U. S. DEPARTMENT OF AGRICULTURE.

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Report No. 70.

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EXHAUSTION AND ABANDONMENT OF SOILS.

TESTIMONY

OF

MILTON WHITNEY,

Chief of Division of Soils,

BEFORE

THE INDUSTRIAL COMMISSION.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1901.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF PUBLICATIONS,
Washington, D. C., July 25, 1901.

SIR: By invitation of the United States Industrial Commission, Prof. Milton Whitney, chief of the Division of Soils, appeared before that body on March 12, 1901, as a witness in regard to the causes of the exhaustion and abandonment of soils. Professor Whitney, in his testimony, gives in considerable detail the causes leading to the abandonment of large areas of land in the New England and Southern States particularly, and in the far West incidentally, together with many valuable suggestions for the reclamation of these deteriorated soils. The subject is of considerable general interest, and it is believed that the republication of the testimony, which also embraces statements relating to other matters allied to agriculture, will serve a useful purpose and enable the Department to meet demands for the information therein contained, upon which there is now no available publication. I have the honor, therefore, to recommend the publication of the testimony as Report No. 70 of the Department.

Very respectfully,

GEO. WM. HILL,
Editor.

HON. JAMES WILSON,
Secretary of Agriculture.

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EXHAUSTION AND ABANDONMENT OF SOILS.

INTRODUCTION.

At the meeting of the United States Industrial Commission on March 12, 1901, at Washington, D. C., Mr. Phillips presiding, Prof. Milton Whitney, chief of the Division of Soils, United States Department of Agriculture, was introduced as a witness, and, being first duly sworn, testified as follows:

Q. (By Mr. CLARKE.) Will you please give your name and post-office address, and also state your official position?—A. Milton Whitney, Takoma Park, D. C. I am chief of the Division of Soils, Department of Agriculture.

Q. How long have you been in your present position?—A. About six years.

Q. Had you, before coming to that position, been engaged in studies like those you now pursue?—A. Yes; I have been engaged in the study of soils for the past eighteen years.

Q. In how many States?—A. I began in Connecticut at the Connecticut Experiment Station, and was then in North Carolina as superintendent at the experiment farm; then as professor of agriculture in the University of South Carolina; then as professor of soil physics in the Agricultural College of Maryland.

Q. Of what State are you a native?—A. Maryland.

Q. The commission will be pleased to have you proceed in your own way to describe the character of your work in the Department of Agriculture, and especially as to how you gather the soils and how you make your experiments.—A. My understanding was that the main question which would come up would be the very important subject of the exhaustion of soils and abandonment of lands, particularly with reference to the New England States and the Southern States, and incidentally the abandonment of certain lands in the West; to see if cause or causes could be assigned, and if there were any suggestions for remedial measures.

Q. Proceed, if you please, in your own way, then, to develop that particular subject.—A. It is doubtless well known to the commission that there are large areas of land in the New England States that

have been abandoned; that there are large areas in the Southern States that have also been practically abandoned and given over to waste; furthermore, that there are large areas in the far West which have once been settled and which have since been abandoned or are now held in very low esteem.

CAUSES OF THE ABANDONMENT OF SOILS.

EXHAUSTION.

The cause of the deterioration of the lands in the South has been commonly ascribed to the exhaustion of the soil, and this is the first consideration that I wish to take up. The exhaustion of the soil is due, in my opinion, to changes in the chemical and physical properties of the soil rather than to any actual extraction of plant food.

A soil, to be productive, must render annually, as the crop needs it, a sufficient amount of food material in a form available to the plants. As a matter of fact soil is a difficultly soluble substance, composed mostly of silicates and aluminates, or difficultly soluble compounds of silica, alumina, potash, soda, and lime in various forms. Through atmospheric agencies, largely, these compounds are rendered more or less soluble and more or less readily available to plants.

A fertile soil is one in which the weathering effects come in at such times and to such an extent as to render available to plants a sufficient amount of this plant food. If that weathering does not take place and the food material is not brought into a condition in which it is available to the plants, the land is as poor as though it actually contained no plant food.

I have never in my experience seen a case in which one could say with any degree of certainty or even of probability that exhaustion was due to the actual removal of plant food. It is perfectly safe to say that the condition of the so-called worn-out soils in the South is due, not to an actual extraction of plant food, but to the chemical condition in which it now is, in which it is unavailable to plants, and that the restoration of the fertility of that land must be, not necessarily in the addition of plant food to the soil, but in bringing about such changes in the physical conditions or in the chemical combinations as will encourage that natural weathering of the soil which brings the plant food into a condition in which the plant can get its support.

To emphasize this statement, which may appear at variance with the general ideas concerning the exhaustion of soils, I would call the commission's attention to the many cases in which soils have been cultivated for hundreds and thousands of years. So far as we know, within historic times they have been constantly cultivated, and cultivated in the same crops. We have the case of the soils of India, which tradi-

tions say have been cultivated for two thousand years, under primitive methods, without artificial fertilizing, and which still give fair returns of the common crops of the country. We have the case also in Egypt of lands which have been cultivated since history began and where the soils are as fertile as ever. We have all through the southern countries of Europe, and still later in the countries in the north of Europe, in Holland, in Denmark, in France, in England, records of the continuous and profitable cultivation of soils for five hundred years—away back to the time when history first opens up our knowledge of these countries.

There is one phase, however, that it would be well to dilate upon here, namely, that with our increase in density of population and with the competition that has been going on, we are no longer satisfied with the yields that are naturally obtained from many of our soils, and we have resorted to the practice of fertilization in order to force plants to produce far beyond what the natural fertility of the soil will give.

There are historic experiments that have been going on in England for the past fifty years in which a crop of wheat has been grown continuously without fertilization, and the yield has steadily fallen from what it was at first (I forget the figure) until it now produces about 12 or 13 bushels per acre. For the past twenty years there has been little or no difference in the yield, except slight fluctuations due to seasonal conditions, and it is believed that the yield that is now obtained measures approximately the power of the soil to produce a crop under perfectly natural conditions. It will produce annually, so far as we know, for hundreds of years 12 or 13 bushels per acre.

Q. Are you able to state whether the kernel is as full and well developed now as it was in the earlier conditions?—A. So far as we know, the grain is of the same value, pound for pound, but not being satisfied with a yield of 12 or 13 bushels per acre they have, by the use of fertilizers and manures, increased the yield on adjacent plots to an average of about 30 bushels per acre. In this forcing of the crop they have found that they could economically increase the production from that soil. The first we would call the natural fertility and the second the acquired fertility. One is perfectly justified in recognizing these two characteristics in the production of the soil: What it will naturally produce through a course of years under the natural weathering of the material, and what it can be made to produce by the artificial application of more food material than the plant can secure through the natural weathering. If the natural yield from a soil becomes so low as to make it unprofitable, it may often be necessary to fertilize in order to make the soil productive.

DEVELOPMENT OF NEW AREAS AND NEW INDUSTRIES.

The second cause of the abandonment of soils arises from the development of new areas and new industries. There is no question that the opening up of the western country, the great corn and wheat producing States of the central West, the wheat lands of California and of the Red River Valley of Minnesota and Dakota, has had a great influence upon the agriculture of New England and all our Eastern States and has done much toward bringing about the conditions that are now prevalent. This will be taken up more in detail later.

In the line of the introduction of new industries I would cite the case of tobacco: Before the war tobacco was grown very generally in the State of Maryland, and since the war it has been grown extensively in the southern counties only; but with the introduction of the White Burley tobacco in Ohio and Kentucky—which produces a large yield and which can be produced with profit at a comparatively low price—the tobacco industry in Maryland has been largely given up, and the effect of this change on the farmers of Maryland has been very disastrous, because tobacco has been one of the staple products of that portion of the State.

Another instance that I should cite is the development of the truck industry. Fifteen or twenty years ago the truck industry was in a very flourishing condition in Maryland. Truck was grown very extensively on certain classes of soil which were not adapted to other lines, and there were certain localities in which the people were extremely prosperous. But with the development of transportation facilities, with the opening up of truck areas in the South, in South Carolina and in Florida, and with the production of those early vegetables which could be rushed up to the Northern markets in the winter and early spring, the industry has languished in certain localities to such an extent that it has been given up. That is the cause of the abandonment of farms in certain sections of the Atlantic coast States.

Q. (By Mr. KENNEDY.) Are you going to discuss the question of irrigation—whether it will have a still further effect to cause abandonment of poorer lands?—A. I will speak later of the West, but I will bring this in at this time, though I was going to speak of that particularly in connection with the New England States.

Q. You had better take your own order probably.—A. I will be glad to answer any particular question as we go along, though.

ATTEMPTS TO GROW CROPS UNSUITED TO PARTICULAR SOILS.

Another very important contributing cause to the abandonment of lands has been in the unfortunate ventures that have been made in bringing a people from a distance to settle a region with which they are unfamiliar, and to grow crops with which they are themselves

acquainted in the localities from which they come, but which they have no appreciation of as adapted to the localities into which they are going. The Department of Agriculture is constantly in receipt of requests for information as to where certain settlements of people could be made—people who are to be brought in to grow alfalfa, to grow stock, to grow tobacco, or other crops. And very frequently the utmost ignorance is shown as to the localities which are to be selected and as to the conditions into which they are going.

There have been many instances of failure from these causes alone in the States of Maryland, Virginia, Pennsylvania, and in fact throughout the country.

One instance I would speak of particularly that has come to my personal attention is a settlement in one of the Western States. A large area of land was taken up and put under irrigation. Agents were sent from this country abroad to attract immigration. People were brought from Switzerland, from France, from Germany, and an extensive plan of development was outlined. They were to introduce the European grapes; they were to introduce and develop the sugar-beet industry; they were to take up all kinds of fruits that had been successful in their own districts; they were to grow truck crops, and they were to develop large grain and cattle interests. But the plans completely failed, as their soils and their water and their climate were not fit for the industries that they started. After a most disastrous and expensive experience they have lost their crops; they have found that fruit will not grow; that the grape is not suited to the conditions there. They have lost their money, and they have come to a realization of the fact that the country and the conditions are adapted simply to grazing; that if they grow alfalfa and stock they can do well, but they can not do well with their fruits and with their sugar beets, because the conditions there are not adapted to those crops.

Q. Would you state what the location is?—A. It is an area in New Mexico that I am referring to. It is an experience in the Pecos Valley. The principal reason for the failure in that case is due to the condition of the irrigation water. It is very alkaline, which these people did not know when they went into that region. Their failure was also due to their unfamiliarity with the conditions in that locality, and their attempt to grow something that they had grown in Switzerland or in Holland under conditions which were entirely different. In this arid region, where they have to use water to produce any crop, the only available water has been found to be unfit at times for irrigation. This is a cause of the abandonment of large areas of land, not only in New Mexico but in other portions of the West.

UNFAVORABLE CLIMATIC CONDITIONS.

Another contributing cause of the abandonment of lands has been in the selection of localities in which there are unfavorable climatic conditions. The commission is doubtless aware of the conditions in Kansas and in portions of Nebraska and of Colorado—how, during the boom times of fifteen or twenty years ago the country was settled, towns were established, and farms were obtained with the idea that fortunes could be made on the agricultural products of the country. Cotton mills were put up out in the semiarid regions, and are still standing as monuments to the unfortunate schemes and ventures that were devised.

Q. (By Mr. CLARKE.) Could you state what the cause of failure was in that section?—A. Yes; I will come to that.

Q. (By Mr. KENNEDY.) You do not mean cotton mills in Kansas and Nebraska?—A. Yes; there are abandoned cotton mills in Kansas and Nebraska.

Mr. TOMPKINS. There is one at Kearney, I think.

The WITNESS. In explanation of the conditions just stated, it may be observed that the semiarid region of the country extends generally from the one hundredth meridian to the foot of the Rocky Mountains, and embraces in my definition such areas as have from 15 to 20 inches of rainfall per year, but so distributed that only occasionally are the seasonal conditions favorable for crops. When they have a favorable season, or two in succession, as they frequently do, they get fine yields and make good returns, but in three years out of five, when they have their disastrous droughts and get nothing, the profits of the two successful years are entirely used up.

With less than 15 inches of annual rainfall lands are seldom or never successfully cultivated, so far as I know, except in certain areas in Washington and California. With 20 inches of rainfall (that is half what we have in the East), provided it is fairly well distributed, good crops can be grown in the semiarid regions; but it is the uncertainty of the seasons which renders farming unprofitable. It is the uncertain and unequal distribution of the rainfall that has caused so many disasters and has been the reason of the abandonment of so many farms.

