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Form 1187  
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"GROW" FOODS OR ONLY "GO" FOODS,  
ACCORDING TO THE SOIL\*

WM. A. ALBRECHT

*Soils Department, College of Agriculture, University of Missouri, Columbia*

That the soil and its *internal supplies of essential plant nutrients* should be involved in this sudden appearance of the problem of a food shortage may seem far-fetched. This internal situation of the soil has not been a change as an explosive disaster. It has been coming on gradually. Absorbed in reshuffling economic and social situations involving peoples and votes, the fertility of the soil as the foundation of agricultural production was being exported or lost to the rivers and the sea, without our notice or appreciation of it.

Hidden away as many of us may heedlessly believe ourselves to be in the midst of our extensive continent, we have been content with its liberal stores of fertility; not so much of it in the soils of the East, but more in the deposits of glacial drifts as ground and well-mixed rock materials to provide plant nutrients generously in the central states; and then still more in the chernozems or the fertile black prairie soils along the shelter belt where bisons once roamed but where now wheat and Hereford cattle thrive. We have had little occasion to believe that the soil and its capacity to provide mineral-rich "grow" foods rather than only the woody "go" foods are of profound significance in the present world war. We are coming, in an international way, to appreciate the truth of the Russian proverb which says "An empty stomach knows no laws."

FOODS GET THEIR "GROW" VALUES FROM THE SOIL AND  
THEIR "GO" VALUES FROM AIR, WATER, AND SUNSHINE

The soil is the ultimate foundation of all life. It supplies the basic dozen (possibly more) chemical elements that are the nutrients coming from there as ash. The soil contributes these to serve in our vegetation as the means of fabricating the carbon

\* Delivered at the Central Association of Science and Mathematics Teachers, Chicago, November 26, 1943.

Reprinted from

*School Science and Mathematics*

January, 1944

TABLE 1. CHEMICAL ANALYSIS OF THE HUMAN BODY IN COMPARISON WITH THAT OF PLANTS AND OF SOILS

Origin or Source	Essential Elements	Human Body %	Vegetation % Dry Matter	Soil % Dry Matter
Air and Water	Oxygen	66.0	42.9	47.3
	Carbon	17.5	44.3	.19
	Hydrogen	10.2*	6.1*	.22*
	Nitrogen	2.4*	1.62*	—
		96.1%	94.92%	
Soil	Calcium	1.6*	.62*	0.3† 3.47*
	Phosphorus	.9*	.56*	0.0075 .12*
	Potassium	.4†	1.68†	0.03 2.46†
	Sodium	.3	.43	—
	Chlorine	.3	.22	.06
	Sulfur	.2	.37	.12
	Magnesium	.05	.38	2.24
	Iron	.00‡	.04	4.50
	Iodine		Trace	
	Fluorene		Trace	.10
	Silicon	Trace	0-3.00	27.74
Manganese		Trace	.08	
Body Compounds	Water	65	—	
	Protein	15	10	
	Carbohydrates	—	82	
	Fats	14	3	
	Salts	5	5	
	Other	1		

\* These are involved in the plant and animal struggles to find enough to meet the high concentrations needed.

† Amounts common as the more available forms in the soil in contrast to the total, most of which is but slowly available.

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and nitrogen of the air and the hydrogen and oxygen of rain-water into what we call plant growth. Using this vegetation as food, the animals and man fabricate these soil-given and air-borne nutrients into their particular body compounds of still greater complexities serving for the growth and energy of our own lives. The dozen chemical elements coming strictly from the soil are the construction units, the building stones of plants, animals, and man. Though, as minerals or ash they constitute only 5 per cent of the weight while the air-borne carbon, hydrogen, oxygen, and nitrogen, constitute 95 per cent of plant and animal bulk, nevertheless, the soil-given nutrients wield the hand of control in spite of our tendency to visualize the air-

contributed elements as more important because of the larger mass they represent.

