Our Soils Our Food and Ourselves

By William A. Albrecht

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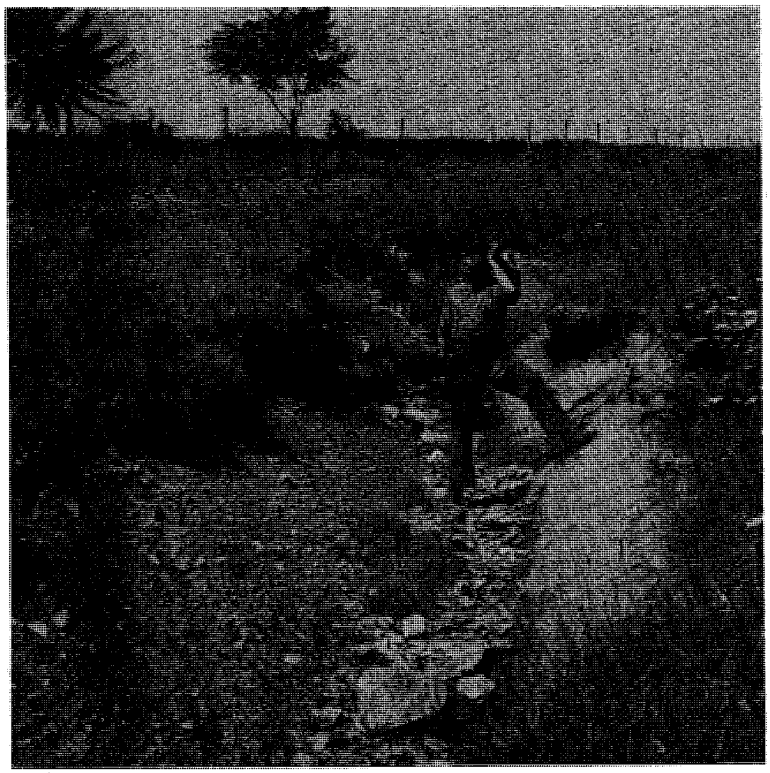

This perplexed farmer is not the only one who loses when soil is washed away. The kind of soil determines the kind and quality of food that is grown. It is now known that good soil and good health as well as poor soil and poor health definitely go together.

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OUR SOILS

Some climates bring about soil construction.
Some climates give us soil destruction.
High temperatures coupled with high rainfall mean more soil destruction.

OUR FOODS

Plant species and chemical composition of any plants are determined by the fertility of the soil.
Fertility pattern of soils gives pattern of food composition.
Any plant can deliver carbohydrates, but only fertile soils give us complete proteins.

OURSELVES

In giving the food pattern the soil fertility also gives the national health pattern.
Better teeth go along with better soils.
The healthy man of the future must be created from a fertile "handful of dust."

Pictures by Soil Conservation Service

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OUR SOILS, OUR FOOD, AND OURSELVES

Wm. A. Albrecht

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The weather has always been considered a very important factor in our agricultural production. Located as we are in the cornbelt, for example, of the central United States, we talk much about the seasonal rainfall and temperature as they determine our crop yields. While the daily variations of the meteorological conditions, which we call the weather, have long been recognized as important, the climate, which is the average of the weather over a long time, is even more important in controlling both the kind and the quantity of what we can grow.

It is the long-time effect of rainfall and temperature combined as climate that determines what kind of soil has been produced by weathering the rocks going to make it. The kind of soil determines the kind and quality of the foods that can be grown. Then, if we are what we eat, as some German put it when he said "Mann ist was er esst," there is a close connection between our soils, our food, and ourselves.

Some climates bring about soil construction

The soil is a temporary rest stop by the rocks on their way to solution and the sea. How far the rocks have travelled on this journey depends on how much rainfall and high temperature have been crowding them along on their route. In regions of low rainfall the soils are still rocky and sandy. There has not been enough rainfall to carry rock decomposition so far as to make much insoluble clay. Nor has there been enough water to wash the soluble materials away. Consequently the soils are alkaline. They are loaded with too many salts to permit good plant growth even if we make up the shortage in seasonal rainfall by irrigating the crop.

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This condition of insufficient rainfall in the past to have made the better soils is illustrated in western United States. If one starts in the west from near the Coast Range and goes eastward across the country to experience gradually increasing amounts of annual rainfall, one meets with a succession of different soils. By the time we reach the middle of the United States the soils are darker in color. They are deeper, higher in clay content, and more productive under the annual rainfall there amounting to near 35 inches. Going upward toward this figure for rainfall in the temperate zone means going toward better soils.

