Let's Live Magazine, January, 1953

Soil and Nutrition

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We are gradually coming to believe that the soil--in terms of food it grows--is a controlling factor in agricultural creation.

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.

Accordingly, we have introduced new crops which readily pile up carbohydrates and caloric bulk. When dwindling fertility makes protein-producing, mineral-providing crops "hard to grow," we fail to undergird them with soil treatment for their higher nutritional values in growing young animals. Soil fertility--as help toward more protein within the body, as protection against microbial and other invasions--has not impressed itself yet.

Feeds and foods

Instead, we have taken to the therapeutic services of protective products generated by animals, and even microbes, in our bloodstream as disease fighters. The life of the soil is not attractive. The death of it is no recognized disaster. Hence, it may seem farfetched to any one but a student of both the soil and nutrition to relate the nutritive quality of feeds and foods to the soil.

The provision of proteins is our major food problem.

Carbohydrates are easily grown. For the output of these energy foods very little soil fertility is required in terms of either the number of chemical elements or the amounts of each.

Long list

But in order for the plant to convert its carbohydrates into proteins by its life processes and not by the sunshine power, calcium, nitrogen, phosphorus, and a long list, including the trace elements, are required.

Plants and microbes--even those in the cow's gut--synthesize the ammo acids that make up the proteins. Animals cannot fabricate these amino acids. They only collect them from the plants and assemble them into their proteins of milk, meat, eggs, and other body-building foods.

Protein components

We recognize about two dozen different amino acids as components of the proteins. We know that life is impossible without providing the complete collection of at least eight of them.

When even the trace elements--manganese and boron--applied to the soil at rates of but a few pounds per acre for alfalfa increase the concentration of these essential amino acids in this crop--especially those amino acids deficient in corn--there is evidence that the nutritive quality of this forage is connected with the fertility of the soil.

Body analyses

In believing that we need "minerals" according to such analyses of our bodies and our foods for their inorganic contents, we consider the soil as the supply of these and the plants as conveyors of them. We conclude therefrom that limestone fed to the cow in the mineral box is the equivalent in nutritional service to lime used as soil treatment coming through the plant.

Crops that do little more than pile up carbohydrates, as was demonstrated with soybeans, make big yields of bulk. To be content with the above simple faith is to be agronomically gullible.

Plant nourishment

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 acidity of 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, that in pre-colonial days allowed only wood crops, or forests, on the soils in the eastern half. It grew protein as meat in the bison on the buffalo grass in mid-continent, and in some scattered areas farther east like particular valleys of Pennsylvania or the present race horse area of Kentucky. It permitted corn in the forested New England when each hill was fertilized with a fish. Corn on the eastern prairies grew well without such stimulation.

Fertility pattern

We may well ask whether the soil in its fertility pattern is of no import relative to nutritive quality of what it produces when--(1) we grow cattle am make beef protein more effectively to day in the former bison area; (2) when that area is now growing the high protein wheat; (3) when we fatten cattle farther east on the more weathered soils and combine this speculative venture with pork production that puts emphasis on fat output by carbohydrates and the lessened hazard by marketing these smaller animals nearer their birthday; (4) when soil fertility exhaustion has pushed soft wheat westward; (5) when the protein in corn has dropped, because of soil exploitation, from an aver age figure of 9.5 to 8.5 per cent; and (6) when the pattern of the caries of the teeth of Navy inductees during World War II reflects the climatic pattern of soil fertility.

Such items related to the national pattern of soil fertility suggest that many of our agricultural successes (or escapes from disaster) have been good fortunes through chance location with respect to the fertility of the soil when we have too readily, perhaps, credited them to our embryo agricultural science.

Search far

When a crop begins to fail we search far and accept others if they make bulk where the predecessor didn't.

The grazing animals have been selecting areas according to better 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.

Eyes closed

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?

"To be well fed is to be healthy". Good nutrition must be built from the ground up.

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The Role of Nitrogen

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The widespread use of legume crops is premised on confidence that their growth is a help in building up the soil. That this improvement occurs merely because of the growth of the crop is the belief of many. There is a rather common inference that since legume crops can take nitrogen from the air, they need none from the soil. There is, also, the erroneous inference that it will seriously disturb them if any fertilizer nitrogen is used on the soil.

Legume plants are not 100 per cent efficient in using nitrogen from the air. They do not "fix" all of the nitrogen contained in the final crop. Fixation is an accomplishment that does not necessarily start with the germination of the seed. The unique process demands the plant root's association with nodule-producing bacteria, and the nodules in larger numbers cannot be present until the root system has become extensive. Like all other plants, either non-legumes or legumes, the young legume plant is dependent on the nutrient elements stored in the seed and those which it can take from the soil. Nitrogen cannot be omitted from this list.

Initial help

Nitrogen is taken from the soil supply by young legume plants in the same manner as it is used by non-legume species. Legume plants get off to a better start and subsequently fix more nitrogen when they get this initial fertility help. On a nitrogen-free soil, the early life of the legume is a nitrogen-starvation period. This delays the advent of, and likewise shortens, the season of nitrogen-fixing activities. The stunted crop can deliver neither bulk nor service in fixing atmospheric nitrogen comparable to the good start of growth it can make through the help of some available nitrogen in the soil.

This early use of nitrogen by the root of the legumes may possibly be a factor in the greater effectiveness with which it mobilizes other soil-borne nutrients through its semi-permeable membranous cover for plant feeding.

