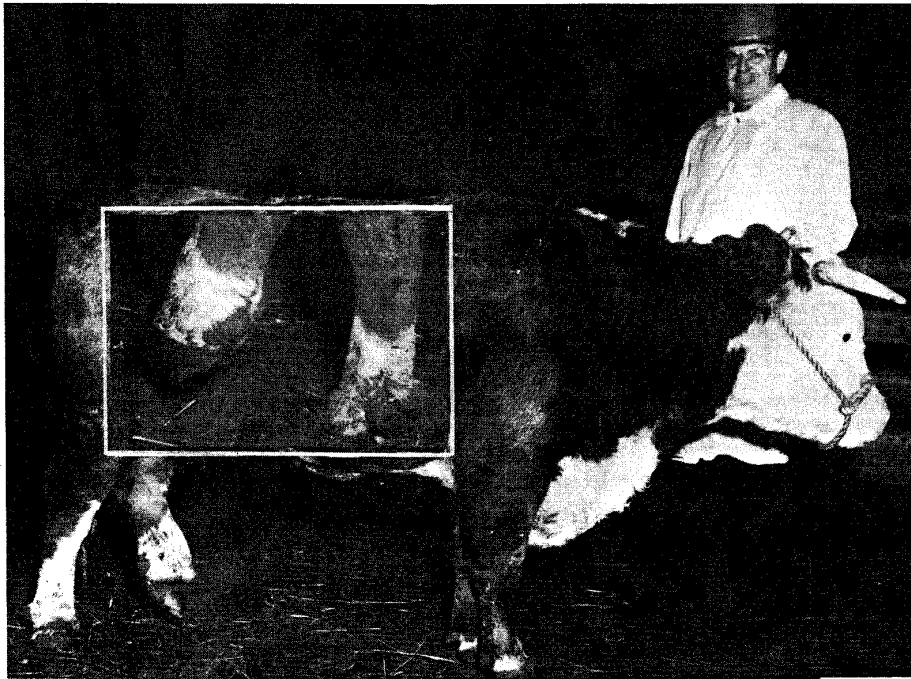


SOILS, NUTRITION and ANIMAL HEALTH



"Tall fescue is a valuable pasture grass but cattle that feed on it occasionally develop a crippling disease known as fescue foot or fescue toxicity." USDA Leaflet 546. This grass is a starvation feed during late fall and winter, apt to be on less fertile soil giving vegetative bulk but little or unbalanced nutrition.

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Soils, Nutrition, and Animal Health

WM. A. ALBRECHT

Department of Soils—College of Agriculture University of Missouri

The subject for discussion, namely, "Soils, Nutrition, and Animal Health", as requested for this occasion, raises the question whether the order of habitual reading from left to right might not be reversed to let us consider the order of this title from right to left. It would seem more logical—even though not habitual—for us to think of animal health as it is related to animal nutrition; then of the latter as it is related to plant nutrition; and finally of the relation of the nutrition of both of these forms of life to the soil as their foundation. This reversed order of thinking from right to left is a case of post-mortem. It is suggested because we are more practiced and more experienced in that mental procedure in agriculture than we are in predictions, starting with the soil, building upward from its fertility to establish agriculture of extensive and healthy crops, and thereby producing many and healthy livestock numbers. So in order to be habitual in our thinking, mainly in terms of post-mortems rather than in prophecies starting from the soil, perhaps we may well begin with the post-mortems. Possibly then we shall find our thinking coming around eventually to the prophecies and predictions.

Past Experience, A Good Teacher

A historical glimpse of agriculture in the Old World may be suggestive. The young European farmer, planning the beginning of his farming career starts with the questions "How many animals can I assemble with the funds I have? How many can I keep on that land area I have in prospect in order to know the amount of manure that can be made? Therefore, knowing the number of animals, I know then the size of the farm I can manage and maintain with that annual turnover of fertility in the manure". In his concern about the management of the farm, he is reading the items of our title, not as a chain from either left to right or from right to left. Instead, he is considering them as an endless cycle of turnover of soil fertility in connection with healthy animals. If we take that viewpoint, as a challenge to our thinking here, we shall approach this discussion inductively from left to right. But if we start with a post-mortem concept, we approach it deductively by starting with the animals, (mainly sick ones), reasoning from them back to the plants or the crops, and from those back to the soil fertility. By that deductive procedure, which has been much of our post-mortem pattern of national thinking, we shall then see the wisdom of future productive thinking which starts with the soil as a determiner of potentialities of our farm management by the individual farmer and thereby of all farmers collectively, or the national result in summation.

