Lets Live Magazine, January, 1952

Soil Treatment AND WOOL OUTPUT

by William A. Albrecht, A.B., B.S., M.S., Ph.D
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The wool of the sheep, much like muscle, is a protein product of growth. While fat is associated with wool fiber in what is commonly called the "yolk," this fat is the secondary rather than the primary part in the growing of the fleece of wool.

In the production of wool, for too long a time, we have been concerned with the quantity the sheep produces. Only recently has the quality of the wool fiber come to attention. And much more recently, we have begun to consider the quality of the wool in relation to the fertility of the soil growing the forages on which the sheep are grazing. We have now begun to realize that the fertility of the soil may come in, to control the wool to degrees not generally appreciated.

Wide variations

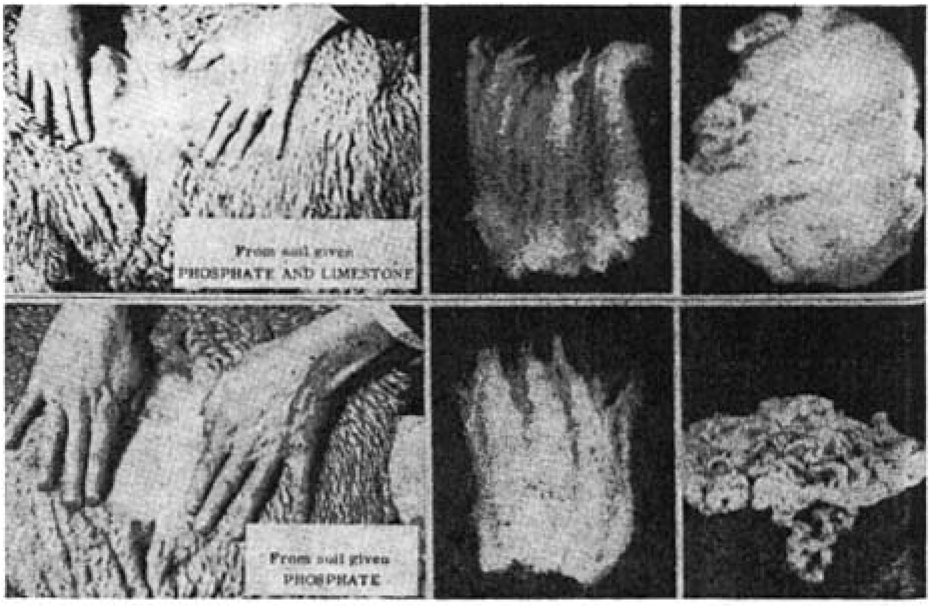
In some trials with hays grown on soils with different treatments, the wool of the sheep scoured and carded out in good order, when the hay was grown on a soil treated with both lime and phosphate. It could not be carded and the fiber was broken, in the attempt at carding, when the hays fed the sheep were grown on the same soil type given only super-phosphate. In addition, there was little yolk in the wool on the sheep in the latter and a generous amount of it in the former. Here the quality of the wool fiber of protein make-up, and the amount of fat associated with that fiber, both varied widely simply because the lime deficiency in the soil had or had not been corrected by an application of limestone.

More recently the regularity in the crimp, or the wave, in the wool fiber of the Merino sheep has been correlated with the presence or absence of some of the trace elements, especially copper and cobalt. In South Australia this was very noticeable in the wool from sheep grazing on the grass on some of the calcareous sands. The drenching of the sheep with from seven to 10 milligrams of copper associated with one milligram of cobalt daily restored to its uniformly wavy appearance the so-called "steely" or wire-like wool fiber.

Color and trace elements

The color of the black wool of black sheep is also related to the presence of these trace elements, especially with the copper. Australian black sheep, grazing on pastures on these coastal soils, lose the black color to become gray. When given copper and cobalt in the feed, or the drench, the black color is restored.

In many parts of the United States it is commonly said "Black sheep never stay black. They always turn gray." It might well be questioned whether this is not merely saying that our soils are copper deficient, and possibly even cobalt deficient. We have only recently begun to think of these so-called "trace" elements and their importance in the body's production--not of fats, but of its proteins, even of the different amino acids constituting the proteins.



UNIVERSITY OF MISSOURI

COMPARISON . . . Wool, a protein crop by the sheep, reflects the fertility of the soil that grows the feed.

Effective

Some studies on the essential amino acids making up the proteins in alfalfa, for example, suggest that the trace elements put in the soil are effective in pushing up the concentrations of these protein constituents created by the plants. Sulfur put on the soil suggests that this element is too low in supply in the soil to let the plants make all the sulfur-containing amino acids they would otherwise make. Magnesium as a soil deficiency also comes into prominence now in connection with possible failure of our forage crops to build the proteins complete, so far as the required amino acids are concerned.

Now that we are measuring proteins more commonly in terms of their nutritional completeness with reference to all the amino acids, rather than by calling all nitrogenous products proteins, the soil deficiencies for plants creating these acids are coming into the foreground.

We need to recall the fact that animals don't synthesize proteins from the elements, including those in the fertility of the soil. They only collect them from the amino acids created by the plants. Sheep and their protein output in the form of wool are telling us that the fertility of the soil, and our treatments of the soil, reflect themselves quickly in this product. All this tells us that the creation of what carries life itself, namely the proteins, goes back to the soil.

Lets Live Magazine, February, 1952

Diseases AS DEFICIENCIES VIA THE SOIL

by William A Albrecht, A.B., B.S., M.S., Ph.D.
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While it has long been common belief that disease is an infliction visited upon us from without, there is a growing recognition of its' possible origin from within because of deficiencies and failures to nourish ourselves completely. Fuller knowledge of nutrition is revealing mounting numbers of cases of deficiency diseases.

Need to be traced

These deficiencies need to be traced, not only to the supplies in the food and feed market where the family budget may provoke them, but a bit farther, and closer to their origin, namely the fertility of the soil, the point at which all agricultural production takes off.

