Crop Growing
and
Crop Feeding

CROP GROWING AND CROP FEEDING

A BOOK FOR THE

FARM, GARDEN AND ORCHARD

With Special Reference to the Practical Methods of Using Commercial Fertilizers Therein.

BY W. F. MASSEY

Member of the National Geographic Society, Vice President of the North Carolina Horticultural Society, Professor of Horticulture and Vegetable Biology, North Carolina College of Agriculture and Mechanic Arts, Raleigh, N. C.

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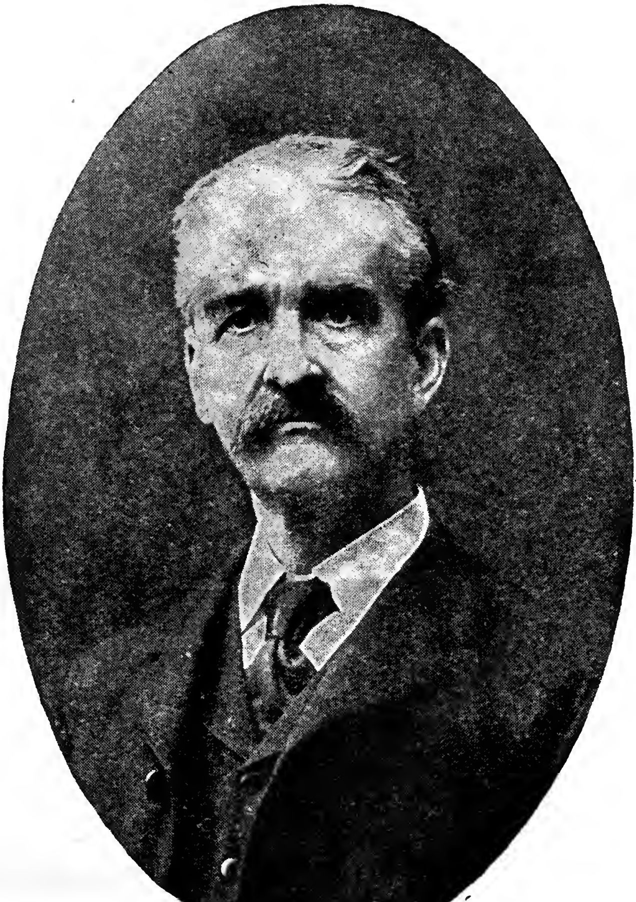

W. F. Massey

PREFACE.

This book is the result of an effort to put into the plain language of the farm the facts which scientists have worked out in the laboratory, and which practical experience has proved to be applicable to the every day work of the farm. It is written for men who know nothing of chemistry, but who are anxious to learn something of the chemical combinations that are of value in the feeding of crops, and the best way to use them in the permanent improvement of their soil. For men who know nothing of the mysteries of plant life, but who are anxious to learn how plants live, grow and perform all their work in soil and air, so that they may be better able to comprehend their needs, and supply them in a rational manner.

While endeavoring to make the book scientifically accurate in all its statements I have tried to avoid all pedantry, but to make the whole so plain that the "wayfaring man, though a fool, need not err." I have undertaken the work with a good deal of misgiving as to what should be its exact position on some of the problems in nature as yet not fully solved, and about which there is much yet to be learned by the wisest minds. When such problems are attempted, I will candidly say that I do not as yet fully comprehend the processes involved, I will give the results so far as they are known. The acquirement of nitrogen by leguminous plants is one of the problems that has not yet been fully worked out, and while we know that they *do* get the nitrogen through the agency of minute organisms that live with them on their roots, the exact process by which these microscopic forms get the nitrogen is not yet fully understood. But for our purpose it is enough to know that they *do get it* and store it in the roots and soil for the future crop.

W. F. Massey

N. C. College of A. & M. A.,

Raleigh, N. C.

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INTRODUCTION.

The only excuse I have to offer for the manner in which this book presents the subject of crop growing and crop feeding, is the fact that there is so much of ignorance, even among men nominally educated, in regard to the vital processes in plant life. I meet men daily, who have taken college degrees and are in professional life, who still think that the sap rises in the trees in the spring and runs down in the fall; that is about all they know of plant life, and even that little is not true. They have never studied plant life in an intelligent manner, for in all of the old college curriculums botany has been rigorously ignored, or even if attempted, it was only a little spring time study and a brief effort to learn the scientific names by which the plants are called; the main effort was merely to do this, and the result was that the student knew no more about the wonderful life of the plants around him than he did before. Hence educated men, or rather men crammed with the information of the books, fall into all sorts of errors and believe all sorts of old wives' fables about plants. A very intelligent gentleman who is interested in some phosphatic rock mines in this State, told me once that the rock they mined was more soluble than ordinary phosphatic rock because of the heavy forest growth above the deposit, for the sap running out from the roots of the trees in the fall had a solvent effect on the rock below. This man has traveled all over Europe and America, and has a large fund of general information, and no argument I could use would convince him that no sap runs from the trees in the fall. Late one fall a few years ago a reader of one of our city papers wrote an inquiry to the editor, saying that he had noticed that just before a rain the springs and brooks had swelled, and he wanted to know the reason. The editor, a college bred man, told him that the explanation was perfectly simple, as at that season the sap was running out of the tree roots and raised the springs. He never seemed to think of the real reason, the release of atmospheric pressure just before a rain. I wrote to the paper and told him that there was no such thing as sap running out of the roots of the trees, and entered into some explanation of the processes of plant life. It was amusing after my letter was published, to note the surprise with which it was received. Educated men stopped me on the street and asked if it was really true that the sap does not run out of the roots, and that all plants get the larger part of their fabric from the air and not from the soil.

This same general ignorance in regard to plant life is the cause of so many otherwise intelligent men believing that one plant can be suddenly transformed into an entirely different one. That wheat will change to chess or cheat. Men who have studied the life history of vegetation know the utter absurdity of this notion, but it is so firmly fixed in the minds of many intelligent men that it is perfectly useless to argue with them. They have never been taught accuracy of observation in their youth, and hence jump to conclusions that are not warranted by the facts. Some months ago a farmer in this State wrote me a letter, asking if there was any premium offered by the Agricultural Department of the State for the positive proof that wheat would turn to cheat. I answered that there was no such offer, and I knew there was no such proof. A friend of mine, a leading lawyer of the writer's neighborhood, then wrote to me that I had treated his friend rather curtly, for he knew that he had the positive proof, and he would send it to me. Accordingly a few days after I received a package containing a well grown plant of cheat with numerous wheat grains adhering to the tips of the rootlets. I wrote to the lawyer that if this was what he called proof, he would have to learn to sift evidence better or his reputation as a lawyer would suffer. The fact that dead wheat grains were attached to the feeding tips of the rootlets of the cheat, was simply proof that the wheat decayed and the roots of the cheat found the grains and were feeding on them. If the cheat had really germinated from the wheat, the grains would never have been found on the place where the absorptive root hairs were foraging for food, but would have been right up where they started from, and that what he regarded as positive proof of the transformation of wheat into cheat was, on the other hand, a positive proof that no such change had taken place, for the roots were simply seeking food, and the weather conditions that killed the wheat were just the kind that were favorable to the development of the hardy cheat, which never winter kills. It is with the hope that a study in a simple manner of some of the processes of plant life will help to banish superstitions, and will be the means of some of our readers getting a better understanding of the reasons that underlie the culture of our crops, and the supplying of them with food. We have made the effort to avoid, as far as possible, language that might confuse the unlearned, and to clothe facts in the every day language of the farm so far as possible.

It will be noticed that we state that 95 per cent. or more of every plant comes from the air, and not from the soil, and we endeavor to explain how the plant gets the material from the air. But to see in a practical way how much of a plant comes from the air, take a good sized corn stalk and weigh it. Now cut it up and dry it thoroughly. Not merely air-dry, but dry it as a chemist would dry it in his dry bath. Now weigh it again, and you find that it contained a great deal of water. Now burn it carefully and completely, till you have only white ashes left. You will find that these weigh but a trifle as compared with the great corn plant. And yet that little handful of ashes contains all the plant got from the soil except the nitrogen, and that the soil originally got from the air. The mineral matters, or ash elements, are what you have left in the ashes. The rest was carbon and water, and it has gone off in the shape in which the plant originally got it, as carbonic acid, to feed other plants and make other structures, for there is no destruction in nature. The same old materials are being used over and over again, perpetually building up new forms. In regard to the nature of commercial fertilizers, there is a general notion among farmers that they are mere stimulants, and that while they can be used to increase crops, their final effect is to exhaust the soil. The injudicious way in which commercial fertilizers have been used in the Eastern Middle States, and in the Southern States, has led to this opinion. Used as they have been in the past by the cotton and tobacco growers of the South, they have been a curse to the country, and have led to poverty of soil and poverty to the farmer.

But this is not the fault of the commercial fertilizer, for well prepared fertilizers are simply plant food, such as we find in any manure; and if properly used for the improvement of the soil, they can be made the means of restoring and maintaining the fertility of our lands more efficiently and cheaply than in any other manner. The only classes of substances used as applications to the soil to which the term stimulant can be properly applied are lime and plaster. These are used not so much for their value as plant food, but for their effects in rendering other matters, notably potash, available in the soil. They thus stimulate the soil to give up to plants matters it already has, and thus gradually tend to the exhaustion of these things if carelessly used, with the notion that lime and plaster will make land rich because we see a good effect from their application. There are extensive districts in the North, where once the farmers got large crops from the use of plaster alone, and imagining that plaster was all they needed, they kept on in its application, and now find that there is nothing more for the plaster to give them and are compelled to use commercial fertilizers liberally. Had they known more of the real work the plaster was doing for them they could have avoided the gradual exhaustion of the mineral elements in their soil. But there are some writers who would persuade the farmer that in the use of commercial fertilizers *alone* they have all that is needed, and that land can be kept perennially fertile simply by giving every crop a liberal application of a complete fertilizer. They beg us, when we urge the farmer to adopt a good rotation of crops in which the legumes are brought frequently to accumulate humus in the soil, to "give humus a rest," insisting that humus is not plant food, and that crops can be grown as well without it as with it. It may be that in a season of very favorable weather and abundance of moisture in the soil, the commercial fertilizers will have their best effects, even if there is no humus or vegetable decay present. But in a season like the one we have just passed through, we have found in late October, in a soil deficient in humus, all the fertilizer applied in the furrow, as dry as it was when applied. Not two hundred feet away was land in which the humus content was much greater, and here the plants had gotten the dissolved plant food, because of the superior mosture-retaining nature of the decayed vegetable matter. Therefore, even if this decay furnished us no nitrogen, it would still be valuable for its mechanical effects in making the soil mellow, and in its power of retaining moisture for the plants. What we try to impress upon our readers in this book, above all else, is the fact that the true use of the commercial fertilizer is the maintenance and increase of the fertility and productiveness of the soil, and not so much for the immediate returns in sale crops. True farming does not consist in the dosing of the soil for every crop with a prescription some land doctor advises as a specific for that crop, but in so using these valuable plant foods in the improvement of the soil that there will be no need in any of our ordinary farm cropping for the use of what is called a *complete* fertilizer at any time, and seldom any need for an application directly to the sale crop. Used in this way, there is no doubt that the fertility of the soil can be restored and maintained more cheaply and more rapidly by the use of commercial fertilizers than in any other way, though no farmer should wholly ignore the foundation of all rational farm improvement, the keeping and feeding of live stock in the best manner, and the making and saving in the most careful manner all the domestic manures. The deplorable condition of much of the cotton land in the South is due, not only to the injudicious use of commercial fertilizers as a means of getting sale crops, but to the entire abandonment of stock feeding by the cotton farmers. The annual cultivation of the soil in the one clean cultivated crop has used up the humus and none goes there, because there are no animals fed to make manure and no renovating crops between the cotton crops, and when a dry season comes, the fertilizers applied are not dissolved and the crops are poor. The season of 1900 was remarkable as the hottest and dryest on record in the South Atlantic States, and the lands without fertilizer did as well or better than those directly fertilized. But recently, meeting a farmer whom I knew was farming in a short rotation with legumes, I asked him about his cotton crop. "I expected to get 40 bales on 35 acres. The drought has affected me some, and I will have hardly more than 35 bales." All around this man's farm there are those who will hardly get a bale on five acres, and they spent more for fertilizers on their crop than he did, who gets a bale per acre. It is, therefore, with the earnest hope that we can induce farmers North and South, to understand the true use of commercial fertilizers that this book has been prepared. We have written it from the standpoint of the practical farmer, and have prepared it for practical farmers.