Accordingly as the contribution of these dozen nutrient elements is made liberally or stingingly, so it is that the soil and our treatment of it determine whether our foods are truly "grow" foods of service in healthful body construction, or whether they are only "go" goods with the more disappointing fuel values. We must build ourselves "from the ground up" in the fullest sense of the word.

Plants are widely different in their chemical composition. These differences occur according to the differences in what the soil offers in nutrients from which the plant can construct itself. Plant species, then, reflect the fertility of the soil in their larger values either as "grow" foods under liberal fertility supplies, or mainly as "go" goods of limited nutritional values under limited fertility given by the soil.

We have mistaken cause and effect in relating the soils to the crops. The prairie grasses do not make the particular prairie soils, nor do forest trees make forest soils. Rather, it is the particular fertility level within the soils that determines whether mineral-rich proteinaceous prairie grasses will grow to support the bisons formerly and the Herefords lately, or whether only the forest trees with their few turkeys the Pilgrim Fathers found in New England and the carbonaceous or cellulosic sugarcane and cotton crops of the South of today. Differences in the soil mean differences in the kind of crop and in the chemical composition as these crops fit into the fertility which the soil provides.

THE SOIL FERTILITY RATHER THAN THE PLANT'S PEDIGREE  
DETERMINES THE CHEMICAL COMPOSITION AND  
NUTRITIVE VALUE OF THE CROP

As the fertility in any soil is ample or deficient so any single crop on it is different in its chemical composition, regardless of the plant's pedigree. We have been prone to believe that the pedigree determines what the crop can do even to the fertility in the clay, or in the rock fragments, of the soil. Under this belief we have been paying our attention mainly to the crops. We have moved them from place to place and apparently believed that they will fulfill our desires regardless of the soil fertility differences. We are now beginning to realize that the soil and its chemical offerings are in control of the crop, and that the plant and its pedigree are no greater factors in plant growth than is the nourishment the soil gives.

Our animals, their health and rates of reproduction have reflected this disposition on our part to look to the crop and to disregard the soil. We have been unable to grow our animals to greater maturity. We have been marketing them younger. We have been changing our breed types and searching for other breed types as the exhaustion of the fertility of our soil has been going on without our heed of it.

#### DIFFERENCES IN FERTILITY ARE REFLECTED IN ANIMAL AND HUMAN AILMENTS

Increasing animal "diseases" have likewise been telling us that the store of fertility in our soil is declining. New kinds of "diseases," for which the physiological bases are still unknown, are on the increase. Eye troubles, acetonemia, rickets, milk fever in cattle, and pregnancy diseases in sheep are illustrations of what has been coming into prominence as animal manifestations labelled "disease," when very probably such ought to be traced back to a deficient nutrition coming by way of declining soil fertility.



Human health goes with the soil and its fertility. Declining soil fertility reduces the "grow" foods and encourages "go" foods. (Scene from Wadesboro, N.C. Courtesy F.S.A. Photo by Post.)

Certainly our national health picture as it is coming into clearer view from the data collected in assembling our armed forces will give us a clear conviction that our health is determined according to the soil. This view should likewise bring into focus the international picture as it rests on the different soils.

Regardless of the multiplicity of colors that may be involved, the picture should have but a single caption as a forceful reminder of what has been said in part before, namely, our national health, as well as "our national wealth, lies in our soils."

Alfreda F. Rooke

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It may seem paradoxical that food should suddenly come to public and critical attention, when only recently we were plowing under surpluses of it. It is all the more disturbing to many when we have led ourselves to believe American agriculture one of the most efficient, and American economics of distribution by means of steel and rubber one of the most unique of our services. Our high standard of living, and the indulgences of our desires and appetites have made us connoisseurs of good food. We have been connoisseurs, particularly, of fine qualities of food products, and of the more delicate and artistic touches of foods on an international scope. Now that we are suddenly confronted with the problem of feeding from our own crops the large share of our population under arms at a reasonably high standard of food excellence, and of sharing generously with other nations according to our customs as hosts, the sudden food shortage is more than a passing disturbance. Even wheat bids fair to disappear as a surplus bogey. Food is now a problem of its provision and not one of plowing it under.

