we envision the help by catalysts modifying immense masses but themselves never consumed by or retained in them.

Long protection

Such functions of copper, for example, in the body will not be measured by an ash analysis of the young and then the older life form. Nor is quantity a variable when a contribution of this element relieves a symptom, and then that symptom cannot be re-established for a long time by withholding copper. The contributed copper does not escape from the organism. Instead it protects that body for a long time without extra copper being required.

In the plant's production of carbohydrates or the animal's laying on of fat and other equally gross and common manifestations, then, one would scarcely expect "trace" elements like boron, manganese, copper, zinc, molybdenum, iodine, and others to demonstrate much effect.

If one hammer and one saw are the essential tools for constructing a dog kennel, the conclusion does not follow logically that there will be a correlated increase in the number of hammers and saws in constructing 100 kennels or dog houses 100 times as large. Nor would an inventory of these kennels and dog houses find a single hammer or a single saw necessarily within them at the close of the constructing performances.

Viewed as tools

"Trace" elements must be viewed as tools, or as enzymes which do not conform to common correlation thinking where large masses are concerned, and are connected with large causes controlling their behaviors.

In our research, therefore, we have looked to the high protein-producing crops--namely, the legumes and more especially those of highest feed value growing young animals and in aiding their reproduction.

Field trials

In the field trials, several trace elements (and also the neglected elements--magnesium, sulfur, sodium, etc.) were used as a multiple rather than single application. After such multiple treatments register their effects, then trials with the separate elements can well be undertaken.

That the synthesis of the separate components of the proteins--namely, the different amino acids--might be related to the "trace" elements, was the hypothesis under test with alfalfa, for example, in Missouri. Grown in Colorado and imported into Missouri, alfalfa, as a dried feed, is an excellent protein supplement to corn. But grown on Missouri soils--even on those treated with the major nutrient elements--it is not of such high value in this respect. When corn protein is deficient, especially in the amino acids tryptophane, lysine, and even methionine, it seemed well to treat alfalfa growing in Missouri with the trace elements--some used separately and several in combination--to learn whether these protein components are shifted in their concentrations in the alfalfa by "trace" element fertilization.

Significant

It was interesting to note that boron was effective for increasing tryptophane decidedly and lysine almost as much. It is significant to note also that the major influences by the "trace" element fertilization registered themselves in increased concentrations of those amino acids most grossly deficient in com; and likewise of lowest concentration in the alfalfa grown on the Missouri soils without "trace" element fertilization. While boron alone containing no sulfur did not increase the concentration of methionine in the alfalfa, the other "trace" elements carrying sulfates did. This was verified by other work and demonstrates the suggestion that soil deficiency in the neglected element, sulfur, (and possibly other neglected elements) may be responsible for the proteins which are incomplete in methionine, the sulfur-containing amino acid.

In the bio-assay of the effects on the plants by "trace" elements as soil treatment, it is highly probable that the animal has been registering the incompleteness vs. the completeness in the required amino acids of the proteins. We have been too easily satisfied when we measure these as "crude" proteins by determining the total nitrogen of which almost half may be in chemical combination other than the amino or readily usable form.

When by means of "trace" elements via the soil, the amino acid nitrogen in the plants can be increased without increasing the total nitrogen, there is the suggestion that the "trace" elements may be more fully understood only when we study the plant parts and processes in which the "trace" elements probably play their major roles, namely, the synthesis of the proteins, the enzymes, and the other phases in cell multiplication or cell reproduction.

Let's Live Magazine, February, 1956

Our Soils Affect Nutrition

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

The twentieth century will be credited with the addition of the science of nutrition as a major contribution to the better life of our people.

Better nutrition is leading us to think less about medicine as cures and less about fighting microbes with drugs. In a more positive way, it is helping us to think more about helping the body defend itself by being well-fed and therefore healthy.

Strong defense

If we are to bring about good nutrition by means of good food, to build up a good defense for the body, that defense must be strong, not only against enemy invasions--as it can be against tuberculosis--but also against the degenerative diseases like heart trouble, cancer, diabetes.

The science of the soil and its fertility, by which alone high quality foods can be provided, may well be an addition during the present century to our knowledge of the better functions and better health of our bodies.

It is proposed, therefore, in this discussion to lead you to think about the health condition of our bodies as they are related to the fertility of our soils.

Excess carbohydrates

In considering soil fertility as it yields excessive carbohydrates but deficiencies of proteins and minerals, we need only look at the chemical composition of the human body in comparison with that of plants.

From these analytical data we see that potassium is taken into the plants in largest amounts of all the mineral elements from the soil, while calcium and phosphorus are next in that order. In the human body, these same elements are the major three, but calcium is first, phosphorus second, and potassium third.

Of amounts still higher than any of these in the human body is nitrogen. This is the key element distinguishing protein synthesized as amino acids from: the elements only by plants.

Less proteins and minerals

Plants offer us mainly carbohydrates; with only small amounts of proteins. Plant composition, considered as our food, represents possible shortages of; proteins, of calcium, of phosphorus, and of probably other essential elements. We, like other animals, are constantly in danger of deficiencies of proteins and minerals, especially as we are more vegetarian.

By the very nature of the creative processes that start with the soil, carbohydrates are plentiful while there are deficiencies of minerals and proteins. Man is, therefore, always faced with shortages of minerals and proteins relative to the carbohydrates and fats. It is this nutritional need that encourages his carnivorousness and his use of animal products such as eggs and milk.

5.5 lbs. ash

To the soil chemist, that which may be interpreted as merely allegory in scriptural language is in reality a great truth.

Viewed in chemical terms, the adult human body of 150 pounds contains only about 5.5 pound of ash--the non-combustibles that came from the soil. This is the handful of clay into which all the processes of creation serve to blow the warm breath of sunshine, of water, of air and all else from above the soil, to build our bodies by way of the foods we eat.