While living in the South, a native of the South, and striving with all my energy to aid in the building up of the agricultural and horticultural interests of the southern cultivators of the soil, the writer has had a wide experience in the growing of plants and crops in various sections, and has traveled and studied the practices of growers in all parts of the country. He therefore feels that he is prepared to help farmers in various sections, and to contribute something, at least, to the general advancement. The great interest that has been awakened in regard to agricultural education is well shown by the great increase of books on agricultural topics. Formerly the effort was to treat of the whole subject of agriculture and farm economy in a single small volume, and our libraries still contain some of those little books. In the organization of our Colleges of Agriculture and Mechanic Arts the greatest difficulty that beset the faculty in these institutions was the total absence of books on agriculture and horticulture that could be used as text books with the college classes. The result was that every professor was compelled to prepare his own lectures and to conduct the instruction along lines devised from time to time to meet the emergency. Out of this work there have grown up books in which various parts of scientific cropping are treated, and there is no longer any effort made to combine in one small volume all the matters that relate to cropping, stock breeding and feeding, farm drainage and soil manipulation; but the soil and its treatment and cropping have come to be considered as something separate and distinct from the animal husbandry of the farm. While in a work of this kind methods of soil preparation and culture are of necessity treated, to some extent, the chief aim of the book will be to make plain so far as has been ascertained, the methods of supplying the manurial needs of crops, and especially to endeavor to do something towards encouraging a more judicious use of the commercial fertilizers than is common among farmers. Few northern farmers fully realize to what extent the southern farmer has come to rely upon commercial fertilizers for every crop he plants. And it is important that in the interest that is now being taken in the Central West in the use of commercial fertilizers, that the farmers be protected from making the mistakes that have proved disastrous to the southern farmer, and that they should be taught in the beginning of their use of these fertilizers, where and how they may be made profitable, and how to avoid the dangers of soil wasting that have followed hard upon the use of commercial fertilizers in the cotton states. The poorest farmers and the best farmers use commercial fertilizers. The first-class dribbles them in small quantity under his sale crop, solely for the purpose of getting a little more to sell; the second class uses them in a far more liberal manner for the purpose of building up the soil and the development of its natural capacity. The first class of farmers simply use enough to add a little to what the land would do unaided, and thus get what the soil would do and all that the fertilizer did, and the result is that the soil is in a worse condition by reason of the application; and it is no wonder that the men who use these forms of plant food in this way have come to the conclusion that they are only stimulants. The greatest educational influence of late years among farmers who have passed the years when they could have attended a college, has been the Farmers' Institutes. When these Institutes were first inaugaurated farmers as a class knew little about the chemistry of the fertilizers they used, and regarded that the best which smelled the worst. Since the Institutes and the Grange have been getting in their work there has been a wonderful change in this respect, and the farmer who does not know something about the chemical composition of the fertilizers he uses, and the nature of the elements entering into them, is as rare as one who did know these things was at one time. These educational influences have also brought about a change in other respects. Farmers, as a class, have now a greater respect for what they formerly ridiculed as "book farming," and today it is only the grossly ignorant among the farmers who fail to realize what scientific study and investigation have done for the farmer. Another educational influence that has been brought to bear upon the farmer is the Agricultural Experiment Station. The whole modern system of spraying for the prevention of fungous diseases in plants and to ward off the attacks of noxious insects, has been brought about through the work of the Experiment Stations, and on no subject of interest to the farmer have the Stations devoted more attention than to the study of the various forms of plant food sold as fertilizers, their composition and value. Before the inauguration of these Stations the farmer was at the mercy of the compounder of fertilizers, and had no means for ascertaining their real value. With the inauguration of the Experiment Stations and their analyses of these mixtures came the passage of stricter laws regulating the sale of fertilizers and protecting not only the farmer, but the honest fertilizer manufacturer, from the frauds that were formerly so common. The result of all these influences is that farmers who never had the advantages of a scientific training have been taught to understand what is necessary in a good fertilizer, and are rapidly learning that they can make these mixtures themselves as easily as to buy them ready mixed, and can save money in so doing. Then, too, the result of the publication of the analyses of commercial fertilizers has had the effect of driving from the market inferior articles and of improving the general standard of the factory-made fertilizers, and in States having a good and well enforced fertilizer control, the farmers are now protected from rogues, and the honest manufacturers are not compelled to compete with them. We have urged the home mixing of fertilizers upon our farmers, not from any antagonism to the manufacturers of fertilizers, but because we know that in the thoughtless purchase of ready mixed articles, growers are continually buying what they do not need to buy, and getting mixtures poorly adapted to their soil and crops, though they may be manufactured with perfect accuracy and honesty. No one mixture will suit all parts of the same farm, or all the crops grown upon it, and the farmer will thus be compelled to buy various brands in order to get what he needs. But if he buys the materials and mixes them to suit his soils and crops he can buy the whole in larger quantity and at a lower price. The fact has more than once been demonstrated at the Experiment Stations, that one may buy at retail the various materials that enter into a commercial fertilizer, and save money from the price he would have to pay for factory mixed goods. This book, being written by a farmer, for the benefit of farmers, will advocate what its author believes to be the best interest of the farmer, without regard to what others may think of what we write. It will, as I have said, treat the subject of cropping and feeding crops from the standpoint of the practical farmer in full sympathy with the work of scientific investigation.

Having been more or less connected with the practical carrying out of Station investigations in agriculture and horticulture, since the foundation of the Experiment Stations, the author of this book has had exceptional opportunities for study and observation; and these apportunities, added to his long experience as a practical cultivator of the soil in farm, garden and greenhouse, enables him to write with some confidence for the benefit of those who, like him, are endeavoring to win bread from the soil. The original design was simply to make the work a reference book on the use of fertilizers for the general farmer. But it is difficult to write of the use of fertilizers without going somewhat into details of cultural methods; and then, too, the market gardener, the orchardist, the florist and the winter forcer of products under glass, are all interested in the use of commercial fertilizers. Hence the idea of the work has grown so as to include some of the work of each, and our hope is that all will find it a valuable book of reference. So far as the garden crops and the work under glass are concerned, special attention is paid to the needs of the market gardeners of the South Atlantic and Southern States, since the work of the gardener in the North will be more fully discussed by those actually engaged in the business there.

CHAPTER I.

THE AIR.

All plants and animals pass their lives at the bottom of the great ocean of air that surrounds the earth. From this air plants derive by far the greater part of their substance. Pure air is a mixture of two invisible gases, nitrogen and oxygen. The nitrogen is for the purpose of diluting the oxygen so that animals can breathe it. But the two gases are not combined with each other. The nitrogen is called free nitrogen because it is perfectly free from any combination with other elements, but in order that plants can use it it must become so combined. But of this later. We have said that plants derive the greater part of their substance from the air. In fact about 95 per cent. of every plant comes from the air, or to speak more correctly, from matters that exist as an impurity in the air. For while pure air is composed of the two gases mentioned, there are always more or less of other gases in it, not as essential parts of the air for animal life, but as impurities and detrimental to animals. But with plants the case is very different. One of the impurities in the air is the gas called, commonly, carbonic acid, and which is known to the chemist as carbon-di-oxide; that is, it consists of two parts of oxygen associated and combined with one part of carbon. This carbon-di-oxide is the gas that accumulates in old wells and mines and makes what is called choke damp, so deadly to animal life. But there is always a minute portion of it in the air everywhere, and while an excess is damaging to animal life a small portion is essential to the welfare of all plants that make green leaves.

HOW GREEN LEAVED PLANTS GET FOOD FROM THE AIR.

All growth in plants and animals alike, is made by the increase in number and the development of certain microscopic boxes known as cells. A very thin cross section of a piece of the pith of the elder will show the primary structure of plant cells under a glass of small magnifying power. There are many plants of minute size existing in water that, during all their lives, consist of but a single box or cell. Then advancing in complexity we find these cells strung together in threads, then in flat surfaces in a single layer, and finally arranged in numerous forms circling around the stem of the plant to make up the structure. We are so accustomed to look upon a tree as an individual existence that it is hard to realize that it is really a great community of individuals, each doing its work in the way it was set out to do in the beginning and never making any mistake about it. It is hard to realize too, that the framework of the great oak is a lifeless thing, around which life circles in a myriad of forms, while it has entirely abandoned its finished work, and that the central heart wood takes no part whatever in the vital functions of the tree, but is merely the mechanical support of the army of builders which, year after year, add thickness to its stem and wider spread to its branches. This heart may entirely decay and the tree become hollow, and the life still continue to circle around it.

Hence it is important to know more of the structure and functions of plants in order to fully understand their needs. We have said that all growth is made by the multiplication of these little box-like cells. The tree grows like a building, in which brick after brick is placed in the walls. But in the case of the plant the brick maker and the mason live inside the brick. The walls of the cells contain no life, but are the result of the vital forces contained within them. Every plant cell in its growing state is filled with the substance that carries life with it. This substance has been given the name of protoplasm, or the first thing formed. It is a clear semi-fluid substance, partly granular and partly transparent, and uniform in its appearance. This substance, resembling the white of an egg more than anything else, does all the work of the plant, and it is what in the composition of the plant is called by chemists the albumenoid or protein part. It is itself entirely formless, and yet this formless substance controls the shape of the cell that encloses it, and makes the wonderful variety of forms of cells that we find in the plant by the aid of our microscopes, and little by little builds up the form of the plant, always with an unerring accuracy, so that the final result is such that we recognize the plant as belonging to a certain genus and species, though it may be, and probably is, in some minor points unlike every other plant, even of the same species.