Discovered

It was recently discovered that the roots of inoculated soybeans, that were richer in protein or nitrogen as a consequence of nodulation, were able to take nutrients off the colloidal clay of the soil to a higher degree than were the roots of the uninoculated plants. As a substitute for the effect of the nodules in the plant's later life, it seems possible, therefore, that a little help by nitrogen in the soil early in the plant's life might facilitate its better use of those mineral nutrients in which it is so much more concentrated and upon which it is so dependent for efficient growth.

It was Giobel of New Jersey who pointed to the value of some "starter" nitrogen for legumes, but his suggestions have not yet become farmer experience. There may be something to be gained by employing fertilizer nitrogen to help the plants get off to a good start through more efficient utilization of the mineral nutrients of the soil.

Erosion

Now that erosion has given us many acres of exposed subsoil and abandoned lands for reclamation, the question may well be raised whether only lime, phosphate, legumes and livestock constitute the entire restorative procedure. Demonstrations are suggesting that legumes can survive even at such low fertility levels. But whether they can build up the soil to where it will make a grass sod with its protective benefits at appreciable rates seems doubtful. Naturally, then, there is the suggestion that on such lands that economically do not permit regular and extensive use of nitrogen as a direct fertilizer for grass, we may well give some thought to nitrogen as a starter for the legumes and, indirectly through them, for the grass. The striking benefit to legumes from as little nitrogen as is contained in animal droppings prompts such a suggestion.

Legumes can be soil builders, but for that service they require some foundation on which to build and some help in the building process. One cannot lift himself simply by pulling on the boot straps. Neither can legumes build much nitrogen into a soil with no nitrogen at the outset.

Less fertile

As our soils are less fertile in this element, as well as in calcium, phosphorus, potassium, and other nutrients, can we expect legumes to restore them when, as a general farm experience, we know that this plant family gives us best results on the soils more fertile in all respects?

There are still some questions to be answered before we can believe that legumes can build nitrogen into our less fertile soils, and even those more fertile in respect to minerals, without some help from nitrogen from other sources than the abundant atmospheric supplies?

There may be wisdom in the idea of helping nitrogen-fixing crops by undergirding them with available nitrogen in those soils on which we hope for them to exercise their uplift.

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More and Better Proteins

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Unlike carbohydrates and fats, but more like vitamins and minerals, proteins are required in the nutrition of man and animals as specific chemical structures. None of these will substitute for any of the others.

As for proteins, the body demands them as certain very specific chemical arrangements of the constituent elements. While the list of vitamins--still growing as a set of specific chemical structures--is a recent matter of the last 20 years, the known 22 amino acids composing the proteins represent evolutionary knowledge extending over a half century. Ten of these are specifically required for the survival of the white laboratory rat. Eight are absolutely essential for man if he is to live. It is the provision of these specific parts of the proteins--more than of mere compounds carrying nitrogen--that has probably become the major part in our struggle for good nutrition.

Problem

Proteins have become a problem of creation in agricultural production. Proteins can be propped up either in quantity, or in quality, only by soils more fertile in terms of both the inorganic and the organic respects--many known and possibly unknown.

It is this significant fact connected with the soil that the declining protein production by our crops ought to be calling our attention more universally.

Mystery

Just how plants make proteins is still one of Nature's mysteries. We have given little thought to the possibility that plants are struggling to *make* their necessary proteins, just as animals are ranging far and wide to *collect* theirs. Nor have we thought that healthy man must be highly omnivorous and that all of these are efforts to make certain that each form of life is getting the complete list of the required amino acids.

Only recently have we become concerned about *feeding* our crops in place of merely *turning them out* at seeding time to *rustle for themselves* until "rounded up" at harvest time.

Unfortunately, for ourselves, in connection with the protein foods and the protein-supplementing foods, we have already too long called anything protein when it contains nitrogen in some organic combination.

More specific

To date we have made sharp distinctions about the quality--for our nutrition--of the nitrogen in our organic compounds, when little more than half of the organic nitrogen we feed, or eat, is really in the amino combination for which we emphasize the amino acids. We must become more specific in our thinking about proteins, by considering them a balanced combination of their component amino acids as the human or animal body requires them.

Alfalfa grows well with little added fertility on soils blown by the wind from out of the Missouri River bottoms. It grows well on such soils representing deposits of soil materials brought from much farther West. But alfalfa is in trouble on some of the Western volcanic soils of such recent deposit that they are deficient in sulfur because of volcanic ignition.

Not widely realized

While we are slowly recognizing the declining concentrations of proteins in our corn and in our wheat, the seriousness of that decline is not yet realized widely enough for much to be done about it.

In the case of wheat, pre-harvest protein surveys--taken by counties over the State of Kansas by the Crop Reporting Service of the U. S. Department of Agriculture in 1940 and 1949-1951--tell of the declining concentration of the protein in this food grain.

Slipping lower

When our corn and our wheat crops are slipping lower in their creation of proteins in total; when these food essentials are already known to be in-complete in the essential amino acid, tryptophane, for example, in corn, and lysine in the case of wheat; and when those originally more fertile soils produced higher concentrations of proteins in these same grains once upon a time, isn't it high time for us to look at our national protein problem?

Shall we not view it as one of soil-fertility exhaustion under two of our most extensively grown grasses, which corn and wheat are? Shall we view our meat problem and our milk problem as merely matters of economics? Shall we not recognize the great natural forces which are responsible for the bad economics?

