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SOIL AND LIVESTOCK

By W. A. ALBRECHT

FOOD bulk is registered by satiation and the relief of hunger. Food quality, when defective, remains unregistered by these means, but gives us the hidden hungers that may be lifetime torments.

These hidden hungers originate in the soil and reach us by way of plants that also suffer hidden hungers. So also animals suffer their hidden hungers, and so humans, in their turn, consuming the products of starved plants and animals, suffer. This whole series of torments is caused by nutrient shortages in the soil. It should be exposed and possibly cured by soil treatment.

Proper nutrition is an enemy of "disease," in plants as in people. Fungus attack on plants, the "damping off" disease, has been demonstrated as related to a hidden hunger for lime or calcium. More recently potato scab has suggested its connection with insufficient calcium in relation to potassium in the soil fertility offered the potato plant. The potato plant demands much calcium in its tops which duplicate red clover in content of this nutrient.

Plant health in the humid temperatures is doubtlessly declining as the soil is declining. As we fail to return manures, fertilizers and nutrients in the equivalent to those taken off in the crops, we are invoking hidden hungers in the plant and encouraging plant diseases.

Man's nomadic habits have covered much of what a life in a limited location might eventually reveal. He has moved to new soil. But now that rubber shortage and gasoline rationing are putting fences about us as we have done to our livestock, our own deficiencies or hidden hungers will lead us more quickly to consider the soil.

II

Calcium and phosphorous deficiencies soon show up in livestock. In some localities animals born in early winter develop rickets by late winter or early spring. Their bones break readily and the pelvic-spine joints separate. The animal "goes down" when the farmer believed "it was doing well."

Disturbed reproduction processes are another consequence, the record of hidden hungers for calcium and phosphorus. Shy breeders among the cattle are increasing.

On some of the less fertile soils farmers are wondering why their cows breed only in alternate years. It is not suggestive that on many of these same soils the calves show malformations enough to make them less true to breed type? The backbone of a cow reared in such a herd reveals she had sacrificed part of her backbone for foetus production and used the succeeding year to replace her backbone rather than to indulge in another reproductive cycle. (She was originally a regular breeder but became a shy breeder and died all too early in her life.)

Males, too, may lose breeding capacity on deficient forage feeds grown on deficient soils. Male rabbits under experiment with forage grown on calcium deficient soils became impotent. Their litter mates, on feeds grown on soil given calcium, retained their capacity to serve as fathers. When the feeds of these two lots of rabbits were interchanged for the second

period of the experiment, the situations were reversed. Those originally made impotent by lime-deficient forage recovered their male potency, while the lot put on forage from lime-deficient soil, lost it.

Reproduction, as a delicate physiological mechanism—if its late arrival and early departure in the individual life cycle is any suggestion—may possibly be disturbed by other soil deficiencies not yet considered dangerous to this process of maintaining the species. Hidden hungers by way of decreasing fertility in the soil may be the quiet force by which species of animal life have become extinct. Nature's warnings allow time for us to heed them against our own extinction if we will look to the soil and conserve its fertility against the forces of exhaustion as well as its body against the forces of erosion.