Coming eastward in the western part of our country means more soil construction. It means coming from the desert and its soil that supports very little life to where the bison once roamed and where wheat and livestock grow today. It means enough lime and other active fertility left in the soil that legumes have grown bountifully enough in the past so that the soils are well stocked with nitrogen. It means soils that have not been leached. They have not had most of their fertility washed out, nor have they had hydrogen take its place on the clay to make them "acid." It means mineral-rich and productive soils because the lesser rainfalls have made enough clay and have loaded it with fertility. But those lower rainfalls have not carried that fertility down through to leave an acid clay subsoil below a shallow surface soil layer, which is the common condition in eastern United States under high rainfall.

Some climates give us soil destruction

Increasing rainfall as one goes eastward from the midcontinent, particularly in the northern part of eastern United States, means soil destruction. This results because there is more rainfall than evaporation. This puts considerable water down through the soil. The percolating water loaded with its carbonic acid takes the lime, magnesia, potash, and many other nutrient elements off the clay by putting hydrogen or acid—a non-nutrient—in their place.

With much rainfall to have weathered the rocks extensively, there is enough clay residue in the soils to make us say, "They are heavy." They require much plowing and working to make

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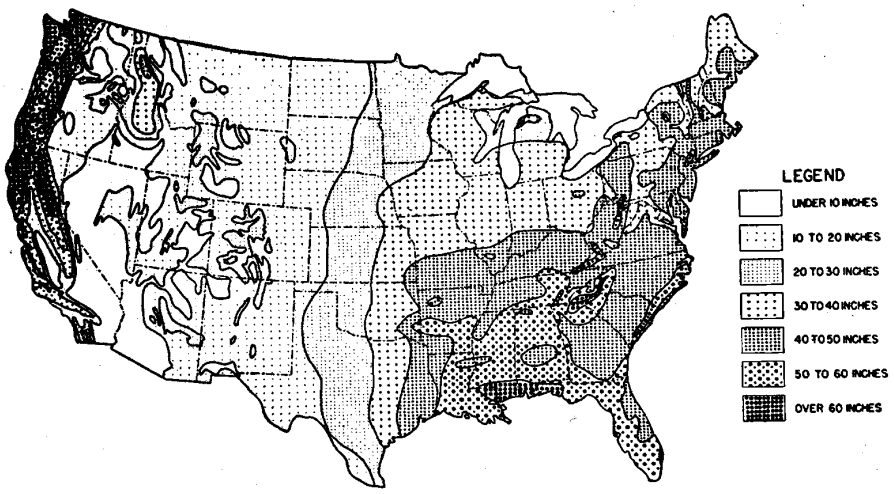

Distribution of mean annual rainfall in the U. S. The pattern of rainfall with the higher amounts in eastern U. S. suggests that the mineral elements have been leached out of the soils there, hence forest in pioneer days and carbohydrate-producing crops today rather than protein-rich and mineral-rich products grow there.

a good seedbed. Fortunately, their clay is still somewhat like the original rocks. It is still a silicate and has a high filtering capacity. By this property it can catch and hold nutrients by taking them out of any solutions, should they come along. This same high exchange capacity of the clay for nutrients can mean a high degree of acidity in case the fertility has been washed out. But it is the same big capacity to hold fertility if we put it back into the acid soil. Such are the clays and soil conditions in the cooler, northern half of eastern United States, where higher rainfalls mean soil destruction in terms of better foods.

High temperatures coupled with high rainfall means more soil destruction

If the climate is a combination of higher temperature as well as higher rainfall, as is the case when in eastern United States one goes from the North to the South, then the rocks

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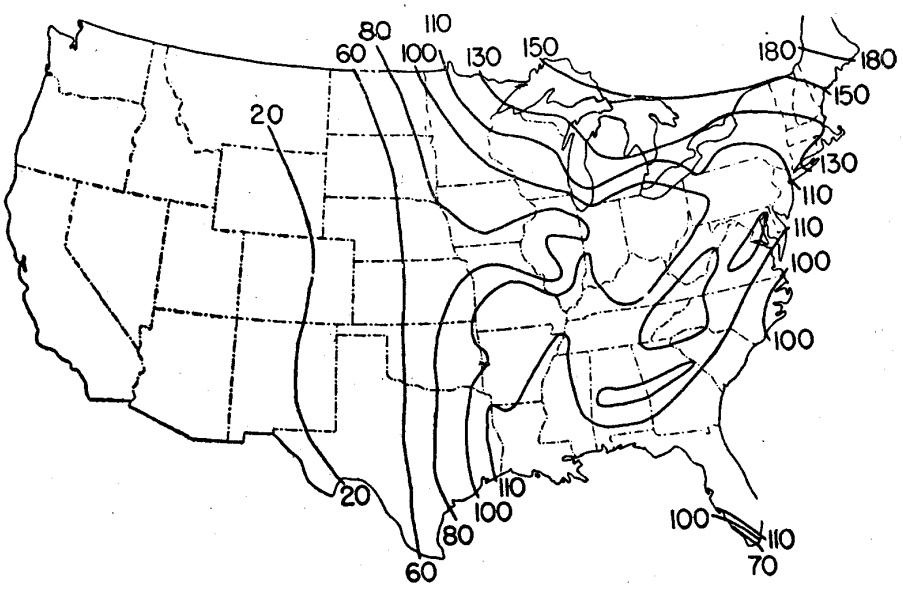
and even the clay are broken down much more completely. They do not leave a gray silicate clay. Instead a red, iron-aluminum clay results. This clay does not have much filtering or exchange capacity. If solutions of nutrients pass through, it does not take the nutrients out so effectively nor hold them for rapid exchange to the growing plant roots. It will not hold much acid either. Consequently in the southeastern states it has often been said "Because there is so little acidity in the soil no lime is needed to remove it."