Grass agriculture

Shall we believe that a different kind of agriculture, called grass agriculture, will solve the problem? It ought soon to become clear that the human's struggle for meat--the choice food protein--is merely part and parcel of the struggle by all life for its proteins. There will be no escape from that struggle by asking our animals to eat grass grown on any soil and to give us the relief from that struggle by their solution of the problem. It is not solved when our farm animals ask the plants on less fertile soil to provide them with protein. The abundance of this nutritional necessity in our crops, in our larger numbers of domestic meat animals, and in the markets for ourselves will become possible, not because we juggle crops or systems of agriculture and economics, but only because we prop up the whole biotic pyramid consisting of microbes, plants, animals, and man by means of the most completely fertile soils as the foundation of it.

Let's Live Magazine, April, 1952

Proteins and Reproduction

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The question I am asked is the probable relationship between the protein supply of the land and the birth rate of the people there. We are, of course, only at the beginning of knowledge about such matters. But a high intake of proteins seems to me--in the light of a whole chain of living evidence--to increase both fecundity and longevity.

Let us start in the soil and examine the evidence logically--and ecologically--from the ground up.

Connected

Protein shortages are intricately connected with the behavior of animals, plants, and microbes--all of which are successive parts in the biotic pyramid that has man as its apex, and the soil as the foundation of the whole structure.

The soil's pattern of fertility elements for various countries was possibly the determiner of man's migrations on the face of the earth. The soil's pattern may be more subtle, but it is more uncompromising than any politics. For it is the soil that determines the proteins by which we get protection and by which we have *reproduction.*

Delineates

The provision of proteins in any area does more to delineate the different life patterns than almost any other ecological factor. It is these protein compounds that alone can keep life flowing. They build the body tissue.

The fattening of our beef cattle in the eastern half of the United States (grown largely farther west), and the growing of pigs in that eastern part as animals mainly fat--may seem an arrangement in accord with natural economic controls, but it goes deeper. Underneath the control by economic forces there is in reality the specific control by a deficiency, of proteins, going back to the soil.

Amino shortage

This controlling deficiency is more often the shortage within the feed and food supply of some of the protein's constituent parts, namely, the amino acids. Eight or possibly 10 of the amino acids are considered absolutely essential (and required regularly) for the survival of the experimental white rat--and inferentially for the human species.

Man and the animals must be given these amino acids. These creatures cannot create their proteins from the simpler chemical elements (except to limited extent by microbial helps in the intestinal tract). Only plants and microbes are equal to this accomplishment. These lower life forms struggle for their required proteins too. But they can grow and reproduce by means of a more limited list of the amino acids. Consequently, the mere growth of plants is no assurance of their serving as a feed which will guarantee growth of the animals consuming them.

Determiner

The soil fertility pattern as it expresses itself in the pattern of protein potential is, then, a significant determiner in any ecology.

The areas favorable to man and the food animals supporting him are those where the soil processes under the particular climatic forces are breaking down the rocks and minerals to provide the flow of all the essential chemical elements to the plant roots. These must come in such amounts and ratios as will support those plants synthesizing the complete proteins.

The favorable place, then, for our protein-rich plants in the climate-soil-ecological pattern is on the moderately weathered soils. Those plants include not only the legumes, but also the protein-rich herbage that puts our protein-producing beef cattle (lean meat) and sheep (lean meat and wool) on these same soils under range conditions.

"Fringe" soils

As man pushes himself off these protein-producing soils on the "fringe" soils, he must extend his life lines from the latter back to the former--except as he can tolerate increasing degrees of malnutrition and partial starvation.

Now that we have overrun the earth, by means of technologies, have exploited our soils by them, and have extended our life lines to the point of fishing the Antarctic for proteins in whale meat, we are seeing those life lines shortened gradually if not already breaking and often severed.

Serious shortages

Much land remains as acres, but the serious shortages in the soil as source of complete proteins offers provocation for a revival of remarks once made by Malthus. There are qualitative deficiences, and while many phases of man's behavior are subjects of debate, no one to date has come up to take the negative side of the proposition that "Man must eat--and particularly of the proteins."

(Continued in May)

Let's Live Magazine, May, 1953

Protein Protection

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(Concluded from April)

Our use of antibiotics is acceptance of the synthetic services for our protection by the lowly microbes.

From next to the soil, at the bottom of the biotic pyramid, these chemical services are passed up to us at the top for our protection against other but dangerous microbes. Plants, too, offer protection in their many compounds simulating proteins, when they give us vitamins, hormones, via catalytic and stimulating effects still unknown. Proteins are still the major protection against disease and degeneration.

Our bodies may often suffer from insufficient ability to corral and to create antibiotic, protein-like substances for protection against invasions by foreign, death-dealing microbial proteins. Yet with a little help from proteins brought to us by the microbes, the plants, and the animals, we carry or create sufficient proteins for protection.

Experiments

Plants also protect themselves by means of proteins. Experimental trials demonstrate that by increasing fertility elements in the soil--which serve for increasing proteins in the young plants--there was provided increased protection against attack by fungus. In another experiment, more nitrogen and calcium offered vegetable plants for higher concentrations of proteins in food crops, gave more protection against attack on the plants by leaf-eating-insects. Here is suggested this: that the increasing fungus of our crops and the increased insect attacks on them seem to be premised on deficiencies of protective proteins in the plant; and these, in turn, on the deficiencies of the fertility in the soil.

Instinctive selection

Seemingly, our wild animals gather their own "medicines" by instinctive selections, not only among different plants but also among the same species according to differences in the fertility of the soils growing it. Our domestic animals manifest similar selections within the limits permitted by our enclosure of them within fences, barns, etc. While proteins are the major nutritional "cure" for tuberculosis, we are still unmindful of the many other diseases against which complete proteins may possibly be a protection.