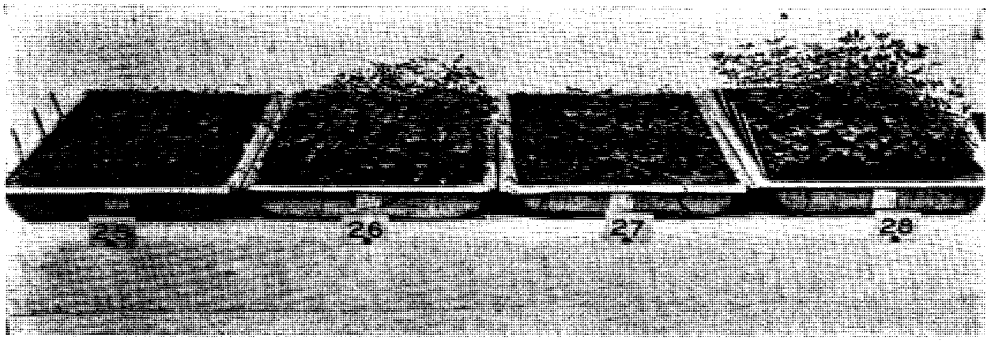
III

One might well say that the moods of Mother Earth are not always constant and kindly toward those creatures whom she nurses. The rates of delivery to the plants of exchangeable nutrients by the soil vary with different parts of the year, or the seasons. Because plant growth stops during the winter season, this need not imply that chemical reactions within the soil cease during the same period. In fact the rapid exhaustion of the exchangeable supply by rapid plant growth should occasion restoration of equilibrium with cessation of plant growth. In the absence of plant growth, nutrients may move into the absorption atmosphere of the colloid to accumulate for ready removal by contact with plant roots during the next growing season.

Spring plowing facilitates these adjustments of concentration of available nutrients by rearranging contacts between colloids and mineral crystals. Consequently, the spring plant growth into this larger supply of fertility and through root extension for its rapid absorption, means a liberal supply of soil nutrients in contrast to the lower rate at which the plant is building its carbohydrates. Further, this means luscious plant growth, of which the lusciousness is contributed by the soil more than by air and sunshine. Such plants are mineral-rich and protein-rich, to say nothing of their contents of vitamins or other growth-supporting essentials.

As the plant growth extends into the summer season, the store of exchangeable nutrients in the soil has already been lowered. At the same time, the increase in sunshine and in temperature bring greater rate of carbohydrate production. Thus, spring growth of plants means high mineral and protein concentration of nutritive value as body construction, but later growth in the summer suggests woodiness and fuel value.

When with each mouthful of luscious grass the animal ingests growth-promoting nutrients assembled by extensive root action through the soil, rather than mere woodiness from an extensive plant top collecting sunshine and



Plant hunger is manifest as early as germination itself. The same amounts of legume seeds give different stands according to the past soil treatments in a three year rotation, namely: 25—manure; 26—phosphate and limestone; 27—no treatment; and 28—limestone and complete fertilizer.

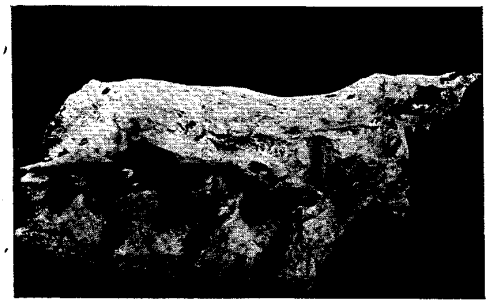
fresh air, is it any wonder that the shaggy winter coat of hair is shed, and that a sleek animal condition comes on in early May? Should there be any wonder that animal thriftiness is lessened by August, and shall we accept the oft-given explanation that it is wholly because of the heat and the flies? Some of you may have heard cattle feeders remark, of the steers in the drylot in February, "They ought to go to the market soon, because they are licking themselves." Some even say that this licking behavior is an index of feeding efficiency. It would perhaps be better to view it as a danger sign that recommends sale before disaster comes. Have you ever asked yourself why cattle do not continue to lick themselves, or each other, after they have been on spring pasture for a few weeks on fertile soil?

It may not be out of place to give some theoretical consideration to vitamins as a possibility in connection with this particular animal behavior of licking their own body coverings. Might it not be possible that after a long period of winter on dry feeds of low mineral and vitamin contents that the body needs for vitamin D become greater than the ingested supply? Might not the animals fatty secretions by the skin become activated in the sunshine with sufficient resulting equivalent of vitamin D which the animal by chance has learned to keep going through the cycle of excretion, activation and ingestion? As a suggestion for this theory, it has been demonstrated that the yolk of the sheep fleece for the fat of the wool is more prominent on sheep fed hays grown on land that was limed and phosphated than on those fed hays grown on soil without lime. Sheep growth per unit of feed consumed was also better by from 25 to 50 per cent on the former. The better body growth and more prominent skin secretions may both be connected with the same physiological improvements connected with the soil treatment. Soil fertility is not flowing into the plant at constant rates at all periods of the season. These differences through the year and in variable soils make for different plant compositions but exert still larger influences on the animals consuming the plants. Naturally, the question implied is this, do the humans escape these subtle forces of the soil?