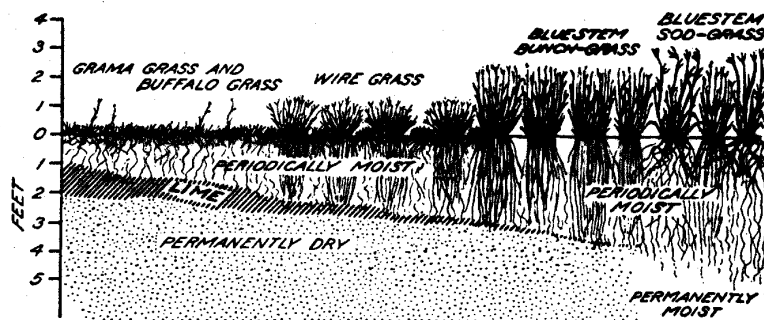
DECLINING SOILS MOVE US SEAWARD IN OUR FOOD HABITS

That the soil and its *internal supplies of essential plant nutrients* should be involved in this sudden appearance of the problem of a food shortage may seem far-fetched. This internal situation of the soil has not been a change as an explosive disaster. It has been coming on gradually. Absorbed in reshuffling economic and social situations involving peoples and votes, the fertility of the soil as the foundation of agricultural production was being exported or lost to the rivers and the sea, without our notice or appreciation of it. Other nations have been brought much earlier to lower standards of living through shortages of fertility and food, because their soils have been depleted. Such nations have pushed larger shares of their peoples nearer to the sea, and now live more by means of seafood into which their soil fertility has gone. The increasing depletion of the soil makes the

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nations eaters of seafood, not by choice but under compulsion. We ourselves are now concerned about two seas—possibly not wholly in terms of food from them but of food for men on them and across them.

Hidden away as many of us may heedlessly believe ourselves to be in the midst of our extensive continent, we have been content with its liberal stores of fertility; not so much of it in the soils of the East, but more in the deposits of glacial drifts as ground and well-mixed rock materials to provide plant nutrients generously in the central states; and then still more in the chernozems or the fertile black prairie soils along the shelter belt



Natural vegetation varies in kind and tonnage. Wild animals (buffalo) select it for nutritional value more than for bulk as the different prairie grasses across Kansas from the West (17 inches rainfall) to the East (37 inches rainfall) clearly indicate. The nutritional value depends on the soil as made by the rainfall more than on the rainfall directly. (According to Shantz)

where bisons once roamed but where now wheat and Hereford cattle thrive. We have had little occasion to believe that the soil and its capacity to provide mineral-rich "grow" foods rather than only the woody "go" foods are of profound significance in the present world war. We are coming, in an international way, to appreciate the truth of the Russian proverb which says "An empty stomach knows no laws."

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and nitrogen of the air and the hydrogen and oxygen of rain-water into what we call plant growth. Using this vegetation as food, the animals and man fabricate these soil-given and air-borne nutrients into their particular body compounds of still greater complexities serving for the growth and energy of our own lives. The dozen chemical elements coming strictly from the soil are the construction units, the building stones of plants, animals, and man. Though, as minerals or ash they constitute only 5 per cent of the weight while the air-borne carbon, hydrogen, oxygen, and nitrogen, constitute 95 per cent of plant and animal bulk, nevertheless, the soil-given nutrients wield the hand of control in spite of our tendency to visualize the air-



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Accordingly as the contribution of these dozen nutrient elements is made liberally or stingingly, so it is that the soil and our treatment of it determine whether our foods are truly "grow" foods of service in healthful body construction, or whether they are only "go" goods with the more disappointing fuel values. It is the above-ground activity by plants that represents bulk and fuel values of our foods. It is the soil-fertility-providing activities of the internal chemical reactions of the soil coupled with the energy collection through sunshine above-ground that make our foods truly "grow" foods for healthy body building. We must build ourselves "from the ground up" in the fullest sense of the word.