It is perhaps one of the most serious problems, that of the semiarid regions, that we have in the agriculture of this country at the present time. In the far West such conditions can be overcome where irrigation is practicable, but so far as known there is no bright future for irrigation in much of the semiarid regions of the country. In Kansas there were in 1889 only 20,000 acres of land under irrigation. In North Dakota, South Dakota, Nebraska, Kansas, and Texas there were only 67,000 acres of land under irrigation in that year, and the possibilities of getting water are small in comparison with the vast areas that would need to be watered to be permanently and safely productive.

Another cause that has contributed to the abandonment of lands in the semiarid regions has been the deterioration of the ranges and the consequent injury to the cattle industry. A division of the Department of Agriculture is actually giving its attention to the investigation of the range problem and the possibilities of conserving and maintaining the ranges, and this being the case, it would hardly be proper for me to discuss this subject at greater length here. It seems to me, however, that it will be necessary and wise to adopt some legislation to protect the ranges in the West, and to prevent the terrible destruction of property which is going on through close grazing, against which there is no restriction in many of the areas of the West. It seems to me that this is a problem for legislation, as it is at present too difficult for the agriculturist to deal with and much of it occurs upon the public domain. Where range lands are rented for 5 cents an acre little expense can be put upon them for improvement. There is little chance at present to make any improvement in the agricultural conditions where land is so cheaply rented, so cheaply purchased, and so carelessly used.

Another example of unfavorable climatic conditions may be cited in the Connecticut Valley, right here in our Eastern States. With a rainfall of about 40 or 50 inches, we have soils that have been abandoned from the same unfavorable climatic conditions—a deficiency of rainfall—as prevail in the semiarid regions of the West. I refer particularly to the Windsor sand, which occasionally produces a very fine crop of tobacco, but the soil is so coarse and leachy that it is only about two years out of five that the conditions are favorable. In the favorable years they get good yields and the farmers are very prosperous and contented; in the other three years out of five, as in the West, the soils dry out and are subject to such disastrous droughts that they are entirely unproductive. The expectation of getting a crop even two years out of five has induced many farmers to hold on until finally there have been successive seasons of failure, and they have had to give up. Under conditions of well-distributed rainfall the soil produces, as does the semiarid land in the West, but it is a desert for three years out of five.

Q. (By Mr. PHILLIPS.) About how extensive is that area?—A. The area in the Connecticut Valley is not large, but along the Atlantic seaboard, in the aggregate, it covers a large area. These coarse, sandy soils are found from the New England States all the way along the Atlantic seaboard and around the Gulf, and many farms have been abandoned on these areas simply because of the unfavorable climatic conditions for these particular soils when other soils surrounding them are favored by the same conditions.

I would cite also another instance to show the effect of unfavorable climatic conditions on the abandonment of soils, namely, the orange

industry in Florida, where they have grown oranges with great success for years and where the industry has flourished in the most promising way until a season of frost and freezes that has thrown back the industry for years and has ruined a large number of people. This is a contributing cause to the abandonment of lands, which can not be overlooked in the consideration of the subject.

SCARCITY OF WATER IN DESERT COUNTRY.

Another cause for the abandonment of lands is found in the scarcity of water in our desert countries. The public lands of the arid States amount to 560,000,000 acres. Only 3,600,000 acres were irrigated in those States in 1889 and only 74,000,000 acres are capable of being irrigated, according to the most careful estimates of the Geological Survey. We have, then, the difference between the possibilities of 74,000,000 acres and the actual extent of 560,000,000 acres, which are used to some extent for grazing lands, and upon which living is, at the most, extremely precarious. Many areas have been abandoned which have once been settled, simply because of the extreme scarcity of water and the impossibility of producing agricultural crops or promoting agricultural interests.

ALKALI AND SEEPAGE WATER.

Another important cause of the abandonment of lands is found in the alkali and seepage waters of the West.

I would call the attention of the commission to some work the Department is doing in Salt Lake County, Utah. This was one of the earliest settlements where irrigation was tried in our modern civilization of this country. When the Mormons first settled the place they naturally took up the richest bottom soils along the Jordan River. The soils were naturally filled with salts, but with the drainage that was started and from the character of the soils themselves the salts were quickly removed and the lands were in splendid condition for agricultural use.

In the further settlement of the country, in the increase in the density of population, as the settlers moved up on the high lands and the water applied at higher elevations, the seepage of water from the canals accumulated in the low places and brought with it the salts, which accumulated to such an extent in the low places that the first lands, the most fertile lands of the valley, were rendered entirely unfit for cultivation. They were wet and swampy, and they were filled with alkali, and the history of this once prosperous community has been that the people are moving up onto the bench land, and are abandoning soils which were once the most productive in the State.

In the area which we surveyed in Salt Lake County, between the Jordan River and the Great Salt Lake, about 50 square miles of land

has been successfully cultivated under irrigation. Of this, 10 square miles, or nearly one-fifth of the whole area, has been ruined and has been abandoned as worthless and useless, and the injury is progressing. Lands are constantly being turned out which have been swamped with seepage waters and which have been filled with alkali.

This is one of the most interesting and most important problems of the West, and one which I should like particularly to bring to the attention of the commission, because it seems to me that something will have to be done, through either State or national legislation, to stop the injury that is going on.

Q. Have you any theory as to how to stop it?—A. I will go on to state that. The conditions may be briefly stated thus: The canal company, whether organized by the farmers or organized with independent capital, constructs a canal and maintains a certain level or uniform grade, going through all kinds of soils which it may be necessary to go through in the construction of its canal. It happens in the Salt Lake Valley, as in many other localities that we have studied, that this canal goes for several miles through a gravelly soil, in which there is a great deal of seepage and loss of water. The water is plentiful and of good quality, so the canal companies are not concerned with the loss. They have a bounteous supply from the Utah lake, and they are getting good water, free from alkali. But the water in seeping out through this gravelly area is slowly filtering through the soil, carrying with it a relatively large quantity of salts, which are in all arid soils, and are concentrating the salts in the lower lands and are filling up the lowlands with water, until, as a matter of fact, there is a string of lakes out in what was once an arid, desert country—artificial lakes on what were later fertile and well-cultivated soils, and which are now abandoned lands and tule swamps.

It seems to me that the farmers situated on those lower levels should have recourse, through civil suits, to damages, and the canal companies maintaining canals under such conditions should either be compelled to protect their canals from seepage or to pay damages to the farmers whose lands are ruined.

These conditions are exceedingly pernicious. If you have a soil under the most careful methods of cultivation, farmed with the most expensive varieties of fruit or other farm products, taking the utmost care, giving the greatest attention to all methods of growth so far as your experience and your skill or the knowledge of your experts will indicate, it is certainly most exasperating to have the land swamped and filled with alkali from a leaking ditch situated perhaps 3 or 4 miles away, and over which you have no possible control. It is an exceedingly pernicious thing, for which some recourse should be had in damages. But, so far as I know, there is nothing to stop it. The lands are going to waste, and one-fifth of the irrigated lands of that district

alone have been abandoned from this cause—a cause which could have been provided against. These lands could have been protected and these farms could have been saved.

Another instance that I would cite in connection with this district is the extensive area that is situated just west of Salt Lake City and extending over to the Great Salt Lake. There is an area of about 90,000 acres, and it comes close up to the Jordan River and extends across to the Salt Lake. The land is filled with alkali, but it is not always apparent on the surface. Frequently the surface looks like a fertile, easily cultivated loam, and many attempts have been made to settle the country. Many farms have been laid out, canals have been constructed, water has been let onto the places, town sites have been located, railroads have been projected and built, and with the first application of water good crops have been produced; with the second, a failure. With the third application the land has become so salty that it is abandoned as a waste and desert land. Thousands of dollars have been invested in the settlement of that tract, and thousands and thousands of dollars have been lost in the fruitless effort to build up an agricultural industry in that area, and this is the cause of the abandonment of these soils—because of the occurrence of alkali not always seen from the surface, but always lying in the lower depths of the soil ready to come up at the first application of water. It will be interesting to state that the result of our soil survey convinced us that it was perfectly feasible to reclaim these lands. There is sufficient fall to put in a drainage system. The soils are naturally easily worked. The expense would be no greater than the drainage of lands in Ohio and Illinois, and the profit that would be realized from the reclamation of the 60,000 acres of land situated on that tract would amount, in our opinion, to about \$3,000,000 in property valuation. Now, a very singular thing has arisen in regard to that section, that while the people seem to realize that drainage may reclaim the lands, yet they seem to be averse to having the drainage work done, and the people who have desired to follow our advice have been unable, in certain cases at any rate, to do so from the objection of their neighbors. There are no drainage laws, as there are in Illinois and others of our Middle States, and the enterprise is stopped right here by the inability to have any recourse to State laws, and by the unwillingness of the people to give access to the drainage canals through their places. This is a matter that I shall refer to later in my remarks upon drainage.

Q. (By Mr. KENNEDY.) Where does the water for irrigation come from—is it mountain drainage?—A. The water is from the mountain streams, fed in this case into Utah Lake, which is a fresh-water lake, and is taken out of the Jordan River.

Q. (By Mr. FARQUHAR.) What is the elevation between the Great Salt Lake and the river?—A. Twelve feet between the level of the

river at Salt Lake City and the lake, but there is a ridge going through the district that gives about 2 feet per mile of fall on either side, and in addition to that there are extensive washes that extend up through the land that would form natural outlets to the drainage system. They run up for 8 or 10 miles into the country.

Q. (By Mr. KENNEDY.) Is the recession of the waters of the Great Salt Lake having any effect on the soils and climate of Utah?—A. It is having a great effect upon the soils. The level of the Great Salt Lake has fallen 14 feet since 1865, and in our survey this year of the area around Ogden we mapped in 60,000 acres—about 10 square miles area—where the lake had receded, and we established the shore line of the lake in some places 9 miles beyond where the former survey had placed it.

Q. (By Mr. PHILLIPS.) What is the cause of the fall of that lake, in your judgment?—A. There is an annual fluctuation that has never been explained, and there are periodical fluctuations that have never been explained. The level has been known to vary from period to period for reasons that are not at present known, but in addition to that the withdrawal of a large amount of water that is being used now for the irrigation of the surrounding lands, which does not go into the lake as formerly, is certainly a very large contributing cause to the lowering of the present surface.

Q. You spoke in regard to canals through the sandy soil portion, saying there ought to be something done to remedy the evil. Have you any theory? Could the water be carried through pipes and thus prevent seeping through the soil?—A. I would state that in California, where water is more valuable, where the companies themselves are financially interested in how much water they sell, it is very common to protect canals from loss by seepage by running through wooden troughs or through wooden pipes, or as is frequently done where the water is carried through sandy areas, by cementing the sides and the bottoms of ditches. We have photographs (I wish I had brought them with me) of large-sized canals and laterals, constructed in California, with the sides and bottoms cemented.

Q. That would be entirely practicable—to prevent seepage and thus prevent the destruction of lands below?—A. It is entirely practicable. In many cases simply the puddling of the canal would be sufficient, but where seepage causes injury by alkaline deposits, in my opinion, it should be stopped, and the companies should be required to protect their canals from undue loss.

FLOODING AND INUNDATION BY STORMS AND TIDES.

Another cause of the abandonment of land is flooding and occasional inundations by storms and tides. The commission, of course, is well aware of the enormous losses from floods in the Mississippi Valley, and

from the recent floods in Texas. This is a matter of such common knowledge that it hardly seems necessary for me to dwell upon it as one of the important causes of the abandonment of soils, where the conditions are so unsafe that settlers can no longer risk their lives or their crops. But I would call your attention also to the vast extent of the tide marshes and inland swamps of the United States. This question of the tide marshes has recently been brought to the attention of the Department of Agriculture from its economic importance in the New England States. It is estimated there are 168,000 acres of tide marshes along the Atlantic and the Gulf coast; and on the Pacific coast it is estimated that there are several million acres of tide marshes. These lands, if protected from the tide and drained, would be of value in agriculture. Some of the inland swamps of Illinois which were selling originally at \$1 to \$5 an acre have a value now from \$60 to \$100 an acre. It is estimated that one-fifth of the area of Michigan is swamp land, which, if drained and reclaimed, would be of great value for celery and corn and potato crops. The tide marshes have also an indirect effect upon the values of adjacent lands, because of the prevalence of disease and the prevalence of mosquitoes. I would not say tide marshes only, but all marshes. The commission, of course, is aware of the commonly accepted views now that malaria is conveyed by mosquitoes, and the Department of Agriculture has been applied to recently from many sources to suggest means of reclaiming the tide marshes and the inland swamps of the United States, partly for their agricultural value and partly for the increase of the healthfulness of the surrounding land. There are many cases where areas and industries have been abandoned from the unhealthfulness of the neighboring marsh lands. I do not know that there is any cause that has contributed so much to the discomfort of many of the Atlantic coast States immediately upon the water, which would otherwise be a delightful location and a fine farming land, as the prevalence of malaria and similar diseases. That these causes have prevented to a large extent the settlement of some of our Southern States and have been the cause of abandonment of some others of our lands is unquestionably true. The prevalence of malaria and these malignant fevers near swamp lands of the South, the unhealthfulness which almost prevents the residence of white persons, is a matter that calls for very great and grave consideration, and it is one that the States, at least, it seems to me, might well consider.