These increasing cases classified as deficiencies are bolstering the truth of the old adage which told us that "To be well fed is to be healthy."

Ample nutrition

Isn't it good nutrition that is used as the "cure" for human tuberculosis? In that "disease" the effort is not given to the extermination of the microbes from the lungs and other body parts by means of antiseptics and other sterilizing agents.

Instead it is nutrition by milk, eggs, meat and all else for a high protein diet. Under such treatment, the germs apparently recognize their premature anticipation of a task of disposition and literally move out. Shall we emphasize the "cure" in this case or shall we raise the question whether deficient nutrition and defective physiology were in advance of, and an invitation to, the entrance by the microbes?

A cure?

Were the "germs" the cause then, or merely an accompanying phenomenon of what is a deficiency but which we call tuberculosis? Might this not be the cause for some of our cattle diseases, accompanied by microbes, but yet so baffling that slaughter is still the "cure."

In cases of undiagnosable animal ailments, the able veterinarian often recommends feeding good alfalfa hay grown on the more fertile midwestern soils, or he prescribes some extra amounts of other protein supplements, as accompaniments to his medication. When the animal recovers, a similar confusion as to correct explanation of causes for the animal recovery is involved.

Real foundation

With the fattening of animals and its speculative aspects so prominent in agriculture, and with so little attention given to real production in terms of good nutrition because its failure is too commonly considered some "disease" or "bad luck," it will take some time before we appreciate fully the simple fact that the soil fertility is the foundation of the pyramid of all life.

We are slowly realizing that the soil is the source from which every branch in the assembly line of agricultural production is kept running full. As long as crop bulk and animals merely fattened for more weight are the major goals of our agricultural effort, our thinking to no greater depths will delay the day when we see the soil as support and in control of production.

Potent fact

That a soil may be speedily exploited of its protein producing power while its capacity for delivery of carbohydrate bulk holds on long afterward, is a potent fact that has not yet been recognized in our westward march. Under such circumstances we shall continue to talk about "buying" and rationing protein-supplements instead of accepting the costs of soil treatments to grow them.

When a soil is not fertile enough to make the protein in a seed crop, as was the case for early trials with soybeans, we say, "This is a hay crop, but not a seed crop." In that remark we show our lack of appreciation of the consequences for the poor cow asked to live, to reproduce, and to give milk while feeding on that hay. When such a "legume" hay was fed to fattening steers, it was a surprise that some of them "went down" on their hocks as if hamstrung and others with paralysis of the rear quarters.

"Poor health"

We are gradually coming to see that "poor health" is creeping into the animals even while in the fattening process, because poor feeds result from poor crops, and the poor crops could do no better in their creative effort than was permitted by the soil from which alone creative potentials spring forth.

Unfortunately, for our domestic animals, it may take a goodly number of their disasters and deaths to convince us generally that much that is classed as animal diseases may be no more than nutritional deficiencies traceable to the low fertility of our soils growing the feeds.

Lets Live Magazine, March, 1952

How Smart is a Cow?

by William A. Albrecht, A.B,, B.S., M.S., Ph.D.

Note--This is a transcript of a radio broadcast heard over WDAF, Kansas City. Dr. Albrecht is Chairman, Department of Soils, College of Agriculture, University of Missouri, Mo.--Ed.

Announcer: I'm just going to ask Dr. Albrecht one question: *Doctor, how smart is a cow?*

Dr. Albrecht: First of all, let me say that the cow is smart enough to be our teacher, for after all, when we begin to learn, our teacher is usually the first one from whom we learn.

It has taken a long time for the cow to teach us that she doesn't eat broom sedge and tickle grass that we see in the fields as we drive across the country. Perhaps you would think that she has a prejudice against that particular plant species. Hers is not against vegetative bulk, or growth, or mass of plant material, but against that crop because it has made only vegetative mass, of little or no nutritional value. It is too low in protein.

Too much nitrogen

You might say, well, now, she doesn't even eat the excessively green grass--those green spots that are very tall and deep green because they are rich in nitrogen, which is the chemical element we use to measure the protein. So you would say she doesn't eat that protein-rich grass and, therefore, her judgment of grass as protein might be bad.

Now, why doesn't she eat that grass? Well, because that is unbalanced in nutritional value. There is too much nitrogen.

No hay baler

Then still further, she is telling us that she is not a hay baler. But she is interested in feed to put it through herself for nutritional value and not for a pastime. She doesn't care how many tons or how many bushels per acre, but she is concerned about the nutrition the feed represents. So she is teaching us gradually that we are going, eventually, to grow grass and other crops for nutritional service for her, or there will be little nutrition for ourselves.

Better chemist

I might say the cow is smart enough to be a better chemist than we are, even with our finest of laboratories. She was a chemical assaying agent measuring the quality of feeds long before we were. Primitive man had his herds and his flocks. He followed the cow around. She went ahead, and he came along behind her with his tent and his plow. She probably said to him, *This is good soil for my food, and I recommend it to you for growing your food.* She went ahead of the plow for the primitive man.

Plow ahead of cow

Unfortunately, in our modern age when we ran over the United States, we put the plow ahead of the cow. Now we wonder why we don't have good food and why we have degenerative diseases. She was a good chemist to make vitamin B-12 in her intestinal tract long before we knew it. We have now discovered that the B-12 is made by her in complex chemical processes because she cooperates with the microbes in her paunch and intestinal tract to make that possible. So she is a better chemist than we are.

Smarter than we are

The cow is smarter than we are even in making the food for us. When she makes milk she does some things and apparently has some ideas we still do not understand. How she can take green grass, put that into her intestinal tract so you can get white milk with yellow butterfat, and a lot of good casein for making cheese, is still something about which she is smarter than we are.