That seasonal differences in soil fertility exert themselves on animals is not so difficult to understand when we recall that nature has put the birth time of animals so commonly in the spring, or the time when the heavy calcium load of lactation can be met more widely by the luscious vegetation for the survival of the species. Unless the soil supports the vegetation, the vegetation cannot support the animals. Human births are not seasonally concentrated, yet in December (1941) issue of Human Biology, reports from a survey of ten thousand students of the University of Cincinnati (birth dates 1904–21 inclusive) that those born in the spring are taller, heavier, and smarter than those born during the summer. Here may be further evidence to the more direct relation of soil fertility to the animal and the human species. Here is human evidence that Mother Nature nourishes more efficiently in the spring than in the winter. The fact that life forms carry the reproductive load of foetus development on the dry feeds in the winter, may make many a maternal animal endure hidden hungers, and even sacrifice itself where some

CALF DOWN: BAD BONE

Consequence of a break at the pelvic-spine joint because of rickets from the feed grown on a soil deficient in lime and phosphate.



Part of the backbone of a Hereford cow, periodically consumed in foetus and milk production and improperly rebuilt as a solid instead of flexible unit when the season of better pasture allowed.

help through better forages on improved fertility of the soil might save.

IV

Leguminous crops have been one of the great feeds to bring breeding animals through the winter in good health and with a generous crop of offspring. They have been fine means of growing young animals with good bone and straight back lines. Farmers all want plenty of legume hays but can't grow them, as they say, because their "soils are sour." Legumes need lime on the soil, to remove what is commonly called "soil acidity." It has only recently been demonstrated that the soil acidity is not injurious of itself. The so-called "plant injury by soil acidity" is largely a matter of a deficiency of the plant nutrient, calcium. It is, in truth, a deficiency of many items in soil fertility of which calcium is the one so pronouncedly deficient on the list that confusion has long persisted in our explanation of the benefits from putting limestone on our soils. We have believed that liming gives benefits because the carbonate of calcium removes the acidity. In reality the benefits come about because the calcium carbonate puts the calcium into the soil to satisfy the plant's needs for this nutrient in its body building requirements. After we have come to understand the function of liming, we shall be putting calcium back to the soil and drive out some of the hidden hungers in our livestock. When once we are fully accustomed to putting calcium into the soil to feed our plant and animals, we shall be more ready to do the same for phosphorus and all the elements that we will eventually put back to relieve the animals and ourselves of all these hungers. When only a few hundred pounds per acre of limestone, less than that of phosphate and less than tens of pounds of other nutrients are all that must be put back to make normally healthy plants and the resulting healthy animals, we should shake off our pessimistic views of the problems involved, likewise dispel our fears of the hidden hungers and go to work optimistically in restoring the soil fertility that drives them all away.

Soil acidity has so commonly been considered as a disaster that perhaps you may not be ready to believe that the soil acidity, so prominent in the temperate regions, may in reality be a blessing. The highest degrees of soil acidity occur in regions of moderate temperature and moderate to higher rainfalls. Maximum concentration of human population occurs in those same temperate regions. We have been inclined to believe that disturbed body comfort relative to temperature militates against denser populations in the frigid or the torrid zones. But when human movements like those of our armies are so much "on the stomachs," we must look to their increased chances to be fed there as the cause of concentration of people in the temperate zones. Soil acidity represents these greater possibilities. The very property of the clay enabling it to hold much hydrogen to make it acid, is the same property that enables it to hold many kinds of, and large quantities of, the nutrients for plant production. Soils of the frigid zones do not develop much clay content, or a clay that is able to supply much plant nourishment. Soils of the torrid zone, particularly, the humid tropics, have a clay product formed from such complete mineral break-down that the resulting clay compounds have little holding, or little exchange, capacities. So the acidic property of the clay, and of its associated humus, formed in the temperate zone may be the reason why we live in greater numbers in the temperate zone.

