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The Soil as a Farm Commodity or a Factory*

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IT WAS ONLY a few hundred years ago when the nomadic pastoral existence of peoples shifted to a stationary agriculture and brought with it territorial claims in the name of the individual who tills the soil. That period gave us land ownership with full land and mineral rights, and complete freedom as to land use. It gave birth to the commodity concept of the land, with privilege of barter or sale of the land area in question.

Viewing the soil as if it were a common agricultural commodity that we might sell, or save, we have brought ourselves face to face with the need for its conservation, not only in territorial area and body mass, but in terms of the producing capacity inherent in its chemical composition as plant producing value.

Now that land has been bartered and traded for years, not only its space dimensions have been carefully and legally defined, but its productivity is undergoing refined definition. Under that attention land has become soil, as a distinct object of study and classification. Values formerly unknown are being attached to it and magnified. Emphasis on these values of the soil is doing much to move land out of the commodity picture or concept, and, as in older countries, to take it off the list of items for simple exchange and sale. We shall be moving rapidly toward a higher appreciation of the soil as it represents our future security and less and less as it is to be considered a commodity.

When carefully examined for its services and functions, the soil plays a dual role. In the first place it is a stock of raw materials. In the second place, it is a factory. As the former, it must contain and retain in stable form against loss by weathering, those items necessary for annual plant growths over an extended time period. As the latter, it must convert the more resistant plant nutrient elements into such forms are are taken by the plants and at such rates as will produce significant plant bulk for an economical crop. We can therefore not view the soil as if it were so many pounds of a commodity to be sold like we sell butter, beef, or grains at so much a pound. Rather the soil is the locality where under sunshine power, the contribution of but 5-10 per cent of mineral or ash materials by the soil starts their assemblage with the other 95 to 90 per cent as

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inflow of air and water to give us that mystical performance we call crop growth, or agricultural production, and the greatest creation of wealth for human good. Considering the matter from that viewpoint no one would deny the need for soil conservation. Who would destroy the very tool of the earth by which the sun and the skies may be brought to clothe her and to feed and shelter her people?

Because of a limited understanding of the functions of the soil, we have not had a clear concept of handling it even as a commodity. We have not known, or reminded ourselves, what part of it is plant nutrient, much less how much of each nutrient supply we are selling annually. We have not translated our stock of goods on the shelves in the soil store into monetary units which can be added or substracted, or can take in part an inventory. Each deal, or sale, has not made the fertility cash register ring up the removals so as to give us totals at the end of the day or year. We have not translated soil organic matter, phosphorus content, calcium deficiency, or soil acidity, into units of human effort and deeper concern, by which values are most permanently fixed and appreciations most effectively generated in our minds. Given to us by nature for the grabbing (still the method of territorial procurement by many nations), we are yet to develop the appreciation for them, and seemingly only after their exhaustion.

As a partial help toward understanding the soil's contribution to plant growth and the mangitude of the performances involved in making a crop, let us first turn to a picture of the composition of vegetation in general for the soil's part in it. The soil contributes but 50 pounds per 1,000 pounds dry matter. But unless these are delivered promptly, the remaining 950 pounds will not be captured from the air and water, and the sunshine power will remain unused.

Conservation of the soil in the fullest sense does not call for the hoarding of the plant nutrients in the soil, but for their wisest use with fullest preservation within the soil. Using more familiar cropping systems, or specific rather than general vegetation as given, we may well examine our business of selling the soil to learn how long we can continue marketing it as a commodity. Much better, let us try to learn how we can run it as a factory without selling off annually much of its essential equipment.

Commercial fertilizers have come to give us a monetary value of plant nutrient items. It will be helpful to determine what the annual cash register report would be, should it ring up the fertility removal in terms of the respective nutrients, at fertilizer prices for their return. It may bring appreciation of the fact that the annual fertility turnover is an unrecognized "big business." In that turnover there are hidden some secret costs and some bookkeeping that is deceptive to degrees more challenging than many accounts submitted to congressional investigating committees.

As a simple case, let us assume a two hundred acre farm on virgin Marshall silt loam divided into five 40-acre units, bearing, corn, oats, wheat, clover, and grass.

With a subsoil laden with storage water and with liberal yields per acre, no larger than 50 bushels of corn, 35 bushels of oats, 20 bushels of wheat, 2 tons of clover hay, and 1½ tons of grass hay equivalent, a five year round on an acre would remove the following in the rotation annually and with the following monetary values.

	Five Year Total pounds	Annual Pounds	Value
Nitrogen	191	38.2	$3.82
Phosphorus	43.5	8.7	1.30
Potassium	187.6	37.5	1.87
Calcium	106.3	21.2	0.02
Magnesium	39.7	7.9	1.12
Sulfur	9.5	1.9	0.02
Iron	6.3	1.2	—
Sodium	5.2	1.0	—
Silicon	106.0	21.2	—

Annual total value per acre $8.15.

Perhaps it will be no mistake if we disregard the values of the iron which is required in such small amounts as contrasted to the supply in the soil; or if we assign no value and no detriment to the sodium and the silicon, respectively, both considered non-essential for plant growth. Before dismissing the significance of sodium too light-heartedly, however, it may be well to remind ourselves that it was only about one hundred years ago that the sodium and chlorine delivery by crops dropped to the low level that made agricultural discussion common then as to whether it would be good practice to feed animals ordinary salt or sodium chloride. Then too, our declining soil fertility is reflecting an increasing share of the plant ash as silicon as we go from the vegetation on the more productive soils to those less productive, or as we go from the better legumes of higher feeding value through the plant series to non-legumes and lower nutritional significance.