Such reasoning fails to appreciate the difficulty of growing crops on soils of which the clay has so little exchange capacity. It disregards the high needs for the calcium in lime as a fertilizer even if those soils do not need the carbonate of lime to neutralize any acidity. Such soils are low in capacity to grow mineral-rich, protein-rich crops. They grow wood instead.



Lines of constant ratios of rainfall to evaporation from free water surface (times 100) give pattern to the fertility in the soils. Corn Belt soils are similar in this respect to those farther west under less leaching. Southeastern, eastern, and northeastern soils are highly leached and low in mineral fertility supplies. Map according to Professor Transeau, Columbus, Ohio.

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They require considerable fertilizing to grow even the simple carbohydrates like sugar and like cellulose in cotton fiber. So much of the fertilizer is washed out to require fertilizer for every crop following.

The soils, then, in the western states are still rich in unweathered minerals. Their clay is well stocked with nutrients. They have a high producing power for proteins. In the eastern states the soils are highly weathered with the clays in the soils of the cooler regions quite different from those in the tropical soils. This climatic pattern that makes the soils from the rocks determines, then, what nutrient elements the soils contain. Thereby it determines also how well those soils will feed our crops, our animals, and ourselves.

Plant species and chemical composition of any plants are determined by the fertility of the soil.

In accordance with the long-held belief that only the weather controls the kind of virgin plants in any locality, we have been scouring the world and making transplants from everywhere to everywhere with little regard for the soil fertility required to nourish the shifted crops. When alfalfa grows dominantly in Colorado soils; when sugar cane grows abundantly in Louisiana; and when the rubber tree quickly takes over in Brazil; are these merely matters of differences in temperature or rainfall with no dependence on the soil? Can plants be successfully shifted merely by keeping them properly heated and moistened?

Alfalfa is a protein-bearing, mineral-containing forage of especially high lime content. It demands large supplies of mobile nutrients from the soil. It grows well where lower amounts of rainfall have not depleted the lime and other fertility elements from the surface soil. When planted on soils in regions of higher rainfall, it demands lime and other soil treatments for its successful growth.

Cotton delivers mainly carbon products in its fibers, only seeds, and shrub-like form. It demands less fertile soils than alfalfa. Lime helps cotton but is not an absolute requisite to grow it. Cotton responds more to fertilizing it with potassium,

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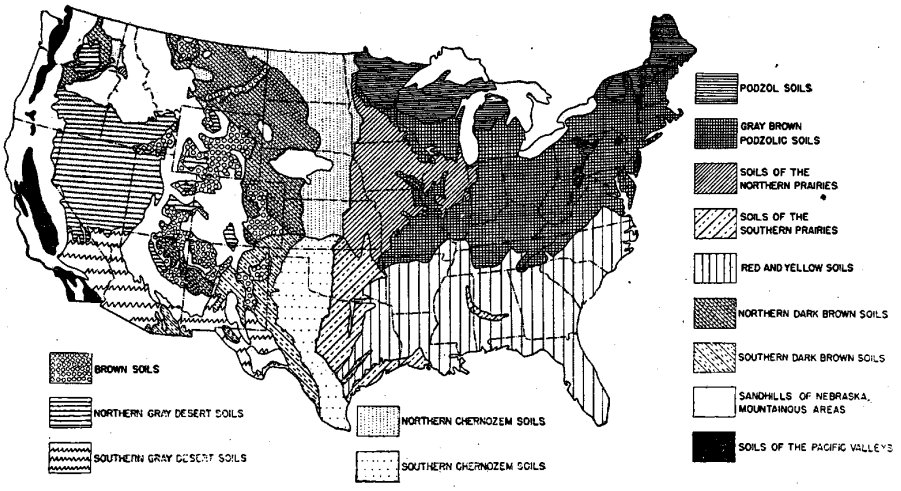
the nutrient which encourages carbohydrate production in plants more than protein production which is encouraged by calcium. Cotton is not a forage feed for livestock, then, because the products it manufactures under its soil limitations are not necessarily feed.