Malnutrition

Many are the failing bodies that reveal weaknesses in their structures and in their functions.

Medical science is moving from cure to prevention. Many leading physicians point to poor bone structure--commonly called rickets--and to disturbed body functions under the more understandable term of malnutrition, traceable back to the soil.

Conservationists are joining with them and going even a bit farther back to fundamentals in thinking and searching for the causes of poor body structure in deficiencies in the very handful of clay from which we are made.

Let's Live Magazine, March, 1956

Basic Facts of Soil Science

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

Let us outline, rather than discuss in detail, some of the basic facts connecting the nutrition of all forms of life closely with the soil; more particularly via the proteins which are becoming more costly as the fertility of our soils declines.

Our national fertility pattern, resulting from our climatic pattern, gives corresponding pattern to crops, livestock, nutrition, health and other aspects of all life whereby it puts the soil in control.

Varied concentration

The varied concentration of farms in the different regions of the United States outlines the varying chemo-dynamics of the soil for nutrition in a pattern duplicated, for example, by that of the radio efficiency. There are more farms in the same areas where there is the better radio service. When it is the fertility salts of the soil that are both the soil's conduction of electricity and the soil's production of crops, shall we not see the variable chemo-dynamics of the elements of soil fertility responsible for both the better crops, and the better radio transmission, to say little about the better physiological settings for higher forms of life?

The national patterns of these activities in farming and radio efficiency are determined by the pattern of the climatic forces (rainfall and temperature) they have been decomposing the soil minerals and keeping the stream of nourishment flowing to give us our feeds and foods of higher protein values for better maintenance of all life. Shall we not connect the soil more directly with nutrition as we study and come to appreciate these larger national patterns?

Nutrient elements

Plant nutrient elements and compounds adsorbed on and exchangeable from the. soil colloids--not necessarily in aqueous solution--are the fertility "available" to the plant roots.

The clays, --that is, the colloidal fraction of the soil--are the seat of these chemo-dynamics. The nutrient elements are adsorbed there from the solutions of fertilizers, for example. They are moved from there to the plant roots. Such elements in their soluble forms do not move into the plant root along with the water necessarily because the fertilizer salts containing them are soluble, or so-called "available." Water movement into the root follows one set of laws; nutrient movement follows another set.

Clay fraction

When the clay fraction--a negatively-charged colloid--is highly stocked with adsorbed fertility elements, then the soil is nearly neutral in reaction--or not very acid. More acidity in a soil means merely less fertility per unit of colloid.

Increasing acidity in our natural soil *is,* therefore, simply *decreasing fertility.* The presence of the *hydrogen is not the detriment.* Instead, some hydrogen, or *some acidity, is a benefit* in connection with fertility. It "mobilizes" the nutrient cations. It will help the acid clays in their "processing" of the reserve minerals to make them become more "available." It helps some soils to "recuperate" when we "give them a rest."

Full output

The acidity, or hydrogen, resulting from the respiration of the root, exchanges itself to the clay for other cations--that is, positively-charged ions--of nutrient service to the plants. The acid on the clay breaks down the reserve minerals to move more nutrient ions from them to the clay, and from it on to the roots. Acidity, then, is the chemo-dynamic power with the soil (but of sunshine origin above the soil) to keep the fertility assembly line of agricultural production running for full output. It does not run because of the water soluble fertilizers there.

Let's Live Magazine, April, 1956

A New Book - -"Our Daily Poison"

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

Note--So impressed by Leonard Wickenden's newest book, "Our Daily Poison," Dr. Albrecht devotes his entire. April article to his appraisal of it. "Our Daily Poison" is published by The Devin-Adair Co., 23 East 26th St., New York City 10. Price $3.00 a copy--Ed.

This book of 178 pages, written by a scientist with agricultural experience, is a forceful presentation of the facts which a few advanced students have recognized in medicine, health, biology, ecology and soil in their relation to the present increasing use of deadly poisons as a hopeful solution of the complex biological problems of agriculture, food and public health.

The discussion of the subject is divided into 11 short chapters. Two of them discuss the poisons used as sprays for micro- and microscopic pests of plants and animals; three chapters are given to fluorides now on trial; one is on the new cosmetics, with emphasis on the skin as an absorber of poisons; one discusses the perils of hormones; one explains the dangers from our use of vaporizers and fumigators; one reports the poisoned soil and plant absorption of poisons resulting from these technological weapons used against microbial life above the soil while disregarding their dangers to the beneficial soil microbes; one chapter is given to our doctored daily bread; and a final one outlines the limited choices facing us under spraying practices.

Evidence

The evidence cited in most of these chapters is taken from the several voluminous congressional reports of the "Hearings before the House Select Committee to Investigate the Use of Chemicals in Food Products." These hearings cited extended from September, 1950 through March, 1952.

Mr. Wickenden brings these extensive reports by many scientists and industrialists into simple, condensed presentation of the major conclusions which are apt to remain buried in the Congressional files and unappreciated as the reasons for some of the laws resulting from those hearings.

Broader viewpoint

The discussion of this subject indicates that our viewpoint about health is becoming broader. We are coming to see health as the result of a nutrition which grows a selfprotecting body according to the same biochemical laws which were operating during the evolution of microbes, plants, animals and man--even before man assumed that he could exercise control over the entire biotic pyramid by means of chemicals of his own compounding.

It exhibits the growing appreciation, among some of the medical profession, of the broad ecological basis of health of ourselves, when that basis is now being recognized under epidemics by some concerned with public health. Some of those officials are no longer satisfied with finding the microbe and its carrier, in an epidemic, which procedure Dr. lago Galdston of the New York Academy of Medicine cited as "The Clinical Bull in the Ecological China-Shop."