No exposure

Now, in addition, the cow is smarter in handling the milk for her children than we are in handling it for ours. When she makes milk for her children, she passes it to them without ever exposing it to the air. Her calf feeds, allowing no air to come in, and does so in a sealed atmospheric condition. Instead, we take that milk, run it through all the air to cool it, and then through some more air in the heating process to pasteurize it. By aerating it, we--no doubt--destroy some of the value of the essential fats.

We must learn

In recounting the cow's smartness, we should point out our dumbness. We are too dumb to know how smart she is for our own benefit. We haven't yet learned to turn over the big responsibility of food production to her, while we merely help. As soon as we learn this, better food production will be earned out by the cow, with our help, than when we control her.

Lets Live Magazine, April, 1952

Quality vs. Quantity CROPS

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
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Crop quality in its relation to soil fertility may have different properties and values in our minds. There is, however, no confusion about crop quantity.

For the farmer the volume of output is important. But his volume is a quantitative matter of bushels of wheat per acre. Even though there may be some premium for "harder" wheat, this extra earning per acre by higher quality is small in contrast to the greater monetary gain he can make from more bushels per acre.

Quality wanted

It is quality that is wanted by the baker, who uses the flour, as he looks to the market offering him his necessary goods. It is quantity that is wanted by the farmer as he looks to the same place to purchase from him the goods he has for sale.

Unfortunately, the consumer and the producer in this case do not meet each other. Nor do their separate desires meet through the common market. Both are content to serve the market rather than each other. Consequently, when lowered fertility in the surface soil layer makes many bushels of "soft" wheat with its low protein, the farmer sees his desires well satisfied by the market. He is then blind to, and unconcerned about, the desires of the miller and the baker on the other side of the market. They, too, do not see the declining quality of the soil--especially its declining nitrogen supply--as the reason for the increasing quantity of "soft" wheat in place of "hard" wheat of the high quality they desire. They may accuse the farmer of growing a poor variety, selected for quantity production when in fact he had been compelled by declining soil fertility to use it, in consequence of which his quality declined while quantity increased.

Soil fertility

The quality of corn, like that of wheat, is also premised on soil fertility. Livestock feeders have been clamoring for help in providing more protein supplements.

Corn producers and consumers have been oblivious to the fact that while there had been a tremendous increase in quantity there has been a serious decrease in quality amounting as protein to almost one-tenth of the total production.

Average falls

It has been reported that during the last 10 years the protein content of com has fallen from an average of near 9.5 to 8.5 per cent. Fattening power in the form of the starch of the grain has increased. Growth power in the form of protein has decreased. Consequently, while steers feeding on the corn may do well in laying on fat, they may not be building a muscular and bony structure strong enough to carry the extra weight to the market.

Starch production with its fattening and fuel values calls for little soil fertility. It calls more for air, water, and sunshine to fabricate this energy-providing food substance. Protein production, however, calls for nitrogen, calcium, and many other items from the soil in addition to the carbohydrates within the plant before it consumes much of its own supply of this photosynthetic product while it converts a part of it into the different amino acids of which the life-carrying and body-growing compound of protein consists. Soil fertility is in reality the foundation of quality in the cereal crops. But unfortunately, while watching the bushels of wheat and of corn increase to our economic satisfaction, we have been slow to see the decrease in quality or in protein that determines life itself.

Proteins

Quality in agricultural products is calling for more soil fertility by which to make proteins rather than bulk.

Good nutrition and fecund reproduction and what we call good health in any form of life do not depend on quantity, but rather on the quality, of the products consumed.

Lets Live Magazine, May, 1952

"Deep Rooting" DEPENDS ON SOIL

by William A, Albrecht, A.B., B.S., M.S., Ph.D.
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When we speak of "deep-rooting" crops, we are apt to give a wrong impression. By that description, we are leading folks to believe that it is the characteristic behavior of the crop that sends its roots down deeply. After all, roots are not being sent. They go only on invitation; and that invitation must include refreshments, namely, something to drink, i.e., water, and something to eat. namely, fertility in the soil.

Roots don't grow in nor go into a dry soil. As the season advances and the sun's drying effects penetrate more deeply into the surface soil, the roots of a com plant, for example, are also going down deeper. By this, the plant escapes the danger that its water supply may fail. Its roots are taking water out of the soil. They exert an additional drying effect on the soil behind their advancing front, as they bore down into soil that is more moist. But while roots are growing downward within the fertile surface soil they are big. thick roots. They are nourishing themselves from the soil, as roots do, in addition to getting nourishment from the. plant tops. The fertile surface soil layer helps the roots to attain massive growth. While they are growing in such soil, the tops of the corn plants are also growing well too.

Going not growing

However, if the crop is on a shallow surface soil overlying an acid, heavy clay subsoil--the high acidity indicating its low fertility--then when the roots grow down out of the drying surface soil to enter the subsoil, they become very thin. They are then merely going. They are barely growing.

That they are finding plenty of water is shown by the fact that the growing top of the corn plant does not wilt. But they find too little nitrogen in the humus-deficient, and thereby nitrogen-deficient, subsoil for the continued luscious growth of the corn. Consequently, the plant transfers nitrogen from the lower, older leaves to the upper, younger ones. Then the lower leaves turn yellow and look burned.

Root-starved corn

All too often this so-called "fired" corn is said to be suffering from drouth or water shortage. If that were true, then the tops would be wilted rather than the lower leaves changed from a green to a yellow color. Plant roots may be going into the subsoil and getting water, but unless it is a fertile subsoil, they are very thin roots. They deliver too little fertility to help the plant much, because they can't help themselves. Root appearances tell us the story of subsoil fertility. Thick portions of roots record the more fertile soil horizons; thin portions, the less fertile ones.

Plowing

Plowing has long been a practice to help plants take more fertility out of the soil. Now as its fertility is dwindling, more folks are plowing to put fertilizers into it.

Erosion is also shaving down the fertile surface layer thinner and thinner, so it is becoming necessary to plow deeper while putting fertility down into the subsoil. We are beginning to see the wisdom of building up the surface soil by building fertility down into the subsoil.