An instance that I would cite as to the effect of inundation and floods as a cause of the abandonment of soils is in the rice lands of South Carolina. These lands before the war were protected by substantial levees that were built through cooperation between the individual and the State and maintained as a protection against the flooding of the fertile swamp lands by floods or by tides. During the period of the

civil war these levees were destroyed, the lands were for a time abandoned, and since that time it has been impossible to get labor to work in the canals, and it has been expensive to construct the levees, and large areas of this once fertile and extremely productive soil have been abandoned from this cause.

Q. (By Mr. CLARKE.) Why has it been impossible to get labor to reclaim this land—on account of unhealthfulness of the climate?—A. On account of unhealthfulness and the unwillingness of labor to work under conditions they have to in the swamp lands. In a way it would seem that machinery could be introduced, dredges; but so far as I know this has not been done on any extensive scale.

Q. Have you given attention to the development of rice growing in southwestern Louisiana?—A. Yes. The conditions there are that these lands, which were semiswamps, have been drained where necessary, and they are not subject to overflow, as the rice lands of South Carolina are. The Louisiana lands are higher, but still they are swamp lands, and the irrigation that is given to these lands is done by pumping or by artesian flow, usually by pumping, whereas the irrigation of the rice lands of South Carolina is from the rivers, and is without any pumping or artificial means, either for irrigation or for drainage.

Q. It is in evidence before the commission that the Louisiana rice region is very healthful.—A. That region is much more healthful than the South Carolina rice lands.

LABOR AND EXPENSE OF MAINTAINING PROPER PHYSICAL CONDITION.

Another cause of the abandonment of lands, at least a contributing cause, is the expense of maintaining the proper physical conditions. The trouble and expense of clearing the stones off the New England fields have been so great and so laborious that they have had something, at least, to do with the abandonment of lands in that locality. The simple expense and labor involved in getting the fields into condition and maintaining them in condition to cultivate in competition with the large areas of the fertile Western plains have been so great that they have unquestionably been a contributing cause to the abandonment of the soils. And the labor and expense and risk in maintaining the proper conditions of the rice lands of South Carolina, which I will refer to again, have been so great that there also these factors have operated against the continuance of the culture of the lands, and have been an insurmountable obstacle to the reclamation of what were once fertile and well-cultivated soils.

TRANSPORTATION CONDITIONS.

I would mention also the effect of transportation facilities. While cheap transportation has opened up new and important markets, it has also been the cause of the development of extensive areas of new and

exceedingly fertile country. The effect of this cause alone in the New England States and in the South has been very great, and will be referred to in a later place.

Another cause has been unquestionably the discrimination in rates and the high freight charges which have prevailed in certain localities. It is not my purpose to go fully into this question, as the commission has had in evidence before questions touching this important subject, but in my experience the commercial value of farm lands is often controlled to a considerable extent by the rates of freight which are locally applicable to these areas. It may be that the lands are situated at such a distance that cheap transportation can not be offered; it may be that there are conditions of expense in the marketing of the products, but certain it is that the possibilities of building up industries, agricultural industries, on certain soils and under certain climatic conditions which in themselves would be favorable is prevented by the impracticability of marketing the products with any profit under the prevailing conditions.

Q. (By Mr. PHILLIPS.) What section of the country is that most applicable to?—A. I would cite, in the case of Florida, the marketing of the bulky and tender products from the truck fields. These products have to be marketed under peculiar conditions. They have to be rushed to the Northern markets on the fast freight or passenger schedule. They have to be provided with proper refrigerating and ventilation cars, and they must be placed upon the market in the shortest possible time in order to be in fresh eatable condition, and to reach the market at the earliest possible date. Now, it is the common experience in Florida that the possibilities of marketing the crop with any profit to the farmer is a pretty close thing to figure on, and that it requires very nice and very close calculation in many cases to determine whether it is possible to send a crop to the Northern markets with any profit. I do not mean to say that there is discrimination, but I do want to show the commission that the possibilities of marketing the crop, the possibilities of transportation, have necessarily something and in many cases much to do with the possibilities of the development of any particular agricultural district, and that that is one of the important factors in the abandonment of many enterprises that have been started—in the abandonment of lands.

Another cause of this same kind which could be cited is in the marketing of the truck crops of southern Maryland. The development of the truck industry there a few years ago was very great, and the product had to be sent by river steamers to the railroad centers, or to the Northern market, and they were picked up by these steamers on their regular runs. The amount of product was large, the distance from the market was great, and the time that was consumed in getting the crop loaded and delivered in the Baltimore or Washington or Phila-

delphia markets became so great, and the transportation service was so irregular, that the industry on large areas has been given up for that one cause, namely, the inability to market the products in the proper way and in the quick time that is made necessary by our present transportation facilities.

Q. (By Mr. CLARKE.) You do not think that the difficulty of getting suitable farm labor for this truck farming was a potent factor in causing the abandonment of it?—A. Decidedly. I shall speak of the condition of labor in the South later on. This is an important contributing cause.

SOCIAL CONDITIONS.

To come now to one of the most important problems—the social conditions and growth in manufactures, and the increase in wages.

New England.—In treating this I shall take up specific cases, first, of the cause of the deterioration and abandonment of lands in New England, about which so much has lately been said. So far as I am aware, there is no evidence to show that the New England soils have any less plant food than they had when first cultivated. That is to say, that so far as the chemical analysis would show, they have all of the essential ingredients for crop production. I do not mean to say, however, that the soils are in as high a state of cultivation as they were, because I do not think that is universally the case; but the exhaustion of soils as it is usually considered has not contributed to any great extent to the present condition of the agricultural lands of New England in the two hundred years in which they have been cultivated. It would be impossible, with the record we have of Eastern countries, to conceive that in two hundred years these soils could be so impoverished by the actual withdrawal of plant food by the crops that have been marketed as to make them markedly deficient in plant food. We must remember that the country throughout the New England States has generally a rough, hilly, and frequently a stony soil, with rocks and bowlders and gravel, left from the Glacial period. The expense of clearing and cultivating these rough and rocky soils is considerable. With the development of the fertile lands in the West, with the ease of cultivation and the methods that can be employed, the cost of production has been reduced. The New England farmer can no longer afford to grow the staple farm products. When wheat was bringing \$1.25 and \$1.50 a bushel, as it was a few years ago, and when hay was correspondingly valuable and cattle a correspondingly important industry, the products from the New England farms were profitable. There is no question that the New England farmers made a comfortable living; but with wheat as low as it is at present, with cattle as cheaply raised as they are in the West, and with hay and

grain as abundant, they have been unable to compete. The contributing cause of this condition has been the small areas which they could devote to any particular crop, and the labor and expense of cultivating and caring for their land. The development of transportation facilities, the lowering of freight rates in the rail and lake and canal transportation, has made it possible to bring products from the West at such a low price that it has been impossible on the rough and rocky New England soils to compete.

Another very important contributing cause has been in the increase in the number and size of factories. It is unquestionable that the social conditions of New England have changed in the past few years—that the growth of the factory system, that the increase in wages, that the lesser cost of the products of the mills, the increase in the number and variety of articles that are considered necessary for comfort and health, the general increase in the cost of living, the general feeling of discontent, and the unwillingness to remain in the quiet and laborious life of the farm have all had their influence.

It seems to me that of all the causes that have contributed to the abandonment of the lands in New England there is no other factor that has been more potent, more important than this one, of the success of individuals in the commercial and industrial lines, and the apparent ease and comfort and luxury of their lives as compared with the laborious and simple life of even the successful farmer.

Q. (By Mr. KENNEDY.) I read in the public press a short time since that the abandoned farms of New England were being taken up again at a very low price; that those who had abandoned them and gone to the West in many cases were returning and trying to get the old homesteads, and that if they could not do that they were buying abandoned farms in the neighborhood, and in one of the New England States, in Massachusetts or Connecticut, there was not now a single abandoned farm.—A. I think there is a reaction going on, but I should think that statement rather overdrawn. Unquestionably, however, I think there will be a reaction, and that the lands will be taken up.

Q. (By Mr. PHILLIPS.) Have not a considerable portion of those lands been taken up by French Canadians in recent years?—A. Yes; they have. One other point I wish to convey to the commission is that the lands in themselves are not worn out; they are in no worse condition. It is other conditions, and not the actual exhaustion of plant food, by which they are affected.

Q. (By Mr. CLARKE.) Is it not a fact that the products of agriculture in the manufacturing sections of New England are worth more to-day than they ever were before?—A. Do you mean of wheat and grain and fruit?

Q. I mean all crops grown by farmers, including of course, truck farming.—A. Well, I should say not, so far as the general farming

goes. Special industries are exceedingly important in the New England States, and I had aimed to speak of that fact in my suggestions for the amelioration of the conditions.

Q. Instead of manufacturing having the effect of depopulating the farms and of rendering agriculture unpopular, is it not true that manufacturing affords so good a market to the farmer near his farm that by changing his agriculture somewhat he finds it more profitable than ever before?—A. Have you not really given the key to the whole situation, namely, that they have not changed their method; they have persisted—farmers are a conservative class—in attempting to compete with the West, when they should have specialized and have met the changed conditions that have confronted them?

Q. My observation, as a New England man, reared upon a Vermont farm and an annual visitor to that State, and somewhat familiar with conditions in Massachusetts, where more manufacturing is carried on, is the reverse of that, and it is that they do conform to existing conditions and are making more money than they ever made before. Now, if I am wrong about that I hope that you or somebody else in the Department of Agriculture can enlighten the country on that subject. A few years ago a Professor Perry, of Williams College, made the statement that one-third of the farm lands from the summit of the Green Mountains in Vermont eastward to the Connecticut River had been abandoned. I contradicted it at the time from personal knowledge. That is one of the most favorable regions in this country. There is scarcely an abandoned farm to be found there, and agriculture near that region, while it has undergone some changes, is more profitable than ever before, and I would like to know why it is. As you say, the soils continue to be fertile and productive, and the markets have improved, and transportation facilities have improved; why is it, then, that the people will persist in claiming that there is a large abandonment of profitable agriculture in that region of the country? I undertake to say that it is not true, but that the exact reverse is true.

Q. (By Mr. PHILLIPS.) Is it or is it not the fact that the price of lands both in New England and the Central States, Pennsylvania, New York, and Ohio, are not nearly as valuable and would not bring as much per acre to-day as they would twenty-five or thirty years ago, or even before the war?—A. Generally, the land values have fallen, but in specific cases they have risen or have maintained their level. And in many cases in the New England States it is unquestionable that very important industries have been created there, notably the tobacco interests of the Connecticut Valley, which we have lately had under consideration, the area of which we have recently mapped; also the truck interests along the Sound, around Providence, around Boston, are very important, and the fruit interests of the Lower Connecti-

cut Valley, particularly the peaches, have all been exceedingly profitable, and I hope I did not convey the impression that I believed myself that there was any such general abandonment of lands as has been frequently stated in the press, because I think myself that there are many industries in the New England States now that are very important. It is certainly our most important tobacco section—the most important for wrapper tobacco—the finest we get in this country.

Q. Is it not a fact that throughout New England when a farm has been abandoned as a home it has been annexed to some neighboring farm and still carried on as a farm? Is not that almost universally the case?—A. I would not say universal, but it is generally the case; yes. There can be no question, however, that, particularly in the last ten years, twelve years, there has been a period in New England in which agriculture has been at a low stage, and that there have been many abandoned tracts, and many people who have moved away. I have tried to show that these conditions are due to causes other than the poverty of the soil, which I do not believe in at all, and that there is no reason why they should not build up the industry of that country and make it as profitable as, and far more profitable by adjusting it to these new conditions, than it ever was.