Sheep

Some experiments using sheep and rabbits, under carefully controlled procedures, demonstrated that soils and proteins can control reproduction possibilities. Ewe lambs were fed on legume hays grown on a less productive soil given (a) no treatment, (b) phosphate, and (c) both lime and phosphate. Their body weights increased in the proportion of eight, 14, and 18 pounds per animal for the above treatments, respectively. Equal amounts of hay per head per day were consumed.

The wool from lambs fed hay grown with more complete treatment, was the only one among three lots which could be scoured and carded without the destruction of the fibers.

Rabbits

As additional test of the possible causal connection between soils, proteins, and reproduction, two hays--grown on varying soil treatments were fed to two lots of male rabbits. Marked changes in reproductive potentials resulted.

When the feeding program was modified, by merely interchanging the hays for the lots of rabbits, only three weeks elapsed when the lot of originally impotent animals was restored to sexual vigor. In the same short period of three weeks those on hay grown with limited soil treatment, had fallen to the same low level of the other lot before the hays were interchanged.

When, in these tests, the soil treatments for improved production of protein by legumes, as measured in terms of increased nitrogen in their hays, were the only variables responsible for shifting the sexual vigor from impotence to potence and vice versa, one can scarcely refute the casual connection between soils, proteins, protection, and reproduction.

Control pattern

When plants get their proteins in varying degrees of completeness--when herbivorous animals must depend on the plants for their proteins as a collection of all the required amino acids--when protection against invasion of our own bodies by death-dealing agencies is given us by proteins--and when the stream of reproduction of any life can be kept flowing only by means of proteins, shall we envision man as capable of sidestepping this pattern of controls? Man's extension over the earth was according to the protein-producing capacities delineated by the reliable animal instincts. But man's extension of his kind under his own technologies pushed him away from the fertile soils that were guaranteeing proteins, protection, and reproduction of himself and his species.

Life lines

It pushed him on to the "fringe" soils in these respects, but at the hazard and necessity of using his technologies to reach back to, and keep connected with, those same fertile soils--which brought him protein foods, and all that comes with them, for supplementing his hazardous location. These life lines may soon become tangled with lines of economics and politics. They may be shortened or cut off, and such fringe soils supporting only mono-cultures of crops then demonstrate man's nutritional insecurity. They generate hungers apt to be interpreted in most any other way, except that they are the result of a protein shortage going back to fertility shortages in the soil. Man is a social animal when well fed, but if put under starvation he even becomes cannibalistic, or gets his proteins at the price of murder.

When the pre-death struggle of the protein-starved man to save himself as, an individual rises to the desperate height of cannibalism, is this not akin to the immediate pre-death struggle of the processes of our bodies manifested by increased rate of heart beat, increased blood pressure, and temperature rise as fever? If then a segment of the human species under protein-starvation makes a desperate survival effort in the form of increased reproduction, when other efforts for that have appeared in vain, would this not seem to aggravate the hazards for survival all the more? Would not such a manifestation seem of more logical interpretation when considered mainly as the pre-death struggle by the species?

Conclusion

Naturally, there are possibilities for wide variances between our individual conceptual schemes for man's behavior under severe hunger. But when in his fundamental physiologies man is viewed as another animal, he can scarcely set himself outside of the natural forces which seem so completely in control.

If the complete proteins determine body protection and reproduction of our animals; if the life forms just below man depend on plants for these essential foods still non-synthesizable by either science or industry, and if plant proteins are determined by the soil, then the soil fertility as it controls the animals in their reproductive potential would seem to be also the logical power in control of man's reproduction too.

Let's Live Magazine, June, 1953

Better Proteins

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Meat proteins have always been considered a major and essential part of our nourishment. It is true that the proteins as body-building and body-repairing necessities are not fully understood in their functions in the body chemistry, in their protection of us against disease, and in all they do for us.

But when we "cure" tuberculosis we give the patient rest. We feed him all the proteins such as meat, milk, and eggs he will take.

In the hospitals, the best defense against shock and the favored means of sponsoring quick recovery, is the regular administration into the bloodstream of protein hydrolysates.

Most essential

Proteins are being more widely appreciated because nutrition, as a growing science, is discovering how essential they are. They can give us calories as well as build body tissue and blood. They multiply the cells to give us growth, or life.

When once upon a time nutrition emphasized mainly calories coming from carbohydrates and fats, it is now looking for more than these fuel foods. It is looking into reproduction, growth, and maintenance of the body in which those fuels are burned. The stove first, and the coal second, goes the pathway of concern. It is only the proteins that multiply themselves; only they can carry life.

Protein "flame"

Late knowledge of plant physiology suggests that carbohydrates give off their fuel values only by burning themselves in what appears like the flame of the proteins. Proteins have always been the problem. They are coming now to be decidedly more so. They are telling us that the solution calls for attention to the soil under the animals, and not just a dependence on more animals.

We must assay what we eat for its separate amino acid contents if we are to judge the food value properly. In like manner, we may well assay the forages and the grains we give our animals for the ratios of the respective amino acids as a fitting ration out of which the steer is to make beef proteins, the dairy cow is to make casein in her milk, or any other animal is to reproduce itself and carry on all that precedes, accompanies, or follows that process.

"Harder" wheat

We feel proud when nitrogen fertilizer on wheat makes the grain more horny or "harder." We pay a premium in many cases on such "hard" wheat. But this extra of crude protein is not necessarily better protein because it may not really contain more of those amino acids commonly deficient. It may consist of more of those already plentifully present. It may unbalance the nutrition still more in respect to the proper array of these essentials.

By merely dumping nitrogen on the soil, we may not be making better proteins even if it is making more of them per acre. It is not the quantity or the yield, but the quality in terms of proteins more complete in the required amino acids that deserve attention in the use of soil treatments with nitrogen so commonly considered symbolic of protein.

