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THE CONSERVATION OF OUR LAND RESOURCES[1]

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OUR domestic empire has grown with the spread of land occupation. In historical perspective it was yesterday when a few venturesome spirits struggled to maintain a foothold on a fringe of land stretching from Virginia to Massachusetts. In terms of to-day we are trustees of 3,000,000 square miles of land on the North American Continent. A little of this land has been occupied for about 300 years. Most of it has been occupied for less than 100 years; and many millions of acres of present-day farm land had not been touched by the plow fifty or even thirty years ago. Human currents have eddied and moved forward, to the West, the Northwest and the Southwest. The conquest of the wilderness and the building of homes represent one page of our national record. The opposite page tells another story; one of land exploitation, soil wastage, agricultural decadence in many places and of people wandering back and forth. Now we are in a mood of contemplation and of looking into the future.

[1] Address of the vice-president and chairman of the section for agriculture, American Association for the Advancement of Science, St. Louis, 1935.

WHAT HAS HAPPENED TO OUR LAND?

Let us consider a very few statistical facts. We have not much less than 2,000,000,000 acres of land surface in the Continental United States. Half of this land is in farms, and a quarter of it is so-called crop land. When the first white settlers came to North America there were about a billion acres of virgin forests within our present national boundaries. Most of these forests have disappeared. They were cut down, burned over and converted into crop acres and pastures. Most of the forest clearing and burning was inevitable. There was no other way for the building of a great nation. But there has been a terrible wastage of timber, of soil and of human effort. We

now realize that in the building of 6,500,000 farm homes we have changed our agricultural geography too much and too often. We have condoned excessive land abandonment, soil depletion and ghost farms, just as we have condoned ghost lumber camps and ghost mining towns. We have paid the price in gullying, in sheet erosion, in soil leaching, in the irrational destruction of soil organic matter. But even this does not tell the whole story. Witness the destructive floods, the silting in of streams and reservoirs, the formation of fans and deltas and the raising of dikes and levees that can not always withstand the rush of mighty floods. Yes, we have sinned against our land and are stirring uneasily as we think of the future.

The Land and Its People

The future of our land will reflect the future of our nation. Lest we take this too lightly, let us consider some facts, some of them in the far reaches of human experience, some of them at our very door. As in the remote past, so in this day, food and clothing and in large measure shelter have as their basis the raw materials of the soil and the air. The air and the sun we shall leave, for man can not do much to change their ways. But as to the land, consider the nomads of Asia and of Eastern Europe. Consider countless generations of men and animals grazing, feeding, building flesh and bones, concentrating in their bodies the calcium and phosphorus of the soil. Consider overgrazing; clouds of dust moving somewhere century after century; the rush of flood-waters growing more intense as the plant cover was eaten and burned off. Consider rocks as the bones of the land and soil as its flesh. Think of hillsides laid bare; of bad lands; of great streams meandering over alluvial plains, carrying a vast burden of silt and clay and withal a great load of dissolved matter. Think of silt deposits in offshore waters, of lowlands and dikes and of the puny efforts of man to reclaim land from the sea as partial compensation for the tribute which he had paid to wind and water uncontrolled.

Ancient peoples lost their land as they lost their soils. There is the oft-repeated story of denuded hillsides, terraces undermined and vanished, stream courses clogged and malaria rampant. Rome drew the strength out of its own soils. It reached out farther and farther to regions not yet despoiled, it drove its slaves to exact the utmost from the land. Thus war and slavery, prompted by greed and vainglory, proved a sorry substitute for land conservation and the adjustment of population needs to carrying capacity. Other empires of old traveled the same road and met a similar fate. But despite the facts of history there are nations who still believe that war and economic slavery, imposed on others, are to be preferred to land conservation and the maintaining of a proper balance between population and the carrying capacity of the land.

Factors of Land Conservation

We learned from the census of 1930 that our farm population represented no more than a fourth of our total population. Numerically, it was great enough to supply us with food, fats and fibers, and, beyond that, to export enormous quantities of cotton and of other agricultural commodities. It had not yet reached its maximum production efficiency. Its output per capita was relatively high, its production per acre, relatively low. Many of our farmers lived in communities more or less isolated. There were human islands in the hills and in valleys under-schooled, poorly housed and miserably fed. They struggled with gully and sheet erosion, with chemical depreciation of their soils. Their farms were burdened with debt, their buildings were in disrepair, their crops were growing smaller and their live stock were shrinking in weight and size. Soil conditions were being reflected in social and economic stagnation. Since 1930 there has been a migration landward, a trend toward higher economic returns from the land and a growing consciousness of the nation's responsibility to the land and of its place in a well-ordered commonwealth.