Soil fertility, then, controls the concentration and localizations of the human species within the humid-temperate belts of the world, rather

than the necessary mass of clothing (or lack of it) required for human comfort. Our soils have the ability to take up and deliver nutrients if we will manage those nutrient supplies by maintaining them through fertility return to the soil rather than mining the soil continually and then moving on.

I say, then, that soil acidity *in the presence of liberal supplies of soil fertility* is beneficial. High concentrations of people and the food to guarantee them have been supported where soil acidity mobilizes the nutrients into the plants more effectively than under soil neutrality. Recent studies, using spinach as the test crop, have demonstrated that this vegetable took more calcium, more magnesium, and others from the soil when these exchangeable nutrients were accompanied by acidity.

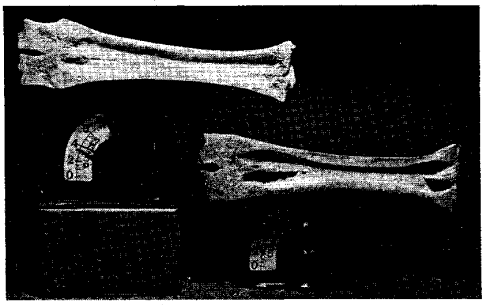
We must not console ourselves too quickly, however, with the belief that soil acidity is always beneficial and that we need to do nothing about it. It is beneficial only when accompanied by nutrients. As these nutrients become exhausted, hydrogen or acidity replaces them, and when acidity is all that remains the plants must suffer starvation.

Such was the situation in our virgin soils. They were acid but fertile because of high humus contents in which fertility had been hoarded by virgin vegetation. These stores have now been mined. With the increasing acidity and the declining crop yields, or legume crop failures, the acidity was considered as the cause of them. It was not the presence of acidity but the absence of fertility, that was the cause. We now know that nutrients in fertilizers put into the soil are taken by plants more effectively in the presence than in the absence of soil acidity. The crusaders against soil acidity may now desert that cause and march under the banner of soil conservation by restoring soil fertility.

V

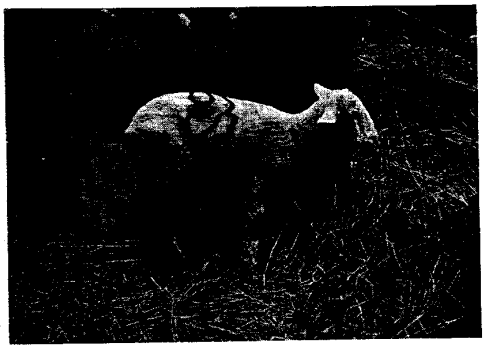
That some of the hidden hungers in animals and in plants can be driven away by putting the nutrients, calcium and phosphorus, on the soil as fertilizers has been demonstrated experimentally only recently. Such is true if increased growth on the same amount of nourishment or within the same time period may be considered as absence of serious hunger. Sheep, as test animals fed the same amount of hay and of grain per head per day, gained weight differently according as the soil had been given phosphate, or lime and phosphate. The plants had some of their hidden hungers routed too, as judged by the different yields per acre. The internal physiology of the plants must also have been changed since they were not widely different in chemical analysis, yet served widely differently in the efficiency with which their offerings in bulk served to be converted into meat as mutton.

Viewed more specifically, if the sheep gains are calculated as coming wholly from the two pounds of hay taken a day, the soybean hay from untreated soil made one pound of gain per 9.7 pounds of hay consumed; that soil given phosphate produced a hay of which 5.4 pounds made one pound of sheep; but when the soil was given lime and phosphate as a means of more properly satisfying the soybean plant hunger, then 4.4 pounds of this hay were all that was needed to give one pound of lamb in return. As an economic consideration of the grain needed to supplement the hay, if one puts all the gain on the basis of grain supplement, the grain requirements per pound of animal gain were 4.2, 2.3 and 1.7 pounds according as combined with the hay from the acid soil without treatment, with only phosphate treatment, or with limestone and phosphate as nutrient returns to the soil, respectively. Even if we should not be moved



TWO BONES

Thigh Bones from Jersey Heifers a year and a half old, of similar stock, but differently fed. Landess cites this Minnesota experiment on page 282