No solution

The crop roots must be nourished into big ones by fertile soils if they are to give big crops. Merely plowing deep to turn up the infertile subsoil is no help. In fact it may be the opposite. It may mean near disaster to a crop. Putting fertilizer into the surface soil--dried during much of the growing season--is not the equal of putting it down deeper, but yet within root reach.

Plowing is a means of putting heavier applications of fertilizers down into the soil. Subsoilers are even more efficient in putting some soil treatments farther down. Roots reaching down to attain thick, massive growth serve to put organic matter deep down, where little was before. This modifies the soil structure. It invites the roots of the following crops to go still deeper. Instead of letting the surface soil become shallower, it helps to deepen it. It is a case of making the fertile soil deeper so the crops will be deep rooting--not merely planting what is said to be a "deep-rooting" crop and expecting it to make the soil deeper. It is a case of inviting big, thick roots down for nourishment rather than sending a few thin ones there without it. It is, in reality, a help toward building up the soil by building down, and at the same time building bigger returns by means of bigger crops.

Let's Live Magazine, June, 1952

Soil Fertility AND NUTRITIVE FOOD VALUES

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
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We are gradually coming to believe that the soil, in terms of the food it grows, is a controlling factor in agricultural creation. The pattern of the soil fertility has only recently been worked out. That this fertility pattern maps out the nutritional quality of feeds and foods is not yet widely recognized or appreciated. We have been measuring our agricultural output in terms of only bulk and weight increase, rather than in terms of nutrition, reproduction, and better survival of the species.

By subscribing to the production criteria of more tons and more bushels, we have watched the crops but have forgotten the soils that grow them.

Hard to grow

When the dwindling fertility makes protein-producing and mineral-producing crops "hard to grow," we fail to under-gird them with soil treatment for their higher nutritional values in growing young animals.

The life of the soil is not attractive. The death of it is no recognized disaster.

The provision of proteins is our major food problem. Carbohydrates are easily grown.

Persistent belief

Our reluctance to credit the soil with some relation to the nutritive quality of our feeds and foods, is well illustrated by the belief, persistent during the last quarter of a century, that the acidity of the soil is injurious; and that the benefit from liming lies in fighting this acidity. In truth, it lies in its nourishment of the plants with calcium and its activities in their synthesis of proteins and other food essentials.

As yet we do not appreciate the pattern of soil fertility in the United States.

Crop failure

When a crop begins to fail, we search far and accept others if they make bulk where the predecessor didn't. We credit the newcomer with being "a hay crop but not a seed crop." If it cannot guarantee its own reproduction via seed, we call it feed for the cow.

The grazing animals have been selecting areas according to better soils. They have been going through fences to the virgin right-of-way. They have been grazing the very edges of the highway shoulders, next to the concrete, to their own destruction on the Coastal Plains soils.

All these are animal demonstrations that the nutritive quality of feeds is related to the soil that grows it. But, to date, the animals rather than their masters, have appreciated this fact most.

Creative power

Shall we keep our eyes closed to the soil's creative power via proteins, organo-inorganic compounds, and all the complexes of constructive and catalytic services in nutrition?

When the health and functions of our plants, our animals, and ourselves indicate the need, isn't it a call for agricultural research to gear production into delivery of nutritional values related to the fertility of the soil, rather than only those premised on bulk and the ability to fill?

By directing attention to the soil for its help in making better food, we may possibly realize the wisdom in the old adage that "to be well fed is to be healthy" and that good nutrition must be built from the ground up.

Let's Live Magazine, July, 1952

Soil and Proteins

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
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Raindrops of the same size and shape are falling today, with the same impacts and foot-pounds of energy for work, in breaking down soil granules as they always have. But the chemical composition and other properties within the soil are significantly altered.

A major, but unappreciated, change has been the decrease in the stability of the soil granules or in the stability of the soil structure. Soils that once retained well their loamy condition and plow-turned forms all through the winter, and through many rains after tillage, are now soon beaten down by only a few of them.

Runs off

As a result, much of the subsequent rainwater runs off and does not enter the soil. We do less fall plowing. Our soils must he spring plowed, if they are to remain granular and well aerated as a good seedbed through a significant part of the crop season.

This decreasing stability of the soil's granular structure is only another way of saying that the incidence of a weakened, if not a "sick," soil body should be taken as the major change in our soil; and thereby the basic cause of the increase in erosion. Here is the big reason why water has not been going into our soil, but running off. It has been increasingly destroying the means by which food is created and agriculture is maintained.

Acid soils

Acid soils that are highsaturated with hydrogen, which is not a plant nutrient and therefore desaturated of calcium, magnesium, and all the other nutrients, do not granulate readily. Nor do they grow the nitrogenous crops to give calcium-rich, nitrogenous humus in the soil that brings about the stable granulation.

Soils deficient in fertility are of weakened soil body. They are subject to severe erosion. When surface soils lose their fertility, to become similar to subsoils in this respect, they—of necessity-erode as badly and as rapidly as subsoils.

Barren soils erode because they are not fertile enough to feed the crop we grow on them. In other words, our soils cannot take the impact of the rainfall because their fertility has declined too far to permit a stable soil structure to grow cover quickly enough for prevention of excessive runoff and erosion, and to add organic matter.

Quantity vs. quality

To emphasize the decline of fertility in our soils may seem to be a mistake. Nevertheless, it is a fact that while the bushels per acre of both wheat and corn have been going upward, the concentration of the protein within each of these grains has been going downward. While our crops have been yielding bushels per acre bountifully, those bushels have consisted mainly of the photo-synthetic product, starch. Implied, then, in our conservation of the soil, is our struggle for food protein in order that we may survive.

It is the fertility pattern of the soil according to the climatic pattern that determines whether we have largely calories in carbohydrates or whether we have also proteins, minerals, vitamins and all the other essentials of good nutrition for man and his animals.