Since folks connected with agriculture are emphasizing more and more the troubles in growing healthy animals, these irregularities

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suggest the dwindling agricultural potential in our livestock. They point to the breakdown in the animals or in the major means of uplift of the monetary returns from farm management.* They point also to the threatening shortage in our choice foods, which are, the meat, the milk, and the cheese, or the costly proteins. Since the starchy, or carbohydrate, crops and the animal, or vegetable, fats, as the energy and caloric foods, represent surpluses ever since the introduction of economic controls, it may be well to follow the deductive procedure or the post-mortem approach for our discussion. By considering our animals and crops post-mortem-wise in the approach to the soil, the consideration of it as the foundation of the entire biotic pyramid might be means of a more predictive or prophetic management of agriculture in the future to a degree of success far beyond that of management by means of the many post-mortems of the past with the soil paying the ever-increasing cost of those diagnostic processings of farm management failures.

Foods and Feeds May Fill But Not Necessarily Nourish Animals

In connection with the production of our farm animals, the economics of the procedure have too often had the first and the only consideration. We have not yet come to view livestock management from its biological base. Feeding trials, reported in the many printed volumes, are given to one objective, namely, making cheap gains or cheap gallons. What price the animal pays in health and reproduction has not yet had thought. When fats, as fuel foods, either on the carcass or in the pail, have been the major objective it is not unexpected that calories as measures of heat should have long been the major criterion of nutritional effort. Naturally for fuel objectives, the fuel foods, i.e. the carbohydrates, would take major concern. Consequently, the carbohydrates have been at the head of the foods list. In that thought pattern, the building of the animal body was taken for granted and only fuel to stoke it was sought. Proteins have been second on the list. We speak of them as "purchased" protein supplements rather than concern ourselves with protein-rich feeds grown where the animal is. Minerals have had similar attention as the **inorganic elements** in the ration mixture. This kept them as a part of the ash rather than as part of the **organic compounds** which contained them or the synthesis of which they prompted. Proteins and the inorganic elements have not commonly been considered together for their close association in the growth of both the animals and the plants. The proteins have been considered only as "crude" proteins. They have been classified as those compounds containing any forms of nitrogen in total to about 16 percent. It is in this lack of complete understanding of the protein compounds, of their functions in our bodies, and of

* Some years ago, Professor Mosher, University of Illinois, Department of Farm Management, gave the following factors and their relative values in determining farm income, as the summarized result of the study of many Corn Belt Farms. Crop yields—1000; Kind of Crops—700; Feeding and Managing of Livestock—1000; Utilization of Machinery—160; Utilization of labor—160; Size of the Farm—60. Of the total 3270 points, the first three, or Nature's management as the biological phase, composed 2700 points or 89 percent; while man's management composed 320 points or but 11 percent. This emphasizes the health and nutrition of plants and animals and their connection with the soil as the major means of agricultural production, or of earnings.

the services by the inorganic elements connected with them that much of the irregularity in being well-fed and healthy arises, whether that be in animals or man. Under no fuller knowledge than this, the feeding becomes mainly a matter of filling with a collection of foods in general, rather than a matter of nutrition with health as the specific function and purpose of what is consumed.

When gains in weight of the animal, consisting mainly of more fat and more water, represent possible sale of the entire animal weight at higher price—and then usually of a castrated male—we are apt to lose sight of the animal health involved. Does a fattened, show-animal suggest buoyant health? Doesn't it suggest the very absence of it? Feeding operations on such a score and purpose ought not to be classified as animal production. Rather, they seem to be a case of mere speculation in a culinary excuse for buying low and selling high. Health would scarcely be an expected associate when the feeding performance suggests its necessity to limit the life span of the animal to that of baby beef or of the barrows in the ton-litters, before the animals break down in health disasters under such treatment. One must naturally raise the question whether animal feeding under no more searching criterion than that provided by an ordinary scale is apt to bring good health with an economic margin, or whether it must be bad health and all the hazards and disasters associated with it. Feeding to encourage the building of muscle, to guarantee fecund reproduction, and to protect from the invasion by the microbes or the diseases calls for a more scrutinizing criterion. It calls also for foods and feeds that are more than mere bulk for filling purposes. It demands the appreciation of some physiology, and some comprehension of body functions. It transcends the matters of economics resting on no firmer foundation than simple arithmetic.