Insidious poisons

Mr. Wickenden emphasizes our disregard of the insidiousness of the poisons intended for life forms other than those warm-blooded, when we forget the similarity in all life processes when reduced to the body magnitude of the single cell. The insidiousness becomes evident in breakdown of the liver, the kidneys, and the skin--our biochemical protectors--through conversions by them of poisons for their excretion but not without the price of slow degeneration of these and other organs themselves.

The reading of this book may well have an alarming effect. It will stir some thinking about independent action for your own well being, when technical manipulation of our agricultural products en route from source to consumer results all too often in decreased, and even poisoned, food values.

Pathetic belief

It should make one intolerant of "the pathetic belief that plants, animals and humans must be dosed and 'protected' if they are to be 'healthy,' this complacent toleration of any commercial innovation so long as it does not actually kill any one (and even sometimes if it does), which is taking us further and further away from better husbandry and better nutrition. It is establishing invalidism with all its costly apparatus of treatment, as a normal condition. It should reaffirm our own conviction that "preliminary inquiries are preferable to postmortem inquests."

You may find endorsement of the book for your reading of it in the fact that three doctors of medicine contribute, respectively, the foreward, the preface and the introduction. These initial eight pages will deserve re-reading after the book has been read.

For any of us concerned with soil as nutrition via agricultural production this book is a challenge to our thinking. It is by no means a collection of facts for complacent acceptance.

Let's Live Magazine, May, 1956

Soils, Plants and Nutrition

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

Note--Dr. Albrecht prepared this article in connection with the Agricultural Advisory Committee's Meeting of the Grocery Manufacturers of America, held recently. They crystalized their entire program around the title, "Lifelines of America." Dr. Albrecht comments that "I thought probably that one needs to remind ourselves that soil is the anchor point for the lifelines of America when all of us want to eat and live." --Ed.

In considering the theme of "Lifelines of America," one is reminded that in any rescue by a lifeline the fixed--or secure--end determines the very possibility of rescue. And in agriculture, the secure end is always the creative or the productive end; namely, the soil and its power to keep the creation of life going. While we may balance the several parts of farming against each other, the soil is the fulcrum which must hold all phases of farming high enough above subsistence if any idea of balancing one against the other is to be entertained.

Fullest meaning

We are now turning more attention to the bigger and better yields per worker as the key point under agricultural production. The bigger yields contribute to the economic line of life. But it is the higher quality as nutrition that contributes to the lifeline in its fullest meaning of life. Food for health is now getting consideration along with food for satiation.

"Hard to grow" proteins

Within the food lot, or supply, we can readily grow the carbohydrate crops, the fattening crops, and those in large surplus quantities. But the protein crops have always been considered so "hard to grow," since so much fertility must be added to the soil in order to grow them.

Crops are struggling to grow themselves rich in proteins. When those growing more proteins fail, we accept crop substitutes which grow less protein.

Smaller percentage

Some Missouri corn samples, 1955 crop, tested for protein were as low as 5.15% of crude protein. That figure is just 50% of the 10.3% protein quoted as the average of Dent corn in Henry's *Feeds and Feeding,* published in 1911. Wheat has shown its decline in protein content, too. Survival of successions of different crops on the soil, given no uplift in its fertility, means that we are accepting crops with less protein.

Less vigorous

Those going lower in protein are less able to protect themselves against fungus diseases and attacks by insects. They are also less able to provide vigorous seed by which the next generation is to be produced and to survive. Healthy plants seem to use proteins for protection.

Animals select

Animals are constantly searching for more protein, too. They demonstrate their unique ability as connoisseurs of feed quality when they select the haystacks grown on fertilized soil, remain more fecund, and give different quality in wool, for example, when fed forages from more fertile soil.

Humans not so selective

Humans are not yet so capable in selecting food for quality in terms of nutritional values contributing to better health in terms of good growth, ready protection against microbial invasion of the body (disease), and prevention of sterility.

We are slowly realizing that the lifeline of America is the foodline with the fertile soils for protein production as the security point from which that lifeline reaches out.

Let's Live Magazine, June, 1956

Soil Calcium and the Quality of Leafy Greens

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

PART I

Green leafy vegetables are recognized as important foods in the human diet. As the providers of minerals and vitamins they are among the "protective" foods recommended by nutritionists. It has long been realized that there are significant and important nutritional differences between certain greens of the mustard family (kale, mustard greens, and turnip tops) and those of the goosefoot family (spinich, Swiss chard, beet greens, and New Zealand spinach).

The nutritional superiority of the vegetable greens of the mustard group must be ascribed to their higher contributions of the inorganic element, calcium, and of the vitamin C, ascorbic acid. The calcium serves in body building and the vitamin C in stimulating body processes, especially those providing energy.