Q. Now, I would like your estimate of the proportion, the relative importance of the causes which you have named which have contributed to this soil abandonment. Is it not, in your opinion, mainly due to the competition of the more fertile lands of the West—that is, the more easily tilled lands? A. I should give that as the first cause, and I should give as the second cause, the increase in the factories, and the demoralizing effect of the factory life and of the factory wages upon the farm people. There is a demoralization; it is more a panic than anything else; they have not the mature sense of perspective, the vision of what can be accomplished if they take new opportunities which have come to them. It is common through our Eastern States. It is a restless feeling that their old conditions have been changed, and a lack of that business planning and management that will enable them to fit their agriculture to new conditions.

Q. Do you think that the young men leave the farms in New England for the factories?—A. I think so.

Q. Have you any information on that subject?—A. I speak from my experience in New England. I lived in New England for many summers when I was a youth, and I have frequently visited there, as it is the home of my father. I spent two years at the Connecticut experiment station when these matters were under consideration, and have also done work since in the Connecticut Valley and in the truck areas of Boston and Providence.

Q. It may be true so far as the machine shops are concerned, and a few other skilled manufacturing industries. Is not the reverse true

so far as the textile industries are concerned?—A. I should say that there is a general feeling among the farm boys in New England that they want the higher education. They want to get into and take up the professions. There is a great ambition on the part of the young men to go to an institute and to get into electrical works at the present time, because the young fellows that they may have been acquainted with are now getting high wages; and there is a desire among the young people of New England, so far as I have seen, to get into these commercial and industrial lines rather than remain on the farms, except where they are situated in communities in which special crops and special agricultural interests are being developed.

Q. Is it your opinion, then, that the system of education in New England is defective—that it tends to work against the best interests of agriculture?—A. That is a very difficult question to answer. It is a notable thing that few of the young men who go to the colleges for their so-called higher education attempt in any way to fit themselves for the farm, and a very striking case of that is found in the small number of students who have attended the agricultural courses at Yale University, which has had a permanent endowment for the purpose of agricultural education, and who have gone out from there as farmer boys. Harvard University maintains an agricultural school and a scientific or technical school, but there is by far a greater attendance at the technical school, as there is at the classical college, than there is at the agricultural courses. This is a question, of course, of the effect of education on farm life, which is widespread; it is found in all schools of the country. My own belief is that the education we are giving our boys is not calculated to make the best farmers, and that we are rather leading them away from the farm. I think there is a tendency the other way now, because we are showing that there are possibilities in agriculture that have never before been realized. We are showing them that there are possibilities of making money, for one thing—of earning salaries that are commensurate in every way with salaries paid to professional men. If we get a tobacco expert now we have to pay \$3,000 or \$4,000. Six thousand dollars is paid to some of the managers of tobacco estates in the South. The practical growers will willingly pay \$3,000 or \$4,000 to a man who can manage their estates and make them productive; and the same may be said in other lines of agriculture. In fruit and in dairy interests they think little now of paying \$4,000 to \$5,000 for experts in different lines—men who can make them successful. These possibilities now are opening up to young men, and they see opportunities for remunerative work. We have recently tried to get tobacco experts in the Department of Agriculture, and it has been necessary for us to pay \$4,000 to get a man who is qualified for the work. The Secretary has been desirous of having men trained, and I have presented the matter to several young men, and they have

agreed to come at low salaries, \$40 a month—young men from colleges, and they are going to put themselves under the direction of this tobacco expert. They are going into the tobacco sheds and are going to learn how to handle the tobacco, and after they have acquired a practical knowledge they are going to have some training in our laboratories in the principles underlying the handling and manipulation of tobacco. The Secretary says, "Train young men for our own use." If we train them to make good tobacco experts they will go out from us at salaries of \$3,000, \$4,000, and \$5,000, just as we have lost men we have already trained. It is the training, it is the ability of these men to produce products wanted now in this highly specialized industry of tobacco that counts.

The young men are seeing these opportunities, and we are able to get them now readily. They are readily coming to the Department because they acquire in our work an intimate knowledge of the operations on the farm, of the judging and classification of soils, of the treatment of alkali and seepage of waters and underdrainage, and of the production and management of tobacco, and we are having no difficulty in getting men who have been trained to some extent. Men are leaving positions in which they were getting \$1,000 or \$1,200 and coming to us for \$40 a month for the experience they will get and the value it will be to them. Some of our young men have had offers at \$2,500 or \$3,000 to go out and protect some of these Western lands from alkali, because they know how to handle the question. We have shown our ability to handle these questions, which are of so much importance to the people. There is one case which I wish to mention later of a sugar factory in California, that we found was situated on a delta plain. The owners have invested something like \$3,000,000 or \$4,000,000 in this plant, an immense sum, but their lands are underlain by alkali to such an extent that when they begin to irrigate, as they are planning to do now, there is no question in our minds that they will lose their crops and their lands also. Two factories have been shut up within the last two or three years from this same cause. They know that there is danger, and they offered one of our men a salary of \$3,000 just because he knew what the trouble was and could handle that matter for them.

A short while ago Japan took one of our tobacco experts from my own Division and gave him \$6,000 to go over there to investigate the possibilities of raising and manipulating tobacco. They came again for another of our tobacco experts and offered him \$5,000 to go over and develop the interests on the island of Formosa. These things are having an effect on the people. They are seeing the possibilities in these special industries, and in my opinion the young men are turning more to the farm than they have ever done before, simply because there is something definite, there is a purpose, and they are willingly taking positions in the Department of Agriculture and the experiment

stations, because they are getting into practical knowledge of these affairs. They are acquiring the practical methods and manipulations which give them control of these agricultural methods, and they are finding that they themselves can handle these industries now in a way in which they can make good money, or can get positions of trust and responsibility at salaries commensurate with what are being paid in commercial and industrial lines.

Q. (By Mr. CLARKE.) Are many of these branches of agricultural science capable of being taught in the public schools, say, of the grade of high schools and grammar schools?—A. I think so; and yet it is rather difficult to lay out a course or suggest lines of work and of teaching. But it seems to me, as you have asked me my opinion on this question of education, that we want more agricultural schools, and we want, to say the least, no more agricultural colleges. That is, we want the schools right out on the farm lands where the boys work—where they are taught to care for products and for crops. When I want a tobacco expert I can not go to the agricultural colleges and get a young man who has any knowledge of tobacco. I must go to Florida or I must go to Pennsylvania, and I must pick up an otherwise uneducated man, and yet that man will command a salary of \$2,000, \$3,000, or \$4,000. He is not a college-bred man, but yet he is familiar with the manipulation and the details of that work. Now, if I should want to educate a young man in tobacco lines, to be a tobacco expert or to know how to raise tobacco in the Connecticut Valley, for example, I would take him and send him right to Florida, where they have the highest type of skill and industry in tobacco, so far as tobacco is concerned, of any place in this country. They have developed the industry along really scientific lines by their practical men.

Q. Now, most of the high schools of this country, even in the agricultural regions, have a curriculum chiefly devoted to preparation for entering classical colleges. Almost nothing is taught concerning practical farming in any line. Is it your opinion that the curriculum might be changed to the advantage of the farmer?—A. I think in certain cases it could be, and we would be extremely desirous of seeing in certain centers farming schools for the education of farming boys. If such a school were established in Lancaster County, Pa., under the splendid agricultural conditions prevailing there; if the boys could see the methods pursued there; if they could go out and actually learn how to handle stock, how to handle the soil, and how to handle the crops, they would acquire information in this individual locality that would be admirable in fitting them to take charge of estates and of farm lands of their own in other localities.

Q. Boys reared upon farms become familiar with practical methods, but what opportunity is offered to them in the neighboring schools to become familiar with scientific agriculture? How much chemistry are they taught?—A. There is very little.

Q. What do they know about soiling crops and about the various plant foods and animal foods? Is any of that information taught in any of the high schools in this country that you know of?—A. Very little or none in any that I am familiar with, even in the agricultural districts.

Q. Then, when the system of education leaves the leading industry of a region to the work of ignorance and teaches the youth something else, are they not rather compelled to go out, and are not their ambitions led out into other pursuits?—A. Yes.

Q. (By Mr. PHILLIPS.) At present it would be very difficult to have teachers qualified in these various rural districts to teach this. They would have to be educated for that purpose?—A. It seems to me, further, that when these schools are established they do not seem to be satisfied to remain schools; they so quickly aspire to the dignity of colleges, and from colleges to the dignity of universities. Abroad it is much more frequent to see real agricultural schools, a sort of primary school in agriculture, or high school in agriculture, where the school is situated in a farming district and the methods and thoughts are all upon farming lines. You take a young man and put him under those conditions and he is likely to be much more contented to follow in the pursuits of farming than if you put him into a university like Yale University where the farming course, the agricultural course, is looked down upon by all other students. Under such conditions the young men are not generally satisfied to take a course which is popularly supposed to be an easy one and one which does not maintain the rigorous training that the classical and mathematical lines are supposed to possess.

Q. Perhaps we have diverted you most too long. This is very interesting.—A. I wish I had prepared myself a little more on this line. I did not think of this coming into the discussion. It is a matter that I have often thought of, because I was professor of agriculture in South Carolina and always realized that I was not doing my duty, as it seemed to me, in the training of my men, partly because there is no course in agriculture for a professor to take up—he has to make one himself—and, secondly, the opportunities are not presented, it seems to me, to train people with the particular knowledge that is required in any line of agriculture.

I think that in the New England States, perhaps even more than in the Southern States, that restless desire for material advancement and the higher education has been felt because of the more thickly settled condition and other natural conditions which have already been referred to. Another contributing cause to the tendency in the New England States has been the demoralizing effect of the summer boarders. It seems to me there is no question that, while their presence has been a benefit to the New England States in the main, it

has had a demoralizing effect upon the agriculture of the region. Furthermore, the severe climate of New England has been against the development in some cases, and it has had some effect upon the development of the agricultural resources of the area.

It seems to me perfectly evident that the conditions which have contributed in any marked way to the depreciation of land values in New England have been, first, the development of the West and the lower prices for farm products through the development of the transportation systems, and the increase in the number of factories, in the restless desire of all of our people to a certain extent to leave the quiet and laborious life of the farm and enter the busy, hurried world of commercial and industrial activities. It is quite evident to me, however, that the future for the New England States, as for our Southern States, is in the line of specialization. They are close to the markets; they are peculiarly fitted, as they have already shown, for certain special industries; and the line of future development must be in that direction. They must give up all thought of competition with the general farm crops and must look forward to the building up of certain industries which their position, their locality, and their conditions specifically make possible to be carried on.

The one case of the Sumatra tobacco, that we succeeded in growing last year in the Connecticut Valley, that brought 71 cents a pound when the ordinary crop is grown for 20 cents a pound, was a result of soil-survey work, in which we thought that the conditions were favorable on a certain soil in the Connecticut Valley for the production of this tobacco under certain conditions which we brought about, and the result has been successful. So far as we know, there is no other area besides Florida and the Connecticut Valley, and only certain soils in the Connecticut Valley, where this industry can be pursued; and it is unquestionable in my mind that this industry can be built up, and that there is a possibility of producing \$6,000,000 worth of tobacco which we now import from the island of Sumatra every year.

I should also mention that the truck interests and the greenhouse interests around Boston are very great. They are enormous industries, and large amounts of money are invested in them and large profits maintained.

Maryland and Virginia.—I come now to the cause of the deterioration and abandonment of lands in Maryland and Virginia.

The exhaustion of the soils, of which we have heard so much in Maryland, Virginia, and the Southern States, is due, unquestionably, to improper and injudicious methods of cultivation and cropping. This will be referred to more at length, under the head of fertilizers, when we come to speak of remedial measures. It is also due to the decrease in value of farm crops, due in turn to the cheaper production in the West and to the reduced cost of transportation, as has been

referred to in the case of the New England States; also to the increase and the development of special industries in other localities—for example, in the production of the White Burley tobacco in Ohio, which yields more per acre, is grown at a less cost per pound, and can be sold at a cheaper price than the Maryland leaf, and has largely taken the place of the Maryland leaf in the foreign markets, particularly in the French and Belgians markets. Furthermore, the changes in the social conditions due to the civil war and the mortgages which are still outstanding against the lands have been a contributing cause to the abandonment or to the deterioration of many of these areas. It has been found possible in many portions of Maryland, with the prevailing crops and methods of cultivation, to obtain a fair interest on the labor and expense of cultivation, but it has been impossible to obtain a living from the land if at the same time the interest on mortgages, which have been running since the war, has had to be met. And I know of once prosperous communities in southern Maryland where they could still be successful, where they could produce sufficient to maintain families without stint and with a fair degree of comfort, but where nearly all the farms are mortgaged as an inheritance of 30 years ago, and it is impossible to support the families and to pay off the mortgages at the same time. Areas now are being abandoned from that cause throughout Maryland and the South.