But as to the essential features, the protoplasm never makes any mistake. The oak may grow beside the pine, and their roots interlock and feed upon the same substances in the soil, while their tops are bathed in the same sunlight. But the oak never by any chance makes a pine cell, nor the pine an oak cell;

though no one can discern any difference in the living matter of the two. Each follows the laws of its inheritance, and obeys the order set out for it in creation.

I have said that this living matter inside the plant cells is partly of a granular nature. Some of these grains are colored green, and thus give us the green color of vegetation. This green color is a very important matter, for without it there could be no growth. We may put a plant in darkness and blanch the leaves white, and then examine the grains under the microscope and we find that they are still there, but the green color is gone, and the plant stops growing. It is evident then that the green is of importance to the growth of the plant. It is, in fact, the substance that enables the plant to get the food it needs from the carbon-di-oxide in the air.

Every leaf has on its surface a mutitude of small valves, opening and closing like a pair of lips, and they are really the mouths through which it takes in food. These mouths are far more plentiful on the under sides of leaves than on the upper, and in some plants there are none at all in the upper surface. The interior of the leaf is made up of a loose aggregation of cells containing the green granules. The mouths open in among the spaces between these loosely arranged cells, and thus bring the air to the interior of the leaf. When the sun is shining, and at no other time, these mouths in the leaf are wide open. The air enters the leaf laden with the carbon-di-oxide. If the temperature around is proper for the growth of that particular plant, the green matter at once decomposes the carbon-di-oxide, separating the carbon from the oxygen. The oxygen is then thrown off to purify the air, and the carbon is retained by the plant. We do not know that this identical oxygen is that which is thrown off, but we do know from experiment that the same amount of oxygen is thrown off as was combined with the carbon.

Now in the wonderful laboratory of the green leaf, begins the work of the living matter. From the roots water has been brought up to the leaves, in which is dissolved the various forms of plant food that come from the soil. As it comes from the roots it is merely water with plant food dissolved in it. With this water, and the carbon that has been gotten from the air through the leaf mouths, the living matter goes to work to prepare food for its own sustenance, and to make the materials out of which it builds its cell walls, and thickens their woody structure. The first thing formed from the carbon, hydrogen and oxygen, is probably some form of sugar for the immediate use of the plant. But the living matter works rapidly, and makes more material than it can use at once, either for food or building walls, and hence it has to store the reserve material. This reserve material is the first thing we can discover in the leaf, and it is starch. When starch is made in the leaf it is soon carried away and stored for future use, unless at once needed to build walls with. It is stored in roots, in underground tubers like the Irish potato, and in stems generally, and in seeds. The surplus over what the plant needs for its existence, forms what animals consume as food. In some seeds, the starch is further transformed into oil for preservation. Now neither starch nor oil are direct plant food, but they are stored in the seed for the future use of the germinating plant, as they will keep unchanged, while sugar, the food, will not keep. But when a seed germinates another wonderful change takes place. A fermentive principle is formed, which has the power to transform the oil back into starch, and from starch into glucose, or grape sugar, which can be used directly by the living matter as food, and as material for building up structure, until the green leaves are formed and the roots begin to absorb matter from the soil.

During the time the seed has been dry, the living matter has simply been dormant, waiting for the coming of water under a proper temperature with the oxygen of the air, to render it once more active. There is a great difference in the length of time during which the living matter will retain its vitality in a dormant state. Some seeds lose their vitality as soon as they become completely air dry; others will retain their vitality for a year, while still others will remain dormant for a number of years, and will grow as soon as the proper conditions of moisture , heat and air are present. Elsewhere will be found a table showing the length of time different seeds are good.

HOW PLANTS GET FOOD FROM THE SOIL.

Put several layers of damp blotting paper in a glass jar or tumbler, and on it place several beans, and then cover with a piece of glass, so as to retain moisture. In a few days the beans will germinate, and begin to throw out long white roots.

Now examine these roots. You will find that the extreme tip of the rootlet is of rather a conical shape and is smooth and naked, while a little back from the tip a magnifying glass of moderate power will show you that the surface of the root is covered with a thick coat of fine velvety hairs. These root hairs are the organs through which the plant absorbs water from the soil. Their extreme fineness precludes the possibility of anything being absorbed that is not in a state of complete solution, as all solid particles must of course, be strained out. The mineral food of the plant is dissolved in the soil water, and is sucked by the root hairs from the watery films that surround each particle of the soil. In order that they shall do this, it is essential that the particles of the soil shall be in a state of fine pulverization, whereby its power of retaining moisture is greatly increased. Prof. King, in his work on the soil, illustrated this in the following way:

A marble, dipped in water, will retain around it a film of water. If it is broken in two there will be an increase of surface to hold a film of water, and if it is pulverized, there will be a marvellous increase in the number of particles, each having a film of water around it.

These root hairs are produced on a short part of the rootlet just back of the tip as fast as the tip is projected into the soil, and as the root back of them grows older, and the cell walls thicken, the root hairs die off, and that part of the root remains simply as a conduit for the water the root hairs are gathering beyond.

In this way, the root hairs are being continually formed in fresh soil and are foraging in new pastures. It should be easy then to understand that where a little fertilizer or manure is placed only in the hill, the roots soon get beyond it, and the feeding organs, the root hairs, are hunting for food in poorer soil.

But the root tip itself is one of the most admirably contrived parts of the whole plant. The extreme point of every rootlet is a little older than the part just behind it. In other words, the actual growing tip of the rootlet is a group of young forming cells under the protection of a root cap. At this growing point new cells are formed to continue the elongation of the root, and to add to the structure of the root cap from beneath, so that the root cap is always being renewed from behind, as it is pushed through the soil by the elongation of the root behind it, and protects the young forming cells beneath it. It is easy to see that this is an admirable provision for the protection of the point of growth. In the older botanical works, it was stated that the extreme tips of the roots were what they called "spongioles," and it was supposed that the work of absorption was carried on by the "spongioles." Having nowadays better microscopes, we have learned that there are no "spongioles" at all, but that the protecting root cap goes ever ahead of the advancing rootlet to search out the way, and to guide the root into fresh food. There seems to be a sort of dull sensitiveness in the root cap, by which it is in a measure enabled to choose its way among the particles of the soil. The roots branch in an irregular sort of a manner, and not after the regularity of the branches above the ground, each branch coming out from the central core of the rootlet, and carrying with it a portion of the outer bark as its first root cap, and then the branches form root hairs just as the main rootlets do.

The root hairs seem to have the power, by some sort of secretion, to attach themselves firmly to the particles of the soil and suck moisture from them. If you sprout a seed in sand, and when the roots have developed, take it carefully from the sand and gently wash the roots, you will find that the root hairs are covered with fine particles of the sand, closely adhering to them. This close adhesion of the root hairs enables them to absorb all the moisture that surrounds the soil particles as a film, and enables them to get an amount of moisture from an apparently dry soil, that is surprising to those who have not studied that matter closely. There is also evidence that the root hairs do to some extent, exert a solvent influence on matters in soil otherwise insoluble.

THE COURSE OF THE SOIL WATER IN THE PLANT.

There is a direct connection between the roots branching in the soil, with their myriad of absorbing hairs, and the leaves on the top of the plant. In our trees and woody plants, this course is through the youngest sap wood, and in herbaceous plants like corn, it is through the pithy soft tissue. Anyone who has observed a corn stalk, has seen that through the soft part of the stalk there are a multitude of threads. Observing a cross section of the corn stalk under the microscope, we see that these threads are really tubes, or elongated cells, with thickened walls, and in the growing state of the plant, the walls of these cells are always saturated. As the leaves branch off, some of these tubular threads branch into the leaves and form the framework, or what we call the veins of the leaf. It is through these fibres that the sap water reaches the leaves, and it is in the leaf where all the wonderful changes are made by which new material for growth is formed. Then after the material for growth is made it is carried wherever there is call for material through the youngest cells of the growing bark, and all the material for growth of top and roots comes from the leaves.

Twist a wire tightly around the stem of a growing plant, and you will see that the growth is coming downward from the leaves. The stem swells above the stricture, and if it is long continued the path for the ascending sap water is finally cut off, and the branch will perish, with a swollen base formed from the materials that were taken in from air and soil before the wire was placed there.

There was an old notion that the sap goes up in the spring and down in the fall. The fact is, that there is no circulation in plants that can be compared with the circulation of the blood in animals. The sap that rises in the trees in the spring is simply sap water in which the food of a mineral nature for the plant and the nitrogen for the living matter is dissolved, and the only descent is that of the formed material for growth.

This sap water, when it comes from the ground, is in a very dilute state; and another function of the valves or mouths in the leaves, is to evaporate water into the air, and in this way, to condense and concentrate the food brought from the soil. This evaporation is also one of the means by which the water is pumped up from below, and that there is a rapid evaporation from the leaves is evidenced when we cut off a leafy branch and note how quickly the leaves wilt when the supply is cut off.

Wilting of the leaves is also one of nature's methods of protecting the plant. During the hours of sunlight, and at no other time, the mouths in the leaves are open to take in carbonic acid. But if the heat is great and the soil is dry, the leaves will wilt, and this at once closes the pores or mouths, and checks the evaporation until the plant can recover a supply from below.

CHAPTER II.

THE GROWTH OF A SEED.

The prime object of the plant's existence is to prepare for the perpetuation of its kind. In some plants, the whole force of its vitality is expended in one season, in the production of a large crop of seed, in the growth of which the plant is exhausted, and it perishes after the seeds are formed. Such plants enduring but for a summer, we call annuals.

There are others that spend the first year of their existence in the storing up in roots a great accumulation of food, which they exhaust the next season in the production of seed, and they, too, then perish. These are called biennials, or two year plants. Others store up growth of larger dimensions, year after year, and finally, when strong and well matured, give some of the accumulated vitality to the production of fruit and seed, and continue to do so for many years; some for hundreds of years, having a rather indefinite term of existence. These we call perennials, or plants living through a long series of years. Still another class accumulate during years of growth, long or short, a great store of food, and finally make the supreme effort of their lives in the production of a vast growth of flowers and fruit, and then perish. To this class belong the plants known as Century plants, the American Agaves and others.

The plants that farmers depend upon for crops are chiefly the annual and biennial classes.

THE FLOWER.

The flower of a plant is considered by botanists to be really a collection of leaves, changed in various ways to serve the purpose of reproduction. Every complete flower has two protecting coats; the outer one called the calyx is commonly green, but is sometimes brightly colored. The inner circle of transformed leaves is called the corolla, and its separate leaves are called petals , while those of the calyx are called sepals. The inner circles of leaves are still further transformed so as to make stamens and pistils. On the stamens are borne certain cells that open by valves, and which contain the male element of the flower called the pollen. The central set of transformed leaves makes what is called the pistil or female organ of the flower. At the lower end of this grows the seed vessel, or ovary, containing the ovules, which are to be transformed into seeds. At the upper end of the pistil is a variously shaped organ known as the stigma, which is naked and for a while moist on the surface. The pollen, or male element, falls on this and swells and begins to grow into a tube of various lengths, according to the character of the flower. This pollen tube passes through the tissue of the pistil till it reaches the ovary, and there in a certain cell of the ovule it sets up a new growth of cells, that gradually take on the form of a miniature plantlet, and form what is called the embryo, or germ, of the seed. In this seed the plant then stores up starch or oil sufficient for its sustenance till in its germination it can make green leaves. It then rapidly parts with the water and the seed becomes ripe, and remains dormant until brought again under the influence of moisture, warmth and the oxygen of the air.