Declining Fertility of the Soil Goes Unrecognized When Quantity Rather Than Quality Rules

The simple fact, that the fertility supplies of the essential nutrient elements in the soil supporting all life have been declining, has not yet been widely comprehended. The dwindling amount of the soil's creative power has encouraged us to search for crop substitutes as soon as a "tried and true" crop indicates its decrease in yield of bulk or of bushels per acre. Rather than rebuild the fertility of the soil to nourish the "tried" crop, we have searched the four corners of the earth for another one to take its place.

By that procedure we have introduced more and more of those crops which are making mainly vegetative bulk but are producing less of real nourishment and nutrition for animals. Those crops have been said to be "hay crops but not seed crops". While juggling the new crops into the particular rotation or the chosen farming scheme, their nutritional quality in protein, and their contents of inorganic essentials, of vitamins and of the other necessary compounds of high value as feed for good health, have been juggled out. By growing more and more of those new crops, the carbohydrates composed mainly of air, water, and sunshine are amply produced for fattening services,

but proteins are becoming scarcer in the feeds. That is the feed situation bringing about the increasing troubles in the health and reproduction of the animals consuming them.

Crops that create the proteins are considered "hard to grow". The cost of the extra fertility for the soil to nourish them so they can create their own needed health and better chemical compositions for better animal nutrition is side-stepped. A big crop yield, but less protein in it, is thereby produced. While failing to see the declining fertility of the soil responsible for less meat and less milk and poorer reproduction, we are calling for more artificial insemination and other technological procedures looking towards improved breeding more than towards improved feeding as a possible help.

While one generation of us is a sufficient time period to exhaust the fertility of the farm, it is, in most cases, not long enough to convince the owner of a farm of what has happened to the soil. Having never figured the costs of maintaining the fertility of the soil, he is not ready (nor are many of the rest of us) to appreciate the great fact that agricultural products have always been priced under the assumption (or the absence of even any assumption) that what the soil contributes is not a part of the cost of their production.

Depreciation of the soil is not recognized in terms of the income tax question. Only the buildings and the fences are considered as depreciable. Our ignorance of the mineral soil fertility as a nutrient-delivery service still leaves that basic substance as of no value in determining farm earnings, and as of no cost in agricultural production, in the minds of those directing internal revenue procedures. Yet oil wells, coal mines, quarries, and similar productive mineral resources may be depreciated as much as 15 to 25 percent of gross income per year. When soil minerals are not minerals for all that unless the political aspect of lobby pressure rather than common sense so classifies them, can there be any other result from exploited soils, abandoned farms, and poor quality in our foods and feeds than the invitation to bad health and poor reproduction in our animals when all the qualities determined by fertile soils are so completely forgotten?

Animal Instincts Go Unheeded. The Plow Precedes the Cow.

One needs only to look at the beef map, or the pork map, (6)* of the United States to see that the beef cow has gone west to the soil which the buffalo mapped out for his choice in making bone and brawn, but not necessarily in making fat. Beef cows range, and choose their grazing from soils that once made wheat of higher protein content and also more nutritious grass. **The beef cattle grow out West. We fatten them in the East.** The buffalo that chose that same western soil area called for no imported protein supplements, no veterinarian, and no mid-wifery helps during parturition. He did not populate our East where the dairy cow in close company with the congested human population is expected to serve as foster mother for that crowd left in the wake of the Westward movement on account of soil exploitation.

* Numbers in parentheses refer to "Literature Cited", page 37.

Beef cattle as our choice protein emphasize the Mid-continent and its calcareous soils for their nutrition.

Hogs and their excessive fat emphasize their location on the more weathered soils and carbohydrate crops of the Corn Belt.

The buffalo was far ahead of the plow. He was choosing the soil under his feed, rather than worrying over the particular plant species, or the pedigree of some supposedly choice variety of recently imported forage crop. The poor dairy cow has no chance to exercise her unique instinct for selecting the forage of higher nutritional values according to the better soils growing it. It was the plow that took her where she is. The fences confine her and so do the stanchions and the feed mixtures until she is little more than the front end of a milk-producing arrangement in which she is a machine for consuming certain allotted daily amounts of feed mixtures according to calculated compulsory delivery of pasteurized gallons of liquid and pounds of fat at the other end of that complicated, highly mechanical rather than biological arrangement. The protein content of the milk, of major value following parturition in the reproductive process that gives occasion for the milk, has been almost completely disregarded and avoided in considering the real values of milk. Seasonal variations in the quantity and the quality of the milk proteins draw little, if any, concern. This body-growing service which the cow intends for her calf has not been guarded for the correspondingly high value to the cow's foster children.