VARIABLE SUPPLIES, AND SHORTAGES, OF NUTRIENTS  
IN THE SOIL MODIFY THE PLANT FLORA AND THE  
QUALITY OF EACH SPECIES IN IT

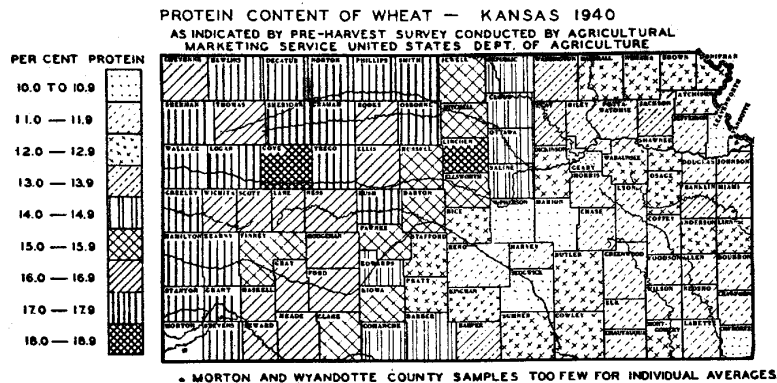
When the responsibility of contributing these dozen elements depends on the soil, and when these contributions represent only the very minutest amounts, we begin to realize that variabilities in the supplies and deficits of the different elements may occur in the soil. It is because of these variabilities and omissions in the soil's offerings of fertility that different kinds of crops occur on different soils. Plants, whether natural, domesticated or otherwise, are different in kind and quality as we go from place to place. We have been prone to believe that the weather, namely rainfall and temperature, determine whether a certain plant grows in one place or another. We have scarcely believed that the plants, like ourselves, are much more responsive to what foods they get, than to how warm or how wet they are.

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It is true that climate is the force that makes the soil by acting upon the rock. But this does not mean that the same climate always makes a soil with the same fertility content. Differences in the original rocks worked upon by climate also help to make

different soils. Prairie soils are made under lesser rainfall. They are soils that are less leached of their lime, or calcium, and of the whole list of plant nutrients among which calcium is the most prominent. Forest soils are produced under higher rainfall and warmer climate that deplete the soils of much that is still left in what we call the prairie soils.

We have mistaken cause and effect in relating the soils to the crops. The prairie grasses do not make the particular prairie soils, nor do forest trees make forest soils. Rather, it is the particular fertility level within the soils that determines whether mineral-rich proteinaceous prairie grasses will grow to support the bisons formerly and the Herefords lately, or whether only the forest trees with their few turkeys the Pilgrim Fathers found in New England and the carbonaceous or cellulosic sugar-



Protein concentration of wheat decreases from western Kansas to eastern Kansas and reflects the difference in composition of a single crop according to the soil as was reflected by the original prairie vegetation. (USDA Crop Reporting Service)

cane and cotton crops of the South of today. Differences in the soil mean differences in the kind of crop and in the chemical composition as these crops fit into the fertility which the soil provides.

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Under the erroneous faith that plants are plants "for all that" and that plants are food "for all that," we have indulged in an extensive crop substituting or crop juggling. When alfalfa has failed we have believed that red clover could substitute. When red clover fails we substitute sweet clover. When this fails we go to soybeans and when they fail we go to lespedeza. This has been the series down which we have come with reference to the legumes, for example, in Missouri.

We have likewise been indulging in crop juggling with reference to the grains and the grasses. The tons of produce from plants have been taken as a measure of crop value instead of the nutrient offerings revealed by our inspection of the composition of the crop and therefore its real food value, as the significant measure. Our animals, their health and rates of reproduction have reflected this disposition on our part to look to the crop and to disregard the soil. We have been unable to grow our animals to greater maturity. We have been marketing them younger. We have been changing our breed types and searching for other breed types as the exhaustion of the fertility of our soil has been going on without our heed of it.