Fertility elements

Magnesium is one of the fertility elements deserving attention in connection with better proteins when it has been found influential in connection with the concentration of the particular amino acid, tryptophane, in forage. Liming with pure calcium stone may not be enough when dolomite, or the magnesium-calcium stone, might help the delivery of more tryptophane in the grasses and various legumes to give better proteins.

Sulfur, the distinguishing feature of the commonly deficient amino acid, methionine, has never had much attention in fertilizer, except that it has been carried along unwittingly in superphosphate because we used sulfuric acid to react with the rock phosphate in making it, or in ammonium sulfate from this acid used there to collect the ammonia. But when the experimental use of sulfur pushed up the concentration of methionine in forages, and when this long-neglected element has shown its effect on the yields of grasses on some field trials in parts of Missouri, we may see the deficiencies in the better proteins going back to the deficiencies in the sulfur as an element in the fertility of the soil.

Trace elements

Perhaps the trace elements, too, that is, the copper, zinc, boron, manganese, molybdenum, and others, in the soil will be credited with having a hand in helping our crop plants make better proteins.

Research with these used as soil treatments in connection with the resulting amino acid array in alfalfa, suggests that trace elements are much more influential in pushing up the concentration of these commonly deficient amino acids, methionine, and tryptophane than in giving, higher concentrations of the already; abundant supply of leucine, for example. Here is the suggestion that if better proteins are produced, the soil must be fertile in the trace elements as well as if the major three, nitrogen, phosphorus, and potassium, so common in the fertilizer formulae of the past.

Dangerous beliefs

It is a dangerous belief that grass can give better proteins merely because it is grass. Grass made its reputation as a producer of better proteins to build the brawny body of the American bison, because of the fertile soil on which it was growing and not because it was known as buffalo grass, little blue stem, or by any other choice species name. Transplanting the grass species will not guarantee the better proteins for better feed unless the corresponding better fertility is provided along with the transplanting.

More grass and more livestock are not enough without attention to the soil that must feed the grass so it can make its own better proteins of the complete array of amino acids, and so that they; in turn can help the animals make better proteins.

Fertility economics

Our meat problem, or our milk problem, is not one of more attention to monetary economics and exchanges between sections of the country. It is one of fertility economics of soil restoration and maintenance with the costs of these reckoned in with the costs of production over the country as a whole.

Offering prices at all time peaks, or rolling them back are activities that will not grow more proteins. Only more of the fertility in the soil in sufficient completeness of all essentials will grow them.

When the beef supply per person is below 60 pounds per year in contrast to the 75 of some 50 years ago, perhaps it will dawn on us that making better proteins is not a simple manufacturing procedure depending on ample technologies assembled, but a matter of creation which according to our best knowledge--still like that of a few. thousands years ago--starts with the soil.

Better proteins can be had only by making better soils to grow them.

Let's Live Magazine, July, 1953

Soil Fertility FOR PROTEINS

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The very mention of the word "protein" calls to one's mind the problem of providing this essential part of foods and feeds.

In the kitchen, the lean meat is the first protein the housewife thinks about in her efforts to supply a diet for her family that is not deficient in this respect.

On the farm, the word "protein" connotes bloodmeal, tankage, and other animal offal; or the many "meals" which include cottonseed, soybean, gluten, bran, shorts, and other milling by-products.

First desire

Whether it is a matter of feeding people or of feeding livestock, the provision of plenty of protein is the first desire, but one not so simply nor so cheaply accomplished.

Supplying protein is a decidedly difficult problem in contrast to the ease of producing plenty of carbohydrate. Carbohydrates are readily and widely grown. But when it comes to the proteins they are so much less common that we first think of them as purchased supplements.

Economic urge

In the distant past the pioneers grew them. In the recent past their ample supply on the market has permitted ready purchase. But very recently compelling economic conditions are apparently bringing us more and more to think about growing our own supplies. This is necessary in order to balance the carbohydrates and get extra margins of profit in having both as home-grown products.

It brings into clearer focus the necessity of putting fertility treatments on the soil of your garden. Fortunately, such rebuilding and conservation of the soil for the future not only provides protein more cheaply now, but also looks forward to make one highly independent of any market for his supply of it. We need more folks among the producers of milk and the meat growers--which are our best protein foods--who will think more about providing most of their needed protein by building up the soil, with its resulting conservation as an added profit.

Not so simple

Growing one's own protein, however, is not so simple a matter. The vegetable proteins we purchase are mainly seed parts. Making protein is a part of the plant's struggle to reproduce itself.

Even for the plant, this is not a simple task. Legume forages, and the seeds of those like peas, peanuts, and beans are relatively rich in this requisite food constituent. But the high concentration of protein in the seed demands its having been first synthesized and put up in the forage part of the plant before it is localized and concentrated in the seed of the crop.

Soil essentials

Legumes do not grow well nor do they manufacture much protein, unless the soil supplies them generously with calcium, phosphorus, potassium, and the others of the soil-borne essential mineral elements that serve not only in the physiology of the plant but also in the life processes of animals and man as well.

All plants manufacture carbohydrates in fairly generous amounts. These are the basic compounds building up the plant body. The very growth of the plant spells carbohydrate construction. This process takes its necessary raw materials from the air as carbon dioxide which is combined with water through the power of the sunshine. Some few contributions and in some small amounts, including potassium, magnesium, and iron are needed from the soil. But these serve only as helpers or catalysts in the construction process. They do not occur in the final or resulting carbohydrate compounds like sugar, starch, cellulose and others. This is the process of photosyntheses operating almost wholly on air and water as the raw materials that bring themselves to the plant and hence represent very little of a struggle by it. It is they that build the plant factory and serve as its fuel supply.