The rubber tree is another carbon—or wood—delivering crop. Its product, rubber, is neither edible nor digestible. Like other forest trees, it uses much less fertility than alfalfa for growth and each annual supply of that is dropped back to the soil almost wholly in its leaf crop. Through decomposition, this fertility supply in the leaves completes the cycle as it rotates from the soil up into the tree to the leaves and from the fallen and decomposed leaves back to the soil again. While making this cycle it does little more than make wood. Even that product consists mainly of air and water elaborated by sunshine into compounds of fuel value only for flames and not for the physiology of animals and folks.



Climatic and vegetational soil groups in the U. S. according to Marbut 1935. The soil map shows itself a composite of the maps of rainfall and the ratios of rainfall to evaporation. The soils divide us into an East and a West. They divide the East into a North and a South.

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An Oklahoma farm that does not pay its owner and cannot produce healthful food for others. "The chemical composition of our food suggests that it takes its pattern for the country from the pattern of the fertility of the soil by which it is created."

Fertility pattern of soils gives pattern of food composition

Perhaps you have never thought much about the variation in chemical composition of the food crops in the various parts of the country according to the climatic soil pattern. It is true that we have different plant species, alfalfa, cotton, and rubber on different levels of soil fertility. More significant, however, is the great fact that the same kind of crop has different chemical compositions on these different soils. The plant's pedigree is no control of this. So when Nature has washed out a soil by pouring excessive rainfall on it, or when we have taken out its fertility by crop removal and no fertility return, there is a change in the chemical composition in such common crops like corn or wheat, for example. Unfortunately, that change is not in the carbohydrate part so much where it would register as recognizable change in bulk. Rather such change consists of the reduction in the protein and mineral contents,

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the smaller and unrecognized, but very significant fraction of the crop. Plants keep right on making carbohydrates as fuel and fattening foods for us in less fertile soils. But they do less in converting those carbohydrates into proteins and mineral compounds that help grow bodies and help in their reproduction.

The protein concentration in wheat, often spoken of as its "hardness," illustrates this fact very well. On Missouri soils under her 40 or more inches of annual rainfall to make them badly leached and acid, wheat does well to have as much as ten per cent protein. Going westward across Kansas, according to data of 1940, the protein in the wheat there went up from the above figure in eastern Kansas to one as high as eighteen per cent in the western part. Putting extra fertility into the Missouri soils at the proper times made equally as high a protein wheat there, according to experimental trials.

While some one may believe that the dry weather of western Kansas makes wheat "hard," the dry year of 1936 in Missouri did not push the protein in the latter state's wheat crop up to where it was a competitor with the former state's "hard" wheat. Rainfall as seasonal water is not in control directly of the concentration of protein in the wheat. Rather it controls indirectly through the fertility it has left in, or removed from, the soils in the course of developing them from the rocks during centuries past.

This variation in the chemical composition of wheat is a part of the soil fertility pattern. High protein accompanies the starch or carbohydrate farther west. On coming eastward there is still plenty of starch as indicated by the high yields as bushels per acre, but there is a decrease in the protein. On the lime-laden, nitrogen-providing soils this grain crop makes carbohydrates and converts a good share of them into protein by the help of this extra soil fertility. On the less fertile, commonly called "acid" soils under the higher rainfall of the temperate zone, the crops make carbohydrates as the bushels per acre measure it. But they do not produce much protein.

Consequently then in feeding our animals we are faced with the problem of purchasing the protein supplements. These

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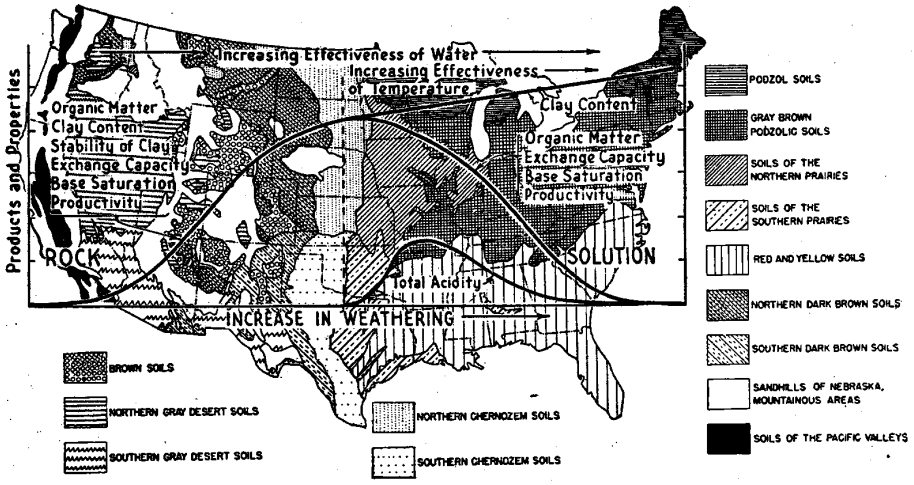
must be grown, and brought from soils somewhere. These once consisted of the by-products of the wheat milling business that also has gone west. Along with the problem of feeding the animals on such soils comes the fact that human foods are not so mineral-rich when the nutrients from the soil required by the plants to synthesize their proteins are not there.