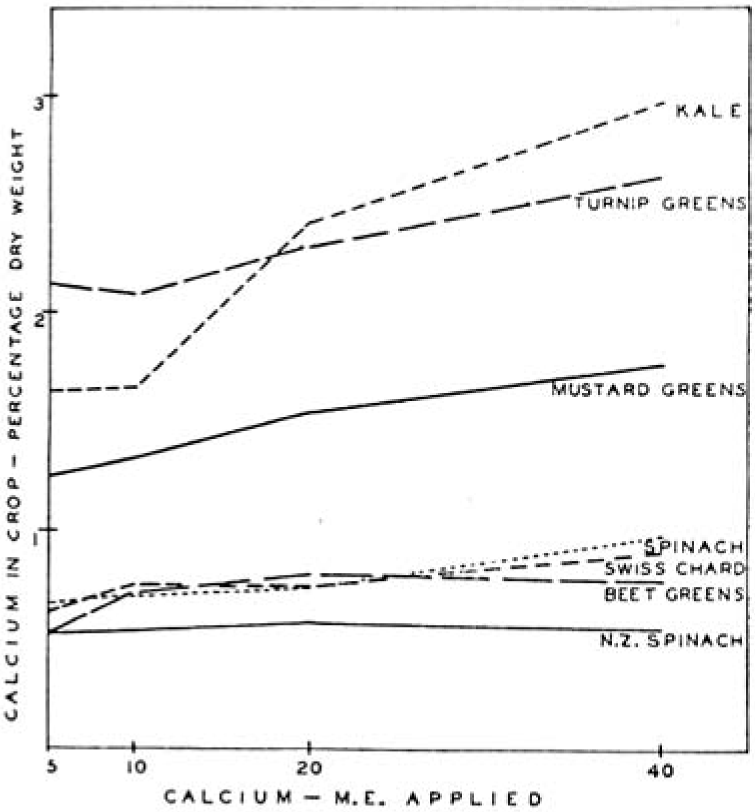
Nutritional quality

Naturally, attention has been directed in these columns to the importance of soil fertility as a determiner of the "nutritional quality" in whatever we grow, whether that be crops in the garden or in the field. We need to focus our attention continually on such quality when even declining soil fertility has given us "surplus" crops in the category of those that fill, fool and fatten, but not of those that truly feed. And it is important to emphasize the calcium in "greens" when so much is said about eating them to get "minerals" or, rather, the inorganic elements for building the bones of the body.

Some experiments showing how much difference the fertility of the soil makes in the concentration of the inorganic element, calcium, were made possible by using the carefully prepared colloidal clay to supply the plant with differing amounts of calcium per plant, namely 40, 20, 10, and 5 units while in combination with each of these amounts of applied nitrogen were varied through the units 40, 20, 10, and 5. This gave an extensive range in ratios of these two nutrients to each other. The seven kinds of vegetable greens cited above were grown, and careful chemical analyses made of them for their concentrations of calcium in the dry matter.

Calcium concentrations

The concentrations of calcium, as percentage of the dry weight, are most easily shown by the curves in the accompanying chart. The superiority of the three greens, in terms of the concentration of the calcium in the crop, is well shown when the curves for kale, turnip greens, and mustard greens are so much higher on the scale at the left of the chart than are those for spinach, Swiss chard, beet greens and New Zealand spinach. The figures for the latter four did not go over one per cent, yet for the former three did not fall as low as one per cent, as providers of calcium in our diet. There can be a decided difference in the nutritional value of the kind of greens one chooses.



COMPARATIVE CALCIUM CONTENTS . . . Of green leafy vegetables.

In addition to the amounts in total by which the kinds of greens are different, it is more significant to note the betterment in quality, as providers of calcium, according as more calcium was applied to the soil. The mustard family, which was superior in its delivery of more calcium in total, also increased its delivery of nutritional value in this respect more than did the goosefoot family when more calcium was added to the soil. This is evident from the greater angle in rise in the upper three lines than in the lower four lines in the chart.

Pronounced rise

The curve for kale shows the most pronounced rise for the concentration of its calcium with more calcium in the soil. Some figures for the calcium of the better kale crop showed how wide these differences were.

When 40 units of nitrogen were applied in the soil and combined with 5, 10, 20, and 40 units of calcium applied, the yields of crops were respectively 558, 468, 544 and 523 grams to make their appearances too much alike for anyone to distinguish between the similar plants had they been put out for your discrimination. But yet the calcium concentrations were respectively, 1.98, 2.25, 2.46, and 3.10 per cent, as more calcium was put into the soil--an increase of over one-half by the highest over the lowest.

Higher delivery

This is a decidedly higher delivery of calcium per mouthful of greens according as the soil was treated with more calcium to bring about this greater nutritional contribution by the crop. The choice of greens can improve the nutritional values put into our diet, but those values are also raised by the uplift of the fertility of the soil with respect to the inorganic nutritional element in question.

These studies, like many others, point out what we can do for the improvement of our nutrition. We should not be satisfied to think only the names of the variety or species of plants we grow, but should also concern ourselves about the fertility of the soil under the plants . . . when this starting point of all plant growth determines what nutritional qualities will be created by that natural performance.

Let's Live Magazine, July, 1956

Soil Alters Calcium Digestibility in Leafy Greens

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

PART 2

That the green leafy vegetables of the goosefoot family (spinach, Swiss chard, beet greens, and New Zealand spinach) do not increase the concentration of their calcium according as the soil is more heavily limed--as is true for the leafy vegetables of the mustard family (kale, mustard greens and turnip greens)--has been previously pointed out. Nor do those of the goosefoot family cany as high a concentration of calcium as do any of the mustard family group.

The differences in the calcium concentrations between these two families are much more magnified when one considers differences in their nutritional availability of this essential inorganic element. The calcium in the four kinds of goosefoot greens cannot even be digestively utilized in the diet, according to good authorities, because of the large amounts of oxalic acid formed and present in these plants.

Of plant origin

This organic compound of plant origin combines with the plant's calcium and also with the magnesium to convert these into insoluble and indigestible oxalates. In sharp contrast, according to these authorities, the calcium, for example, in the mustard greens, turnip tops and the kale is almost completely useable since these of the mustard family are practically free of the oxalates which make the calcium and magnesium indigestible.

In some experiments using soils controlled as to both their available calcium and their degree of acidity (pH values) while growing spinach, we made the startling discovery that the spinach grown on the more acid soil had higher concentrations of the inorganic elements, calcium and magnesium, and also of the organic compound, oxalate, than were those found in the spinach grown on the less acid or nearly neutral soil.