A seed then is a living organism in which vitality is simply suspended for a time, and which contains all the elements of a future plant when placed under proper conditions for growth. If it has these conditions it will grow. If they or any one of them are absent it will remain dormant or perish. If the seed is buried so deeply that the oxygen of the air cannot properly affect it, though there may be moisture and heat, it will not grow. We see this frequently in the case of clover seeds deeply buried in the soil, which grow after they have again been turned up to the influence of the air. If moisture is absent, the living matter of the seed cannot swell and become active, and though there may be heat and oxygen enough, the seed cannot grow. Then, too, there may be moisture and oxygen, but if the temperature is not right for that particular seed, it will not grow. This proper temperature varies with different seeds. All cultivators know that some seeds need more heat than others. The garden pea will germinate at a temperature but little above the freezing point, while Indian corn subjected to the same conditions will perish. It is essential then, to know something of the nature of the seeds we plant so that we may give them the proper conditions of growth.

THE FRUIT.

While the seed is the final result of the plant's effort at reproduction, the fruit is the ripened vessel or ovary which contains these seeds. The pea pod is the fruit of the pea plant, and is simply the ripened seed vessel. But there are some plants in which other parts are commonly known as the fruit.

In the apple, the ripened seed vessel, or core, is surrounded by the thickening calyx of the flower, which increases in size after the petals of the flower fall, and surround the fruit proper, which we call the core, and this thickened calyx is what we use as the fruit of the apple and pear and quince. In the strawberry, the end of the stem on which the fruits are borne, swells up and carries the collection of little fruits up, borne on its outer surface in little depressions. We call this edible part the fruit, while the botanist calls the seed vessels that contain the seeds, the true fruit. The edible part of the strawberry is merely the swollen receptacle which bore the flower.

In our Indian corn, each grain that we call a seed is a separate fruit, the result of the ripening of the ovary of the pistil, which is the silk. For every grain on the cob is the result of a single female flower, and each grain has its own silk, and if each silk does not get pollen from the tassel, or male organ, there is no grain formed. Hence we can easily see why a single stalk of corn standing in a field seldom makes a perfect ear. In the field the great cloud of pollen that floats all around and covers the ground insures the fertilization or impregnation of every silk. The cereal grains then are ripened fruits and not mere seeds. In a state of nature the plant simply stores food enough to insure the growth of the plantlet for a while after germination. In cultivation the effort is to increase this store that it may be made use of by man for food for himself and domestic animals. Nature is content with mere reproduction; we want something else. Hence to keep plants up to a greater production of useful material, it is necessary that we should accumulate the desirable qualities by constant selection of those that show the greater tendency to make what we want. Nature is perfectly content with a wild crab apple. It has all the power of reproduction, and is more hardy and vigorous than the highly developed apple, since it is the survival in the struggle with other plants of like character, while the plants we would choose have developed a certain desirable character for our use, but have in other respects gotten less able to survive in a struggle with wild plants. So we have paid attention to the accumulation of a desirable growth of the edible portion of the apple, and have bred it away from the original wild crab into something we want. But turn it back to the unaided forces of nature and it will soon revert to a form adapted to survive and the fruit will become less and less desirable to man.

We find, then, that the more we refine a plant and fit it for our use the more it needs the fostering care of man, and the less able it is to take care of itself.

The wild potato of Peru and Arizona makes small underground tubers, simply enough to keep a portion of the plant with buds and capable of growing again. We have bred the cultivated potato into the habit of storing larger quantities of starch in its under ground tubers, and this, too, has been brought about by a gradual accumulative selection of those that develop this habit to the greatest extent. Left to themselves, there is a constant tendency to revert into original and inferior forms.

Our tomatoes are the result of long selection, starting with a cross of the smooth and hollow forms on the crooked and solid fleshed sorts, we have by accumulative selection gotten the knobby tomato inside the smooth skin of the hollow one, and we find yet that it is hard to keep it there, and the volunteer plants that annually come up in the garden are apt to revert into one or the other of the original forms.

CHAPTER 3.

PLANT BREEDING.

Many people imagine that the new and improved forms of garden and field plants that are brought out by our enterprising seedsmen are the result of some sort of magical hocus pocus of crossing or hybridizing, and think that by taking two plants that have characters we wish to combine we can, by crossing them, at once obtain the combined character we want. The fact is, that crossing simply gives us a starting point from which, by long and careful selection towards an ideal plant we may have in mind, we may finally reach a point near what we aimed at. The new varieties introduced by the seedsmen, when they are really new and valuable, are the result of long years of careful selection through which hereditary characters have been formed that may be expected to be permanent in the offspring. The writer once attempted the development of a variety of sugar corn that would have stamina enough for the Southern climate. As a starting point, a cross was made of the Leaming, a Western field corn of a yellow color, on the Mammoth sugar, a large eared, late sugar corn of a white color. The first result of the cross was to cut the plant loose from its inherited character, and the ears came sprinkled all over with white wrinkled grains, yellow wrinkled grains, white dent grains and yellow dent grains. We assumed that the yellow wrinkled grains were the ones that inherited the characters of both parents. Therefore we selected only these for planting. The next season there was a larger proportion of grains that had this character, and they were produced on a plant of a sturdy, yet short habit and just the style of plant we were aiming at. The process of selection was carried on year after year in a location where the plants could not be affected by pollen from any other corn. But it required seven years of careful selection before we could establish the heredity that caused the plant uniformly to make yellow wrinkled grains all over the ears.

I mention this to show that the making of an improved variety of any plant that is reproduced from seed is not a sudden thing, but must be the result of long and patient effort. But it is an effort that any observant farmer can make for himself, and he can thereby increase the value of his crops to a very marked extent. There is no magic about it, but only the patient working towards an ideal well formed in mind to which we wish to attain.

But in all plant breeding and improvement we must work for the character of the whole plant and not for a single feature. In the colder sections of our country plant breeders who have undertaken the improvement of the Indian corn have been compelled to take earliness of ripening into account, and hence have developed a character that is not essential to the farmer in the more southern sections. In the South farmers have for generations been breeding corn simply for the biggest ear. They get enormous ears, but by taking no account of the habit of the plant, they have developed a tall, long-legged corn that bears but a single ear and requires a greater distance in planting, and hence makes a small product per acre. Southern improvers of the corn plant should work for a more dwarf and sturdy habit, and greater prolificacy. In other words, they should work for the character of plant they want without regard to whether it is a late ripening sort or not, since they have time enough to ripen any. But the Northern improver must take also the quality of early ripening in addition to the character of the plant and its prolificacy. Breed for a plant suited to your needs and not for one character of the plant alone. But it is not the corn plant alone that may be improved by selection. All our cereal grains, our cotton, tobacco and all other plants that are reproduced from seed, will yield to the same course of treatment and may be immeasurably improved. But to keep these improved forms to their standard the selection must be carried on the same way it has been done. A farmer gets an improved variety of corn, which has been selected on a certain line. He finds it really an improved variety. But he goes at once to work selecting seed out of the crib as he has always done, without reference to the character of the plant that bore the ear, and soon he finds that the corn has changed its character and is no longer like the corn he got, and he concludes that the improved sorts soon run out. But it is simply because he has bred it on a different line from that by which it was originally developed. He has worked simply for a big ear while the introducer worked for the whole plant.

Another point to be observed in the improvement of plants is to remove them from disturbing influences around them. We may have corn which shows very nearly the character which we wish to perpetuate, and it is surrounded by stalks that have produced no ear, but have made an abundance of pollen on the tassel. The chances then are that the seed taken from the fine stalk will have been crossed by the inferior ones, and will take more of their character than its own. Therefore, in saving seed corn, we should make sure that none of the barren stalks are allowed to make tassels and thus to interfere with the process of seed improvement. I once undertook the improvement of my tomatoes. I found one plant in the field which showed remarkable productiveness and fine, smooth fruit. It was surrounded by rough and undesirable plants. If I had taken the seed from this plant it would have been crossed by inferior kinds. Therefore I made cuttings from it late in the fall and potted them, and placed them in the greenhouse. They were there cared for as other greenhouse plants are, and more cuttings were made late in winter. By spring time I had plants enough to set a considerable area and all of the same identical habit, and could now save the seed with some certainty of getting plants more nearly like the original than if I had taken seed at first. These seeds were sown the following year and another selection made and carried over from cuttings, and in a few years I had a tomato which I have never seen excelled. Unfortunately, after years of effort the stock was lost in fire. I give this as a sample of what may be done by intelligent effort with almost any of our garden vegetables and flowers. There is no branch of cropping either in field or garden, more interesting and profitable than the improvement of cultivated varieties. Form in mind the ideal plant which you wish to produce and annually select seed from plants that come nearest to your ideal plant. Never select for a single character in the plant. If you select simply for big ears of corn you may get the big ears along with other undesirable characters. If you select for a big tomato, you will get that, but it may be unproductive and of bad shape. In plant breeding we must take into consideration all the characters we wish to perpetuate in the plant, and try to breed out all the bad features by avoiding them. The improved tomato of today is the result of long-continued crossing and selection, for the purpose of getting the crooked, but solid and meaty Mexican tomato inside the smooth skin of the old smooth, but hollow tomato. It is always trying to get out, apparently, and hence constant selection is needed to keep a variety near the type. While we can, to a certain extent, get plants into the habit of coming true to seed it requires constant watchfulness to keep them so, for there is always a tendency to break away from the inherited form and to sport into others. A break of this sort may be an advantage and a starting point for a new variety found. I have recently had my attention called to a curious instance of this. A gentleman has a tree of the old Blood peach, which has for years borne the same peach, and this peach is of such a fixed type that it commonly comes true when raised from seed. But the past season, the tree in question abandoned its habit and produced a crop of white peaches instead of the typical ones, blood red to the seed. It is impossible to explain the cause of these reversions, or "sports," as the gardeners call them. But when we find these variations from the normal type, we can frequently make them permanent by propagation. Many years ago, at Kenansville, N. C., Rev. Mr. Sprunt found a shoot on a Safrano rose bush in his garden, which made a flower of a lemon yellow color, whereas the Safrano is a buff colored rose. The sporting shoot was used for cuttings, and from this variation we have the Isabella Sprunt rose. Many other florist's plants have originated in the same way.

But in plants that are annually grown from the seed, it is necessary to fix by selection through years, the hereditary habit of coming true to the desired type. It is in this way that the races or strains of certain plants have become established. Carelessness in the selection of seed is the main cause of most of the degeneration of types that bother the farmer. He gets a corn or a wheat of a certain variety, which has been bred to its present state through a long series of years, by selecting towards a well established ideal plant in the mind of the grower. When he has brought it to a point of comparative perfection it is sent out, and at once men who have different ideals or none, get hold of it, and the tendency to variation which all plants possess, starts it off in various ways, and while the seed lists continue to give the name of the variety the seed has often been bred away from the original type in to a variety of forms. A neighbor of mine many years ago, sent North and got seed of the King Phillip corn, a variety of a dark brownish yellow color, with a small cob and broad, flat, flinty grains. His idea was to get an early ripening corn for late planting on the low lands near a river where the soil did not dry out early. Under his mode of selection the corn has assumed an entirely different type, and the only point in which it now resembles the King Phillip is its color, for the number of rows on the ear has doubled, and the corn is a dent instead of a flint, and is now more similar to the Leaming. He selected simply for the largest ears, as is the common practice among the majority of farmers.