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The figures dealing with our own draftee rejections in assembling men for the national service may help us understand this problem of the soil as a factor in making for better or for poorer foods, and consequently in making for better or for poorer health according to the soils concerned. When only three men out of ten are rejected in Colorado while seven out of ten are rejected in a southern state, according to a report by Mr. Rowntree, can we not look to our soils as they are less depleted in the lower rainfall of Colorado and more highly depleted of their nutrients in the South as having causal connection with this draftee situation? Is it not possible that we may be talking about "disease" and calling it a case needing "cure" when we ought to be talking about "malnutrition" and "starvation" as cases for their "prevention" through soil treatments?

We as higher animals, along with those lower in the scale, are finding ourselves pushed into this picture of soil fertility. Unfortunately, the picture is unfolding itself more in terms of *deficient* than of *efficient* living and health. Higher standards of living encourage more freedom in the choice of our foods. Choice of more sugars seems to be a freedom that is highly exercised, when in the United States we are correctly characterized as the "sugar eaters," since over a hundred pounds of sugar were consumed per person per annum in pre-rationing times. We have shoved up our "energy" foods or our "go" foods to an unbalanced proportion. To make matters more unbalanced, our soil fertility has been slipping away to reduce the "growth" values and the mineral values in many foods commonly credited with these services in nutrition. This shift in our thinking about ourselves has brought a similarly changed attitude toward our animals. They are compelled now to do more on roughage. Through crop juggling and declining soil fertility our roughage feeds have come to have fuel value mainly and too little of growth value. They too are mainly carbon consumers, when grown on deficient fertility of the soil.

#### NEWER KNOWLEDGE WILL SHIFT CONCERN ABOUT WEATHER TO CONCERN ABOUT SOIL FERTILITY

We have moved in this direction, namely going toward the fuel values and away from the growth values, because we have been thinking about farming the weather and the climate in place of thinking about farming the soil. We have been giving emphasis to moisture as the main criterion of crop production.



example, from the desert as the annual rainfall increases to about 30 inches. In the pattern of the climate of the United States, the 97th meridian represents approximately the line of 30 inches of rainfall. As the rainfall goes above 30 inches, and as the temperature rises, the climatic forces bring on processes of soil destruction. East of the 97th meridian the higher rainfalls and temperatures represent soil destruction. West of this line the rainfall represents soil construction. It is east of this line that we find our forest soils. It is west of this line under the influences of lower rainfall—and to some distance east of the line where there is higher evaporation as in part of the cornbelt—that we find our prairie soils.

The prairie regions amongst the forests in Alabama and Mississippi, and again in Texas seem to be misplaced, according to this reasoning. Prairie soils of the black soil belt in Alabama are there because of the high lime content of the soils even though this is in a high rainfall region. The high lime content was retained because of the high lime in the materials originally serving as parent material of the soil. These lime-rich soils of Alabama and of Texas make prairie vegetation today in spite of the high rainfall and the forest vegetation surrounding it.

#### CROPS ARE "GROW" FOODS OR "GO" FOODS ACCORDING TO CLIMATIC SOIL GROUPS GROWING THEM

When we take the distribution of crops that grow naturally or readily across the United States we find particularly nutritious grasses and alfalfa as common crops in Kansas. We speak of the alfalfa crop as a "growth" food, and prescribe it for young animals and for production of milk, the natural food for growing animals. We find corn, one of the grasses, common in Iowa and Illinois, the two states on the eastern limit of our prairie soils. As we go south from these states, there is cotton, but this is on soils that were originally forests. In the tropics there is rubber, another forest crop where the rainfall is still higher and the heat more intense.

In this transition from the west to the southeast and across this array of crops, we pass through a definite series of chemical compositions of the crops at the same time. If the pattern of the chemical composition of the crops should be superimposed on the soil fertility pattern, the crops would reflect the soil's delivery of the nutrients according to the more recent concepts of this in relation to soil development in different climates. In

this transition across the states one goes from the "grow" foods of the West on the high soil fertility to the "go" foods of the Southeast and the low fertility of the soils.

SOIL TREATMENTS SERVE AS A SHIFT IN  
THE SOIL'S GEOGRAPHIC LOCATION

It does not follow, necessarily, that one must go far and wide to cover soil differences sufficient to bring this shift in nutritional values of the crop. Such shifts have been occurring in a single soil and in a single place in consequence of time, of intensive crop removal, and of neglect to return fertility to the soil. This shift has taken place most rapidly as the soils were initially less fertile in organic matter and in nutrient reserve minerals of the silt and sand fractions.