One of the most important causes of deterioration, however, and I think I should put this first of all, is the method and system of agriculture that prevails throughout these States. The Division of Soils made a careful soil survey with soil maps of two of the counties of southern Maryland this year—St. Mary County and Calvert County—and of Lancaster County, Pa.; and the study of the conditions which have prevailed and the methods, particularly, which have been used in these two areas has been a matter of considerable interest to me. In the first place, I would state that the soils of southern Maryland are in no way exhausted in the sense that that term is generally used—that is, a chemical analysis shows that they have sufficient plant food for innumerable crops and that there is apparently no lack of plant food in the soil. Unquestionably the soil has been abused, the methods of cultivation and of cropping have been injudiciously selected, and the soils are not now as productive as they should be. There is one area in particular of a certain soil with a heavy subsoil in St. Mary County, probably about 40 per cent of the area of the county, that is, in my opinion, as valuable in its way, and in much the same way, as the limestone soil of Pennsylvania. This soil in St. Mary County sells for from \$1 to \$3 per acre in forest, as it usually is, or for about \$10 per acre where it is under cultivation, while the soils in Lancaster County sell now at from \$125 to \$250 an acre.

Q. (By Mr. PHILLIPS.) That is chiefly for tobacco, is it?—A. Yes; chiefly for tobacco. It is fit for general crops, but tobacco is grown in

places. But on the soil in St. Mary County there have been several good farms that have been well kept up. The Maryland farmer grows on soils in good condition from 15 to 20 bushels of wheat; he grows clover; he grows tobacco, and he gets from 6 to 10 cents a pound for the tobacco. The Pennsylvania farmer grows from 25 to 35 bushels of wheat; he grows clover and grass, as in Maryland, under good treatment; and he grows tobacco, for which he gets from 6 to 10 cents a pound also. He gets the same price, but a larger yield. It is heavier tobacco. Now, from consideration of the crops that are obtained from this southern Maryland area, and of the staple crops and of the yields and values obtained from the soils of Lancaster County, Pa., it seems to me evident that the soils of southern Maryland ought to have a relatively higher value; and the reason why they have not is largely, in my opinion, because of the social conditions and the methods of farming. If you go into the home of a Lancaster County farmer and sit down to dinner with him, he has an abundance of food in great variety. Everything, the chances are, has been grown upon his own farm. The meat has been raised by himself, the vegetables have been grown in his garden or in his fields, the preserves, or whatever they may have for their dessert, have been made by their families from the products of their garden. Even the sugar, the chances are, has been produced on the place, and actually nothing but the tea, coffee, salt, and pepper have been purchased that goes to make up the family meal. The families as a rule are large. They have a good many children. The boys and girls are all brought up to work on the farm. It is the rarest thing that any of them leave the community or leave the farm. They stay there and they marry. It is a common thing for them to settle on a portion of the farm or on some neighboring farm. The farms are small, and labor is all done by the owner and his family. The girls are all brought up to look after the house. There is no expense for servants. They have their garden and their fruit. They put up their preserves and their apple butter, and such things for their winter use. We find that very few products are sold from Lancaster County; very few things are sent out of the county except tobacco and stock. And they not only feed up all their corn and hay that they grow to the stock, but they import it often from other States and from other countries, so that they can raise more stock and make more beef and mutton. Most of the products of the farm, including the wheat, which is ground up for flour in adjoining mills, are used on the farm or manufactured there into some sort of product that is sold or is used up in the district. There are manufactures and industries which require to be kept up in the large city of Lancaster and many smaller towns, in which there is a ready market for everything that is produced in the county, and the interesting thing is that this supply and demand is nearly equal, so that very little is sent out of the county and very little is brought in. The

result is that it is a happy and contented and prosperous community. The lands have been handed down from generation to generation for ages and people seldom think of leaving the place. They are a contented and happy and prosperous people.

In Maryland the methods are altogether different. In the first place the Maryland farm is seldom worked by the man who owns it. There is for some reason an unfortunate prejudice which prevails in many localities, at any rate in Maryland, for a man who actually goes into the field and works his land. He usually has an overseer, a man who is paid to look after and direct his interests instead of doing this himself. Frequently he has not even so much control over his interests, and lets his land out to a tenant farmer who farms it in his own way, by his own methods and for a portion of the crop, and occasionally for a money consideration. The crops grown are the ordinary staple crops of general agriculture. They have corn, wheat, and tobacco. The competition from the West and the low prices of wheat and corn make them scarcely profitable. The competition with the Ohio tobacco and the general specialization which has taken place in the tobacco industry, and the necessity of producing something that is peculiarly adapted to a certain market or to a certain demand, has lowered the price of the Maryland tobacco. Now, after the Maryland farmer has raised these three things he has done, as he thinks, the best he can and he has nothing further to consider for his development. The corn is fed mainly to his work stock, and it all goes to that and his own labor. The wheat is sold and sent off the farm in exchange for flour, which he buys at a considerable increase in cost over what it would have cost him if he could have had it ground in his own neighborhood. The tobacco, of course, is sold and goes out in exchange for productions of all kinds for himself and his family. He buys his meat, he buys his groceries, and he frequently buys the vegetables that he should have raised in his garden.

There is no comparison with the conditions in a prosperous community like Lancaster County and the improvident methods that prevail in some of our Maryland counties and Virginia communities. There is no comparison whatever in the economical methods that are employed, and it seems to me that one of the most important contributing causes to the abandonment and impoverishment of the lands in Maryland and Virginia and of many of the Southern States is due to this one fact, that they do not use the same thrifty methods that have marked the success in Lancaster County and in many other counties of the Northern States.

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Professor WHITNEY (after recess, resuming). At the time of the adjournment or recess I had compared the methods and system of agriculture prevailing in the southern counties of Maryland with the

system prevailing in Lancaster County, Pa., and had drawn some suggestions as to the cause of the differences in the land values in the two localities. In following out our soil investigation and the mapping of lands, we find the same limestone soil which is so productive and valuable in Pennsylvania extending down to the Hagerstown Valley of Maryland and down through the Shenandoah Valley of Virginia. They have the same character of soil, essentially the same climatic conditions, and yet the soils of the valley of Virginia are selling to-day at from \$10 to \$20 an acre—rarely more than \$40 or \$50 an acre—while the farm prices in Lancaster County have been maintained about where they were—about as high as they ever have been—and I can not say that this is due to any cause connected with the soil, but conclude that it is due almost entirely to social conditions, to the respect agriculture has in the community, to the thrifty methods employed by the people, and the way in which the occupation is esteemed.

DETERIORATION OF SOILS OF THE SOUTHERN STATES.

Undoubtedly, the system that prevailed for so many years in the South was satisfactory under the conditions prevailing some years ago, but certainly, with the rapid and phenomenal advance and improvement in industrial lines and in the improvement of transportation facilities, the old methods are no longer applicable. The trouble in this case, it seems to me, is a lack of business method, want of appreciation of changed conditions and of business perception of opportunities that could be taken up and made productive.

In the States farther south than Maryland and Virginia there have been other causes which have operated in this same direction. In the first place, the kind of crop and the clean cultivation that have been given to the cotton crop have caused a tremendous oxidation and loss of the organic matter, and the soil is left relatively poor in these organic substances that are necessary for the normal weathering of the soil material and the preparation of the plant food into a form that is readily available to plants. It has also caused in many areas the erosion and washing of lands that has proved destructive to very considerable areas in the Southern States. There is one condition which has also prevailed against the competition with the South in certain lines of general agriculture—that is, the unfavorable climatic conditions for grain crops. The normal yield of grain in the South is about one-third of what it is in the Northern States. This is due to the fact, so far as we can see, that the greater humidity and larger rainfall are bringing about conditions favoring extensive leaf development rather than the production of grain. In the Northern States the cold, frosty nights are liable to occur about the time the plant has obtained its full development, and this condition favors the production of fruit, as is well known in all life functions. Where there is

danger of the destruction of the plant it tends to reproduce itself in the formation of seed. In the Southern States, with the more equable climate, with the higher temperature, higher rainfall, and generally higher humidity, there is a persistent effort to the production of vegetable growth and a distinctly less chance of the production of grain and seeds. While this is natural, it is by no means necessary, for the largest yield of corn on record is from South Carolina, where there was an abundant growth—abundant vegetative growth—which was checked by methods of cultivation at the proper time—that is, the tendency to vegetative growth being checked, the plant produced seed in proportion to the vegetative growth, and the yield was phenomenal; and it has seemed to me at times as though by a change in the method of cultivation—by some mechanical checking of the growth—that the vegetative growth could be checked and the yield could be largely increased. However that may be, the fact remains that the climatic conditions in the South have never been favorable to a large yield of grain.

I have presented to the commission now the principal causes that operate in the exhaustion and abandonment of soils. These several lines, of course, operate in different proportions in different parts of the country. In nearly all localities one or more of the causes that I have mentioned have operated at the same time to produce the deterioration, if not the abandonment, of soils.

METHODS FOR RECLAMATION.

I come now to the conditions of reclamation and certain recommendations that it seems desirable to make.

Q. (By Mr. PHILLIPS.) Before proceeding with that I should like to bring up a question which has been touched upon. You said in the early part of your testimony that in England the soils had not deteriorated; that the growers raised about the same amount on the land in the last twenty years as they had for forty or fifty years—about 15 bushels. Is there anything in the climate favoring England in this respect? Would the climate in Virginia and Pennsylvania have the same power or force? Is it on account of the damp, or are the climatic conditions there different from ours?—A. Yes; the climatic conditions have a great deal to do with it.

Q. Then you would not, therefore, claim that 15 bushels could be raised on good wheat land in Pennsylvania, as is the case in England?—A. No; but what I say is that under given climatic conditions and with a given soil, a soil even without fertilizer, there would be a certain grain yield that would be maintained for a good many years; indefinitely, so far as we know. It might be 5 bushels to the acre or it might be 10, or it might be 15. It happens to be that under the conditions in England in this one experiment it was 12 bushels.

Q. I know of farms that have become quite poor on the hills because of the water. England being more level, perhaps the conditions would be more favorable?—A. In this experiment that I cite, yes; it was conducted on a level tract.

FERTILIZATION.

Q. Pardon the interruption and proceed. —A. The first method that I will speak of in the reclamation of lands, although in my opinion not the most important, is the subject of fertilization. The primary object of fertilization is the improvement or adaptation of soils to the cultivation of any desired crop or crops. As I have shown, all soils have a natural fertility which can probably be maintained under any condition of cultivation for an indefinite number of years. Very frequently this natural fertility is so low that it is unprofitable to raise a particular crop, as so little is obtained from the soil that it does not pay for the attention given to it. Frequently, also, on a very rich soil the aim is to force the crop, and we call it intensive cultivation—that is, we may have a soil which will produce a large crop, and yet we want to force it to produce all it can. It is like the fattening of stock. We can produce a fairly good animal on our ranges, but if we take an animal and feed it up with concentrated food mixed in the proper proportions for a good diet we can put fat and flesh on it which will make it far more profitable than if we had depended upon the natural food of the locality. It is so with soils. We can unquestionably force the fertility far beyond the natural limit and far beyond the ordinary limits of crop production. This we see particularly in the truck crops, where the poor, barren sands are highly fertilized and where large crops are grown from what would naturally be considered a poor soil. In this sense the effect of fertilization is a simple addition of plant food to the soil in such form that the crops can immediately use it. But fertilizers have another effect, that of increasing the decomposition of the soil particles themselves—that is, the mere addition of fertilizers of different kinds may increase the weathering power, and the soil itself will disintegrate and decompose under their influence faster than it would without their application.