Isn't the protein problem from the animal's viewpoint possibly a large part of the picture when the cow breaks through the fence, or when she searches out certain plants in the pasture and eats them shorter while she lets others grow taller? Are not her instincts given to building her to produce proteins, too, and not just fats? When once we think about more protein for healthy boys and girls as well as for calves, rather than just bottles of milk and pounds of fat for sale, we shall be compelled to think of the complex soil fertility required under the cow in making the former rather than just rainfall and sunshine above her giving us the latter. Apparently only some necessity compelling us to think, some threat of disaster, or some disaster itself will make us appreciate our natural resource, namely, the soil, which we have too long taken for granted.

**Soil Fertility Pattern Under Patterns of Animal Distribution
Suggests Better Health Via More and Better Proteins**

With meat proteins, milk proteins and vegetable proteins now coming into national concern because some few folks are recognizing the fact that our national resources producing them are dwindling, we are compelled by animal troubles to center our thinking on this one food requirement, namely, our needs for proteins, and the problem of growing them. When these requisities in our foods and feeds are not manufactured, but are assembled by our animals only as the plants which they eat have synthesized them from the elements of soil fertility, air, water, and sunshine, we may well see that the fertility supplies in the soil mark the possible protein supplies of our country by way of the crops or the plants which the soils will grow.

A look at the soil fertility map of the United States according to the climatic forces that give increasing soil construction on coming out of our arid West to the Mid-continent, then increasing soil destruction in terms of protein potential in going from there to the East and the Southeast, helps us to realize that our soil resources are already so low as to make the shortage of proteins our major national problem. While there are cries for, and hopes in, grass agriculture which is being propagandized so glibly for cover of the soil against its loss by erosion, only a few folks are reminding themselves that one does not get a grass agriculture by mail order and spread it over the farm. It must be grown on the soil it covers. Even then, it must be more than cover. It must be nutrition for animals in order to pay its own costs. For that nutritional contribution it must be a balanced ration for the livestock. And it can be that only when the soil fertility is properly balanced nutrition for the grass, a creation of complete proteins rather than merely bales of bulk. **The curve of soil development and its crest of high production of protein suggests reasons for the concentration of livestock in the Mid-continent.**

The rainfall in total per year, balanced against evaporation in the West and against leaching in the East, gives soils in the West which are under-developed, and soils in the East that are over-developed for protein production. In the West, there is excess of the alkali and alkaline earths, or an excess of soil neutrality in terms of simple chemistry. In reality, that neutrality represents a deficiency both in soil acidity and in soil fertility in terms of plant and animal physiology. In the East, there is an excess of soil acidity in terms of simple chemistry, but that also is a deficiency of soil fertility in terms of those same physiologies, namely, those of our plants and animals.

The crop pattern superimposed on that of soil fertility tells us that the Creator himself was making only wood on the eastern half of the United States. Even for no more than the growth of the starchy grain of corn, the American Indian in New England was compelled to fertilize the corn plant with some fish protein, as the Pilgrim Fathers observed but failed to appreciate fully. Grass, and not forest, prevailed under the Creator's agricultural management in the Mid-continent and the West where the buffalo roamed. High-protein, or "hard" horny wheat grew recently on those former "grassy" plains. Credit for the high protein grain of the wheat is still erroneously given to the pedigree of the plant or to the particular wheat variety, because we have not looked deeply enough into plant physiology to see the soil fertility responsible for it. Now that most of the Kansas soils have given us bumper wheat crops to exhaust the fertility, especially the nitrogen, to the point of making "soft" or low-protein grain, we are gradually coming to see that the fertility of the soil was in control of the protein that made quality for nutrition more than just quantity for sale. The many flour mills, closing now that the fertility is gone, give occasion for us to really appreciate what we once had.

Unfortunately, it is to just such soils where denser human populations are now expecting to bring the animal agriculture and a diversified agriculture. Where extensive single crop specialization prevails, it

is usually the limiting soil fertility that brings such single crop prevalence. Single cropping is evidence that it is the soil, limited in fertility, that holds the agriculture down to crop specialization. From those areas of single crop agriculture there are commonly numerous life lines reaching out to other areas of higher fertility levels, reaching especially to those areas producing proteins. Into the Mid-continent, into its soil fertility for protein, and into its livestock markets, numerous life lines come from all directions. From the area of crop specialization known for its cotton farming in the South, one can see the life lines reaching to the Mid-continent while the menus of the hotels down South announce "Kansas City Steaks", and point back to that present beef-slaughtering center of the United States which was once located much farther east.