Plans and Programs of Land Use

Let us consider the demands made on land by modern society. In the first place, provision must be made for areas to be given over to crops and pastures. More or less extensive areas must be set aside for forests and others for recreational uses, water storage, residential and industrial sites, roads and other uses incidental to the maintenance of our agricultural, industrial and commercial activities.

Agriculturally speaking, no civilized nation is sufficient unto itself. To a lesser or greater extent, foods, fats, fibers and other agricultural commodities must be imported. In some instances, as we know, the importations are relatively slight; in others they are of substantial proportions. The relation of imports to exports of agricultural commodities must be determined, in each country, by land resources, climate and the political, economic and social organization of the commonwealth. There is ample room for adjustments that, in the long run, will be of benefit to the nation concerned. With economic nationalism in the saddle, the rules of logic are often ignored. None the less, the agricultural use of land, in most countries, is directly or indirectly affected by the price level of staple agricultural products in the world's markets. A greater degree of international cooperation would bring about shifts in the use of land for the production of crops and live stock, as well as of forest prod-

ucts. Our own country will make such adjustments as in our own thinking will strengthen our economic and social structure. For the sake of developing a balanced land-use program, we must consider most earnestly certain of the major facts and implications involved.

SURVEYS, INVENTORIES, CLASSIFICATION

Geodetic, topographic and soil surveys have been in progress in our country for many years. Some of our topographic and geological maps are among the best of their kind. A considerable proportion of our agricultural land has been covered by detailed or reconnaissance surveys. Maps have been made available to us which indicate our soil provinces, soil series and soil types. More recently there have been produced maps showing the great soil regions of the world. We are thus able to establish a fairly adequate inventory of our soil resources from the point of view of texture and crop adaptations. A great volume of additional soil survey work is still to be done. In the same way, we are in possession of many thousands of analyses of representative samples of our important soil types. Here, much additional information is needed. Nevertheless, we already have a basis for establishing an inventory of the physical and chemical resources of our land and soils. When the information on this score becomes more adequate, we shall be in a position to classify our agricultural lands from the point of view of their inherent productive capacity. We shall be able to measure the gains and losses of plant nutrients, and shall have a basis for the rational use of the land for the benefit of agriculture as well as of industry and commerce. Due emphasis should be laid, at this time, on the need of completing our surveys, of carrying farther the preparation of maps, and the speeding up of physical, chemical and biological soil studies as a basis for the most effective use of our land and soil resources.

THE PROTECTION OF OUR LAND AND SOIL RESOURCES

We know that the continents are being gradually planed down. We may designate this process as geological erosion. As measured in human terms, this is a slow process. The rate of soil removal, except on the steeper slopes, is offset or is more than offset by the rate of soil formation. Hence, under an adequate plant cover of forest or grass, the depth of the soil tends to increase; but when arable farming subjects the land to various types of management, soil removal is speeded up, often to a point where the entire top-soil is lost in a relatively short time. The destructive effects of erosion are easily observed in many places in the United States; indeed, in some localities, the landscape is dotted with gullies and abandoned fields. Sheet erosion, while less spectacular, is often no less destructive. Many millions of acres of land have lost their surface soil within a generation. They are occupied, if at all, by people who have been designated as "sub-soil farmers." Obviously then, we must plan and carry out systematic procedures for the protection of our land against gullying and excessive sheet erosion.

Carefully conducted studies on the silt load of our streams indicate the removal of three to five billion tons of fine sediments from the soil surface of the United States. This load, suspended in moving waters, is dropped on the way, and a large proportion of it deposited in tidal waters. There is another type of soil wastage which is not recognized as readily. This has been designated by F. W. Clarke as "chemical denudation," and the mass of dissolved material in our surface waters as the "chemical load." The total volume of calcium, magnesium, sodium, potassium, iron, sulfur, chlorine and of various other ingredients carried annually to the sea is truly enormous. Our soils are gradually being deprived of a portion of their basic elements. Given a period long enough, and protection from erosion adequate enough, soil decomposition may proceed to a point where only the silica skeleton remains. An effective plant cover will protect the land against undue losses resulting from erosion and soil leaching.