The specific objects of fertilizing are to obtain an improvement in the texture of the soil—that is, frequently a wet refractory clay can be made more pliable, more easily handled; drainage is improved. Frequently also loose soil may be made more compact and more retentive of moisture. At times also the influence of the fertilizers is felt more in balancing up the ratio. We have in Maryland and Pennsylvania small areas of lands that are derived from the disintegration of serpentine rocks that carry a large proportion of magnesia; and it has been found that where the amount of magnesia is in excess of the amount of lime plants rarely do well and frequently are an entire

failure. In such case the application of lime simply to reverse the ratio and make lime a predominating ingredient in the soil will restore the fertility of the land. Very frequently also, and probably more often even than we now suppose, soil is acid. It has been found that the soils of Rhode Island are very generally acid, and the addition of lime simply to neutralize this acidity will promote the fertility of the land in a very remarkable degree. This same cause of acidity of the soil is found now to be much more prevalent than we have heretofore supposed to be the case. The fertilizers that are commonly available are farm products—that is, stable manures and green manures, which are used to a very considerable extent and are both exceedingly important in the list of fertilizing materials. Then we have the commercial products, such as guano, ground bone, potash, and then the mineral fertilizers other than lime, and then lime, marls, and gypsum. It will hardly be necessary for me to go into the question of the fertilizer laws. As the commission knows, most of the Eastern States have rather stringent laws about the inspection and sale of fertilizers; and this subject has been taken up by the Department of Agriculture with the idea of having a more uniform system of laws, if possible, and with some idea of having national laws for the interstate commerce and trade. I am not at all sure how far this has gone, and I therefore do not feel competent to speak upon it.

Another series of fertilizing agents is found in the bacteria and other ferments. This newly discovered nitrogen is really a pure culture of bacteria, which have, by reason of their activities in the soil, rendered available the plant food—that is, they increase the weathering of the rocks and also add to some extent (we do not know how much) nitrogen from the air, converting it into some form in which it can be used by the plants.

ROTATION OF CROPS.

Still another method which I would call to your attention by which reclamation of these waste lands can be realized is in the rotation of crops. There is no question whatever but that in general a rotation or a change in the crops grown on soils is of value in preventing undue waste and undue extraction of certain elements of plant food and the undue tendency for cultivation in a particular way, and unquestionably where intelligent rotation of crops can be inaugurated it is one of the most desirable things to do. There are instances, however, in which the same crop has been grown on the same land for many years without any apparent deleterious effect. On the eastern side of the Connecticut River, near Hartford, they have grown the broad-leaf tobacco continuously for 25 years on the same land, and they claim that the quality of the tobacco as well as the yield is as fine as it was at the beginning—even better.

Q. Is that done without fertilizing?—A. No; that is with fertilizing.

Q. (By Mr. FARQUHAR.) Why is it that the tobacco soils of Virginia here are almost worthless to-day for raising anything?—A. The deterioration of the tobacco lands of Virginia is due more to the general methods of cultivation, which have not looked forward to the maintenance of the fertility of the land or to the proper physical conditions. You will find it almost universally believed in Maryland and Virginia that tobacco is a very exhausting crop and has ruined their soils. On the contrary, if you go to Ohio, or Kentucky, or Pennsylvania, or Connecticut, you will find that it is the one crop which they value as a renovator for their soil. This is, in my opinion, due to the fact that they take so much care of their tobacco lands. They cultivate them so carefully, so perfectly, and so thoroughly; they fertilize them so heavily in order to maintain a good yield and a good quality, that the land has actually improved in spite of the relatively large amount of plant food removed by the crop. I think unquestionably it is a matter of culture rather than of any other one factor. If the Virginia farmers took as good care of their land as they do in other localities there would be no suggestion of deterioration of their soils. But they plant tobacco with little or no fertilizer, or manure, usually without much organic matter. They give the land a clean cultivation and leave it exposed for a considerable portion of the year; and the consequence is that it is not maintained in that vigorous condition in which these necessary changes go on as they should, and the soil is said to be worn out. It is not the loss of plant food; it is a change in the physical and chemical condition of the soil brought about by indifferent methods of cultivation.

SPECIALIZATION OF CROPS.

One of the most important methods for the reclamation of abandoned and exhausted lands is in the specialization of crops. By this I do not mean the exclusive growing of one crop without regard to all other conditions, but I do mean the adaptation of the particular crop or crops that the land is best suited to, and specialization in that particular industry. I shall cite in support of this position the truck industry, which has reclaimed vast areas of lands in the Atlantic States. Twenty-five or thirty years ago the sandy soils along the Atlantic coast were worth about \$1 or \$1.50 an acre. I remember myself well when they were worth no more than this. By the introduction of the truck crops—that is, the growing of vegetables for our early markets—those lands have risen in value until now they are the most valuable soils in those States, selling anywhere from \$50 to \$500 an acre, according to their location with regard to the water, freedom from frost, and in regard to the markets and transportation facilities.

Q. (By Mr. PHILLIPS.) You do not mean in the primitive state, but

that under a state of cultivation they are worth that amount?—A. Yes; I mean that the same land that was worth \$1 an acre is now worth \$100.

Q. By reason of cultivation, and not in the natural state?—A. In the natural state. Any soil that is suitably located for truck farming, especially near the water, and where there is a freedom from frost and where the transportation facilities are adequate, is worth that in its natural state.

I should also state a similar fact as to the case of the pineapple industry in Florida. There is a narrow strip of sand along the coast in the southern part of the peninsula of Florida that was formerly comparatively worthless. It is simply beach sand thrown up by the tide in former times, and is in a ridge about 15 or 20 feet high. It is white, like glass sand, and to the Northern farmer would be just as barren and unpromising as anything could be. By the introduction of pineapples these lands have been redeemed, and a very fine variety of pineapple can be grown upon them. They are worth now anywhere from \$200 to \$1,000 an acre, according as to whether they are set in pineapples or whether they are wild lands. Even the wild lands, covered with the native jungle, will sell now for from \$100 to \$200 an acre when favorably located. I know of no more striking illustration of the possibility of specialization in the reclamation of waste and abandoned lands than this instance of the pineapple industry of Florida.

Q. Are they fertilized?—A. Fertilized very heavily. The sand is used simply as a medium apparently for the fertilizers that are put on. They would be of no value for general crop, but are of exceptional value for this one crop, because there is no other soil which can compare with them in the possibilities of growing pineapples of the superior quality that is grown on them.

Q. That strip is in the southern portion of the State, is it not; below Palm Beach?—A. Just above Palm Beach. It begins about there. It extends from Jensen down to Palm Beach.

I would also cite the case of the bright-tobacco industry in the South. Many areas that were formerly of little value and considered very unproductive have been developed by the introduction of that industry and are now worth more than they were formerly, and are the most productive and valuable lands in that section. In this case, also, it is a special adaptation of a particular kind of crop to a particular soil. The bright tobacco can not be grown successfully on all soils. It is confined to certain soils with certain peculiarities, and they happen frequently to be conditions which are unfavorable for the general agricultural crops, fortunately.

I would cite another instance of the cultivation of tobacco in the Connecticut Valley. On the light, sandy soils a fine grade of wrapper leaf is produced which can not be grown on the tobacco lands of

Pennsylvania or of Maryland. It is confined to that one locality of the Connecticut Valley and the Housatonic Valley, and is a special industry that seems to be adapted to that place. The introduction in 1865 of the Sumatra tobacco from the island of Sumatra has had an effect upon the tobacco industry of the Connecticut Valley. The fine texture and fine veins and the working qualities of this Sumatra tobacco have been so appreciated by the cigar manufacturers that it has been imported in increasing amounts ever since in spite of the revenue duty of \$1.85 per pound on all that is brought into this country. In other words, the cigar manufacturers prefer paying \$2.50 or \$3 a pound for Sumatra tobacco to paying 18 cents or 20 cents for the Connecticut leaf, although, as far as quality goes, the Connecticut leaf is preferred by many. Now, it has seemed to me that the industry in the Connecticut Valley was threatened. The trade wants this Sumatra type of tobacco, and have been giving but a low price for the Connecticut leaf. One dollar a pound is paid for the Sumatra and \$1.85 a pound is paid as duty upon it. We take only the best that they have, and there is more and more a feeling against the use of the domestic leaf.

Realizing this condition and the necessity of successfully competing with the Sumatra tobacco, the Department of Agriculture two or three years ago looked around for the possibility of raising a Sumatra tobacco in this country which would prevent the importation of such large quantities from that island, and we decided to try a particular soil in the Connecticut Valley.

Last year we procured some Sumatra seed and planted it under a shed. This shed was erected at a height of about 9 feet, and was covered with cheese cloth so as to partially protect the plants from the sun and maintain a very quiet and humid air. The tobacco was grown and cured by the methods used in Florida and in Sumatra and Cuba— a combination of the different methods— and it was pronounced by experts in New York and Philadelphia to be fully equal to the Sumatra leaf that is imported. We confidently expect to be able to establish an industry in the Connecticut Valley upon certain soils adapted to this very fine leaf, in which we hope to be able to successfully compete with the Sumatra tobacco, which we import to the extent of \$6,000,000 a year in addition to the duties.

Q. Could it be profitably produced by covering the ground with canvas as you describe?—A. Yes; the profits are good.

Q. Could it be produced without the covering?—A. No; that is necessary in order to change the climatic conditions to get the particular growth that we want. Even with the expense of \$500 an acre, which we estimate for the first cost, the profits are likely to be large. We estimate this year \$1,400 worth of tobacco from our experimental crop of one-third of an acre.

Q. Have you sought any lands in the South where the climatic conditions would be somewhat similar to those of Sumatra without the canvas?—A. Yes; some Sumatra leaf is being grown in Florida, and the growers are getting large yields. Their finest wrappers are bringing from \$2 to \$4 a pound.

Q. They raise it, then, without canvas?—A. No; with canvas there also. The climatic conditions during the growing season are not very different in Connecticut and in Florida. It is the same hot, tropical weather.

Q. (By Mr. CLARKE.) Is that cheese cloth strong enough to protect the leaves from hail?—A. There is no ill effect from hail, except possibly an exceptional storm. There is no injury from wind or from insects or worms of any kind. The protection is carried all the way down the sides. There is a gate with an opening for men and teams. It is entirely covered with canvas, and it is a perfect protection against all extraneous conditions.

Q. (By Mr. PHILLIPS.) It would be liable to destruction by storm, would it not?—A. In a very severe storm such as they had two or three years ago in Florida, where one of those Gulf towns was destroyed by the floods that came up, they were destroyed to a considerable extent; but ours in the Connecticut Valley last year withstood the most severe storms. Any ordinary storm has no effect on it.

Q. (By Mr. CLARKE.) Can you give the expense of constructing and maintaining these canvas coverings?—A. The first cost is between \$200 and \$500 an acre. That seems rather a wide margin, but it depends on the cost of the lumber. In the South, where they have the sawmills right on the place and where lumber is cheap, it costs about \$200 an acre for the shed. In the North it will not exceed \$500 an acre, and the shed will last about five years. The cheese cloth will cost about \$100 an acre, and has to be renewed each year.

Q. (By Mr. PHILLIPS.) Is it taken down in the winter season?—A. The cheese cloth is hardly worth preserving.

Q. (By Mr. CLARKE.) Are those coverings for each row or are they broad enough to cover several rows?—A. The covering goes entirely over the field. It is 9 feet high, so that horse cultivation is carried on under the shed just as it would be in the open air. It may be a 10-acre field or it may be a 30-acre field, but the entire field is covered.

Q. Like a great greenhouse, then?—A. It has the effect of a great greenhouse. The sunlight and the sun heat is very much reduced and modified, and the air is a stagnant and moist air, humid, because there is no wind to carry off the moisture or change the air. The conditions there are really tropical. The plants keep on growing, and in the Connecticut Valley they went right up to the top of the roof; that is, they were 9 feet high.

Q. (By Mr. KENNEDY.) What is the ordinary height of tobacco plants?—A. Ordinarily, about 4 feet.

Q. (By Mr. PHILLIPS.) This cheese cloth does not prevent the rain going through?—A. No; it does not prevent the rain, but it does prevent evaporation, and it conserves the moisture so that the crops do not suffer as much from drought as they do on the outside. It is also a protection against frost. Indeed a covering of the kind described has been used very successfully in the cultivation of pineapples in Florida to protect them against frost. It seems to be a method that is coming into very extensive use in the protection of crops under intensive farming. In the production of truck crops it is getting to be used extensively to protect them from frost and to maintain humid conditions and protect from drought on the sandy soils.

Q. In a very large per cent of these the flavor is due to the direct rays of the sun. For instance, strawberries would not be marketable raised under such conditions?—A. No; I should not think strawberries would. There is some sunlight under the cloth covering, but it is not so intense. It is the intense sun in the middle of the day that hurts some of our tender vegetables, unless they have plenty of moisture. Covered, they have the sunlight, but it is diffused and not so intense as it is outside.