As we mined our virgin soil fertility, we naturally moved on west. The beef cow with her limited output of milk went ahead of the plow. Instead of her instincts guiding us to the better soils while she assays them for protein production and delivery of high nutrition, or as she would outline for us the soil fertility pattern for production of that high food value, we have put the plow and other machinery ahead to enslave our cows physiologically, while the significance of that soil fertility in terms of the proper soil management for protein production for our animals has not yet been appreciated.

Our Gadgets Measured Increasing Soil Acidity but Missed Its Reciprocal, the Declining Soil Fertility

Legume plants have long been the growing animal's choice among forages. Most students of animal nutrition and animal health have been ready to believe that the higher concentrations of proteins, of inorganic elements, and of other food compounds in these nitrogen-fixing forages, have been reasons for the choice. These crops have always been the feed desired most by both the cow and her owner. But with the cow on the highly weathered soils, from which virgin forests were cleared, we discovered that the better legume crops failed to grow on those soils except as the soil fertility was given uplift. With the advent of laboratory gadgets measuring the degree of acidity of the soil, it was soon observed that the increasing degree of soil acidity in nature is associated with more trouble in growing these highly desired forages. Consequently, the erroneous conclusion was drawn that acidity of the soil is bad, since it seemingly prohibits many protein-producing crops from growing and hinders livestock production.

Had we studied the physiology of the plant with emphasis on its biochemistry in place of learning no more soil chemistry than that required to send us out to propagandize laboratory gadgets for sale of limestone as a cheap neutralizer of acids, we could have seen that soil acidity is not a detriment but is in reality an asset. It is the soil acidity that is regularly making mineral nutrients within the rocks and the soil available to plants. When acidity accumulates in the soil naturally to a high degree, the resulting injury to our crop is not occurring because the acidity has come into the soil. This injury results

because many of the fertility elements replaced by the advent of that much hydrogen, which is a non-nutrient, have gone out to leave this acidic element as infertility to take their place.

Instead of seeing lime on the soil as beneficial because it provided the nutrient calcium, (and magnesium) we saw its benefit in the accompanying carbonate as provided to neutralize the acidity or to get rid of the hydrogen (1). Simple gadgets measuring acidity should have been accompanied by means of measuring the plant's better physiology making more and better proteins rather than just more yields.

Now that we have made so many originally-acid soils nearly neutral by stocking them heavily with calcium while attempting to drive out all of the hydrogen, we find that those soils so highly loaded with calcium are not more productive than those soils loaded to a corresponding degree with hydrogen as acidity (5). What is needed to grow nutritious forages in acid soils is the balance of all the nutrient elements rather than only to replace the acidity. Getting rid of the acidity by liming with a carbonate, or an alkali, is not the equivalent of providing the plant with a balanced diet within the soil. Feeding the crop via the soil, not fighting soil acidity, is what is demanded for nutrition of the plant. A little science came in to lead astray the art of agriculture that had long been using lime, as far back as the Romans, to grow better feeds but not to wage a war on soil acidity.

Limited Knowledge is Apt to Propagandize Itself Too Soon

While fighting soil acidity, during the last two decades, unfortunately there was a delay of just that many years in the progress towards better nutrition of better plants of high protein output and thereby towards better animal health. Fertilizing the soil went into vogue on the basis of no more knowledge than that required for one to get bigger crop yields and bigger monetary gains by this practice. The fundamentals establishing the procedure of fertilizing the soils for better nutrition of all life are not yet common knowledge (3). Nitrogen, phosphorus, and potassium became standard fertilizers on their score of making bigger yields. Even calcium going on as lime did not—and does not yet in the minds of some—classify as a fertilizer. Sulfur, applied to the soil unwittingly in superphosphate and ammonium sulfate, has not been credited with its values in plant nutrition and better animal nourishment. Commercial nitrogen was not used until recently, because we did not know that nitrogen fixation by legumes is often only a hope and not necessarily a realization when those crops are grown. Copper, manganese, zinc, boron, molybdenum, and other trace elements are not yet considered by many minds that are closed to the possible services of these as enzymes or protein promoters in plant and animal nutrition (4).