Higher concentrations

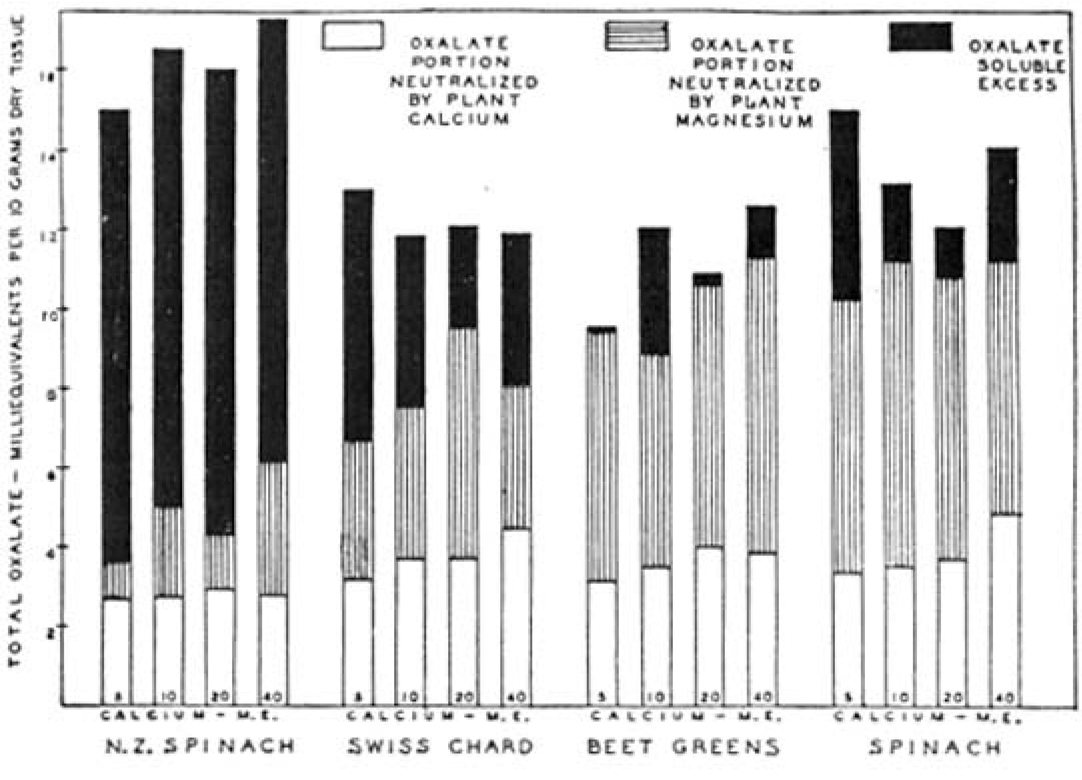
But even at these higher concentrations, those amounts of the calcium and the magnesium added together were more than sufficient to neutralize the oxalic acid by forming oxalates and to leave some extra calcium and magnesium in other forms than this indigestible combination of them.

The spinach plants on the nearly neutral soil failed to take enough calcium and magnesium from the same soil's supply to offset the oxalic acid produced within the plants. Therefore, they could offer no digestible calcium and magnesium when these greens were put into the diet. Also, on the nearly neutral soils, the application of varied amounts of extra calcium to the soil failed to change the concentrations of calcium within this green leafy vegetable significantly.

Goosefoot greens

When the four goosefoot greens were grown on nearly neutral soils and chemical analyses made of them for their (a) calcium, (b) magnesium, and (c) oxalate, their high concentrations of oxalates were most noticeable. Even though the calcium in the soil was increased through units of 5, 10, 20, and 40, while the magnesium in the soil was held constant, these four leafy greens each produced more than enough oxalic acid to make both the calcium and the magnesium insoluble and indigestible.

This is quite different from what would have been the case, had the soil been varied in its available calcium while kept at a more acid reaction, which results when calcium in the gypsum rather than in the limestone or carbonate form is used. The chemical results of these greens as carriers of calcium and magnesium in combination with the oxalates when grown on nearly neutral soil under variable calcium supply are shown in the accompanying chart.



PROBABLE DISPOSITION OF OXALATE . . . In New Zealand spinach, Swiss chard, beet greens, and spinach when grown at variable levels of calcium.

Beet greens

In only the best greens was the combination of calcium and magnesium almost enough to overcome the detrimental effect of the oxalic acid in making these two essential elements wholly insoluble and indigestible.

These data tell us that not only the amount of calcium in the soil but even the degree of soil acidity comes in to determine whether the green leafy vegetables will give us the "mineral" elements, calcium and magnesium, in a digestible form. Only slowly are we coming to realize that the condition of the soil, as well as the kind of crops, determine the nutritional value of what we grow and eat.

Let's Live Magazine, August, 1956

Is Commercial Urea an "Organic" Fertilizer?

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

Recently an organic gardener raised the query, "Is not the commercial nitrogen fertilizer, urea--which is chemically made from nitrogen of the air--improperly called an "organic" fertilizer?"

This is not a recent question. Urea had its discovery as a white crystalline compound in urine in 1773 by Rouelle. As a waste product of the body's breakdown of proteins, it originated in a living organism and was considered organic for 55 years. Then, in 1828, a German chemist, Wohler, made urea from some laboratory chemicals, potassium cyanate and ammonium sulfate. Since that date, folks could take their choice as to whether they want urea to be called an "organic" or an "inorganic" compound, so far as its origin is concerned.

Commercial type

In considering commercial urea as a fertilizer, (in contrast to it in manure) it is well to be reminded that the chemical urea compound has long been used, and in considerable quantities, when given off by another inorganic substance, namely, calcium cyamid containing nitrogen of atmospheric origin. When put into moist soil, this nitrogen fertilizer breaks down liberating urea slowly. The change may take a week. In some conditions, intermediate or secondary compounds resulting may be disturbing to seedling growth. But this reaction is transient and its dangers can be prevented by making the soil treatment with it ahead of the planting. Here, then, is another fertilizer combining air nitrogen by means of limestone and coke to make an "organic" fertilizer, urea, result within the soil, and one no different than the urea from animal urine.

In terms of more common chemical thinking, however, urea should be considered an "organic" substance, since by its composition of carbon, hydrogen, oxygen and nitrogen it leaves no ash on burning. Also, the nitrogen has two hydrogens connected with it and is itself, in turn, attached to a carbon.