Climatic forces

In attempting to conserve the surface layer of the earth's crust, one dare not disregard or run afoul of the climatic forces in control of the development of the soil. They are in control of the assembly lines of agricultural production and in all creation originating in the soil minerals and soil organic matter. Either they supply us--or they deny us--the nutrients serving as the foundation of the entire biotic pyramid, with man at the top.

Soil conservation is not the application, on a national scale, of any single practice. It is the use of many practices according to the conditions of the soils. Conservation calls not only for prevention of erosion, but also for efforts in building up the soil in its fertility supply by building downward.

Let's Live Magazine, August, 1952

OUR TEETH AND *Our Soils*

by William A. Albrecht, A.B., B.S., M.S., Ph.D.
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That Hereford, Texas, is in the part of the United States of highly fertile soils is not so startling when the geography of dental defects on a larger scale is considered. The physical examinations of the millions of men taken into the Army and the Navy give a wealth of data in relation to the many possible factors in control of our health and condition of our teeth. These data may well be correlated with the fertility of the soil for their suggestive value. In these data and records there is opportunity to relate the caries of the teeth to the soils of the United States according to their pattern of fertility, or to their degree of development by the climatic forces.

Comdr. C. A. Schlack and Lt. J. E. Birren of the Navy Medical Research Institute have presented some data by regions of the United States which represented the condition of the teeth of 69,584 men coming on active duty in the Navy. *(Influences on Dental Defects in Navy Personnel. "Science,"* 104:259-262, 1946.) These represented 93 per cent of a lot from which seven per cent had already been eliminated for dental reasons. This screening reduced the regional differences, but even in spite of this, those regional differences show a decidedly interesting relation to the development of the soil.

Astounding

From the report of these naval officers, one is almost astounded at the poor dental condition in this sample of our people. It is especially serious when these naval inductees represented the mean, youthful age of 24 years with 82 per cent of them below the age of 30 years. For the group as a whole, the report reads: "The mean number of simple and compound cavities was found to be about 10 per person . . . and five fillings per person. . . . Few teeth required extraction, despite the large number of carious teeth, the mean number per person being about 0.2. In contrast, the mean number of missing teeth was 4.7 at the time of the examination."

This is a sad commentary on the dental condition of our young men when the statistics list them for an average of 15 carious areas each, in spite of the regular encouragement by the radio to use the tooth brush daily and to "see your dentist twice a year." But when the chemical composition of our teeth tells us that they consist mainly of calcium phosphate and when the foremost fertilizer treatments needed to grow even carbonaceous vegetation on our soils are lime (calcium) and superphosphate (phosphorus), there is good reason that the poor dental condition of these naval inductees should be connected with the low fertility of these soils. When soils need lime and phosphate to grow agricultural vegetation, much more will they need these fertilizer additions of calcium and phosphorus.

Striking

By recalculating the dental data of these naval inductees so as to make them represent more nearly the soil areas according to increasing degrees of soil development in going from the arid West to the humid East, the correlation is very striking.

It is highly significant that the lowest numbers of carious teeth are in the longitudinal belt of dual-state width just west of the Mississippi River. Hereford, Texas, is included in this belt. As one goes either westward or eastward from this belt to other similar belts, the tooth troubles increase. This increase, however, is much larger in going eastward; that is, to the excessively developed soils under higher rainfall and temperatures, than it is going westward to the underdeveloped soils.

Here is a clear indication that those soils with a high capacity for protein production--because of their high mineral fertility--are the soils that have also grown better teeth. These are the soils of the open prairies.

Low capacity

Quite differently, however, those soils that have a low capacity for producing legumes, beef, and mutton and have been growing starchy grains and fattening the livestock, have a much higher number of carious teeth per person. These are the soils of the forested areas, or the potential producers of mainly fuel foods.

The maximum number of caries was exhibited by the men from the New England States. There the cavities amounted to 13.5 accompanied by 7.8 fillings per person or a total of 21.3 carious areas per mouth. With so many defects, it's a pity that we can't have more than 32 adult teeth. In the Middle Atlantic States the total figure was 19.6. Still farther south the corresponding value was 13.4 of which 9.7 were cavities and 3.7 were fillings.

Three factors

In the case of the soil and teeth, as one goes south from New England, there are three factors that may help explain the decrease in caries. There is first, a decreasing ratio of rainfall to evaporation and therefore less relative leaching of the soil. Second, there is less acidity to break down the mineral reserves because of the nature of the clay. And third, in the South, there is more general use of fertilizers consisting mainly of carriers of calcium and phosphorus.

In these regional data are the suggestions that the curve of the condition of the teeth is the reciprocal curve of the fertility of the soil. We may expect also, from these relations, that the pattern of soil fertility is in control not only of the health of the teeth, but also of health in general. This is strongly suggested by a careful study, reported by Dr. L. M. Hepple of the University of Missouri, of the more than 80,000 draftee rejections from more than 310,000 selectees for the Army from Missouri alone. He points out, for example, that Kansas had lower rejection rates than Missouri. This is another way of telling us that the health troubles increase in going from the calcareous soils of Kansas to the lime-deficient soils of Missouri.

Less fertile

Equally as interesting, in terms of the increase in draftee rejections as the soils are less fertile, are his data in going across Missouri from the northwest to the southeast--which means going from the legume and cattle area to that of cotton. His series of figures for rejections in making that traverse of the state was 208, 247, 280, 339, and 368 per thousand selectees. Even for an area so limited as Missouri, the health condition in terms of Army standards reflects the pattern of the fertility of the soil.

Important statistics

From all these Army and Navy data, there is the suggestion that more of our so-called "diseases" may well be statistically mapped for the United States and compared with the map of the soil fertility. If all other body irregularities as well as those of the teeth were so viewed, it is highly probable that many of our diseases would be interpreted as degenerative troubles, originating in nutritional deficiencies going back to insufficient fertility of the soil. Surely the millions of health records will not be left lying idle in Federal archives when they can be sorted out as specific diseases; plotted as densities over the soil fertility pattern; and possibly furnish suggestions for combating the failing health that rests on this great fact: degeneration of the human body goes with the exploitation of the soil.