Any plant can deliver carbohydrates, but only fertile soils give us complete proteins

Any plant that grows is making carbohydrates by that process. These are built from air and water by sunshine energy. The plants that make proteins need the fertility from the soil to help make these complexes which the animals can only collect from the plants, but can not synthesize themselves. Carbohydrates pile up readily as bulk to give big yields as tons and bushels. But when plants are converting this sunshine product into proteins, they do not pile up such yields so rapidly. Our selection of a crop merely for big bulk as yields has brought



The pattern of soil development of the U. S. shows the maximum of soil construction in the Mid-Continental area. It is there that the maximum of protein and inorganic nutrient delivery by crops is possible as good feed and food. Carbohydrate crops are more prominent on less construction of soil to the West and on more destruction of the soil to the East.

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Health records of children from soil-depleted areas tell their own story. The cavities and fillings of teeth required among persons from such areas are markedly higher than other sections. This family is from a countryside in which the soil has been "mined" and not replenished.

into prominence those crops that are mainly producers of carbohydrates. It encourages the "soft" wheats and the low protein corn. It has encouraged production of the fattening foods and less of those for body-building and fecund reproduction.

The pattern of the chemical composition of feeds and foods reflects the pattern of soil fertility beneath and in control of it. Less weathered soils in the Midwest grow alfalfa, high protein wheat, beef cattle and sheep. Those same soils were growing big crops of protein when they had thundering herds of bison on their short grass. The more weathered soils in the east central and eastern states grow carbohydrate crops and fattening power as we recognize readily in corn and hogs. Such soils pile up the crop bulk, but they give us the problems of protein supplements and the troubles in animal reproduction.

In the quality of our foods we must recognize the soil and its fertility in control. By the traverse from the more fertile

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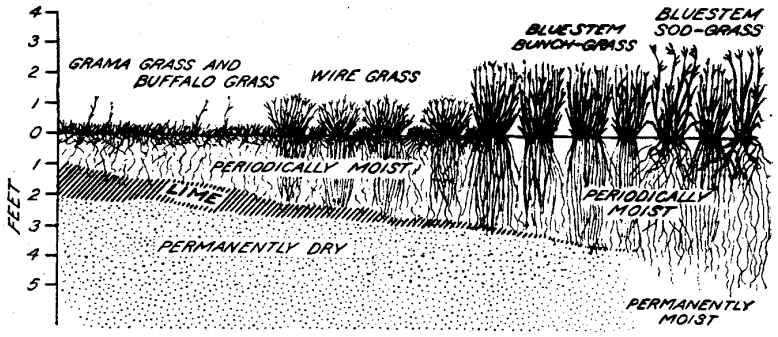
soils in the West to the less fertile in the East there is the change from both carbohydrates and proteins to mainly carbohydrates. When less fertility means more carbohydrates and less proteins we can understand that the depletion of the soil is responsible for the decline in the protein of corn from 9.5 to 8.5 per cent during the last ten years of higher yields and much-mentioned hybrid vigor. The chemical composition of our food suggests that it takes its pattern for the country from the pattern of the fertility of the soil by which it is created.

In giving the food pattern the soil fertility also gives the national health pattern

Because we have given so little thought to health and so much more to disease, the national health pattern has not very generally called itself to our attention. We have been slow to believe that the pattern of variable health is a reflection of the variable nutritional values of our foods that go in good measure with the variations in the fertility of the soil. That we should grow cattle in the West and fatten them in the East has not been considered a pattern of animal health even by some of the folks of the experiment stations. They have been prone to consider this a matter controlled by economics. Likewise some folks have been content to believe that the same economics, rather than the exhaustion of the soil fertility, is



Kansas with its 17 inches of rainfall in the west increasing to 37 inches in the east had different virgin grasses because of the different soils. Diagram by H. L. Shantz.