Starting point

Proteins, in contrast, are not so simple in chemical composition, nor are they so abundantly synthesized by the plant. Carbohydrates seem to be the starting point for their construction. This conversion is brought about not by sunshine power but rather by the "life" processes of the plants. Proteins vary widely in their chemical composition. They are still a kind of mystical chemical compounds as to their particular structural make-up. There are infinite kinds of them, too. We know they are combinations of complex compounds called "amino acids," which are the simple building stones or structural parts of all proteins.

Unfortunately, these amino acids cannot be synthesized either by the animal or the human body processes. We and higher animals below us all depend on plants to synthesize these for us from the simpler elements. The plant in turn, is highly dependent on the soil fertility, that is, calcium, phosphorus, nitrogen, and other nutrients for help in synthesizing them. These ammo acids are the components of its own proteins within which alone the life processes of cell multiplication or growth can be carried forward.

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Soil Conservation

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More fertility in the soil is the means by which plants do more than make energy feed values in their carbohydrates. It is this means, contributed by the soil rather than the weather, that makes protein synthesis possible. Growing our own protein means less attention to the weather and more concern about treating the soil with manures.

Better soils for better feeds to give better bearing of young, better milk production, and better health have not been in our thought in agriculture as much as the idea of more feeds for increasing the body weight through laying on of fat.

Likewise in thinking about fertilizers and other soil treatment for crops, our measure of their efficiencies has been the increase in plant bulk.

Quality needs emphasis

Agriculture originally was primarily a food-producing effort. Fundamentally it is still the sustainer of life. In the recent past, however, it has attempted to swing itself into the industrial class. But shortages of foods push one back quickly to agriculture for the production and consumption of them rather than for their sale. Conservation of soil may well measure its own efficiency, not by reporting how little soil is eroding, but how much protein per acre we are producing by use of the land without loss of it.

Such is the philosophy of some of the trials carried out on the Missouri Soil Conservation Service Farm operating under the cooperative efforts of the Soil Conservation Service Research and the Missouri Experiment Station.

Special tests

Three pasture areas were under test as separate areas fenced out of a large, uniform bluegrass pasture. One was given no treatment; one was given furrows on the contour for water conservation; the third was renovated by some surface tillage and fertilizer applications. During the four years of the records, the pounds of beef produced per acre were: (a) 115, with no soil treatment; (b) 103, with contour furrows; and (c) 151, with renovation through fertilizers. These results point out clearly that merely holding back water was of no help as more feed value. Rather it was even detrimental. The tests point out positively that the soil treatments with extra fertility made more protein per acre.

Ratios

When the plant is building protein it, too, does this in varying degree but according to the nutrients it gets. Quite contrary to expectations, more bulk of forage per acre is not necessarily proof of higher concentration of protein in the forage or hay.

Experimental studies have shown that it is not necessarily the large tonnage per acre that make the most protein per acre. Rather, it is the combination of nutrient mineral elements in the soil--or the fertility ration we feed the plant--that encourages its internal activity in protein production, rather than mere storage of carbohydrates.

These nutrient ratios for plants are suggested by the different degrees of soil development, for example, in the United States. On the highly developed or leached soils of northeastern, eastern, and southern United States, which originally grew only forests and where the ratio of calcium to potassium is low or narrow, we may well expect carbonaceous or woody crops today.

In the Midlands of the United States which originally grew grass with many natural legumes on less leached, calcareous soils, --and also grew buffalo without purchased protein supplements--the crops were originally proteinaceous. Here the soil fertility suggests a high or wide ratio of calcium to potassium.

Building bulk

Plants making mainly carbohydrates build much bulk readily through sunshine power. But when plants build proteins, they burn much of these carbohydrates in converting them into proteins . As a consequence, this gives less bulk per acre. We can, therefore, not be certain that much crop means much protein, nor that even the crop, whose pedigree says it is a legume, is rich in protein.

Protein cannot be made by our crops drawing on only air and sunshine. They must draw on plenty of lime, phosphorus, potassium, nitrogen, and other fertility elements in the soil. By supplying more fertility to the soil more of this essential that carries life--namely protein--can be provided, while at the same time we are making a more conservative use of that natural resource, the soil, by which all of us must be fed.

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The Importance of Soil

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An age-old saying declares that "to be well-fed is to be healthy." But as yet, health in its positive aspects has not been clearly defined. In the negative aspects, we have professional practitioners in great numbers. Deficiencies in health are, then, well recognized.

The question of good food, and plenty of it, goes back to the soil, by means of which food is produced. Unfortunately, there is danger in losing sight of the fact that agricultural production is food production, rather than production of only salable mass or bulk.

No criteria

Bushels and tons are no longer sufficient criteria for what the soil is growing. When meat, milk and eggs are the great foods for health recovery and for its maintenance; and when these are the proteins rather than the carbohydrates; it might be well for us to think about food deficiencies--and thereby health deficiencies--as deficiencies in protein and all that comes along with them when we produce them on more fertile soils.

Unfortunately, animals do not create proteins--they only assemble them.

When the cow went ahead of the plow, she was assaying the vegetation for its protein service to her in growing her body and reproducing it. But, when we sent the plow ahead of the cow, we moved both her and ourselves onto the vegetation and onto the soil that was not necessarily providing her with all the essentials for protein.

Fundamental

It is the soil fertility then, in its variable pattern that gives pattern to the possibilities of either being well fed or poorly fed. Its pattern can be the pattern of health deficiencies, too.