If the decay of teeth is linked with the declining fertility of the soil, this concept of tooth troubles may well be a pattern to guide our thinking about other health troubles, not as calls for drugs and medicines, but for conservation in terms of a new motive, namely better health via better nutrition from the ground up.

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Mineral Hunger

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Fortunately, we are better able to combat hungers at the point of origin, namely in the soil, than at any later stage in the agricultural assembly line. At that point, the problem is no more complex, probably, than supplying one or more of a few simple inorganic elements. A little effort there cures the deficiencies that cause the hidden hungers of the soil microbes and the plants. Properly fed plants prevent deficiencies in their synthetic products that serve as animal feeds and human foods. Here are solved the problems of providing the hosts of essential chemical compounds, the required amino acids, the necessary vitamins and the specific fatty acids. These problems of provision in the diet are more nearly insurmountable than those of getting some dozen elements, both major and "minor," applicable as fertilizers on the soil. At any later stage the problem is more complex and the situation more prone to induce the micro-hungers.

Differences

Lespedeza hay grown after phosphate application and fed to sheep caused them to grow fleeces that were low in fat or yolk that scoured out too poorly to be carded except as broken fibers.

Yet the same plant species grown on soil given both lime and phosphate helped to grow fleeces of heavy yolk and wool that scoured well and carded out as fibers of good quality for spinning and weaving.

Treating the soil to grow good quality wool was as simple as giving the soil some extra fertility in the form of calcium. Just what should have been chosen as the particular supplement to make this deficient lespedeza hay better sheep feed, so as to make better wool, is a problem not no simply and easily solved. It is clearly a case of hidden hunger, the cure of which is extremely perplexing but the prevention of which is a simple as the practice of liming the soil.

Soil fertility

In our thinking about "diseases," both empirical and scientific knowledge are influencing us to think less about cure and more about prevention by ministrations to sick soil. Once the mind thinks soil fertility, observations come rapidly.

Calves eating plaster, not the exposed first coat but the hidden last coat, in a fine barn prompted a farmer to ferret out a magnesium deficiency in his soils. Prompted by curiosity and intelligence to use some magnesium as a fertilizer he started a train of apparent miracles, including the curing of scours in calves, and some reduced mortality, less mastitis in the cows, better alfalfa, better corn, and other blessing in his farming program. When other major and minor elements given the cattle make them negative to the blood test for brucellosis, and when medical research is pointing to similar good suggestions of improvement of undulant fever patients, these are no longer hidden troubles. Attention to the soil fertility, the point of their origin as deficiencies rather than as diseases, is making them major hungers for major attention by more of us than those in the curative professions alone.

Save ourselves

It can truthfully be said that rapid progress is being made in recognizing hidden hungers. Many of them are now being prevented because they are being diagnosed as originating in our declining soil fertility. Foremost among the gross nutrient factors of serious decline are those connected with the synthesis of proteins by plants. Soil treatments are no longer appreciated only because they encourage production of greater bulk per acre. They are being made on increasing acreages because they add nutritional qualities to relieve the long chain of hidden hungers coming up from the soil through the entire biotic pyramid to torment man at the top.

Micro-hungers

For better reproduction of farm animals, and for the better health for them and for ourselves as well, we are becoming increasingly concerned to know more about the fertility of the soil as the means by which such good fortune can be guaranteed. The disturbing and perplexing micro-hungers are hidden mainly from our thought, our recognition, and our full appreciation of their origin. They are not hidden from our body physiology nor from our mental processes when as little iodine, for example, as a fraction of a grain coming from the soil up through the plants to us is all that "stands between us and imbecility."

It is a good sign for the future that we are coming to realize that our hidden hungers are provoking deficiencies in mind as well as body. We are coming to think about keeping up the soil in order to keep us mentally able to realize that our hidden hungers are pointing to the soil fertility as ready means for their prevention.

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Soil Acidity IS BENEFICIAL

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Only recently have we come to appreciate the services of soil acidity in mobilizing--making available--many of the nutrients in the rocks and minerals of the soil.

When we learned that soils are less productive in giving us legumes and other protein-rich forages, according as they become more acid--either naturally or under our cultivation--we came to the conclusion that soil acidity is the cause of this trouble. We now know that a plant puts acid into the soil in exchange for the nutrients it gets. It is that same acid held on the clay that weathers the rock fragments and serves to pass their nutrients on to the clay, and from there on to the plant.

Nature's process

The coining into the soil of excessive acidity is merely the reciprocal of the going out of the fertility. Nature's process of feeding the plants, and thereby the animals and us, is one of putting acidity into the soil from the plant roots in order to break out of the rocks what nutrients they contain for nourishment of all the different life forms.

Limestone

When we put lime rock on the soil as a fertilizer supplying calcium to our legume crops, we know full well that this rock reacts with the acid-clay of the soil. The acid goes from the clay to the lime rock which, being calcium carbonate, breaks down to give carbonic acid while the calcium is absorbed or taken over by the clay. While the calcium goes on to the clay to be available there for the plants, the carbonic acid decomposes into water and carbon dioxide as gas. Since this gas escapes from the soil, this escape takes away the acid, or, as we say, "it makes the soil neutral."

The benefit to the legume crop from the application of this lime rock to the soil does not rest in the removal of this soil acidity. Rather, it rests in the exchanging of calcium as a nutrient to the clay which was holding the acidity or hydrogen, a chemical element that is not of direct nutritional service.

Other fertilizers

Soil acidity has been breaking potash rock down chemically too. During all these past years the potash feldspars have been undergoing weathering attacks by soil acidity. On this rock the acid clay carries out its weathering effects in the same way as it does for lime rock, except that it trades acid to the feldspar and takes potassium unto itself in exchange. Magnesium rock, as we have it in dolomitic limestone, is also broken down by the acid clay. By this same process the clay becomes stocked with magnesium. This is then more readily exchangeable and available to the plant from the clay than it would be if the plant root were in direct contact with the rock fragment itself. By exactly the same mechanism we can expect phosphate rock to be made available for the plant's use.