With increased yields of vegetative mass as a major ambition and the criterion by which we judge the services from soil treatments using fertilizers, much that results therefrom in the physiology of plants and animals is not commonly observed, much less appreciated. We therefore have not seen the decrease in plant disease, the reduced

insect attacks, the better seeds for reproduction, the better health of animals, their more fecund reproduction, and many higher nutritional values in plant and animal products used as food, all resulting as we discover the nutrient deficiencies in the soil, and adopt the methods of correcting them for balanced nutrition and thereby for better plant health and better animal health.

Inorganic Criteria are Insufficient. Quality Criteria Point to Organic Differences for Better Health on Better Soils

To date it has been impossible to explain the many plant and animal improvements from soil treatments merely, (a) by the bigger yields for the animal's consumption of more, (b) by a higher concentration of ash or mineral elements in the feed, or (c) by changes recognizable after the plant has been ashed for chemical study. But even the differences in the ash from plants grown on soils fertilized differently gave differing digestive results in the studies with an artificial rumen (9). From increasing experimental evidence, there comes the suggestion that the better soils make not only more but also better proteins. Accordingly, then, we may well look to the more nearly complete array of required amino acids composing the proteins as possibly the nutritional improvement in forages and feeds from fertilized soil. Isn't it possible that the instinct of the animals is directing them to recognize these better proteins when those beasts break through the fence from the fertility-exhausted soils of our field and go out to graze the grass on the still-fertile soils of the highways and the railroad right-of-way? Is not the imbalance of too much nitrogen, or too much crude protein, of the grass growing on the urine-soaked spot just as quickly recognized? Cannot the wild animals and the unhampered domestic ones judge the quality of their feeds in terms of health and reproduction more effectively for their survival than we can do it for them? Do they not carry their search for quality of feed as far as they can, namely, down into the fertility of the soil growing it?

Proteins For Better Nutrition and Better Protection Against Disease

It is only when our soils are better in terms of all the essential fertility elements, that they can grow the **complete** proteins. Just when are proteins complete? This is still an unanswered question. They should be complete as regards all the eight or ten amino acids recognized as required for survival. Some recent research, especially with the trace elements, points out that soil treatments may increase the nutritional value of grains and forages by increase in the concentration of some of the amino acids commonly deficient, like tryptophane and methionine (2). The use of these trace elements on the soil growing alfalfa and corn, points out by microbiological assay that better soils increase the output of these essential amino acids. Rabbits feeding on the corn, balanced with amino acid supplements, suggested that trace elements function, apparently, through the modification of those amino acid values commonly more deficient in the feeds grown on the less fertile soils (8).

Magnesium and sulfur, not classified as trace elements, come in for

similar effects. Magnesium, applied to correct the soil's shortage indicated by soil test improved the tryptophane content of forages. Sulfur, applied even in the elemental form, increased the amount of methionine (2). When these amino acids are grown to higher concentrations in the feed, may we not expect those better proteins to result in the animal and human bodies by which there is protection against invasion by the microbes? When the common cold and tuberculosis are invasions via the mucous membrane; when both are considered as breakdown of our defense; and when tuberculosis is "cured" by a high protein diet; is it too much of a stretch of the imagination to theorize that mastitis and brucellosis may also be microbial invasions through the mucous membranes of the teat and the vaginal tract respectively? Should we not test that postulate by treating the soil with all possible fertilizers to include the trace elements, and by studying the physiology, blood properties and all other animal manifestations, in order to learn whether animal health is not related to soil fertility? (10). The blood picture of the cow suggests that it should be a warm-blooded body's reflection of the soil fertility connecting with the blood by way of the paunch carrying the microbes and the plants still very near to the fertility of the soil nourishing them directly and through them the cow indirectly.

Studies so far with animals suggest the truth of the old adage which says "To be well fed is to be healthy." Experimental evidence now lets us say that some cows must be better fed via the soil if they are to reproduce better, to give more milk, and to be healthy with respect to some diseases which the cows now have and for which—because of transmissibility to humans—the cows are about to be innocently slaughtered. Surely such a negative approach, by which the cow species would become extinct, ought to be replaced by a positive one looking to better proteins via fertile soils, and to better protection against diseases for the animals so as to keep them living and healthy. Proteins complete for this kind of protection may call for a new degree of completeness not yet regularly associated with this organic food substance which we call proteins, much less associated with the fertility of the soil creating it in the grass or the other crops.