Since the Indian corn is more susceptible to improvement than most of the crop plants grown by our farmers I will here give the method I have heretofore advised in regard to the saving of seed corn. If the grower is in the northern limit of the corn belt, he will have to pay attention to the earliness of the variety he wishes to secure. In the South this item may be entirely ignored, since we have plenty of time to mature any corn. I would begin with the best variety attainable in the section where the corn is to be grown, for it is far better to start with an acclimated corn than to get a variety from north or south of the locality. Therefore get the best corn in your neighborhood, and plant a patch especially for seed. Give it the best of care in the preparation of the soil, the manuring and the cultivation, for a complete development is what we want first. Do not crowd a lot of plants in one hill, but plant singly in the rows. Now watch the corn as the tassels first show, and go through it and cut out every tassel before it ripens, from every hill that does not promise to make an ear; for these barren stalks are strong males and their pollen will have a deleterious influence on the plants around them. Then, as the crop matures, mark the stalks that come nearest to the type of plant you are after. In the North, have an eye to the earliness of the plant as well as the other characteristics. In the South we need to breed towards a shorter and more sturdy plant, and to get away from the long-legged style so common, in which the ears are almost out of reach and are borne singly on the stalks. Select for productiveness, by marking only those with two or more ears. In the South, select for the seed ear the lowest one on the stalk, and this will generally be the smallest one, but it will inherit a tendency to form another ear above it, and we need this as well as the tendency to grow nearer the ground. In the North it may be best to save both ears.

From the corn thus saved plant not only your entire field, but another seed patch, and on this seed patch, practice the same plan of selection, always keeping in mind the ideal plant you wish to establish. As the number of ears on the plant increase, and the productiveness of the variety is established, we would select for the general character of the plant year after year. The southern corn has become long-legged from the constant practice of selecting the largest ears in the crib. These large ears are commonly the only ones on the stalk, are usually borne high above the ground, may have been surrounded in the field by a multitude of barren and inferior stalks, and, as it is the pollen around the plant, rather than its own, which sets the grains, the planting of the big ear will often lead to disappointment. If every farmer paid the proper attention to the selection of his seed corn, the crop all over the country would be immensely increased without any additional acreage.

The cotton farmer in like manner should have his seed patch and select for the ideal cotton plant, and not merely for big bolls; and in all our annual crops plant breeding in an intelligent manner would greatly increase the average yield. But as the majority of farmers will not undertake this work, it leaves a wide field for intelligent effort for those who do, for they will be able to get a greatly increased price for their well bred seed from those who are not disposed to take the trouble. Not long since I had a letter from a North Carolina farmer saying that he had been practicing the method of saving seed corn which I had advised, and that his crop had increased in productiveness to such an extent that his neighbors were wanting his corn for seed. Such is always the case with the improvement of any of our crops, and shows that the reward of intelligent effort at improvement is certain.

IMPROVING THE COTTON PLANT.

There is no plant grown by our farmers which will yield more ready results from intelligent selection and breeding than the cotton plant, and there is no plant grown in the United States of greater commercial importance. In fact, the greater part of our foreign commerce is founded upon the fact that we lead the world in the production of this great staple, and yet there is no farm plant that has been so persistently neglected by plant breeders. Of course here and there thoughtful men in the Cotton States have done much for the improvement of cotton for their particular section, and for a while the varieties produced by them have a certain popularity. But soon the careless methods of selection among cultivators in general, change the character of the plant, and the ideal plant towards which the originator was working is lost sight of and a deterioration is the result. There is no one point in which there is greater need for intelligent effort on the part of the agriculturists of the Experiment Stations in the Cotton States, than in the improvement of varieties of cotton for the different sections of the cotton belt. In fact, the whole matter of plant breeding should claim the special attention of Station workers, for in no other way can the workers in agriculture and horticulture more efficiently aid the farmer and gardener, than in the production of more prolific plants of the various crops and the increase in the quality of their products. Here and there this matter has been receiving attention, and the real improvement in the cotton plant dates more from the origin of Experiment Stations than during any previous time. The cotton grower, like the grain farmer, has too long been aiming at special features in his product, rather than the general development of the whole plant. The corn grower of the South has worked simply for a big ear. He gets this at the expense of prolificacy and gets a tall and ungainly plant. The cotton grower is enraptured by a big boll, and fails to see that when breeding simply for a big boll he is getting a long legged "weed." No real improvement can be effected in any plant that proceeds upon the selection for a single feature of the plant. The cotton grower wants, of course, as large a boll as possible, but he does not want the large boll at the expense of yield in general. He likes a good length of staple, but he does not want the long staple at the expense of late maturity and weakness in the constitution of the plant. Hence anyone who attempts the improvement of any of our crop plants must study the character of the whole plant, and not attempt to breed for characters that are antagonistic to each other. Our southern farmers readily recognize the fact that there are good and poor varieties of corn, wheat and other crops, but the great majority of the growers seem to think that cotton seed is simply cotton seed, and take very little thought about it so long as it will germinate and grow. The result is that only here and there have there been men who have given any attention to the selection of improved varieties of the cotton plant, and when these improved varieties are sent out among farmers they are delighted with some of them for a while, and then, having secured the improved strain, they assume that they have it for good, and go ahead as they formerly did, get their seed from the general crop at the gin, and the variable force so strong in the plant, soon takes it out of the strain into which care has bred it; and though the grower claims that he is still growing the variety, he has simply allowed it to run back to an inferior variety and finds it no better than the others. It is not the fault of the improved variety, but of the careless grower. So long, then, as the great mass of cotton growers will take no pains in the proper selection of their seed, there is room for great profit to the grower who will work in an intelligent manner to produce, for his own use at least, a cotton that will prove of increased productiveness and quality. Mr. H. B. Mitchell, an intelligent cotton grower in Georgia, writing in regard to this matter, says that he has proved the utter fallacy of the notion that any kind of cotton seed is as good as any other. "Starting out with unimproved seed making one-fourth of a bale per acre, we have, with improved seed and careful selection each year, produced a cotton which, under very adverse conditions, yields a bale per acre, and from which we are satisfied the limit has by no means yet been reached. To improve seed, the first of September we go over the cotton, marking such stalks as evince the highest points of merit. The cotton from these stalks we pick in advance of the regular cotton pickers, rejecting all damaged or immature bolls, and spreading as picked, till thoroughly dry. It is next carried to gin, the gin completely cleaned out, and swept around, a large sheet spread down to receive the seed, which is then sacked up and so kept till hauled to the field at planting time. Were it not for bees there would be no trouble in keeping the cotton pure, but they bring the pollen from fields of unimproved cotton, causing a good deal of mixture."

Mr. W. E. Cole, of Cartersville, Ga., writes: "I was raised on a cotton farm in the old South, and no care was taken in the saving of the seed, but it was simply taken from the general seed pile at the gin in the fall. As I grew older I began the study of the cotton plant more closely. I noticed that some stalks produced more lint than others and of a better quality, while some had hardly any as the seed was black and lintless, and these, of course, had their influence on the plants around. I began to think that if one could get rid of those black and lintless seeds it would be a great improvement in the cotton. (Lintless seeds bear the same relation to cotton as barren stalks do to corn.—W. F. M.) But upon noticing more closely I found several varieties of cotton in the same field. Some was storm proof, while in others the cotton would fall from the boll in the least shower of wind or rain. In 1897, while picking cotton, I found a variety which suited me better than any I have ever seen, as it produces more and larger bolls and lint of a superior quality, being long and fine and the seed of small size. When the season was over I had fifty pounds of seed cotton of this variety. I took it to my ginner and gave him the lint to take the seed out clean and separately. He cleaned his gin of all seed that was in it, and fed it through by hand, so that I had a bushel of clean seed to take home. In the spring this was planted on an acre, well cultivated and thinned to eighteen inches apart in three-foot rows. It made a rank growth and we had to lay it by the last of June, as it was then too rank to get through. When fall came it was a pleasant sight to look upon, the stalks averaging 40 to 50 bolls and some as many as 80 well developed bolls; and would pick nearly a pound of cotton. I cleaned 1,000 pounds of lint from that acre and got seed enough to plant my entire crop the following year. I sold no seed that year. One of my neighbors contended there was nothing in selected seed and I gave him a bushel of my seed, which he planted in the middle of his field with mixed varieties on either side, to give it a fair test; when fall came he was thoroughly convinced, as the selected seed made double the crop of the mixed seed on the same ground. I make 35 to 50 per cent. more cotton than with mixed and unselected seed."

These items of experience, from practical cotton growers, show plainly that there is no crop more amenable to improvement than the cotton crop, if the seed is wisely selected. If every grower of cotton would take the same pains the crop could easily be doubled without any increase of acreage, and there would be more profit at low prices than there is now at fair prices. Since the price of cotton in this country is almost entirely dependent upon the size of the crop, and a large crop is apt to run the price down to a point at which a careless grower finds no profit, it is evident that if a careful man, by intelligent selection of seed, can double the product of his area, the selection is well worth looking after.