THIN LAND, WEAK WOOL

Wool fibers scoured differently according to soil treatment. Hays given only phosphate produced a scoured fiber that couldn't be carded without tearing. Hays given phosphate and limestone produced a stronger animal with a strong wool that carded nicely. "Yolk" on the wool fiber is a body secretion that reflects soil treatment. The lambs fed hay that had been fed phosphate plus lime grew wool with a lot of yolk.

out of sympathy for the animals that are suffering hidden hungers, there are economic bases that bid fair to have consideration for them. In the last analysis, the most economic animal gains can not be made by animals enduring hunger, either visible or invisible.

Rabbits have been used extensively as forage eaters to test the hay crop for its dangers as an inducer of hidden hungers, or conversely its efficiency as a producer of healthy animals. This miniature form of livestock is serving as excellent biological assay of the soil's store of plant nutrients. Calcium and phosphorus, in their mobilization in the body from the intestine to the blood stream, to the bones for storage, or in the reverse direction from the skeletal storage into the blood, the body, a foetus, or milk, manifest their deficiencies and unbalanced relations in terms of enlarged parathyroid glands. Here in these small bits of tissue, the soil fertility shortages as calcium and phosphorus are recorded in the same manner as iodine shortages in food are recorded by goiterous developments of the thyroid glands. Post mortem weights of the parathyroid of the rabbit reveal in some measure the magnitude of the hidden hunger of the animal for calcium and phosphorus. They tell of the torment the animal was enduring while confined by a pen or a fence to the quality of forage feed that itself in turn was confined to the low fertility of the soil.

VI

Animal hungers for energy-supplying compounds are not so common as they apparently are for the growth-promoting substances, such as protein that contains nitrogen and phosphorus, and for calcium and other elements going into the plant from the soil. Plants reflect the same shortages, in their changed composition and lowered seed yields, within which the nutrient concentration must be constant to guarantee the next plant generation. When these soil-given nutrients are denied the animal, it may be even possible that the animals are not using their energy foods efficiently. Growth-promoting foods do more than serve as building blocks. Energy-producing foods do more than deliver heat and power. They have interrelated effects. There are suggestions that lime and phosphate on the soil may play some role in aiding the animal metabolism to use its energy supplies more efficiently. This is the suggestion by acetonaemia in the pregnant cow, by forms of acidosis or incomplete combustion of energy foods, by pregnancy diseases of sheep. When some good green alfalfa hay or an injection into the blood stream of calcium gluconate represent relief for a case of acidosis in conjunction with the animal's body shortage of calcium and phosphorus in foetus building, the question may well be raised why the failure to burn the energy foods can be temporarily relieved by a blood treatment carrying calcium, and cured by feeding a legume that demands so much calcium and phosphorus in making a vitamin-rich forage of itself. Perhaps the efficient body metabolism of burning energy foods is in some way influenced by these growth-promoting foods that are so significant in the soil fertility-plant relations. Further research alone can supply the answers to these questions. Possibly the helps from the soil may make a contribution to their solution.

While the *modus operandi* of our hidden hungers may still be partly unknown, or at least not fully understood, it is consoling to know that much can be done to the nutrient quality