The proteins are slowly being appreciated in terms of the struggle required for their syntheses and their assemblages. Plants are literally struggling for their proteins. They make carbohydrates regularly, and quickly as a weight-gaining performance, but fail often in finding in the soil fertility the helps for converting those carbohydrates into complete proteins and much seed to multiply their species. Animals struggle for their proteins, too. They can easily put on fat, and add weight, but for the proteins needed in their reproduction they go long distances, search over myriads of kinds of vegetation, and are active from dawn till dark on many of our less fertile soils. But when on good feed grown on better soils, they fill quickly and soon lie down in what we call "contentment", but which is maximum in body physiology in action. Man, too, struggles for his proteins. Unfortunately, he fails to see it as a struggle premised on a similar one by his animals; that, in turn, premised on the struggle by the plants; and

that in its final turn, limited because of the insufficient fertility of the soil. We scarcely indulge in even this simple bit of analytical deduction.

When our best proteins, like those in lean meat, milk, and eggs must be assembled and brought to us through that long creative line connecting back to the soil, surely, in this post-mortem approach, we shall finally see that the shortage of proteins, which has much to do with our failure to keep well fed and healthy, is not one of economic quarrels between groups of us. There is, rather, a declining soil fertility under all of us and under all of the lower life forms below us as our nutritional support. Soil conservation is not a fad of the 15 percent or less, of our population classified as farmers. It is a necessity, to a far greater degree, for the 85 or more percent of us classified as urban, and too far removed from the place where the proteins can be created by our own individual management.

When we still have two acres per person in the United States and one acre does well to make only 250 pounds of live beef per year, which dresses out to give 125 pounds of meat and fat, we may see no reason yet for concern about dwindling soil fertility as the shaky foundation of that protein creation. But when we drop to the world level, by taking on world feedership under the guise of world leadership, and cut ourselves back to one acre per person, we cannot have other foods as well as our meat and our milk proteins provided for us so generously even at higher prices. Then, we may be content to call for our daily food allotment of a little more than a bowl of rice. Does it require the experience of that situation for us to realize that healthy nations are protein-eaters because they have ample acreage, because they conserve their soils, and because they keep them fertile?

Health in the Positive via Nutrition—Not in the Negative via Drugs

In the discussion so far, we have considered our mental procedures as a kind of post-mortem, working from poor animal and human health back to the plants and the soils. Let us now reverse our order of thinking and substitute induction for deduction. Let us consider agriculture a call for judicious soil management; that management premised on critical study and knowledge of the soil; and thereby estimating, if not predicting, what amounts will be produced rather than an approach to agriculture with economic calculations setting goals for the yields required to match them; then holding post-mortems for failure in quantitative yields to say nothing of failing yields as food quality and real nutrition.

Food for the human has long been taken two or three times daily as a pleasant experience looking towards satiation, rather than as a careful study leading to good nutrition with good health as the resulting by-product. Health has become less and less a positive matter resulting from ample quality of food to keep us buoyantly active in both body and mind. The same is very true of our animals. Health has become more and more a worry about finding the appropriate drugs and using the hypodermic needle practices under professional guidance to relieve us of the misery of pain and to help escape the chagrin

of insufficient health even to work enough to care for ourselves. We are gradually coming to realize that bad nutrition and poor health in any form of life, whether the lower or the higher, can result from deficiencies in the quality of food, or from hidden hungers, even when ample bulk of extensively labelled products may be regularly ingested.

Do we manage, do we contribute, or do we merely console when we hold post-mortems? Do we not merely analyze and explain deductively from death as a starting point? Is that a form of creative and productively sound reasoning? Can farm management be a success, if like the prevailing veterinarian philosophy, it deals only with sick animals, and their failing health? Are we not merely clinicians under those circumstances rather than creators? Can we not see agriculture now in its bad health of the microbes, the plants, and the animals suggesting serious subclinical conditions due to declining soil fertility when as Professor Loeffel of Nebraska, once remarked, "About every two years we report that we have conquered one new hog disease only to have another one break out on us." During this past year—in fact, during this last half year—two new hog diseases were announced. In the farm magazine, *Successful Farming*, August, 1955, the following was reported, "Pig raisers can add another disease headache to a list that is already too long. The disease called **hemorrhagic intertoxemia**, was first found in cattle and lambs. Now the disease is reported to infect pigs in Illinois and is suspected at least in one case in Colorado. The disease is characterized by internal bleeding . . . A vaccine . . . appears to be effective in preventing this disease in pigs."