The rapid exhaustion of the calcium supply in our soils is familiar, as you remind yourself of the prevalence of red clover not so long ago where liming was later necessary to get this crop, and where today clover will not grow. The prevalence of the liming practice testifies that our cropping under disregard of the soil and its exhaustion is equivalent to moving our soils farther east into higher rainfall or the territory of the "go" foods, while liming is a partial attempt to hold them in, and push them westward toward the territory of the "grow" foods. Other nutrient elements, such as nitrogen and phosphorus, put into the soils are also helps by which the soil is magically pushed into regions of greater nutritive services to man and beast by way of more nutritious vegetation.

EXHAUSTED SOILS OF CENTRAL EUROPE VERSUS  
FERTILE SOILS OF OTHER COUNTRIES AS  
AN INTERNATIONAL PROBLEM

Our increasing and more intimate acquaintance with the Old World is bringing us to realize its exhausted soil condition and to appreciate our own fertility needs and supplies more thoroughly. Perhaps the present international disaster will take many of us away from home far enough to give us a more comprehensive view and a better perspective of our soils. That view, even after some extensive war period, will still carry a bigger welcome in post-war than any foreign soil view, as was true for the returning Yank soldier in 1918, who addressed the Statue of Liberty in these words, "I salute you, dear Lady, but if I ever do it again, you'll have to turn around." Perhaps in viewing

critically our post-war situation, the fertility of our soil will get its proper appreciation—prompted by rationing experiences at home as well as army deprivations abroad—to reshape our sense of values of it.

Soil conservation has just begun. Its evolution to date has brought it from building dams as cures to crop cover and proper soil management as prevention for running water and soil erosion. It is moving rapidly toward consideration of the internal condition of the soil, namely its fertility that grows the cover, encourages water infiltration, overcomes droughts, fills our wells and makes the lands bloom with foods for a healthy nation.



Human health goes with the soil and its fertility. Declining soil fertility reduces the "grow" foods and encourages "go" foods. (Scene from Wadesboro, N.C. Courtesy F.S.A. Photo by Post.)

You and I are probably going to be pushed much closer to the soil than will be done by our first "Victory Garden." We shall doubtlessly become better "Friends of the Land" in a deeper sense than one simply invoked by a backyard hobby. We shall soon realize that our soil fertility, like our scrap iron, has too long been exported. We need to begin now to cherish jealously the glaciated area of the central United States, and the "Midlands" of the United States or the belt of chernozem soils extending from Minnesota to Texas. We need to appreciate the



soil more, as well as to recognize erosion. Erosion has been hauling away the very body of the soil because we first extracted the fertility to weaken the body in its production of self-cover. That weakened soil body is reflecting itself now in weakened human bodies so that a "Town without a toothache" is startling news with headlines in place of a normal expectancy. Good health is such an anomaly that even the doctor doesn't know what his patient should be like when he finishes with him.

While we have moved to the "go" foods and speeded up our lives to burn them out in many ways, we have also burned out the fertility of our soil, that will be needed so much more in the near future. In rearranging the world's economic conditions, certainly the problem of food will not be considered as only a matter of tariffs, prices, and politics, but rather a matter of greater service in sustaining life that depends on the fertility of the soil. The map of the world can be properly remade only on the basis of its soil on which the nourishment and final contentment of peoples rest.

Certainly our national health picture as it is coming into clearer view from the data collected in assembling our armed forces will give us a clear conviction that our health is determined according to the soil. This view should likewise bring into focus the international picture as it rests on the different soils. We hope there will be some artistic mind on the final settlement committee which will correctly interpret what can be seen in terms of the fertility of the different soils. Regardless of the multiplicity of colors that may be involved, the picture should have but a single caption as a forceful reminder of what has been said in part before, namely, our national health, as well as "our national wealth, lies in our soils."