It is in these processes by which the acidity of the soil is beneficial. If the soil contains the two colloids, clay and humus, which can hold acidity, and then if that soil has scattered through it fragments of lime rock, of magnesium rock, of potassium rock, of phosphate rock, or in fact of any rock with nutrients, it is the soil acidity that mobilizes to the clay the calcium, the magnesium, the potassium, the phosphorus, or all the other nutrients respectively for rapid use by the plants.

Plant nutrients

This is Nature's process of providing plant nutrients on the clay of the soil in available form. By it Nature has stocked our moderately acid soils with fertility. It was that condition of our virgin soils that spelled our prosperity. We need to go back and study the soil in order to learn how we can gear the lime rock into our acid soils so it will stock our soils with calcium and still not remove all the acidity needed to make the other nutrients available in other rocks, of which some are giving phosphorus, some giving potassium, and some giving one or more of all the other nutrients in whatever rock form Nature has them.

Slow mobilizer

Of course, Nature's processes do not demonstrate high speed. It takes six months or more for limestone to stock the clay with enough calcium to feed our legumes. It takes longer for others. So when the soils are not acid we may expect shortages of some fertility elements like phosphorus, for example, in the plants and even in the animals. It is on the acid soils where most of our population has always fed itself, suggesting that it is on those acid soils where there is much more speed in making the fertility active and available from out of the reserve minerals.

No speculation

That human health may be related to the deficiencies in the soil has come to be more than mere speculation when animal troubles are localizing themselves more and more according to soil fertility deficiencies. It is significant that this health trouble is most severe in those states where the less acid soils give deficiencies in phosphorus for the plants and animals.

There are also other nutrients in addition to phosphorus that are not mobilized effectively unless the soils are acid. These include iron, manganese and boron.

We have used lime rock, phosphate rock, and green sand as potassium rock, in both the experimental work in the laboratory and in the field trials, to convince ourselves that the plant nutrients within these are made available to plants by the acidity of the soils.

Benefits

Possibly as we come to appreciate the benefits of soil acidity we shall no longer fight it with carbonates, but shall guard it and use it to treat our lime rock as calcium fertilizer, our phosphate rock as phosphorus fertilizer, and possibly many other rocks whose fertilizer values we still do not appreciate.

In the future more of these mineral or rock types of soil builders will very probably go into the soil to build up a reserve of minerals there. This will occur when it becomes more common knowledge that soil acidity is beneficial and not detrimental.

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Too Much Nitrogen?

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That plants may go on a "nitrogen jag" has long been pointed out by the grazing cow. She lets the rich green spots of grass grow taller, while she grazes the short grass.

She can balance the protein and carbohydrate in her diet as she grazes selectively in her pasture. That is why she leaves more white clover but less bluegrass. That is why, by June, the pasture is mainly white clover.

Too much

Those deep-green grass spots, fertilized by much nitrogen, do not appeal to her as providing a balanced diet perhaps, and so she by-passes them. At any rate, her body physiology directs her appetite to balance her ration. The excess of nitrogen represents an unbalance to her, and she says so by refusal.

"Too much is too much" only in relation to something else. If too much nitrogen is used in relation to the supply of phosphate, potash, calcium, or other growth factors, the unbalanced situation causes trouble.

Spectacular

We do know that when the right amount of nitrogen is available, and other necessary factors are adequate, then growth and yield can be truly spectacular.

That animals instinctively select food which provides a balanced ration was suggested by some work by Dr. George E. Smith.

In his test, rabbits were fed grasses grown on soil that had been treated only with nitrogen. (This work was part of studies leading to the bio-assay of soil fertility, by using the animal to measure the value of soil treatment rather than a mere increase of yield in bulk.)

Tempting

Nitrogen fertilizer on the grass, it was true, made a large and luscious green growth, if only the human eye judged it. But the rabbits, when fed the grasses from areas with different soil treatments, had their own criteria for judging the resulting food values.

The seemingly beautiful green, nicely cured grass hay was consumed only as a partial defense against starvation. And it did not keep the rabbits from getting dangerously close to that before their death was prevented by shifting the ration. Other rabbits, given grass hay from plots that had no soil treatment, maintained themselves by consuming the ration more completely.

Common belief

In dealing with a ration of fertility elements for plants, we too commonly consider the plant ration as merely the sum of the separate items: of calcium, plus nitrogen, plus phosphorus, plus each of all the others necessary. These are taken into the plant and eventually delivered through it to the manger and thereby to the animal for its use. Through chemical analysis of plants, we believe that soil fertility is a collection of some 10 or more elements taken from the soil for the use of animal and human bodies.

This concept suggests that, if that is all we need to do, we might just as well use a shovel and truck to haul calcium as limestone from the crusher to the mineral box. As a curative help to an animal already in disaster this may have some value. It illustrates the widespread failure to appreciate that plant nutrition is not as simple as limestone plus phosphate, plus potash plus any other thing in any amount merely dumped on the soil to produce crops to haul to the feeding rack.

Synthesizing plants

An important matter in plant nutrition is the fact that plants must eat where they are. Unlike the cow, they can't pass up the place where there is too much nitrogen. Consequently, they run their own manufacturing business--of synthesizing the fertility of the soil into organic combinations by means of air and water--the best they can.

If there is much nitrogen, the plants weave this into chemical combinations with carbon, hydrogen, etc., that builds a lot of green vegetable bulk that may not keep the plant from lodging and may not result in seed to keep the species multiplying.

Root growth suggests that plants do make some selective searches through the soil.