Then another magazine, *Farm and Ranch*, November 1955, reported as follows:

"Keratosis—a serious skin disease of hogs in some areas—has been prevented and treated successfully at the University of Wisconsin by adding zinc to the hog ration."

By reasoning from the grave and the morgue backward in the case of human disease, we have offered many explanations but few preventions with little attention to nutrition until the human family has more degenerative diseases than we have ever imagined. In connection with the diseases of our livestock and their cure by drugs rather than their prevention by quality feeds, this deductive reasoning backward from clinical cases has developed the **veterinary business** to the point where a farmer recently reported that he couldn't afford to call the veterinarian because even if the animal was resurrected from the poor health condition it would not have enough extra value to warrant the investment in the curative effort by the veterinarian representing a fifty-fifty chance only, or one no better than what was represented by the animal itself without a veterinarian.

We have not yet seen the larger pattern of animals and plants in the ecological setting, or each creative life form of agricultural use in the place where the soil development of its fertility according to the climatic forces would suggest what the nutritional potential for a certain life species is. Curative medical struggles have attempted to prop up the misfits and have encouraged our injudicious transplantings

15 rather than help our introduction for agricultural use of life forms ecologically suited according as the soil fertility and the vegetation in terms of biogenesis of protein which support them. We need to see animal health in the positive according as the soil and its vegetation will grow the animal to protect itself by means of the proteins it makes, and as those protective proteins consume the invading foreign proteins, whether they be microbes or viruses. We need to catch that vision of growing healthy animals in place of merely recognizing the disease and then calling for a hypodermic insertion of technologically prepared protective serums, antibiotics, etc. The horse takes our typhoid fever and by eating grass builds his antitoxin by the wholesale with no more attention on our part than providing plenty of good grain, hay, grass, or good feed. Is it not time to see the declining soil fertility, the substitute crops, the poor nutrition responsible for the disreputable animal health?

Farm management may well believe that in studying disease by this deductive reasoning from post-mortems we have brought the "clinical bull into the ecological China shop" as one of our doctors of medicine so nicely put it (7). We are failing to see our agriculture with its success founded in our growing healthy animals and producing crops, all in their suitable ecological setting. We have failed to see those ecological settings as they represent the levels of soil fertility as animal and plant nutrition complete enough for each of the life forms to be not only well filled but to be also properly nourished. We must manage the soil so that any feeding complies with the requisites of complete nutrition and thereby subscribes in the fullest way to the ancient adage which said, "To be well fed is to be healthy."

Is not the day here when farm managers will use inductive reasoning and start it with the fertility of the soil as their first premise in considering their responsibility in guiding agricultural production most efficiently in cooperation with the laws of Nature? Are we so self-satisfied with our present production of starchy, vegetative bulk that we shall continue to be deceived by the boast of our expert agricultural management because we have so many surpluses? Our economic criteria and large yields resting on monetary bases are becoming more and more of a disappointment to farm managers. Are we not about ready to see the many sick animals, the poor results from mating, and other troubles, to say nothing of all the plant diseases, as reasons for farm managers to believe that better animal health and more fecund reproduction by them will come to pass only as better soil management is the first and foremost criterion for better farm management on a biological base? Can we expect Nature to do the creative work alone while we apply no more than the economic measures of her services?

If veterinarian clinical procedures must be used because we are dealing mainly with sick animals, why not study the chemical and biochemical blood picture of the cow and then by the help of those biochemical data diagnose the failure or the success of our nutrition of her? From that source, namely, the blood stream itself, we can have pointed suggestions as to what chemical irregularities in her body

originate from chemical irregularities in the fertility of the soil. In my humble opinion, a new day will be ahead in agriculture when we view the health of the crop plants and the health of our animals in the positive via nutrition from the soil up, and view our business of farm management as a participative effort in the Creator's processes in place of viewing them in the negative via drugs and concoctions that cover, relieve and cure, but do not prevent. Creation in agriculture, or production in that industry, starts with a handful of dust. Up to this date, in my humble opinion, our agricultural science has not found much that suggests possible substitutions for the fertility of the soil as a basis for agricultural production of healthy plants, animals, and people, and thereby a prosperous agriculture and all dependent on it. A new day in agriculture will come if, and when, we get both our hands and our minds a bit deeper into our soils.

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