But, as we have said, any selection for the improvement of the product must take into consideration the whole plant and its surroundings. The habit of the plant has a great deal to do with the size and character of the crop. A cotton plant that habitually grows long-jointed and single-bolled can never be as productive as one that is more compact in habit and makes twin bolls. Long staple is a good feature, but if mere length of staple is the only feature looked after it may be accompanied by other less desirable characters. Hence, in the improvement of cotton, it is desirable to get together the plants that have certain desirable features, though they may not all be combined in one plant. But by planting together the ones that have at least one feature we are after, and taking them away from the influence of plants like the lintless ones, we may by degrees get the desirable features combined in one variety, if we annually work towards an ideal. Mr. Cole was very fortunate in making such an advance in a single season, but if the same selection is not followed up the variable character of the plant will soon run the cotton back to its former mixed character. The permanent improvement of no plant that is annually reproduced from seed can be effected in a single season. We must patiently, year after year, select towards the ideal we have in mind, until we have established hereditary tendencies to come like the seed plant. Only after years of careful selection can we claim to have an improved variety. And here is right where there has been more failures than in anything else connected with the cotton crop. One grower, like Mr. Cole, finds plants of extra quality and saves the seed. The result is an improvement. But the plants selected from were surrounded by others of inferior character, and, as Mr. Mitchell says, the bees are always bringing pollen to the blooms, for there is a great deal of nectar in a cotton flower, and the result is that the variety is not uniformly the same, nor permanent. The plants for seed should annually be planted in a section by themselves, and all inferior plants that vary from the type sought should be rigorously rogued out. No matter if your entire crop was planted that season from selected seed of the year before, save no seed but from the seed patch where the watch has been kept on it, and finally you will get a real race, or strain, of improved cotton that will be permanent. I have treated thus fully on the fruit and the seed, since upon these depend all the improvement we are to make in our cultivated plants that are to produce the crops we sell and use. And there is no one point in farm economy more neglected than the breeding of the plants we cultivate. Seedsmen fully understand the great value of pedigree in their seed stocks, and pedigree in a plant also that in an animal, comes through thoughtful and persistent breeding towards an ideal plant or animal. We have treated of the selection of seed in the corn and cotton plants as types of two great crops that are of interest to two large classes of growers. But the improvement through selection is not confined to cotton and corn. There is not a crop grown on the farm that will not yield improved results to the intelligent plant breeder. The broom corn grower can increase the length and quality of his brush and get it on a plant nearer within reach by careful selection and the growing of a seed-stock by itself, for no permanent advance can be made so long as the seed-stock is subject to disturbing influences around it. We have been hearing a great deal of late years about the need for seed testing under Government control, and our great Department of Agriculture has, until recently, done a good deal of laboratory testing of seeds. While this work has a certain value in the determining of the clean character of the seeds and their germinating quality, it does not go far enough to determine anything of real value to the cultivator. The wide awake gardener, farmer or seed grower lays more stress upon the pedigree of the seed than upon the mere matter of percentage of germination. Of course a fair percentage of germinating power is essential in any seed that is to be planted, but the wise cultivator will take seed of a lower germination test than another if he knows that it has a better pedigree behind it. The laboratory germination test proves nothing in this regard, and, in fact, would not show whether a certain sample was cabbage seed or cauliflower or some other cruciferous plant, or whether a certain sample of beets was an early or late variety. All that the laboratory test proves is the percentage of pure seed free from trash and weeds there is in a sample and the percentage of these seeds that will germinate. The only real test of seeds is that practiced by the best seedsmen who run farms at great expense, for the sole purpose of testing the seeds they sell, in the same conditions that their customers must be under; and also by the workers in the Experiment Stations in their variety trials. Intelligent seed growers must of necessity understand the laws of nature under which all their attempts at improvement must be carried out. It is an easy matter for the gardener who is propagating plants from cuttings, buds, grafts and layers to catch and make permanent a certain variation in his plants that may be desirable, for he is simply reproducing that identical plant; and he can retain the variation at once and make it permanent, as I have shown, in the instance of the rose grown from a sporting shoot, which at once makes a new variety to be cut into thousands and put on new roots. But in the case of the plants annually grown from seed there is a set of very different conditions. Plants are infinitely variable, and the blossoms that are to form the seeds are subject to infinite interference from insects, winds and the neighborhood of other plants of the same species. Plants of a vigorous character are always tending to break away from the line of their breeding, and if the grower slack in his efforts, or loses sight of the ideal towards which he is selecting, nature makes a reversion, and it may be towards an inferior type. Hence, as we have said in the case of the cotton of Mr. Cole, it is not enough to have made a start. It must be kept up, and only constant vigilance will keep any plant true to type and above its fellows. Therefore we would lay down the following rules for those who would improve their cultivated crops:

1. Fix well in mind the type of plant you wish to grow, and never for an instant lose sight of it.

2. Begin by selecting the plant that comes nearest to the type, and do not expect to get your ideal all at once.

3. So far as practicable, remove inferior plants from the immediate vicinity of your selected plant; save seed from the selected plant only.

4. Plant the selected seed as far removed as possible from any other plants of the same kind, and then rigidly root out every plant that falls below the first selection; save seed only from plants that show a decided advance towards the ideal plant you have in mind.

5. Never breed for a single character of the plant, but take the whole plant into consideration. If you breed simply for a big ear of corn or a big boll of cotton, you may get these at the expense of other desirable characters; but take the whole character of the plant, its habit of growth, its general productiveness and every desirable character, so as to get not only the kind of product you want, but get it on an ideal plant. If you follow this up with patience, year after year, always remembering that what you want is seldom what nature would place in the survival of the fittest, and that any relaxation of effort on your part will give nature a chance to undo your work,—you will finally find that you have a race of seed on which you can rely with certainty as to the result, you will find that intelligent seed merchants are ever on the hunt for the men who have sense enough to study and improve their plants, your neighbors will take an interest in your crops and there will be more money in your purse, and you will be a benefactor of your race by improving production.

While the improvement of the soil for the production of crops is the main object of this book, there is no doubt that we will be excused for dwelling so long on the seed and its selection, for there is fully as much to be gained in this way as by the improvement of the soil in which they are grown.

No matter how a farmer or gardener may improve his soil in productive capacity, if he plants seed of inferior character his crops will not be what they should be. If our farm readers could visit, as I have done, the seed farms of the seed growers, and the testing farms of the great seed dealers, they would be amazed at the minute care that is needed to preserve and improve the seeds they purchase; they would no longer wonder that first class seeds must bring a fair price, and they would realize that the most costly thing a man can buy is poor seed. Not merely seed of poor germinating power, but seed destitute of breeding, and, like a scrub cow, not entitled to register among well bred animals. And yet in all their purchases there is no one point where farmers are so short sighted as in the purchase of seed. This is particularly true of seeds of forage and grass crops, which are so generally purchased. A farmer finds in the hands of a commission merchant a lot of clover seed right from the huller, and buys it, solely because it is to be had for a dollar or more less per bushel than seed that a seedsman has carefully recleaned. The recleaned seed is usually cheaper by reason of the greater number of clover seed in the bushel, and it is infinitely cheaper in the fact that the farmer sows no weeds with it. The larger part of the weeds that infest our farms and reduce our crops, have gotten there in foul grass and clover seed. A farmer recently wrote me that his farm is so completely stocked with the narrow-leaf plantain gotten in clover seed that he can no longer make a decent crop of clover. I never read a better sermon on the value of clean seed than his letter. Buying cheap seeds, or rather low priced seeds, is "saving at the spigot and losing at the bunghole." Better pay two prices for clean clover and grass seed than to have the inferior given to you. Farmers should be students of seeds in more ways than one. They should learn to know seeds of all sorts when they see them. For instance, take a sample of clover seed. It may have in it as a purposely added adulteration (as is practiced by some), seeds of the worthless yellow trefoil; and the farmer who has not studied seeds will not detect the adulteration till he sees his fields yellow with the trefoil instead of red clover. It may have in it seeds of dodder that will speedily destroy clover, and they will pass muster with the careless observer, by reason of their yellow color. A good magnifying glass is of greatest importance in the selection of seeds, and a knowledge of seeds is quite as important. Hence every farmer should get a collection of the seeds of all sorts of foul weeds, and get completely familiar with them, so that he can at once detect what impurities are in the seed samples he is examining. The seed is the starting point of the crop, and if the crop is to be a success the seed must be the best. The seed is also the starting point of the weed, for a weed is merely a plant where it is not wanted. Hence if we do not want weeds we should be extremely careful never to sow them. Many thousands of acres of the best mowing lands are so foul with weeds that there is more weed in the hay than timothy or clover, and the losses to farmers all over the land, through foul clover and grass seed, are so great that we cannot too urgently insist upon the importance of the seed.

CHAPTER IV.

THE SOIL.

While, as we have seen, plants get by far the larger part of their structure from the air, they get by far the most important matters from the soil, so far as the making of a crop is concerned. While the carbon-di-oxide in the air and the oxygen itself are essential to plant growth, the soil and the matters which it furnishes are also essential. Some idea, therefore, of the origin of soils and their nature and composition is essential to a proper understanding of plant life, and the means for best sustaining and improving it.

Back in the eighteenth century, the great French chemist, Lavoisier, enunciated the great truth that in this earth nothing is created and nothing is destroyed. That is, all substances that now exist have existed from the beginning and will always exist. We cannot create anything; we can simply make new combinations of things already existing in soil and air, and when this new combination is destroyed, these matters go back to the forms in which they were acquired. We grow a tree from materials existing in soil and air. Finally we burn the tree and get back the heat it originally got from the sun. It is destroyed as a tree, but the carbon-di-oxide and water and nitrogen have gone back where they came from, into the air; we have left a handful of ashes, representing what it got from the soil, and these we put back in the soil, where they can be used over again to build other plants. The elements that went to make up the tree are still in existence, just as they were before they were combined into a tree; and so in soil and air nature is simply working over the same old materials and forming new combinations.

The soils that form the foundation for our farms are all the result of the gradual breaking down of the old earth-crust, and the crumbling and pulverizing of the rocks through natural agencies. When the earth first cooled from a molten ball, the old, crystalline rocks were formed, and in the lapse of ages other rocks were formed under water, and afterwards were elevated. As soon as rocks are above the sea the process of disintegration begins. The waves of the ocean dash upon them and grind them into sand. Rains, by imperceptible degrees, dissolve them. Water gets into the cracks and by freezing, forces off particles large or small. It is, therefore, by this weathering process that the materials for our soils have been formed, and then washed down from the higher to lower elevations, and spread abroad over the rocky base.

Many soils are formed from the gradual decay of the rocks on which they rest, and are, therefore, of the same composition as the rocks themselves. Other soils have no connection with the rocks beneath them, but are formed by the decomposition of other rocks, mixed with decayed organic matter, and brought down in flood and deposited on the low lands, making what are known as alluvial soils. Then, too, in many instances the valley lands, known as limestone soils, are the beds of ancient lakes, in which the limestone was formed from the shells of mollusks; the alluvial soil was afterwards accumulated above the rocks, and the soil really contains less lime than soil of a very different formation.

The mountains of the present day are far lower than they were when first formed, and the constant wearing away is still going on; the streams still bring down from the mountains vast amounts of fresh soil to accumulate on the flats and river bottoms, gradually forming more alluvium.

Every hill that is in cultivation is constantly being carried off to the lower lands; hence, the low lands are of varying nature, sandy, clayey or silty, according to the kind of material brought down to them from time to time. Of course, there is a great variation in the mineral constituents of soils everywhere, depending on the chemical make up of the rocks from which these mineral matters come. Low lands about the bases of the hills are generally fertile, not only because of the masses of soil transported to them in floods, but because the rain water running down to them from the hills carries the most soluble elements of fertility with it, to be absorbed by the low-land soil. The low lands are constantly being extended and elevated, and the ponds are constantly being filled, till finally the smaller lakes become fast land, being filled up by soil washed down from the hills and with the remains of the vegetation they produce themselves.

But while all the soft earth above the solid rocks is called soil, the soil that the farmer is mainly concerned with is that upper portion that has become altered by exposure to the effects of the air and the carbonic acid in the rain water, and which has become mixed with the decay of vegetable matter and has assumed a darker color by reason of this vegetable decay. We call this the soil, and all that lies below is called the subsoil. They may be, and generally in our upland soils are, identical in their composition; and differ only in the fact that the surface soil has accumulated humus from the vege-decay, and, by being exposed to the action of the oxygen of the air, has been brought into a condition in which it more readily gives up to plants its store of food.

The original source of the humus in the soil was the natural growth on the land. Nature does not like bare ground and she soon covers it with some sort of vegetation. Among the grass and weeds the seeds of trees find lodgement and grow, and soon a forest is formed. The trees send their roots down deeply into the soil, and then scatter their leaves on the surface to gradually decay, year after year forming more and more of the black decay, and increasing the fertility of the soil.