The commission is well aware of the important part celery has played in the reclamation of many areas of formerly wet, mucky lands in many parts of the country; also the importance of the fruit industry in the reclamation of what we considered worthless or abandoned lands.

The introduction of peach culture in western Maryland has created an industry there on some of the soils which were formerly of little or no value, and where they are now worth anywhere up to \$1,000 an acre. The location and the character of the soil has made it possible to produce a late peach which does not come into competition with the peaches from the Eastern Shore and southern Maryland, and which has a very fine color and a splendid flavor. These soils are of no value for general farm purposes, but they are particularly adapted to the production of peaches which ripen late, and which have a good flavor and a bright color.

The commission is also aware of the success of grapes and vineyard culture on gravelly soils, and it will hardly be necessary to dilate on the importance of this crop as a means of reclaiming such areas. The most valued soils along the Rhine are frequently so destitute of soil covering that they have to be maintained by stonework, and on these very gravelly soils the finest varieties of grapes have been produced. Over a large class of soils, particularly in rocky and stony areas, fruit trees and grapevines have been found a most important means of reclaiming otherwise worthless lands.

There is one consideration, of course, in the production of fruit which must always be considered, and that is the possibility of marketing. That problem has been solved to a considerable extent by

the possibilities of marketing the fruit in a dried or canned condition, and the exportation of dried fruit is to-day a matter of the greatest importance, and one that is increasing in magnitude, especially on the Pacific coast, where large and increasing quantities of fruit are being consigned to China and Japan.

REFORESTATION, PROTECTION FROM FIRES, ETC.

Another important means for the reclamation of poor or abandoned lands is in reforestation and protection from fires and a more rational method of cutting the timber. This is a subject which is being investigated in the Department of Agriculture, where we have our Division of Forestry concerning itself with this one problem; and it is one of the important problems applicable to areas in which there seems at present to be no other means of improving the land.

THRIFTY BUSINESS METHODS.

The question of thrifty methods and efficiency of labor is one that is very hard to deal with. I can not understand how, by education or by legislation or in any other way, thrifty methods can be introduced into certain areas that are at present of little value simply because the methods are not good. Under present conditions, I do not think that any education would make farming in southern Maryland attractive to a young man. It would be discouraging, no matter what kind of education he had, for him to go back and live under the conditions that prevail there at the present time. The social conditions are such that he can not work with his own hands, and he does not have the intelligent or efficient labor to organize and carry out his ideas. He is confronted from the start with conditions that are almost hopeless for the introduction of new methods and of new crops on a scale commensurate with the importance of the work and the facilities at his command.

Q. Is the negro population very numerous in southern Maryland?—
A. It is quite large. It is the principal but not the only labor, and not nearly so large as it is farther south. In my opinion the importance of reclaiming large areas of lands is indicated by the necessity of more thrifty methods and more businesslike plans than they have at the present time in the selection of industries and in the cultivation of crops.

Another very necessary means to the reclamation of lands is business methods and organization in the marketing of crops. The success of the truck industry in Norfolk is largely due to the splendid organization and to the means by which the truck farmers place their crops in certain markets, according as the demand may be greater in one or the other. This is an essential thing in truck farming, because the vegetables can not be held over, but must be marketed or sold as soon

as they reach maturity, and they have to be sold for what they will bring. The organization of growers gets regular daily returns of the market conditions in different cities, and they are able to divide their crops and to send a certain portion to this market or to that, according as they think the conditions will stand. It seems to me that this organization and the introduction of these business methods are the most important factors in the reclamation of abandoned areas and the introduction of new crops.

IRRIGATION.

The commission is of course quite well aware of the method of irrigation which has been so important in the reclamation of certain areas in the West. Unfortunately, about all of the available water has been already appropriated and is nearly all in use.

Q. (By Mr. KENNEDY.) Is that true? Governor Steunenberg, of Idaho, told me a week ago last Sunday that the possibilities of the Snake River for irrigation purposes were wonderful, saying they had not begun to use the water of the stream up to its full capacity.—A. That is so in certain cases. It is so in the case of the Yellowstone River also. But nearly all of the water in California and in Washington and in certain portions of Arizona and in the Pecos Valley in New Mexico is now used to its fullest extent. There are other areas in Montana and in Idaho and in Wyoming where there is still some available water, but as a general statement it may be said that the available waters are already appropriated and in use, except, as I was going to say, such as may be added by the construction of reservoirs for the storage of waste waters.

Q. (By Mr. PHILLIPS.) There are very large possibilities in that regard, are there not?—A. Yes; it is estimated that about 74,000,000 acres can be irrigated by the construction of reservoirs.

Q. (By Representative BELL.) What are the possibilities of the irrigated soil?—A. They are very great for special crops, but they are not so very great for our general crops. For instance, it no longer pays to irrigate wheat. The principal crops are the fruit crops of all kinds, and alfalfa for stock feeding, and special industries of that kind. With these special industries the possibilities are enormous.

The average cost of placing land under irrigation, as shown by the last census, was \$12.12 per acre, and the annual cost thereafter of maintaining the water was \$1.07 per acre of the public lands. Newell estimates that 74,000,000 acres are capable of being irrigated. The cost of the opening of this area, taking the average of previous experiments, would be \$897,000,000. But as the methods of applying the water to the land heretofore have been the simplest possible, the cost per acre has been much less than the cost will be in the new areas that are to be taken up, where the water must be stored and carried

over long distances. For the storage of water under the most favorable conditions in Arizona Mr. Lippincott estimates the cost at \$4.30 per acre-foot, and as at least 5 acre-feet of it must be stored for each acre in order to provide for two or three seasons of low water, the cost would be about \$21.50 per acre. I would call your attention to the basis of this calculation. It assumes that all of the land that could be watered by the storage reservoir shall be actually taken up and put under water. If only half of that area is taken up, the cost would be twice as great per acre; if only a quarter, it would be four times as great, and so on. So this cost that is given in the estimates of the irrigation engineers is the cost provided all the land possible should be taken up and put under water and the rate per acre was paid in to the canal company.

Q. What would be the value of this land after it was put under water?—A. It would be from \$60 to \$100 an acre.

Q. (By Mr. PHILLIPS.) Notwithstanding the cost of maintaining the water afterwards?—A. Yes.

Q. (By Mr. KENNEDY.) In what localities?—A. Through the arid regions. This example was in Arizona. Lands in Utah are worth from \$60 to \$100 an acre; and, set out in good varieties of fruit orchards, anywhere up to \$1,000 an acre. In southern California lands are worth generally from \$50 to \$100 an acre, but many of their orchards are worth from \$1,000 to \$2,000 an acre.

Q. (By Mr. PHILLIPS.) That would be when they were fruit bearing?—A. Fruit bearing, yes; in fine varieties of fruit. The difficulties in the way of the extension of irrigation by the construction of storage reservoirs are the alkali and the silt in the water. There is no question that the amount of alkali in the water is a very serious factor in many localities. In the Pecos Valley it has been found that the alkali increases in amount as they go down the valley to such an extent that in the lower part of the valley the water is entirely unfit for crops. In the storage reservoir in which water is stored above the town of Carlsbad the evaporation is so great that the salts become concentrated in the water, and at the end of a long dry season the water is too salty to be applied safely to the land. This region, by the way, has the highest evaporation of any place in the United States—approximately so. Considerable trouble has been experienced also and losses have been encountered by the storage of alkali waters in California, particularly in southern California.

Q. Is that water obtained in the hills and mountains or from the rivers? Do you not get pure water from the mountain streams?—A. Yes; and the water in Utah is very pure because there are short rivers that come right down from the snow-clad mountains and deliver pure water; but in the Pecos Valley the water travels 200 or 300 miles from the mountains and gathers up these salts as it goes along. The Pecos

River is entirely taken up about 6 miles above the town of Carlsbad, and 6 miles below the reservoir the stream has about the same flow that it has above the reservoir. Frequently out in the Western lands the water is entirely used up before it gets down the whole course of the river, going out in seepage and flowing again into the river after it has been applied to the land. By the time it gets down to its mouth the water is pretty salty.

There is another difficulty in the storage of water in reservoirs that is particularly troublesome in some areas in the West; that is, the amount of silt carried by the waters. In our work in Arizona, where the waters are very heavily laden with silt, we found a soil that has been recognized as a distinct type, which is undoubtedly a sediment left by the irrigation of some prehistoric race. The old canal systems are there and the old irrigation works and the remains of the houses, indicating that irrigation was carried on in some prehistoric time, and the evidences show that this is simply a deposit of sediment or mud from the rivers. The amount of sediment is so great that the people now have great difficulty in maintaining their canals. They have already dug it out and piled it up as far as they can throw it, and it is a serious question now what they are going to do with the canals in certain areas of the Salt River Valley in order to keep them open. It is very generally believed that reservoirs will quickly fill up with the silt in such districts as that unless special precautions are taken to keep them open; and that is an engineering feature that has not yet been satisfactorily solved. In other localities there is no trouble with this silt, as the waters do not carry any great amount. Even if we get water that is free from silt and an absence of salt, there is the further danger of seepage waters and the accumulation of alkali in the soils, as I have already stated.

Q. This accumulation of alkali is only in arid countries? There is no alkali to speak of in the Appalachian Range, is there?—A. No; because the drainage is so great. So much rainfall comes down that it is carried off. The alkali is the natural weathering of the rocks, resulting from their disintegration.

Q. Peculiar to arid regions?—A. Yes; although we have it here in the East occasionally. The mineral springs that we have are due to nothing more nor less than the decomposition of the rocks, and the same cause accounts for the alkali in the Western States. It is the weathering of the rocks being carried off by the water. In the West these decomposed rocks accumulate in the soil and stay there. Our iron springs and our alum springs and mineral springs generally are the products of the weathering of the rock being carried off by the water. But we get no such accumulations here as they get in the West, simply because we have 40 inches of rainfall here, 20 inches of which goes down through the ground and is carried off in the rivers.

Out there we have a very small rainfall, only about 5 per cent of which ever goes off, and then usually over the surface of the ground.

In the consideration of irrigation as a means for the reclamation of lands, I would call the attention of the commission to the necessity of uniform State laws and the possibilities of national legislation. There are certain phases of this subject which will undoubtedly have to be taken up by the National Congress, particularly with interstate streams and where the streams form the boundaries of adjoining States. But as the Department of Agriculture has a distinct division for the study of irrigation and its laws and methods, it would hardly be advisable for me to go into it at any great length. My own connection with the matter, however, in our study of the soils and of the seepage waters and alkali has convinced me that it will be necessary to use more care in the application of water, not only conserving it for use elsewhere, but to protect from the injurious effects of overirrigation and the accumulation of seepage water and of alkali. I think it is safe to say that in nearly all the irrigated districts twice as much land could be irrigated with the water that is now used, with actual benefit to the soil, provided it was intelligently applied.

I would also refer again to the matter that I spoke of a while ago; that is, the necessity of legislation in the case of soils damaged by the accumulation of seepage water and of alkali from leaky ditches and from overirrigation on neighboring farms. It seems to me that a remedy of some kind must be worked out. It hardly seems fair or just that a person owning a piece of land which he has planted and cared for and upon which he uses the most careful and most intelligent means, should be allowed to be injured by a seepage from a canal or from the careless methods employed on a neighboring farm. It seems to me that either through State or national legislation recourse should be given for the recovery of damages in civil suits.

DRAINAGE.

The next method to which I would call your attention for the reclamation of lands is the subject of drainage. There are many areas of swamp lands and still larger areas of cold, wet clays in the United States that are unproductive or have been abandoned from a small accumulation of water which needs to be removed by artificial means. It is claimed that one-fifth of the State of Michigan is swamp lands. The report of the Illinois board of agriculture for 1894 states that during 1893—that is, in one year—there was laid in the State of Illinois alone 26,985,000 feet of tile drains. Of this, 18,310,000 feet were laid in the northern part of the State, 8,607,000 feet in the central part, and the remainder in the southern part. In the north there were 28 feet of tile to each acre cultivated. In the central part there were 29 feet of tile for each acre cultivated, and in the southern

part 1 foot of tile for each acre cultivated. In Douglas County there were 85 feet of tile for every acre of cultivated land, and in Livingston County 78 feet to each acre. In the eastern part of Livingston County is found the Vermilion Swamp. As late as 1880 lands could be purchased there for \$3 to \$5 per acre; the same lands, which have since been drained, are now valued at from \$60 to \$90 per acre for general farm purposes. As a result of this widespread system of drainage as practiced in Illinois and in Michigan, the swamp lands have become the most productive, the healthfulness of the vicinity has been much improved, and the public roads have been kept in much better repair. The drainage laws of Illinois, and in fact of most of the States where drainage is practiced to a considerable extent, are very complete and deal with all phases of the question, from the rights and liabilities of the drainage commissioners of the district down to the minute details which concern the individual. It seems to me that this question of drainage legislation is one of the important questions, at least for the Western country.