There is other damage that is being done to our land. Floods not only increase the silt load of our streams, but often do damage by covering fertile land with a layer of sand and gravel. Fires which occur in our forests, our prairies and peat lands destroy millions of tons of organic matter, and allow the fixed carbon to escape as carbon dioxide. Fires and overgrazing lessen the effectiveness of the plant cover as a soil-conserving agent. Where the land is overgrazed, the surface material is moved, in greater or lesser amount, by air currents. In the course of time, a vast volume of surface material may be removed by the prevailing winds; and good grazing and other agricultural land may thus be seriously damaged.

Over vast areas of our arid and semi-arid region, the improper use of irrigation water has led to the accumulation of soluble salts in the top-soil to a point where the land is no longer productive. Alkali accumulation and increasing salinity are of common occurrence in some of our irrigated areas. In other sections, the rise of the water table has created drainage problems. In still others, the water table has been gradually lowered by pumping so that the underground water resources are no longer sufficient for maintaining a profitable agriculture. We may cite numerous instances where undesirable plants, insects,

microorganisms and animals have increased to a point where they are detrimental to farming, grazing and forestry. In considering plans and programs of land conservation, these and other factors must not be left out of the reckoning.

Rationalization of Production

At any given subsistence level, and with any given dietaries, we can tell what our food requirements may be. For example, a population of one hundred and thirty million people will require, at five bushels per capita, something like six hundred and fifty million bushels of wheat. This is aside from requirements as to seed. Our per capita consumption of wheat, corn, oats, barley, rice, potatoes, etc., may rise or fall. Our prevailing dietaries may be improved upon, but by and large, we are sufficiently well informed to be able to determine what we may need of cereals, vegetables, fruits, dairy products, meats, spices, condiments and what not for maintaining proper food standards. In the same way, we know what we may require of fibers, fats, starches, celluloses, organic acids and other agricultural commodities for direct consumption or processing. We may readily ascertain, therefore, what the land must provide. On the other hand, we have not come to the point of rationalizing production as to place and time. We should set out to determine where our foods and industrial raw materials should be produced. Should the great volume of wheat or corn, or tobacco or cotton, or vegetables and fruits, to say nothing of milk or eggs, be produced in one place or another? From the standpoint of yield levels, production and transportation costs, which should be the favored localities? Again, we have too much agricultural land in use partly because of the relatively low yields per acre, and partly because of the tremendous wastage which occurs on account of weather, insects and microorganisms. What are the economic and social considerations that would justify more or less far-reaching adjustments in yield levels and in the distribution of crop areas with due regard to national as well as local interests?

There are many soil areas of fine physical and chemical quality but containing an insufficient amount of one or another chemical ingredient. Far-flung soil regions of the United States are deficient in phosphorus; there are others deficient in potassium or magnesium or nitrogen or even manganese, boron, zinc, copper, etc. Soil deficiencies are reflected in physiological plant deficiencies, and these, in turn, in animal deficiencies. Animals may become stunted, emaciated and deformed because of the lack of sufficient amounts of essential ingredients for the building of the animal body. Again they may be abnormal because of the presence in the soil of toxic substances. The progress of soil research has already made it possible for us to recognize the nature of soil deficiencies, and to devise more or less effective means for correcting them.

The plant physiologists have shown us how to grow plants to maturity in water or sand culture. Under special conditions, their methods and procedures may be commercialized; but for the production of staple crops and live-stock products, we must depend on soils, as they are subject to modifications by soil management, but always within economic limits. Among the major constituents of soils whose importance we have underestimated is organic matter. It is not enough that a soil contain the essential ingredients for the production of plants. The soil must be able to absorb and store sufficient quantities of water. Their texture and structure should be such as to provide optimum conditions for the vertical and horizontal movement of water and air. A good soil must furnish a source of energy to various microorganisms which are a positive factor in crop production. Soil organic matter is a source of food and energy for microorganisms. Soils may contain an excessive quantity of water. This represents a problem in drainage. Other soils may be undersupplied, and irrigation may be resorted to, if the cost of it is not excessive. We must consider such types of soil and crop management as will lead to the greatest net returns from the land. The organization of production must go hand in hand with the organization of distribution. All told then, the rationalization of production will call for far-reaching adjustments as to the location of the major production areas, yield levels, farm organization and planned and controlled distribution.