Characteristic arrangement

This is a characteristic chemical structural arrangement of the nitrogen in proteins, the living compounds of carbon, hydrogen, and nitrogen (sometimes also of sulfur and phosphorus) which can grow, protect themselves from other proteins, and reproduce. In the case of urea, this arrangement of nitrogen is called the "amide" of carbonic acid (organic origin) because of the nitrogen-hydrogen combination in a larger compound.

Used as a soil treatment, or as "activator" in the compost heap to balance the microbial diet, the behavior and effects of the urea are the same regardless of its origin in an animal or in the manufacturing laboratory.

Changes

It changes into ammonia, water, and carbon dioxide quickly, especially under the influence of microbes or even enzymes in some plant products. The ammonia released may be held by adsorption on the soil colloid, may be taken as such by microbes or plants for their nutrition, or may be converted into nitrites and then nitrates for more nutritional services by those forms.

Of course, urea is not the equal in effects by urine in composting straw and other fibrous wastes, when the latter carries both other inorganic and organic compounds not present in the chemically pure urea.

No distinction

So in terms of nutrition of the plant and of the microbes, these life forms draw no distinction as to whether you call urea an inorganic or an organic fertilizer according to its origin. For them this compound is one and the same in function, regardless of our possible quibble over its particular classification into the one or the other of these categories.

Let's Live Magazine, September, 1956

Compost for the Sea or the Soil?

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

We have seen the problem of the disposal of kitchen waste by mechanical disintegration, and the interest in composting organic wastes and all else one connects with the need to return to the soil for maintenance of its fertility all of the organic results of its productivity.

In facing the problem of kitchen and food wastes, we are concerned--at first thought--only with disposal. Refuse of this kind accumulates very rapidly, especially with shells of seafoods or rinds of watermelons. The idea of flushing this through the drain into the sewer, by means of mechanical disintegration, takes hold quickly as a convenience in disposing it to the streams and to the sea.

But it neglects the necessity of maintaining the cycle of growth, death, and decay right in place of all organic materials, if soils are to be maintained in productivity, rather than simply mined and destroyed.

Return of organics

Kitchen gadgets for disposal eliminate the garbage man. But we need to consider garbage disposal in terms of its potential in maintaining soil fertility . . . by return of the organic matter as a help in plant production, rather than the return only of the ash or of the chemical salt equivalent.

So, while the enthusiasm for mechanical disintegration may carry the wastes to the sea, we need to consider the mechanical disintegration as a secondary effect of microbial decomposition of these wastes in the compost heap. Thereby, and through the balancing of the microbial diet by the addition of chemical fertilizer salts to the composting, a fertilizer of balance in terms of both inorganic and organic essentials for plant growth may well be made. This is, then, truly "conservation of soil fertility" in action, rather than in lip-service only.

Unknown factors

Rather than being a case of biological shock of salt application to plant roots in the soil, this salt shock is transferred to, or taken up by, the soil microbes in the compost heap by using the fertilizer salts there. Those salts are combined with less active organics. They may be chelated, or made more effective, for plant use--and may give play to many unknown factors in soil productivity.

While household conveniences are always welcome, it is well that the matter of composting our wastes for return to to the soil--to become soluble and to be reused there, rather than to be made soluble for disposal to the sea--be given more serious consideration and wider practice. Plants reach a climax in maintaining a pure stand of the species when they grow in the place where their own wastes, or they themselves, are completely returned to the soil. Man may be considered in the same light of better survival, as a species of life, if he will return all his waste to the soil, rather than primarily to the sea.

Because of the idea of turning, more and more, to the idea of returning our organic wastes (along with chemical fertilizers) to the soil for soil fertility maintenance, we want to add our encouragement . . . in the scientific study of the potential for production of higher nutritional quality in crops when the return of this organic matter is more completely brought about.

Let's Live Magazine, October, 1956

Food Quality--as Physiology Demands It

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

The old saying, "The proof of the pudding is in the eating thereof," is challenging the scientists to give us the values of what we eat in more specific characterizations than those of that simple--and usually pleasant--experience. Eating gives proof in terms of taste, but that is not yet specified by any standard, or reproductible, units of common agreement. We cannot report scientifically all that food does for us. We do not comprehend all the services of it, much less all the body functions in which it may play some vital roles.

Chemical analyses of the ash of vegetables or field crops are not highly informative. The very analysis destroys by ignition the organic compounds for which we eat food in the main. Vitamin assays, specifying these catalytic compounds, are more suggestive. Feeding tests, measuring the food quality by gains in body weight of animals, or by shifts in rates of body processes--of both animal and human--are more widely used to measure the nutritional qualities of food crops in relation to the inorganic fertility of the soil growing them. Though they are laborious procedures, assays of the rat, the Guinea pig, and other animals are about the only accurate measure of food quality now at our command.