Q. What State has the best laws as to drainage? A. My opinion is that Illinois has the most complete; Illinois, Michigan, Ohio, Wisconsin, Minnesota, and New York.

As a result of our soil investigations in the Salt Lake Valley last year, we found that it would be quite possible to reclaim the large tract of salt land west of Salt Lake City, and perhaps that this should be done by the people; but it was apparent in the first place that if it were done it would have to be done by private enterprise, as the State was debarred by its own constitution from taking any part in internal improvements of that character, as is done in Minnesota and in some of the Central Western States. It was further found that, by reason of the lack of any drainage laws, it would be almost impossible to drain any considerable part of that area without getting the written consent of every individual landowner who would be in any way affected; and strange as it may seem, it was not found possible to get such consent in the attempts that have been made.

PROTECTION BY LEVEES.

Another method for the protection and reclamation is by levees for protection from floods and from tide. The commission of course is aware of the important work of the commission having this matter in charge on the Mississippi River, and it is scarcely necessary for me to refer to it at this time. I have also spoken at some length in regard to the levees protecting the rice swamps of South Carolina and adjoining States.

A question that is assuming some proportions now in this country is the possibility of reclaiming the swamps of the Atlantic and Pacific

coasts. Not only is it desirable to reclaim these lands for their agricultural value, which it is admitted would be great, but for the protection, the help, and the material welfare of the surrounding country. We have a very excellent illustration of the tremendous bearing this question has upon the healthfulness and prosperity of a community by reference to the conditions prevailing here in the city of Washington, where the swamps have rendered almost uninhabitable, at least by the wealthy and well-to-do people, certain portions of this city, and where there is no possible question that the cause could be removed, and an appreciation of property aggregating thousands and thousands of dollars could be effected simply by reclaiming the swamp lands.

Q. Have you any method of or any theory concerning the reclaiming of those lands? The tide comes up the Potomac. How can it be prevented from overflowing?—A. The same method would have to be used that is used in the rice lands of the South, where similar conditions prevail. There should be a levee with gates which will let the water out and drain the land, and will shut when the tide comes up and prevent any access from the outside. With that protection against the rise of the tide, accompanied by the necessary drainage in the soil itself to carry off the seepage waters which come from the surrounding country, the land could be reclaimed and put in a high state of cultivation.

This question has been asked in regard to the possibilities of reclaiming many of the marshes of Long Island and of New Jersey particularly. It has been estimated that the reclamation of the marsh lands in New Jersey adjacent to Jersey City would cost something like \$3,000,000. The plans are under consideration now, and, in fact, large areas have already been undertaken in the reclamation of those lands. Also along the coast, particularly in connection with the residents on Long Island and along the Jersey coast, in Delaware and in Maryland, and in North Carolina and in Virginia, the disastrous effects of these swamps are keenly felt by the people who go there to spend the summer near the seashore. Not only are they unpleasant, but they are at times and in places distinctly dangerous because of the prevalence of mosquitoes, which convey malaria, and because of the presence of other fevers that are very fatal or injurious.

A plan has recently been proposed to the Department for the reclamation of a large area of swamp land on Long Island for the purpose of being able to treat the swamp for mosquitoes. They are not able without enormous expense now to control the mosquito pest and the consequent malaria that has come to the locality. They want to see if the land can be diked and subsequently drained, so that they can entirely exterminate the mosquitoes from that locality. It is probable that the plan will be carried out.

It seems to me that such work as that is primarily for the individual

and in the second place for the State. I hardly see that the National Government has any interest or control in the matter. It is certainly not like the development of harbor privileges or the improvement of rivers, for it applies only to the locality in which it is conducted.

Q. (By Mr. CLARKE.) Are you aware of the experiment in reclaiming marsh lands that was made in Marshfield, Mass.?—A. Not particularly.

Q. There the dike had the effect to close the harbor, practically; not but that there was sufficient area of harbor below the dike, but the failure to accumulate a large body of water above that checked the passing out with the ebb of the tide, and resulted in the accumulation of sand bars in the lower harbor, so that the harbor was practically ruined, and there was a great clamor on the part of the fishermen, which finally came to be supplemented by that of cottagers who built along the shore of that small bay, until, finally, the legislature was induced to cut away the diking and abandon the experiment of reclaiming the lands.—A. Oh; it was the outflow of this immense volume of water that filled up the channel?

Q. Yes; so I apprehend that whenever the experiment is entered upon along the shore anywhere to reclaim the marsh lands the question of harbor rights and the like will come in to affect the problem more or less.—A. There is no question that legislation will be necessary, and it is likely to be a complicated matter. It is one that would affect the State, however, and not the National Government, unless it interfered, of course, with the channels of the harbor; then it would be a national matter.

I think that I have covered in these remarks the principal causes of the exhaustion and the deterioration of soils, as I view the question, and I have spoken at some length in regard to measures which should be used for the reclamation of lands. If I have left anything unsaid that should have been said, or if I should have made anything clearer, I should be very glad to answer any questions that the commission may be pleased to ask.

Q. You said something about animalcules in the soils. Is that a comparatively recent discovery, or has it been long known to scientists that soil abounds in animal life?—A. It is comparatively recent, that is, within thirty or forty years, that the bacteria have been recognized and their importance understood.

Q. I have seen a statement that you can take a small tract of soil which is very fertile, and accustomed to produce large crops, and strike it with a pole persistently until you kill all the animal life that there is in it, and that the next year it would not bear anything. Is that correct?—A. I do not think so; I do not think it would be possible to kill bacteria in that way.

Q. (By Mr. PHILLIPS.) You spoke of cultivating bacteria. What process is used?—A. Certain leguminous crops have tubercles on their

roots, which are found to contain large numbers of these bacteria, and by inoculating with this suitable culture medium, they can be cultivated and pure cultures be made. Such cultures are for sale in Germany and to a limited extent in this country, and it is found that certain crops will not grow unless these bacteria are in the soil; therefore many of the leguminous crops, for example clover, will not grow unless there are certain forms of these bacteria in the soil, and by seeding this pure culture over the land, that is, mixing with a little soil, and sowing on the land, the yield may be doubled, or increased even more than that.

Q. The small bulbs are used in producing cultures in the same way?—A. Yes; the tubercle is just mashed in the culture medium, so that the inside is exposed, and these bacteria get out and thrive on this culture medium.

Q. What is used for that culture medium?—A. I am not sure what is used; I am not acquainted with the method of making the pure culture.

Q. (By Mr. TOMPKINS.) That is similar to Conn's culture in giving flavor to butter?—A. To butter or cheese.

Q. Where is this culture made in this country?—A. Some important experiments have been made at the experiment station in Alabama.

Q. At Auburn?—A. At Auburn; yes. Some of the most important work has been done there.

Q. Under whose charge?—A. I do not recollect now.

Q. (By Mr. CLARKE.) Can you ordinarily determine by the examination of soil what is requisite to make it more productive?—A. No; you can not, and that is one of the most embarrassing questions that we have to answer. As I have shown in my testimony, the cause of the deterioration is quite often due to lack of good management, good judgment, and good practice on the part of the farmer, but we can not tell from a chemical or physical examination whether the soil is productive or not. We can often tell the kind of crop it is adapted to, whether it is a truck soil, or wheat soil, or a grass soil, but whether it is fertile in its condition the chemical analysis does not clearly indicate.

Q. Recently Mr. Hammond, of South Carolina, a very intelligent planter of long experience, testified before the commission that in his opinion the use of commercial fertilizers was an evil rather than a benefit, especially in his State, and particularly because it led many farmers to abandon making an application of the ordinary farm fertilizers, manures, etc. What is your opinion about that?—A. My opinion is that in the main that is correct; that the use of fertilizers tends to make the farmer more shiftless and less careful in saving and in the cultivation of his land. Fertilizers have been introduced in comparatively recent years. There was never any trouble for lack of fertilizers in the Eastern countries. The lands there have been culti-

vated for hundreds and thousands of years, but it had been done by careful work. The farmers have saved everything that came off the place. They have saved all of the litter and put that back; all manure and put that back, and all excrements and waste of the farm and put them back on the soil and worked it in; they have had small holdings and used intensive cultivation. With us, we have these large areas, entirely too large to manure with the ordinary waste from the farm, and we rely on these commercial fertilizers with no addition of organic matter, and after with clean cultivation. There is no question in my mind that much harm has been done by continuous and excessive use of commercial fertilizers without the intensive methods that should be employed when they are used.

Q. Would it not, in your opinion, be possible to reclaim very many of the so-called worn-out farms of Maryland and Virginia by gathering muck from the low places and subjecting it to the tread of live stock, and mingling with it the manure that ordinarily accumulates on a well-stocked farm, and applying that intelligently to the various soils of those farms?—A. It would be where the cost of the process would not be too great, but unless it was adjacent to the land it would not be feasible. The cheapest method in that case would be to grow cowpeas and other forms of green manure. There is no question if you adopt such methods as that, of being able to bring the land up. It is simply because farmers do not do what they know is the simplest and most efficient thing to do. There are lands that are kept up in good shape just by the methods that are used on the average farms which are in very good condition, simply because they are attended to in those ways.

Q. Have the farmers of the West begun to practice fertilization a great deal more than formerly?—A. They are not using fertilizers to any great extent. I think the practice is increasing a very little, but very little fertilizer is used throughout the West at the present time.

Q. Is there not danger that their soils will become comparatively barren unless something is done to restore what is taken from them?—A. There will be if the owners persist in the cultivation of the same crop year after year, as is done now in Red River Valley and in some of our Central States; but by a rotation of crops or by introduction of more intensive methods when the soils begin to wear out their fertility can be maintained and improved. Now, they say very justly that while they are getting 12 or 15 bushels of wheat to the acre at the low cost at which it is produced, 20 cents, they don't care at all what becomes of their lands; they are going to last the lifetime of the present generation and they are not concerned with what becomes of them after that. I think very likely that that yield of 12 or 15 bushels that is obtained now in the Red River Valley can be obtained for a long series of years. The soils are almost identical with the fertile wheat lands

of Russia that have produced wheat for a great many generations, but the time will come, I presume, when the yield will decrease below what they are getting now, and they will feel the need either of fertilizing the soil better or of changing their crops and introducing more intensive methods than they have at present.

Q. What is your advice on the subject?—A. I see no opportunity of changing the methods at the present time. It is a good deal like the arrangement made where you can rent range lands for 5 cents an acre per year, and where you can not afford to put much improvement on the lands. They are only worth \$1.25 an acre, and you certainly can not spend much money in maintaining the fertility of such lands. It seems to me it is an economic question; it is not an agricultural question. We simply can not afford to maintain the fertility of those lands with the expense attending that process until lands become more valuable than they are at the present time.

Q. It is cheaper, is it not, to maintain fertility than to restore it?—A. That, of course, is a relative matter; it is more expensive for us and it is less expensive for our grandchildren.

Q. Have you investigated the subject of flowing sewage upon the lands?—A. I have not, except quite incidentally. We have never made any investigation of that question at all.

Q. (By Mr. PHILLIPS.) What is the best green crop to raise to fertilize the land—plowing it down, for instance?—A. Clover is one of the best renovators of the soil where it can be grown, but the possibilities of growing it are limited and the most generally useful crop is the cowpea of the South.

Q. That came into use quite recently?—A. Yes; well, twenty-five years ago in an extensive way.

Q. Is it used to a considerable extent in the North and West?—A. It is being used to a considerable extent now in the North.

Q. It is supposed to have this bacteria, is it not?—A. Yes; it has these root tubercles.

Q. (By Representative BELL.) Have you ever visited Greeley in Colorado?—A. I was there once, six years ago.

Q. They have a rotation there on first wheat; then they follow with alfalfa, which they plow under; then follow with potatoes, and in turn follow the potatoes with wheat. They thus grow an enormous crop every year. I think they make over 40 bushels of wheat there to the acre following those crops. —A. And they get enormous yields of potatoes.

Q. Enormous. It is the best potato spot in the world. They haven't a rival in the United States. I think they ship the best potatoes to London.

(Testimony closed.)

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