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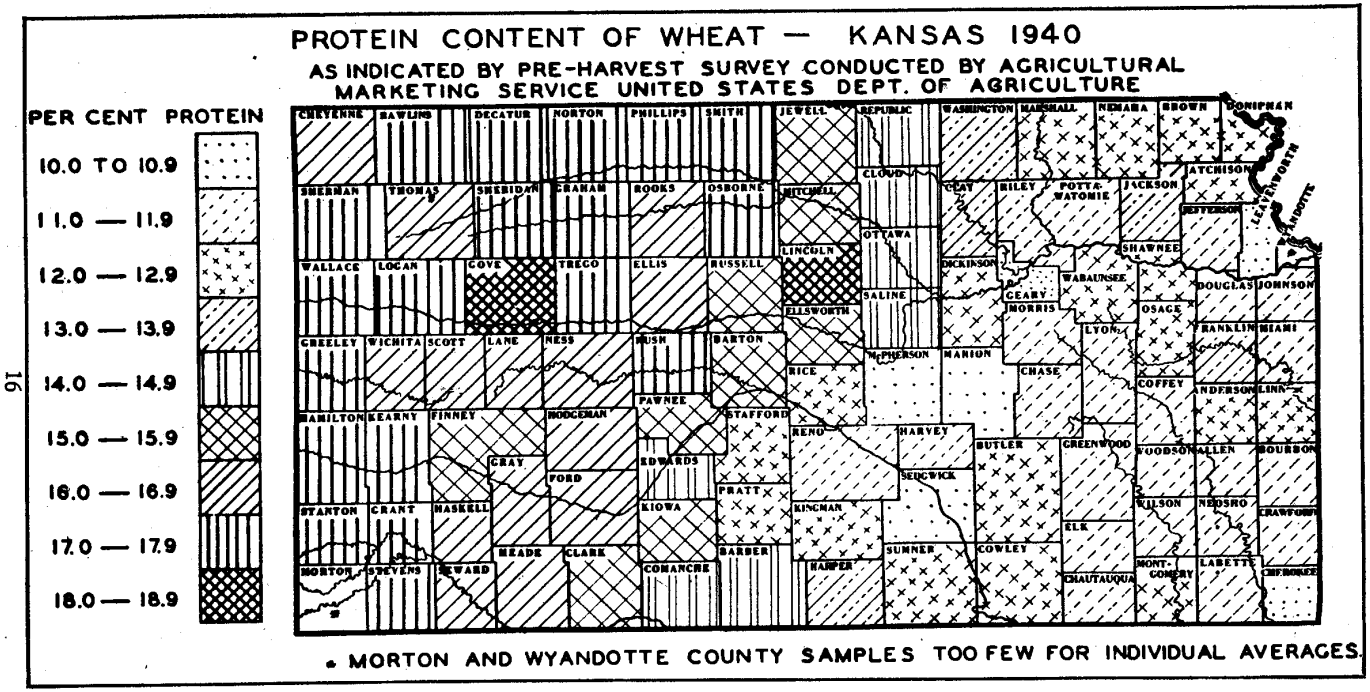

The protein, or "hardness," of wheat increases from 10% in eastern Kansas to 18% in western Kansas more because of the soil than because of the seasonally less rainfall.

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responsible for the westward march of high-protein wheat from the Geneseo River Valley in New York—where big milling works were originally set up—across the continent as far west as Kansas to date. While economics are connected—more as a result than a cause—with such changes, one needs only to look deeper and consider the question, "What controls the economics?"

Certainly if one can grow only fattening feeds it will be more economical for the farmer, but healthier for the animals, to use them to hang fat on the animals grown near to adulthood somewhere else than to face the odds of trying to breed and raise them with no better nutritional help than such feeds bolstered by imported protein supplements, mineral mixtures and drug concoctions. When our dairy calf crops in eastern United States are less than sixty per cent of the cows bred; and when in Missouri, for example, we get to market less than sixty per cent of the pigs the brood sows deliver as their litters; there is the suggestion that some significant economics are coming into play. Unfortunately, such is bad economics. There is the further suggestion that a nine month period of gestation by the cow and the life span of but six months of the porker are even too extended a period for us to carry successfully our responsibilities as animal feeders. These bad economics seemingly are crowding the marketing dates for our livestock closer and closer to their birthdays. Instead of attributing these troubles to disease and calling for more veterinarians it looks as if we need to see the health pattern of our animals and of ourselves in relation to the map of soil fertility as it makes the map of crop composition, especially the proteins and minerals.

Better teeth go along with better soils

Maps of the variable health of our folks need to be made as a means of relating health to the soil and helping agricultural production serve in giving better food for better health. Health records of the draftees for the Army are numerous for areas as small as a county. There is no shortage of data that might well be studied on a national scale to give helpful information. Data for the condition of the teeth of nearly