An illustration

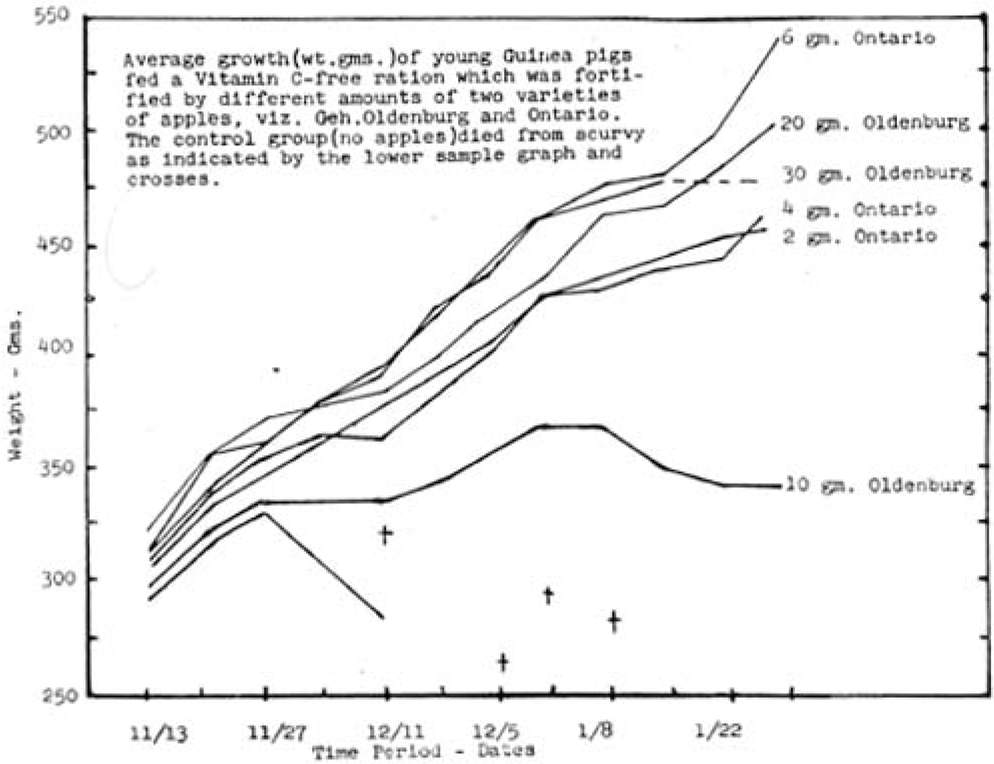
Visible properties may be appealing, but they are not proof. The tomatoes serve as an illustration. The British market offers the housewife--and she seems to prefer it--a small tomato with fewer sections in it, with more acid and more juice. The American market has large, fleshy, many-sectioned, less juicy and highly flavored tomatoes. But what of the nutritional values, and what evidence thereof can we specify after the eating?

Food quality is arousing more concern in other countries under higher press of population than in ours. That may well emphasize nutrition and good health, as the reason for purchase of groceries for ourselves with decreasing tillable acreage of productive soil per person and declining fertility of those remaining areas under continued cultivation and higher costs. In Germany, and other European sections, a growing number of scientists, of magnitude sufficient for an international society, have concerned themselves in research in the nutritional qualities of different foods.

Apples vary

As an illustration of some of their work, there was reported a study of the qualities of apples used in feeding the children of two comparable orphanages. While the health of the children was studied and examinations of them made regularly, the apples were also put under bioassay by Guinea pigs for measure of vitamin C content.

Some of these results in summary (see accompany chart) for a feeding test--from November through January--show that two, four, and six grams of one variety of apple, Ontario, were the equivalent in vitamin C content of 20 and 30 grams of another variety, Oldenburg, when used as supplement to a diet free of this essential nutrient.



Proof

Here proof is given to us in vital characterizations by the Guinea pigs. No apples meant their death; 10 grams of Oldenburg were but little more than survival; and as little as two, four, and six grains of the variety, Ontario, were the equivalent of from 5 to 10 times those weights of the former variety. If once we assay as accurately as this, not only the varieties of foods we grow, but each in relation to the inorganic fertility of the soil producing it, and if we specify the results as life and death for Guinea pigs, we shall no longer be indifferent to nutritional qualities of what we eat. Instead, we shall also be in position to improve and control nutritive values in what foods we grow.

Let's Live Magazine, November, 1956

Blast Furnace Slag--a Soil Builder

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

The term "conservation" implies so much, and is taking on so much importance, that many folks are asking whether the soil might not be built up in fertility by using some of our industrial wastes. Numerous inquirers, interested in soil organic matter, have asked about city garbage, and septic tank sludges recently. Also, inquiries have come in concerning the value of blast furnace slags, the wastes from making steel.

Such slags should be considered, though their variation in composition demands that one know something about them, and about the fineness of the materials. They are the residue from putting limestone, feldspars and other minerals in with the iron, to serve as fluxes, to purify it. The carbonate part of the limestone burns off to let it become quicklime, calcium silicate, or calcium phosphate, and other combinations possible at those high-furnace temperatures.

Fertilizer value

Slags are the rock-like residues dumped out after the molten iron has been drawn off. They are of fertilizer value, therefore, as carriers of phosphorus as well as calcium, with much of the latter in silicate form. In making some steels, manganese and other "trace" elements are often present, too, in this complex silicate rock.

Sometimes the hot-rock is slaked and granulated by spraying with water, or it may be cooled and crushed. Either treatment aims to make it serve as a lime substitute for soil-building.

Sustains fertility

Since, like many other original rocks, it is a silicate, therefore, it weathers down slowly. Its use is, then, a case of adding "sustaining" fertility to the soil rather than as a "starter" fertilizer. By its decomposition it adds not only calcium, some phosphorus, and "trace" elements, but also some silica. This is a clay-builder for the soil which would be helpful on sandy soil with "too little body," or not enough capacity for adsorption and exchange of nutrients to the plant roots. In the slow reaction, by this kind of "lime," there may be more of a safety factor than when lime carbonate is too generously used under the belief that "if a little is good--more will be better."

Since we lime soils now to supply calcium (and magnesium) as fertility, rather than to remove the acidity, the blast furnace slag has been shown by tests to be a good way of building up the soil in calcium (and magnesium). We can, therefore, practice conservation with profit by using this waste from the steel mills to build up the soil.

A factor

The fineness of the slag, into which it is ground--as for limestone--becomes a factor in its rate of being effective in crop nourishment. Also, its lime content (calcium and magnesium) must not be too low (preferably near 45 per cent) if its effects are to follow more promptly after its application on the soil. These may be greater because it is not so much of a reagent to reduce the soil acidity as it is an active silicate providing calcium. Combined as a silicate rather than as a carbonate, it is more of a "buffer" in that it does not bring on, or permit, sudden shifts in the degree of soil acidity under heavier applications of it.