The soil fertility deficiencies in our national soil pattern have given patterns to crops, as these are mainly carbohydrate foods and fattening foods, or as they are also proteins, minerals, vitamins and foods that grow the bodies and reproduce them. Soil treatments to make up soil deficiencies for better health are telling us that health deficiencies may come with those soil deficiencies.

Our pattern

Our crop pattern, as it is creating proteins or failing to do so, is both citing the soil deficiencies and also suggesting their connection with our national health pattern.

Soil deficiencies include a long list of nutrient elements. Plant nutrition for good food production is a matter of providing in the soil the balanced ration which those plants need to put out proteins and high feed values, much as animal nutrition is a matter of supplying properly balanced rations to put out milk or meat, or just as good food and plenty of it is a matter of human health of high order.

Nitrogen, phosphorous and potassium in fertilizers are a part of the picture. So are calcium and magnesium. Then. too. there is a growing list of trace elements whose functions seem to connect them with protein production.

Growing research

Attention may well go to the growing amount of research in soil fertility as this is nutritional foundation for the microbes, the plants, the animals, and man. or the entire pyramid of life for which the soil is the foundation and the starting point of nutrition.

Deficiencies in the soil, so readily remedied by soil treatment with fertilizers, may well be given more consideration as reasons for deficiencies in our national health and the means of preventing them by growing more food of better quality in health than for just more bulk for sale.

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High Time to Learn About Our Soils and Our Health

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We are beginning to be concerned about our national needs for food, fiber, and shelter. No longer taking our resources for granted, they are being cataloged as consumable, renewable, scarce, abundant, etc. We see our population mounting at geometric rates, while resources per person are becoming less and less.

Little attention is given to the possible long-time deficiencies insiduously leading up to these shortages recognizable only when they approach disaster. Food, as it has been losing its nutritional quality while agriculture becomes a fixed one in place of one that was nomadic, has not yet come in for consideration of its nutritional deceptiveness. Nor has the fertility of the soil growing our foods and our feeds been considered as significant in the health of ourselves and our animals.

Postmortems

We have been content with postmortems. We have been satisfied to work backward from the grave and the morgue in our search for health. We are slowly coming to approach health from the ground up, from the quality of the food as the soil growing it guarantees the inorganic elements, the vitamins, arid the proteins as tissue builders as well as the carbohydrates for only calories and fuel values.

The pioneer farmed to feed himself and his family from the farm and not from the grocery store or the drugstore. For him "to be well-fed was to be healthy." not highly fattened. Modern farmers farm for economic reasons, for profits, for dollar values, and not for nutritional values. Modern agriculture views itself through the eyes of the industrialist who converts and transforms materials. These he assumes to be available. While agriculture may convert its products, it is not mainly a technology and that alone. It is first biology and technology second. It deals not in lifeless materials. It is concerned with living matters. It promotes the processes of creation, all originating in the soil. Soil depletion, by taking the soil for granted as if agriculture were only a mining industry, has brought us face to face with present shortages of the proteins.

Decline

Quality of food and feed are declining under the criterion of agricultural production mainly for sale. With yields per acre measured only in bushels and tons we have dropped out more of the protein-producing crops and have brought in the carbohydrate producers. Starches, sugars, fibers have increased but proteins and all the other body-building, and body-protecting qualities have decreased. Juggling the crops with substitutes for those starved out on declining soil fertility has given us those which are "hay crops but not seed crops." We are accepting those which can't make seed to reproduce themselves. Going to a grass agriculture appears as an escape from seed production but casts doubt on the possibility of the cow's surviving by it.

We are worshipping calories, while the proteins are still too crude to be complete nutrition. Supplements of protein are slipping out too. Corn is deficient in the essential amino acids, namely tryptophane, lysine and methionine, but its yields per acre for sale were pushed up by hybrid vigor. Its proteins slumped tremendously.

Failing reproduction

Failing reproduction goes with proteins jailing in quantity and failing in quality. Missouri's pig crop marketed is only 60% of those given us by sows in their litters. The Missouri dairy calf crop at weaning time is only 60% of the conceptions. Putting the blame on "diseases" and killing the cow to escape them, seems an absurd approach by legal minded veterinarians to troubles in cows' or pigs' health going back to the soil fertility for prevention.

The animals have survived in spite of us and not because of us. We are keeping livestock because we keep them close to their birthdays when resistance to starvation and disease is higher. We call it baby beef, ton litters and cheap gains. It is correspondingly cheap health too.

Curatives accepted

Preventative measures have been disregarded but curatives were accepted. We have curtailed the consumption of the proteins and fresh foods under poor economics for health We have taken to the hypodermic needle for health introduction into the bloodstream directly when health should be introduced into the body via the alimentary tract in the form of complete foods. Animals, too, are given limited proteins mainly as purchased supplements.

The problem ahead looms large now that we are internationally entangled, and with our food generosity taken for granted by the rest of the world. It is slowly dawning on us that soil fertility is a readily exhaustible resource.

Failing health

We may perhaps realize that more hospitals, more nurses, and more doctors are not the solution for failing health. Perhaps this realization will not come until half the crowd is in the rapidly multiplying hospital beds, and the other half of the crowd is trying to care for them.

It is high time to learn that our national health lies in our soil and that the guarantee against failing health lies in the wise management of the soil for production of nutritious foods. Fertile soils are the first requisites if we are to be well fed and to be healthy and thereby to remain a strong nation.