Commercial and Part-Time Farming

The tides of migration have risen and fallen between city and country. In absolute terms, our farm population is as great as it ever was; in relative terms, it has been shrinking consistently since the early days of colonization. The growing efficiency of American agriculture released a greater number of people for the building of our cities, of our industries, our commerce and transportation. Production efficiency in agriculture is still growing. Despite the fact that a strong return current had set in in the period of 1930 to 1935, with the resulting addition of millions of people to our farm population, this, presumably, is a temporary phenomenon, even though the adjustments ahead of us will involve the placing of relatively as well as absolutely greater numbers of people on the land. We can vision the gradual development of two types of farming in the United States. One of them may be designated as commercial farming; the other as part-time farming.

Commercial farming will utilize all the expedients of science and technology as well as of business organization and management. These large farms will be held either by corporations or by farmers' cooperatives. They will be so managed as to promote the conservation of the land, the raising of yield levels and the improvement of crop quality. There will be the question of the distribution of population as it may be affected by large-scale farming, on the one hand, and part-time farming, on the other. There will be the question of agricultural commodities as raw materials in manufacturing of, let us say, fuels, plastics, celluloses, organic acids, higher alcohols and what not. Present-day systems of marketing and distribution will undergo far-reaching changes. The interrelations of agriculture, industry and commerce will be more clearly defined. Our taxation systems, certainly land taxation systems, will, of necessity, undergo substantial modifications. Industry will draw an increasingly greater proportion of its employees from families living on small farms and deriving a part of their living from them. We may thus readily vision land-use planning as the touchstone for the redistribution of population and industry; for the rationalization of production; and for the steady rise of earnings and living standards.

Incidental Use of the Land

In planning the use and conservation of our land resources, we shall make provision for playgrounds; for game preserves and wildlife sanctuaries; for fisheries; for storage reservoirs; and for the effective management of areas that would assure us of flood control. Obviously, agriculture, industry and commerce have a stake in this great enterprise. As we develop and maintain our forest resources, we shall almost automatically provide also for playgrounds, wildlife sanctuaries and more effective control of soil erosion, soil leaching and the silting in of streams and reservoirs. It is no less obvious that we are dealing here with a group of local problems that seem to fuse, as we study them, into one great national problem. Time and again, we must return to the conclusion that the conservation of our land resources lies at the bottom of our national security and progress.

Educational Factors

Physical resources are in themselves of slight value. It is only human intelligence and human knowledge that may put value into these resources. Technical information and a sense of moral values are the key which alone can unlock the door of the treasure house. We must know how to make bread out of stones and beautiful landscapes out of raw earth. It is essential that, in dealing with the conservation of our land resources, we do not fail to educate and train our men and women to the point of greatest adequacy and effectiveness. General and vocational training and education, an understanding of economic and social values and such organization of local, state and federal governments as would provide the needed safeguards, the best guidance and the most thoroughgoing coordination of all social efforts are the ideal toward which we should strive. Our strength lies in the soil; our hope, in the land; our salvation, in the upward climb toward the higher peaks of economic and social justice.

THE CONFUSION OF TONGUES[1]

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To this point in this discussion we have invited you to recall something of the broad scope and fine heritage of the zoological sciences; something of the great significance, and also the adequate establishment, of the evolution principle; and something of the inestimable human values which lie in the numerous disclosures of practically all branches of our science within the past 30 or 35 years. Let us now desert the laboratory and make a bit of an excursion. The direction or distance we go doesn't much matter; wherever we turn we shall meet man—whom Shafer calls a fearful compound of grandeur and misery—and we shall encounter schools and laws and tradition, in short, the world for which we and our laboratories exist.

Within the past thirty years in this country the number of anti-science, anti-medical, anti-vivisection and anti-evolution crusades has greatly increased. Before some state legislatures biologists and medical men must each year give valuable time to fighting the annual anti-vivisection bill. In still other states that fight, like the one on the teaching of evolution in public schools, is already lost. A public unfamiliar with the nature and contribution of animal study is the prepared ground for all these "anti" societies; and on such a public counter-arguments are peculiarly inef-

[1] Continuation of the address of the vice-president, Section F (Zoological Sciences), American Association for the Advancement of Science, St. Louis, January 1, 1936.