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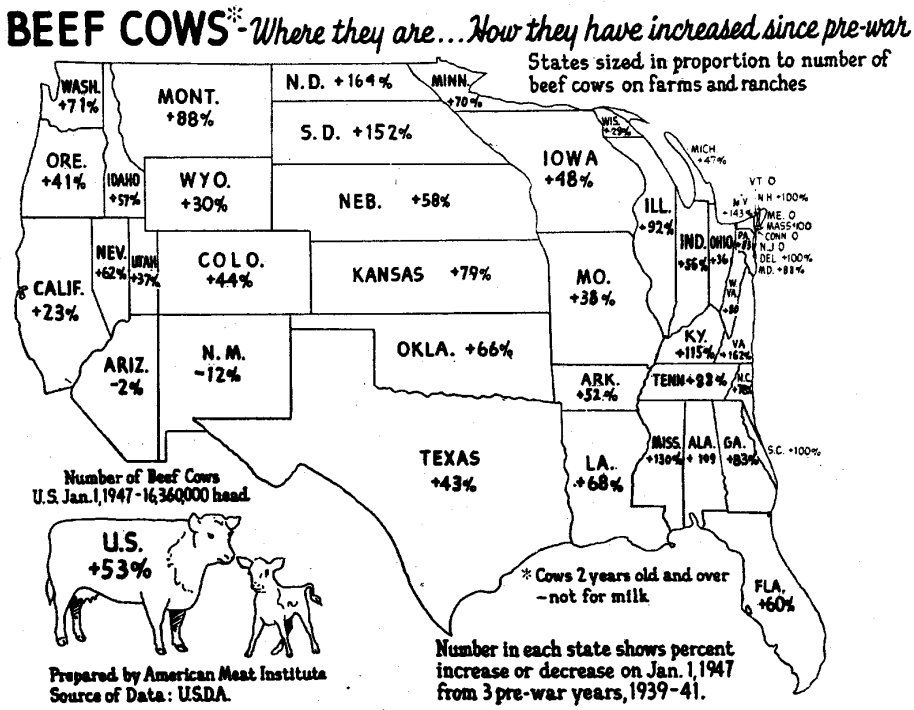

The western states produce proteinaceous mineral-rich forages to make animals with protein rather than fat as their choice food quality for us. Courtesy American Meat Institute.

70,000 inductees into the Navy in 1942 are a good illustration of what such records tell us about our soils and ourselves in terms of dental health.

The Navy reported its records of the number of cavities and fillings per mouth gathered as a means of estimating the number of dentists needed to keep the masticating section of the Navy in a good state of repair. These data were assembled for the different sections of our country. When arranged by longitudinal belts two states wide and considering these in going both westward and eastward from the Mississippi River, this map of dental health of our young men reflects the soil fertility pattern clearly.

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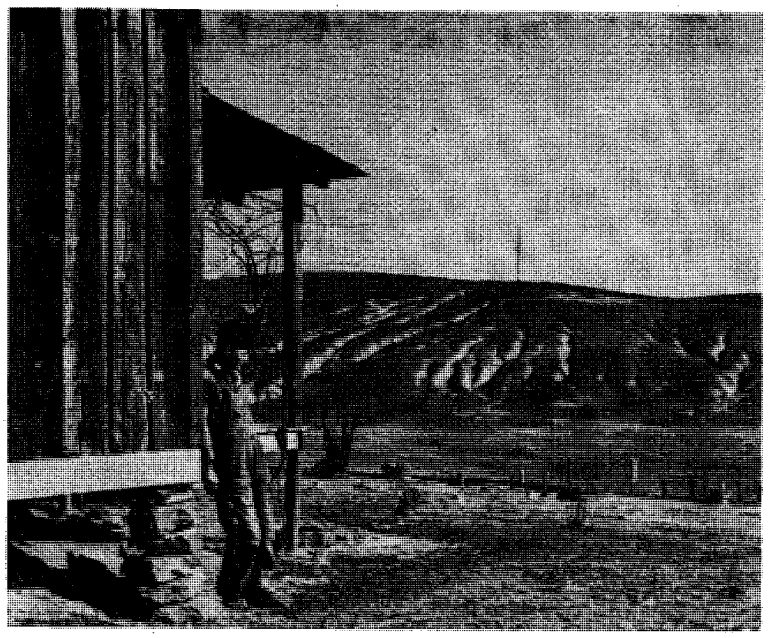
For the area two states wide adjoining the Mississippi River on the west each Navy inductee had, as an average, 8.38 cavities, 3.70 fillings, or a total of 12.08 caries in his mouth. Farther west by two states, each mouth reported 8.80 cavities, 4.30 fillings, and 13.10 caries. For the west coastal states the corresponding figures were 9.10, 6.40 and 15.50, respectively. Thus, in going from the midcontinent westward the numbers of cavities and fillings of the teeth per inductee mounted by more than 25 per cent as poorer health.

Much more serious are the implications concerning the health of the teeth, according to these data, in going from the midcontinent eastward. For the belt of two states wide just east of the Mississippi River there were 10.06 cavities, 4.89 fillings, or 14.95 total caries. Much worse are the conditions for



Human health goes with the soil and its fertility. Courtesy F. S. A. Scene from Wadesboro, N. C. Photo by Post.