Then, after a while, some one comes along and cuts the forest down, and begins to cultivate the soil. He finds it fertile and productive, and he goes right along cultivating it in the same crop year after year, and it gradually becomes less and less productive, till finally it is abandoned, to grow up once more in grass and weeds and once more be taken by nature for a new forest. Then, on the soil which was called worn out, but which was simply rendered unproductive by bad treatment, nature, by her unaided forces, with no fertilizer but that which she gathers from her own bosom, makes a grander growth than the man who wasted the soil ever grew. And she repeats the same process that formed the soil in the beginning, bringing up from deep down in the subsoil matters for the growth of trees, and spreading it year after year on the surface. Then another fellow comes along and makes firewood out of this second forest, and goes to work to reduce again the soil made fertile by the forest. He succeeeds sooner than the first, for the accumulation is more recent and lighter. But this man cannot afford to throw the land out and clear another piece as the first possessor of the soil did.

So he begins to dribble a little commercial fertilizer on it to induce the soil to yield him crops to sell. He does this year after year, and keeps cultivating the land in cotton or corn or wheat, as the case may be, and he wonders that the land seems to grow poorer and poorer, and the farmer gets poor too. But let him stop in despair, and nature will grow a grand crop again on that land without calling in the aid of the fertilizer man. Of course, we cannot, in our modern agriculture, adopt the methods that nature does exactly. Life is too short for a man to wait for the forest to grow and enrich a piece of land for him; he must get the same results in a far quicker manner. Getting a hint from nature's methods, we can do all that she does, and do it in a very brief time compared with her work. That the soil has not been exhausted as was thought, is shown by the fact that the forest grows readily on this land when it is left to its own resources. It had simply declined to give up its plant food as rapidly as we needed it for crops, but was still in condition to gradually give it up to the slower demands of the forest. The fact is, that *no land, originally fertile, and of good mechanical composition, is ever worn out.* It may be brought into a very unproductive condition, and its mechanical condition be made unfavorable to the production of crops, but it will still have the matters in it that can be made available. By proper tillage and the use of restorative crops, such soils can be restored to their original productiveness through their own resources. The process of restoring such soils in this way would be too slow for our modern ideas, and hence the soluble matters used in a concentrated form as fertilizers have their legitimate use in the upbuilding of the modern farm.

In many cases the soil has simply been robbed of the humus or vegetable decay, and is still as rich in mineral plant food as ever, but its mechanical condition is such that plants cannot thrive in it as they did.

The soil runs together and bakes hard after rains, and the cost of tillage is greatly increased, while the productiveness of the land has decreased. It simply needs a restoration of the black humus that made it mellow and retentive of moisture, and rendered the plant food in it more available.

There are many soils called worn out which never had much to wear out. A little accumulation of vegetable matter on top of a deep sand was soon used up, and a blowing sand is the result. Such soils had far better be left to pine and scrub oak.

Thousands of American farmers find themselves confronted by the problem of "worn out" lands, and how to restore them to productiveness, and it is with the hope of aiding them in the solution of the problem in an economical manner that this book has been written.

LIVING SOILS AND DEAD SOILS.

There are in many sections of the country, large areas of land originally fertile and productive, which would have remained permanently productive, had they been properly managed. Their condition is due largely to the fact that life has abandoned them, because the low forms of plant life that carry on the changes in the soil and make plant food available, have been starved out, and no addition simply of concentrated plant foods will take the place of the foods on which the bacteria of nitrification exist. When these lands were cleared from the forest, or broken from the prairie sod, they were full of the black decay of organic matter. They were retentive of moisture and gave up their plant food to the cultivator in abundant crops. Year after year the process was repeated and the soil robbed. No steps were taken to keep up the amount of the black humus that made the soil originally productive, and gradually it was used up. The minute organisms, whose life is spent in the transformation of this organic matter into forms adapted to the use of crops, perish by reason of the burning up of the humus. There is nothing for them to work upon. The soil runs together and bakes under the influence of the rains, and rapidly dries out, so that there is a lack of moisture for the solution of the plant food it contains. The oxidizing influence of the air fails to penetrate the compact soil, and though it still contains all the plant food needed for big crops, it becomes an unproductive soil because plants can no longer get what the soil has for them in abundance. It is a dead soil. And all over the land one sees these dead soils, made so not only by the using up of the humus but by the settling of the soil into a sour mass; where formerly it hardly needed drainage, now it is sour, not from lack of food but from lack of the ability of the air to penetrate and mellow it. That humus may not have had in it nearly the amount of plant food that still remains in the soil, but it was the preservative agent in the soil, the only thing that kept life there, and its absence means death to soil and crops. One of the most thoughtless advocates of commercial fertilizers some time ago said in print: "Give humus a rest, we can get along without it if we have plenty of soluble fertilizers for our crops." All over the country, and especially in the South, farmers have been giving humus a rest, and their lands have become less and less productive, notwithstanding the millions of dollars' worth of commercial fertilizers they use upon them in the vain hope that they will take the place of permanent fertility. If the worn soils are ever to be redeemed it must be through the getting back there of that bacterial life that carries on the changes in organic decay, and these can only exist when there is this organic decay present. A soil filled with bacterial life is really a living soil and a fertile one, while one without it will always be less productive. It will be less productive, not only by reason of the absence of the organisms that release nitrogen in the soil, but by reason of its smaller power to retain moisture and heat and to dissolve the plant foods applied in the fertilizers. Last summer we applied a dressing of fertilizer to a crop of sweet potatoes on some of this dead land. The summer was extremely dry, and when the potatoes were dug the crop was only such as the soil would have made alone, for the fertilizer was lying there as dry as when applied. On another piece where the humus had been to some extent restored, the fertilizer acted well, simply because there was moisture retained there to dissolve it, and the plants got it. If there were no living organisms to help us in this humus, its mechanical effect would alone give it sufficient value to warrant every effort to retain and increase it.

HOW TO DETERMINE WHAT THE SOIL NEEDS.

When men first began to be interested in the chemical composition of soils, and the improvement of their productive capacity, they jumped to the conclusion that a chemical analysis would show them just what was lacking; and by adding this they could restore the soil to its original productive character. But chemical analysis at once showed them that there may exist very large quantities of all the needed plant foods and yet the soil remain in a very unproductive state, owing to the fact that the plant food it contains is in a condition insoluble in the soil-water, and, as the plants cannot take anything through their roots that is not completely dissolved in the soil-water, they starve in the midst of potential plenty. Therefore, while soil analysis has its use, it can never be depended upon to tell the farmer just what his soil needs to render it productive, so far as the food supply is concerned. The fact is, too, that soils vary widely within narrow areas, and an analysis of the soil from one portion of a field will not give a correct idea of the nature of the soil in another portion. As the uselessness of soil analyses became apparent men began to study the needs of plants, and the way in which different crops use the food elements. While all plants use the same kinds of food from the soil, they use them in varying proportions, one needing more nitrogen, or more phosphoric acid, or more potash than another. Acting on the belief that from the analysis of the plant we could accordingly proportion the different plant-food elements for each crop, the manufacturers of fertilizers began to make what are known as special fertilizers, and recommended one for one crop and another for another. There seemed to be a reasonable basis for such notions, but really there is not such a serious difference after all, in the manurial requirements of plants, while there is a wide difference in the manurial requirements of soils.

If chemical analysis, then, will not materially help us in deciding what our soils need, how are we to ascertain what we should apply and what we need not buy? All farmers know that without some such knowledge they are likely to be wasting money in the purchase of matters that they do not need on their land. This is a matter which every farmer must find out for himself, and no one can find it for him elsewhere than right on his own farm.

Hence every farmer should be, to some extent, an experimenter. He must experiment with his land not only to discover its food needs, but also to find whether through imperfect preparation and imperfect drainage he is not obliged to buy plant food which he does not need at all. Of the methods of this experimentation we will treat in detail elsewhere. First let us see what things are essential in the soil in order that plants may grow.

CHAPTER V.

PLANT FOOD.

We have already seen that by far the larger part of the bulk of the plant comes from the air, through the assimilation of carbon by the green leaves. By burning the plant we drive this off into the air again, and with it also the nitrogen, which came to the plant from the soil, but originally was derived by the soil from the air.

What we have left in our ashes shows the mineral matters that were derived from the soil. Chemical analysis shows us what these were. We find that the ash consists of various combinations of what are known as elements. An element is matter reduced to its final form, or something in which we can find nothing else of a different nature. These elements are either metallic or non-metallic. The element nitrogen, for instance, is a gas existing, as we have seen, in all air. Iron is a metallic element. None of the elements are used by plants as pure elements. Nitrogen must be gotten into the soil in combination with something else to hold it there and render it soluble in the soil-water so that plants can take it up, for the ordinary green plants cannot use the free nitrogen gas. Nor can they use a metal like iron, until it is acted upon by the acids and made into an oxide or a sulphate, and even then they use very little of it. It has been found by carefully conducted experiments that plants cannot grow without a supply in the soil of some combination of the following elements: Nitrogen, potassium, magnesium, calcium, iron, phosphorus and sulphur. As we have already said, while iron is essential, it is used in very small quantities, and all soils in which plants make green leaves will be found to contain an abundance of iron. Magnesium and calcium (the element from which lime is formed) are also generally in abundance for all the needs of them as plant food direct. Of the further use of lime we will speak more fully hereafter.

The elements which become deficient in the soil through long cultivation and the removal of crops are nitrogen, potassium and phosphorus. Any one familiar with the composition of commercial fertilizers knows that it is these elements in some combination which give them value.

Nitrogen must be changed into the form of nitrate; that is, some combination of nitric acid with lime or potash, making a neutral salt, before green-leaved plants can take it as food. Potassium must be changed by oxidation into potash in order that it may be dissolved in the soil-water. Phosphorus must be in the form of phosphoric acid, for the element phosphorus burns up at once on exposure to the air. It is generally combined with calcium, making the phosphate of lime, an insoluble compound, which is rendered soluble by sulphuric acid; and thus gives us a superphosphate of lime, which is available to plant life.

Phosphoric acid is a compound of phosphorus, oxygen and hydrogen, but in phosphates the metallic bases replace the hydrogen. Nitrification, or the transformation of organic matter into nitrates so that green plants can get nitrogen, is carried on by minute organisms in the soil, and the life of these organisms depends on the presence of the organic matter in the soil; making it, as we have seen, a living, rather than a dead soil. Of this process of nitrification we will treat more fully further on.

CHAPTER VI.

SOURCES OF FERTILIZING MATERIALS.

SOURCES OF NITROGEN.

Nitrogen, as we have seen, is a gaseous substance which makes up for-fifths of the atmosphere, mingling with and diluting the oxygen so that it can be breathed, but never combining with it under ordinary conditions. It is the oxygen of the air upon which animals depend for respiration, but it must be diluted for this purpose, and hence the nitrogen is mixed with it, though nitrogen takes no part itself in respiration. Plants even, which need nitrogen as food, will die if confined in nitrogen gas alone. Ammonia is a hydrate of nitrogen which acts as a base in connection with acids. Thus with sulphuric acid it forms the sulphate of ammonia, with carbonic acid, the carbonate of ammonia, which is the ammonia we smell so strongly escaping from a heating manure pile exposed to the weather. Manufacturers of fertilizers always like to print the percentage of ammonia on their bags rather than that of the actual nitrogen, as the figures look larger. When you find the percentage of ammonia thus on a bag you can get the true amount of nitrogen by multiplying the ammonia per cent. by 0.8235. Thus if the bag has 2 per cent. ammonia printed on it, this means that there is but 1.647 per cent of actual nitrogen.