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The Use of Mulches

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In considering the use of mulches in gardening, it is necessary—at the outset—to define the word "mulch." Let us agree that a *mulch is a particular arrangement of, or addition to, the surface of the soil to stimulate, or to provide, a cover.*

According to this definition, then, a mulch may be made, either by Nature or by man. from the upper or surface portion of the soil itself. It may also be the result of applying on the soil some cover consisting usually of organic materials, particularly plant residues.

Soil mulch

When a soil has been watered generously by rain and when the drying of its surface starts, it is by that rapid surface drying that Nature herself makes a soil mulch In some cases. this is a soil crust of one or two inches of depth. In others it is a granular, non-crusting cover. Both of these dried soil layers are mulches to help to reduce evaporative loss of water up through them.

While the crust mulch functions to cut down water loss by evaporation, it fails in the second function of the mulch-soil-water relations: namely, it does not facilitate ready entrance of the rain water into the soil. Aiding infiltration of the rain is the really significant function of the mulch or the soil cover in relation to water. For this function alone, the breaking of the soil crust and the mechanical maintenance of the granular mulch are well considered practices.

Organic mulches

The use of a straw, leaves, sawdust, and other organic materials as mulch is a well-known and good gardening practice. The use of these mulch materials assumes that the soil under them has been brought up in its fertility level to the point of discounting any possible disastrous effects by microbial competition with the crops for the nutrients in the soil's supply. It is around this simple principle, that the wisdom of the use of the mulch turns for failure or success.

Mineral mulches

More recently there have become available mineral materials, of very little weight per unit volume which serve as mulches, particularly in potted plantings. The most prominent of these, known by various commercial names, are the expanded micaceous materials. Almost completely inert chemically, as they are--save for possibly the contribution of some potassium--they are long-lasting and bring about an open structure when incorporated into the soil. This effect is particularly advantageous on soil of more clayey nature. Such soils are benefited highly by the mulches in preventing crusting and cracking and then still more by the successive incorporations of these flakey mineral materials into the body of the soil itself. This repeated incorporation brings on the improved granular condition for self-mulching, so much desired.

That the mulch might be a by-product of the crop itself or that extra fertility might be added to the soil for growing one crop that is to be the mulch for another, is a newer concept in the use of mulches.

Nature's suggestions

While the soils in the Midwestern United States form a granular mulch naturally under sparse grass vegetation, nature has been applying an organic matter mulch in the form of either heavy prairie grasses or forest leaves and litter on the more humid soils in the Eastern United States.

Here is nature's suggestion that the degree of development of the soil, according to the differing degrees of weathering under the climatic forces with the resulting different levels of soil fertility, points out the mulching procedure that would be wise. If the soils of the Eastern United States are to be self-mulching by their own granulation in place of requiring applied mulches, then they must be brought up in their fertility to the level duplicating that of the soils in the Midwestern States.

Self-mulching

Only by building up the organic matter and the fertility contents in the more highly weathered humid soils will they become granular and mulch themselves effectively. With the naturally more granular Midwestern soils, the high fertility and the organic matter contents make each unit of rainfall more effective.

Mulching artificially seems to have come into vogue because the soils were less fertile. But the emphasis went to the water rather than to the creative power of the soil. If such is the case. then, by reasoning conversely and building up of the soil fertility to enable the soil to grow into itself more organic matter, the need for extra mulching should be less or the extra mulching should be so much more effective.

Better use

Nature's climatic patterns of the soil are giving their suggestions by which we can make better use of mulches. Our soil will find itself undergoing conservation much more extensively and will be used more efficiently when we see nature's pattern of natural mulching with its benefits according to the levels of soil fertility concerned.

Mulching alone, as a mechanical ministration, can not offset completely the shortage of fertility in the soil. Conversely, however, building up the fertility can be all the more reason for mulching also, a combination with doubled benefits because of the more efficient use of both the soil and the mulch that covers it.

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Protein Service in Nutrition

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Nutrition has done much to interpret the fuel and energy values of feeds and foods. Plant physiology is interpreting plant nutrition for carbohydrate delivery as this registers changes in plant bulk, by more or less tons and bushels. Unfortunately, in the nutrition of both plants and animals, we know all too little about the roles played by the proteins; the foods that rebuild the body, that carry life and that guarantee reproduction. They, in certain liquid forms as serum and in compounds of cellular dimensions as corpuscles, constitute the blood stream.

It is those proteins that combat invading microbes, that build antibodies and give protection against so-called "disease," "allergies," etc., in biochemical ways and means yet unknown.

Realm of mystery

The myriads of different kinds of proteins coming about by no more than just rearrangement and varied combinations of the constituent amino acids of that molecule, are still in the realm of mystery.

Undergirding the blood stream, through the synthesis by the body of the special proteins for it. is now being considered a significant role of good nutrition when we speak of "protective" foods. Through the wider acceptance of that principle, a big step will be made toward the absence of disease and the presence of its counterpart, namely, good health.

Tests of alfalfa

Some recent tests of alfalfa for its content of the different essential ami-no acids, as related to soil treatments with trace elements, pointed to deficiencies in these components of protein according to the trace elements as soil deficiencies.

These demonstrations suggested the working hypothesis that possibly the declining and exhausted supplies of soil fertility are responsible for less synthesis by crops of proteins in total (so crudely measured in terms of total nitrogen multiplied by 6.25) and for less, or absence of some specific amino acids. With total protein going lower in our wheat; with a drop from 9.5 to 8.5 per cent of it in corn during 10 years; and with the deficient specific amino acids in corn possibly low because trace elements are deficient, should we not turn to considering some diseases as possible deficiencies coming by way of the soil?

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 of whether deficient nutrition and defective physiology were in advance of. and an invitation to the entrance by the microbes? 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.