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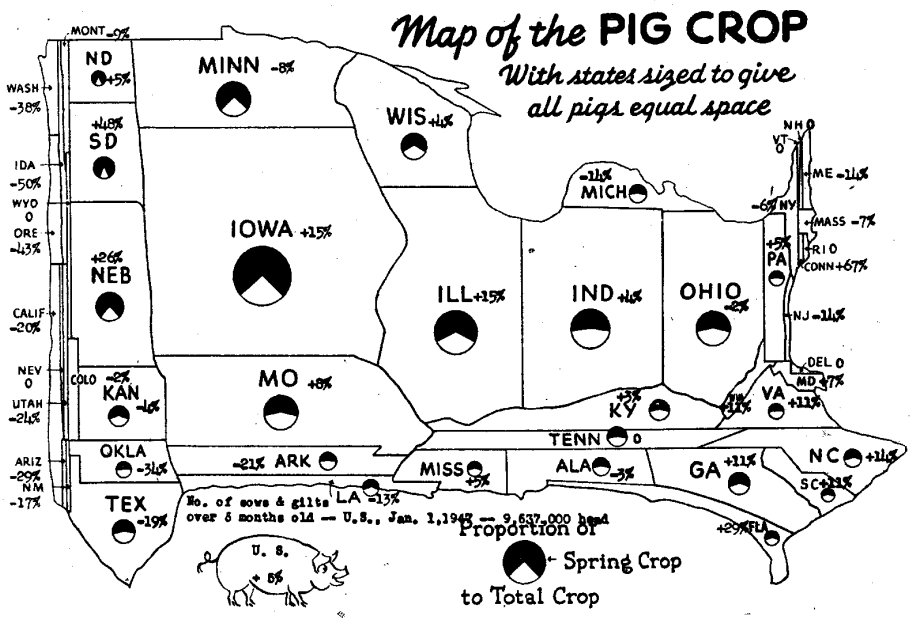
the Altantic belt of states where the records give 11.45 cavities, 6.10 fillings, and 17.55 total caries.

While we have none too good a health condition of our teeth even in the midcontinent with its soils of maximum protein-producing power in the better fertility supply, the teeth are poorer as one goes westward to the less developed soils, and much poorer in going eastward to those excessively developed and less fertile. Only the soils more fertile in terms of making more protein in plants give better health of the teeth.

The healthy man of the future must be created from a fertile "handful of dust"

When we make more health maps of our country in terms of other body parts and functions, very probably we shall

The eastern states produce carbohydrates to make animals with fat more than lean as protein. Courtesy American Meat Institute.



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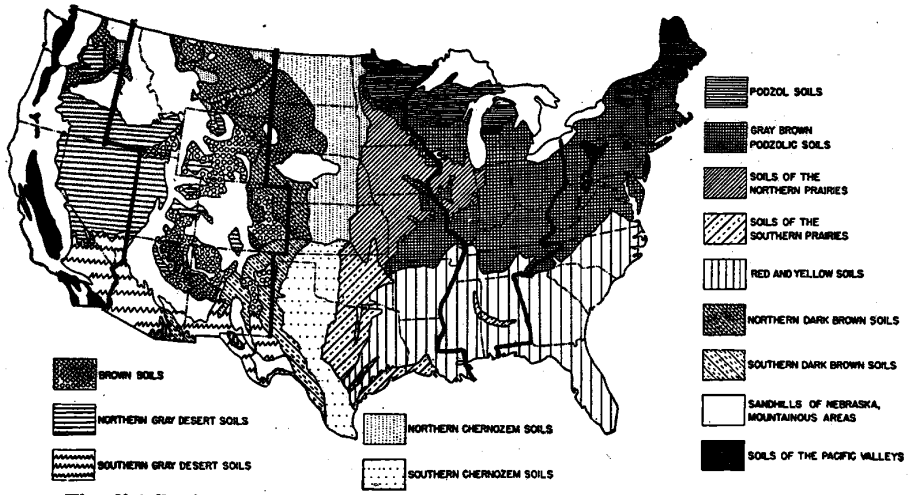
9.10	8.80	8.38	10.06	11.45	Cavities
6.40	4.30	3.70	4.89	6.10	Fillings
15.50	13.10	12.08	14.95	17.55	Total Caries



The distribution of dental caries according to data from the Navy inductees is a reciprocal curve of that for soil development (Fig. IV). Maximum soil construction in the Mid-Continental area gives minimum of dental caries. Either less soil construction to the West, or more soil destruction to the East give more caries.

find the same suggested relations between their health and the soil as is indicated for our teeth. Since the teeth are an exposed part of the skeleton, shall we not expect a map of our "creaking bones" to point back to the map of the soils' contents of lime and phosphate of which bones consist almost completely? Since we can build no better bodies than is permitted by the quality of the foods we eat; and since the agricultural business of food creation can scarcely put the quality of its products higher than is allowed by the fertility of the handful of dust into which the warm moist breath of air, rainfall and sunshine is blown; is it a fantastic stretch of the imagination of any one who tills the soil to believe in the close relation between our soils, our foods, and ourselves? The growing science of the soil is reminding us more and more that already two thousand years ago they were emphasizing the importance of a handful of dust in the creation of man.

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This picture is typical of large parts of entire counties. Proteins and minerals are lacking in proper amounts in plants produced from such soil. Human erosion and soil erosion go hand in hand.

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