In terms of the microbial life of the soil, its application is no "shock" because of any "salting" effect. Yet it stimulates (a) nitrification, as the change of ammonia nitrogen to the nitrate form; (b) the speedier oxidation of the carbon compounds; (c) the fixation of nitrogen by microbes living independently of the legume plant roots; and (d) all the other biological soil processes which distinguish a "live" soil from a "dead" one.

The employment of blast furnace slag as a fertilizer for the fields, and as an aid in composting, has been a practice in the "art" of agriculture by some folks long before recent scientific studies, tests, and partial commercialization gave its use greater sanction as a soil treatment--using this accumulating waste from the dump heaps of steel mills. We can use such material not only for true conservation but also with assurance that it builds up the soil for more nutritious crops.

Let's Live Magazine, December, 1956

Plants Struggle For Their Proteins, Too

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
Chairman, Department of Soils, College of Agriculture, University of Missouri, Columbia, Mo.

Man and other warm-blooded animals are always hungry for proteins. Man is ever craving meat, fish, eggs, cheese and other foods of animal origin. These compose the item on the menu that sets the price of the entire meal. He is hungry for what was another animal body, or the body products creating and feeding another young and growing body. He needs what is more nearly "living" foods if he is to keep his own body living. It is the proteins in our food by which our body, (a) grows; (b) protects itself from its own degeneration and its disruption by invading foreign, living proteins; and (c) reproduces its own kind.

Domestic animals, breaking through the fence to feed on the grass of the virgin soil of the highway, or on the railroad right-of-way, are telling us that they are struggling to get out for more protein per mouthful of the grazing there--than from the grazing of crops where the fertility of the soil has been depleted by extensive cropping and little maintenance of the soil fertility. Wild animals marauding our cultivated fields--even our gardens--risk their lives in the open to get feed they recognize as more nutritions--because its growth on more fertile soil makes it of higher concentration of nitrogen and all else that distinguishes the protein from the carbohydrates and fats.

More protein

Students of wildlife tell us that a few small areas of forest cleared, and grown to protein-rich crops by soil treatments, will increase the fawn crop of deer not only by more births but also by more twins as well. The struggle by wildlife, like that by our farm animals and ourselves, is for more protein, too.

Nitrogen is the one element, going from the soil fertility supply into the plant, by which we distinguish proteins from carbohydrates and fats in making chemical analyses.

No simple process

But in order to grow proteins and their nutritional quality into plants, rather than just carbohydrates and fuel food values there, all the other nutrient elements for plants must also be offered them by the soil. When a plant makes proteins, it does more than attach the element nitrogen to the carbon chain in carbohydrates or fats. That synthesis is a biochemical reaction carried out only by life processes. It is not even considered a process as simple as carbohydrate production by photosynthesis, using the energy from sunlight. Plants are struggling to get soil fertility completely enough to build up their proteins just as animals and man are searching to find foods offering this essential to them.

Plants naturally differ widely in their concentration of proteins (nitrogen x 6.25) in their total bulk, that is, in the percentage of nitrogen in their dry substance (D.S.). Nature has given us protein-rich plants, but they do not deliver much tonnage of vegetative growth.

Natural law

When plants are naturally low in their concentration of protein, or of nitrogen (N), they make much vegetative growth per acre. This simple natural fact, or natural law, namely, that large yields of vegetative bulk by a crop should suggest lower concentration of protein within it, and lower feed and food values in terms of body growth, health, and fecundity, is well illustrated in Figure 1.

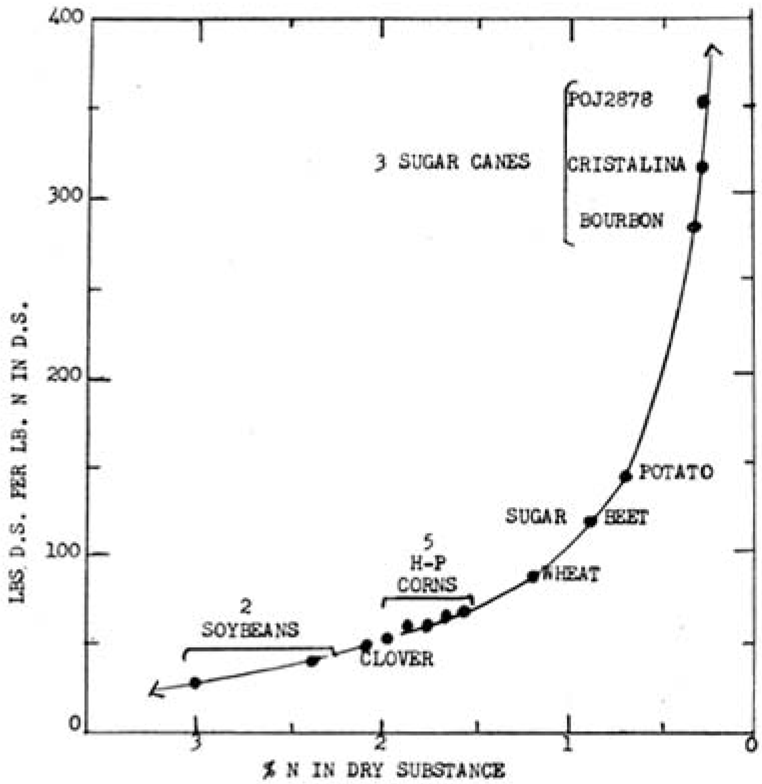


Fig. 1 - Yields of dry plant substance as function of nitrogen in dry substance

The curve does not go high enough beyond sugar cane to include forest trees where the living protein part is limited to the cambium layer under the bark. Much bulk or dry substance (D.S.) does not guarantee much protein (nitrogen x 6.25) or necessarily much food value. We need to know food value of the crop, that is, the protein values, and that in relation to the fertility of the soil, rather than only the bulk produced per acre. We need to realize that a large amount of vegetative growth suggests a small concentration of protein and other growth values in it.