The significant item in the table is the high value of the fertility taken from the soil annually, given as the figure, $8.15 per acre. Have you ever imagined that on a two hundred acre farm the fertility equivalent of $1,630 is taken out of the soil annually? We do not appreciate the possibility for economic and soil fertility leaks that this unrecognized capital turnover involves. In this capital turnover and its leaks, there are well smothered most of the economic disturbances for which the numerous remedies in the form of changing gold standards and other panaceas are so freely offered in our thinking which stays at no small distance above the surface of the soil. This $8.15 an acre represents an annual production of 3,824 pounds of organic output at the cost of 200 pounds of the soil commodity. One pound of the soil is expended per 19 pounds of produce grown. In terms of the fertilizer prices for the soil expended, the organic matter produce is costing more than 20 cents per hundred weight.

Have we granted that every ton of produce coming from the field is liquidating $4.00 per acre of the assets we initially purchased in the form

of a farm? Have we thought that a rent of $4.00 per acre would cover only one-half of the fertility coming out of the soil? Who has been willing to grant that in our economic arrangements we have failed to charge against the produce going off the land this cost to replace to the soil the removed fertility, even if we handle our soil only as a commodity? We have been selling our soil without appreciating its cost, and then find ourselves at a loss to understand our economic troubles. We haven't even understood the material we are selling as a commodity.

Should we view the soil more as a factory and less as a commodity, we would return more of the stuffs taken from the soil store and would market more of that portion of the produce captured from air and water. Let us examine the idea of passing the vegetative produce through the animal machine to learn how much the animal will carry away and how much can be returned to the soil.

The working or fattening animal excretes, as an average, 85 per cent of the fertility ingested. Then if the $1,630 worth of fertility capital all goes through such animals they would excrete $1,385. Should they be milking or growing animals, a 65 per cent recovery would excrete but $1,060 of fertility that might go back to the soil. Even with animal use of much from the soil and with no manure loss, one must still be prepared to write off an annual inventory loss of soil fertility on this farm amounting to $245 and $570 annually in these two cases.

Such figures take into account no loss of the fertility in the manure before getting it back to the land and are only the losses going off "on the hoof." Additional losses must still be proportionate to the difficulty or the carelessness in manure handling or getting its fertility back to that part of the farm where crops can use it again. Should this manure loss be held to the minimum of about 25 per cent, then this would permit the animal fattener to return $1,222 or 65 per cent, and the dairy farmer $795 or 50 per cent, of the $1,630 of the rotating fertility capital. Should they permit one-third loss of the manure, which still represents good manure management, then $923 and $706 or approximately 45 per cent and 55 per cent, respectively, of the fertility capital are taken away from the soil.

Should any grain or forage be sold rather than be fed, then by just these percentages of that item's fertility content would the rotating capital suffer additional loss, and the soil be that much more nearly in the commodity sale category rather than in that of the factory.

It might seem that fruit farming, where so much of the bulk of output is water, should be more conservative of soil fertility. Let us take an apple orchard of larger tree size with 30 trees per acre, forty feet apart. In terms of only the three major plant nutrients, the total, annual rotating fertility capital would be represented by $2.74 per acre. This, for the apple grower, is much less than the $8.15, which was the amount for the general farmer. But again the loss is 55 per cent of this amount. Though smaller in the absolute, it still represents a loss of more than one-half of the offerings by the soil.

For the peach grower with smaller trees, at 100 per acre, the balance sheet would show a total annual rotating capital of $1,306 per acre. In his case the removal is greater in absolute than for the apple grower, or for the general farmer and again 45 per cent of the rotating capital goes off the soil.

Thus fruit farming in apples is lower, and in peaches higher in rotating capital annually per acre. The fruit farming does not lessen the responsibility to the soil, only perchance as the seasonal risk is greater and the fruit farmer does not so nearly duplicate the figures annually.

It is conceivable that there may be methods of producing farm products of such nature, and of marketing the parts of such chemical composition so that little more than carbon, hydrogen, and oxygen originating in the air and water is moved off the farm. Should only butter go off for example, it would sell no soil fertility save that in the casein and in solution in the water in the butter. Sugar cane juice is seemingly mainly carbohydrate, but yet even it carries fertility along with the sugar in solution, reflecting in the juice the fertility of the soil growing it.

Escape from the problem of returning fertility is not an easy one. It may be more simple to accept the fact that most any system of farming brings with it the responsibility of knowing how much fertility is leaking out of the rotating supply and how much must be regularly restored.

Should we take the simple calculation that about 50 per cent of the rotating fertility is being removed annually, it is still necessary to recognize how this is related to the entire stock in the soil. Using Marshall silt loam with 3,800 pounds nitrogen per acre in virgin surface soil producing the crops previously listed with yields not above 50 bushels of corn or other crop equivalents, with the loss—not covered by clover return—amounting to 19.1 pounds per acre per year, this would be just one-half of one per cent of the original supply. Using phorphorus at 1,200 pounds in the virgin soil with only 33⅓ per cent loss, or 2.9 pounds annually, this is more than one-fifth of one per cent of the total. Should these annual rates of loss continue, then the Marshall silt loam would be exhausted of its nitrogen store in 200 years. Using the soil as a commodity it would be "sold out" in that time.

More complicated calculations are needed to express the declining curve accurately, but yet these results are sufficient to bring us to the conviction that our soils can not be taken as commodities—and still serve as the basis of a permanent agriculture. If our farming is to be permanent and profitable, our soil must be a factory to which we bring regularly or restore promptly the calcium, phosphorus, nitrogen, and other fertility elements escaping from the stock of rotating capital, and in which we maintain these at high operating level. We cannot have permanent agriculture that sells out its soil as a commodity, nor can a national economy of permanence be built on an agriculture operating blindly on such a policy toward its soil.