Selective searches

This is indicated when we find more roots around decaying organic matter, a piece of limestone, a granule of phosphate, or see the high concentration of roots in a fertilized portion or band in the soil. It is by such cafeteria-like "browsing" through the soil by the roots that the plant top is the final blending of fertility elements into the compounds that are built in a major way by photo-synthesis. It is this soil fertility that makes the plant more than just sugars or starches--a contribution of sunshine power and the weather.

It is this synthetic performance, controlled and determined by soil fertility, that results in plants of nutritive value for growing bodies which does something more than just fatten them with such energy foods as sugar and starch.

Proper balance

Here, then, is the idea of a balance, or the proper amount of each element of soil fertility--nitrogen, phosphorus, calcium, etc.--in relation to each of the others. It is a matter of not too much, or of not enough, of any one in relation to the others that are needed by the plant.

A plant's functions are not confined to the use of only one recipe. When carbon, hydrogen, oxygen and nitrogen are involved, there are infinite kinds of chemical linkages. It is these that the cow is trying to help us appreciate as she selects her grazing according to the differences in soil fertility.

Too much nitrogen or not enough else, you say? Yes, as long as we are not as well informed about differences in synthetic output by our crops for nutritive values as the cow, the chicken, or even the hog. After all, it is a matter of proper balance or of being moderate in all things.

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PROTEIN DEFICIENCIES . . . *through soil deficiencies*

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Proteins alone are the substance through which life flows. This intensively concentrated study of the proteins bids fair to make the last half of the twentieth century the era of real nutrition. Unfortunately, it is the deficiencies of proteins--under failing nutrition and failing health--that are crowding this output of knowledge about them into such a limited time period.

Fit subject

Since proteins are the carriers of life, we may well learn of their nutritional services from biochemical investigations of them in the plants and animals as well as in man. Accordingly, it would be well to study what Dr. Fairfield Osborn, of Massachusetts Institute of Technology, would call comparative biochemistry, much as we study comparative anatomy.

That the microbe may be coming into its own in biochemistry is no flight of fancy. As a synthesizer of unusual compounds, its antibiotic products have attained prominence not only as protection but also as nutrition. We have been moving away from nutrition as a matter of merely dumping into the gastrointestinal hopper, the carbohydrates, fats, proteins, vitamins, minerals, and water, as items measured and studied mainly as requirements in bulk for fuel. We have moved our thinking toward the delicately integrated functions of the chemical compounds for their services through their transformations.

Gratifying progress

This progress of integrating the comparative biochemistry of the entire biotic pyramid is particularly gratifying to a soil microbiologist and a student of soil fertility. It is gratifying to learn that not only the medical profession is using antibiotics for protection of man against invasion of himself by various microbes--even to the dangerous extent of sterilizing the entire intestinal tract--but also that nutritionists are turning from *fighting* to *courting* microbes, from the products of which we get highly improved nutritional values in all the food components when these are ingested together.

But this movement of our thinking through comparative biochemistry from man down through animals and plants to the microbe should not stop there. Instead, it should lead our thought on down to the foundation of all life, to the base of the entire biotic pyramid, which is the soil fertility, the essential elements of the soil. It is from there that the synthetic performances, building all life forms, must take off.

Fertile soils required

The nutritional approach to so-called "diseases" has been showing much promise for better health. Students of the soil and its microbial flora see still greater promise for it, when the fertility of the soil under the vegetables and the forages rather than the species of the plant, name of variety, breed, or pedigree is recognized as the determiner of the nutritional values of those foods and feeds. That the invasions of the body by microbes should often be only symptoms of, and not responsible for, diseases, and that decadent health should be ascribed to malnutrition bringing on degeneration of tissues and functions are growing concepts of the facts. These concepts are being demonstrated in the mounting numbers of deaths from heart failure, cancer, diabetes, arthritis, anemias, leukemias, and arteriosclerosis.

The high value of proteins in nutrition for body regeneration are coming into prominence. It is now acknowledged by the profession itself that the "medical practice is highly dependent on nutrition." The use of protein hydrolysates for intravenous feeding during coma, ante- and post-surgery periods has already demonstrated nutrition, at high protein levels, as basic for recovery from disease regardless of whether this originates from degeneration or other causes. If these desperate situations of threatening death can be removed, or its grasping hand stayed off for a longer time--by the more complete list of amino acids suddenly thrown into the blood stream--is it illogical to consider that the body's degeneration was possibly brought on by a long period of poor nutrition under protein deficiency?

Broader viewpoint

Perhaps by looking at nutrition and the soil together, on a larger geographic scale or in a wider array, there will stand out more clearly the indications from the ecology of various life forms that protein deficiencies are provoked by deficiencies in soil fertility. By the term "ecology" we mean the particular order in the distribution of living species over the earth. Naturally, many factors come in to determine the places where a certain kind of life is found in dominance. It is essential to point out that food to maintain the species registers its significance quickly and forcefully.

In considering the term, "food," one would scarcely give major emphasis to the caloric value of carbohydrates and fats as the commonly limiting factor. The delivery of calories is a function of most any carbon-containing compound. The shortages in calories is not the first or most prevalent food deficiency. To date there has been no experimental suggestion that carbohydrates of specific chemical structure are required. We propose to consider proteins, and all that is associated with them, in their synthesis and transformation for nutritional services, as the major means of connecting soils and nutrition.

Nutritional support

Since animals do not synthesize their proteins--or amino acids--from the elements, but are dependent for this creative activity and this nutritional support on the plants and the microbes (some of the latter living in the animal's alimentary tract), we must first undergird the plant's production of complete proteins, if our animals and we are to be well-fed in respect to this complex food constituent.

For an appreciation of the plant's struggle to elaborate the complete proteins for us generously, we must look to the many soil factors concerned. Different soil fertility factors represent differences in the array of amino acids, and in the amounts of each coming from the plants, as they are different species or as there are differences in chemical composition within the same plant species.

By such reasoning, then, human nutrition as a struggle for complete proteins goes back--not to agriculture as it represents industry or economics concerned with prices to be rolled back--but to fertile soils alone on which plants can create proteins in all completeness.