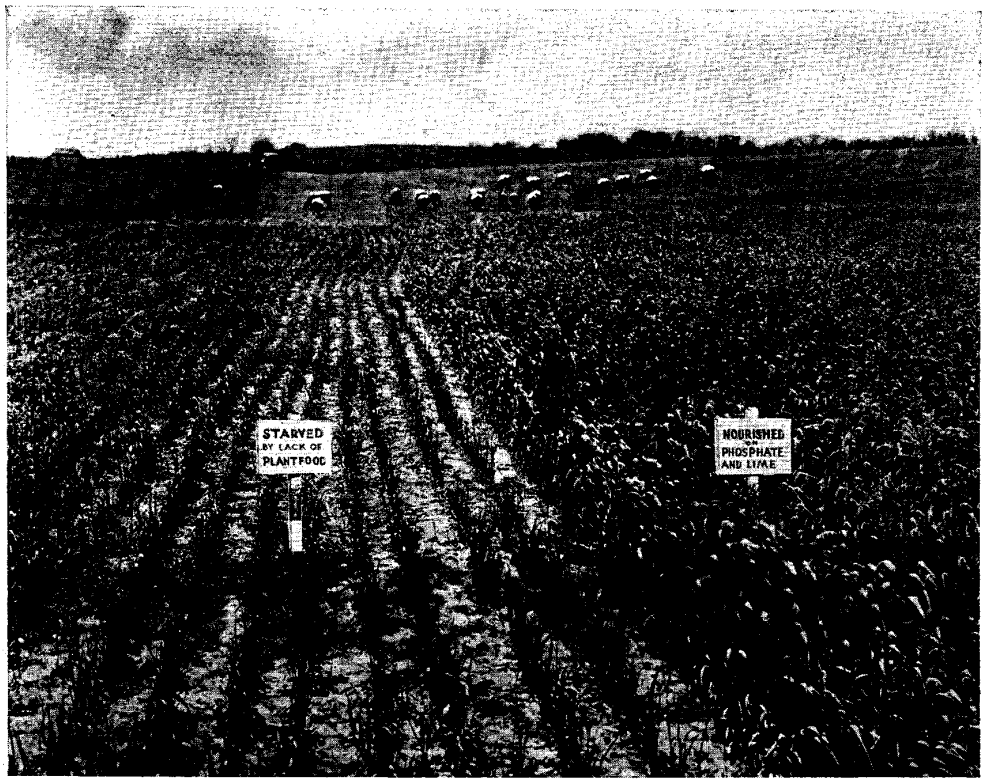


Photo by TVA

DUMB ANIMALS CAN TASTE THE DIFFERENCE
They seek out the forage that has in it "what it takes"

of forage feeds for animals and of the vegetables for humans by looking to the soil fertility. Wild animals and our domestic ones, where possible, have exercised unique choices in selecting their herbage with fine degrees of discrimination according to soil treatment. Hogs have demonstrated their choices of the grain according to soil treatments, and it took many years of study and is still a confession to be wrung from some hog feeders with difficulty as Professor Evvard has put it, that "a pig will make a hog of himself in less time—if he is given a change—than we can."

Applications of limestone and phosphate to the soil have been pointing themselves out as the main nutrients involved in animal troubles. It has often been demonstrated by choices of many different animals that we need no longer hesitate to see in these two soil treatments a significant help in making the forage feeds from many soils more efficient for animals in growing their own bodies and in producing their offspring. By the time these become common dosages on soils to relieve plant and animal hungers in the humid soil areas, there may follow shortages of other nutrient items as potassium, magnesium and others to bring up hungers again. If their addition to the soil can set in motion the microbial service within the soil, and the manufacturing business within the plant above the soil to give complete foods, certainly this method of preventing hunger by natural routes working from the ground up will be far more simple than searching for drugstore dosages as antidotes against hungers, bad health and impending death. We need to see in the restoration of the soil a means of demonstrating the age-old truth that an ounce of

knowledge applied as prevention is worth libraries of information serving as the pounds of cure.

Conservation of soil fertility and its regular return to restock the soil to the level where it grows its own cover against erosion before erosion is disastrous, needs to be more than ideas. It must be action out on the soil. Our lands given treatments of lime, phosphate, and, in many instances, complete fertilizers, for one or two tilled crops, must regularly be put up for the rest and recuperation under sod crops with their fertility restoring effects. The metabolism within our soil has been over stimulated. While the soil has been burning itself out, the crop quality has declined to bring on hidden hungers. Judicious attention to the soil for the better understanding of it as a complex biochemical performance, and of the plant as an equally complex phenomenon, can offer hope against what today may seem like starvation by degrees. Soil conservation as a national effort has begun to lead our thinking in that direction. Better nutrition is taking us there also. As we get the fuller knowledge about the soil and the role it plays in making Mother Nature a better nurse of us all, our present prodigality toward the soil will change to a reverent conservation.

MALNUTRITION FROM THE GROUND UP