The source from which the nitrogen comes is a very important matter to the purchaser of the fertilizer, since chemical analysis may show that there is a large percentage of nitrogen present, but at the same time it may be almost entirely useless because in an unavailable form, and all that chemical analysis can tell you is that it is there. Hence it is important to know from what source the nitrogen is obtained. Pulverized leather scraps, hoofs, horn shavings, hair, will show on analysis a good percentage of nitrogen, but in such a form that plants cannot use it, being insoluble. Hence the source of the nitrogen is, perhaps, of more importance than the actual amount.

There is at all times a very small and uncertain amount of nitrogen in the form of ammonia in the air. It is believed that plants do, to some extent, absorb some of the ammonia, but it has never been proved that they do. But there are varying amounts brought to the soil and within reach of the roots in the rain water. Then, too, during thunder storms, some of the nitrogen of the air is converted by electricity into nitrous acid, which is further transformed into nitric acid, and this in the soil forms the nitrates of lime, magnesia and other bases. It has been stated that this formation of nitric acid in the air is the only source of the combined nitrogen in the earth, but later studies of the work of soil bacteria have developed the fact that there are other and more powerful agencies at work in the getting of the free nitrogen into a form that plants can use. It has been estimated that in this country about six pounds per acre of nitrogen are brought to the soil annually in the rainfall, in the forms of ammonia and nitric acid.

But the greatest source of the nitrogen in the soil is in the black, organic decay which we call humus. A soil well filled with the decay of plant and animal life will have a large nitrogen content, while a soil from which all the humus has been used up, or burnt out, will have very little nitrogen. This accounts for the superior fertility of freshly cleared land. It is true that the nitrogen contained in the humus is not at once in a condition to serve as plant food, but it furnishes food for millions of microscopic plants known as bacteria, which are the means of carrying on the process called nitrification, through which the organic matter is broken down and its ammonia changed into nitrites and then into nitrates, which last is the form in which green plants can use it. A soil, then, which contains a large percentage of humus may be properly called a living soil, while one in which there is no humus, and from which the nitrifying bacteria have been starved out and have died, may be well called a dead soil. Nitrogen is an essential element in all living matter and the absence of nitrogen means death either in animals or plants.

From whence, then, are we to get the various combinations of nitrogen needed in our complete fertilizers? It is always the element that gets away from us most rapidly in the soil, for if it is not taken up by plants when it gets into the available form of a nitrate, it quickly leaches away from the soil, and therefore we need to frequently renew the nitrogen in the soil.

All organic matter, as we have seen, contains nitrogen. But this can only be used by plants after the substance has completely decayed and the soil bacteria have transformed it into a nitrate. The rapidity, then, with which any organic matter decays, determines its value in plant feeding. Some forms, as we have noted, such as leather scraps, horn meal, etc., decay so very slowly that their nitrogen is of little use to plants, while other forms decay rapidly and soon come into an available shape.

Pulverized fish scraps from the fish oil factories along the coast, or from the refuse of the fish canning houses, form a valuable source of organic nitrogen. The article made by the regular fish oil factories along the Atlantic coast is a richer article than that made from the refuse of the packing houses, since the whole of the fish, after the oil is extracted, goes into the scrap, which is ground from the pressed cake. In some sections there are other refuse matters from the sea used in the making of fertilizers, such as crabs, but this cuts a very small figure in the general market and is available to few.

One of the very best sources of organic nitrogen is the blood from the great abbatoirs, or slaughter houses, where animal products are packed for commerce. It is not only rich in nitrogen, but it is in a form that decays very rapidly in the soil, and soon reaches an available form. It is important, however, to note the character of the dried blood offered for sale, since it may contain all the way from 6 to 14 or 15 per cent. of nitrogen. The best grade is always of a red color. If black, it shows that it has been charred in the drying, and has assumed more the character of leather, hence is less readily decayed, and has lost some nitrogen.

Probably the cheapest form in which organic nitrogen can be bought, at least in the South, is in cotton seed meal. This contains between 6 and 7 per cent. of nitrogen, and a smaller percentage of phosphoric acid and potash. The exact percentages will be found in the table of analyses of the various fertilizing materials, given elsewhere. It is now largely used as a food for cattle, and when used in small quantities, in connection with carbonaceous foods, forms a valuable part of a ration. But there is a practice becoming common in the South, of feeding cattle on a ration entirely of cotton seed meal and cotton seed hulls, which is mischievous, resulting in very inferior beef, and in butter but little better than oleomargarine. Properly used the cotton seed meal is a valuable addition to a food ration, and it is only the bad method which I have uniformly opposed.

Cotton seed meal decays rapidly in the soil, soon becomes nitrified and available to plants. In some parts of the country linseed meal is used to some extent as a fertilizer, but as a rule the price is prohibitive for this purpose; it should be used only as a stock food, and thus enrich the home-made manure.

Castor pomace is a valuable source of nitrogen in limited localities. It usually contains nearly 6 per cent. of nitrogen, decays rapidly in the soil and is soon available as plant food.

Another product of the great western slaughter houses is tankage. This is composed of the dried and pulverized waste matters from the slaughtering of animals, and is of a very varying nature. One form of the more concentrated tankage may contain as much as 12 or more per cent. of nitrogen, while other samples will not have more than 4 to 5 per cent. of nitrogen, but a larger percentage of phosphoric acid than the concentrated form. The price of tankage, of course, varies with its composition, and a low-priced article is always one that has the least percentage of nitrogen. It is, therefore, important to look after the analysis claimed for each sample.

About the most worthless form in which one can get organic nitrogen is in the meal made from leather scraps. Analysis will show that this contains a large percentage of nitrogen, yet it is almost worthless to the farmer, since the leather so long resists decay in the soil. The making of a fertilizer in which leather is used as a source of nitrogen, should be looked upon simply as a fraud. In the same class should be placed wool and hair waste, which can only be made available by dissolving in sulphuric acid.

From the fat rendering establishments, where the dead animals from the large cities are utilized, there comes dried meat; which has value for nitrogen nearly as high as that of the dried blood from the slaughter houses.

Formerly there was a rich deposit of natural guano with a very high percentage of nitrogen on the Chincha Islands, on the coast of Peru. But this was long ago exhausted, and though we have occasionally so-called Peruvian guano offered for sale, it is far inferior to the old article; as it comes from localities where rain has washed out a large part of the nitrogen, and consists mainly of insoluble phosphate of lime. The exhaustion of the old Peruvian guano beds gave the first great impulse to the manufacture of commercial fertilizers, so that now the natural guanos make little show on the market, and being largely of a phosphatic nature are mainly used by the manufacturers of fertilizers.

When any of these organic matters, containing nitrogen, decay, the first result is the formation of the hydride of nitrogen, or ammonia, from the combination of hydrogen and nitrogen. But green leaved plants, as a rule, do not use nitrogen in the form of ammonia. The bacteria in the soil which bring about what is known as nitrification, break down the ammonia and form the nitrogen into a nitrite. Another form of bacteria then takes up the work and transforms the nitrite into a nitrate, which is the form in which green leaved plants use nitrogen. Ammonia is manufactured as a by product in the making of illuminating gas, and also in the manufacture of bone charcoal for the sugar refiners. This is the source of the article in commerce known as the sulphate of ammonia. Large quantities are now made also in the manufacture of coke for the iron furnaces. In the sulphate the ammonia is in a very concentrated form, and will probably become more largely used as the price is reduced; though with many plants is seems at times to exert a poisonous influence. It is common to say that cotton seed meal and other organic matters have a certain percentage of ammonia, but there is really no ammonia there until the organic matter has decayed and the combination of the nitrogen has been made with the hydrogen. The more correct way would be to give the percentage of nitrogen in the matter which forms ammonia in decaying. But, as we have said, the figures for ammonia look larger, and hence manufacturers like to put it as ammonia in their claims. Pure sulphate of ammonia contains 21.2 per cent. of nitrogen.

In recent years there have been large discoveries of nitrogen in the form of a nitrate of soda, which is formed in large masses in certain parts of the western coast of South America where no rain falls. This is now probably the cheapest source of nitrogen for fertilizing purposes. We have seen that green leaved plants use nitrogen in the form of a nitrate, and that the organic nitrogen must be changed into this form in the soil before they use it. The nitrate of soda being already in the nitrate form is at once available for plant food. As it rapidly leaches from the soil in the rainfall this form should only be used while plants are in active growth. If applied during the dormant season much if not all of it will be lost by leaching. In making a complete fertilizer mixture, if nitrate of soda is used, it should always be accompanied by a due proportion of organic nitrogen to continue the supply after the nitrate is used up.

The nitrate is useful in the first growth of the plant while the nitrification of the organic matter is going on, as it is immediately soluble and quite concentrated. It is often sold under the name of Chili saltpetre, (ordinary saltpetre being the nitrate of potash) and contains from 15 to 16 per cent. of nitrogen. Professor Voorhees, in his book on fertilizers, well says that "The practical point, and the one of prime importance to the farmer, is, then, to know how to estimate the relative value or usefulness of these different products, what is the rate of availability as compared with the nitrate, and thus the relative advantage of purchasing the one or the other, at the ruling market prices. Relative values, however, cannot be assigned as yet, though careful studies of the problem have been made, chiefly by what are known as 'vegetation tests'; that is, tests which show the actual amounts of nitrogen that plants can obtain from nitrogenous products of different kinds, when grown under known and controlled conditions. The results so far obtained, while only serving as a guide, indicate that when nitrate is rated at 100 per cent. blood and cotton seed meal are about 70 per cent., dried and ground fish and hoof meal 65 per cent., bone and tankage 60 per cent., and leather, ground horn and wool waste as low as 2 per cent. to as high as 30 per cent. These figures furnish a fair basis for comparing the different materials, when used for the same purpose. If, for example, the increased yield of oats due to the application of nitrate of soda is 1,000 pounds, the yield from blood and cotton seed meal would be 700 pounds, the yield from dried ground fish and hoof meal would be 650 pounds, from bone and tankage 600 pounds, and from leather, ground horn and wool waste from 20 to 300 pounds." As regards the last we are of the opinion that the increase would be nearer nothing at all.

While these figures may be useful, we would suggest that the cultivator cannot depend upon the same results in practice for the varying conditions under which the plant food is applied, and the atmospheric condition after the application, might easily make the soluble nitrate the least productive. The practice of all good cultivators is to use the nitrate to some extent in a complete fertilizer mixture, but to place the main reliance for nitrogen for the crop upon the organic forms, since all of the nitrate of soda that is not used at once is rapidly lost to the soil and plants, and the cultivator who depends for nitrogen on the nitrate alone will often be disappointed in the result.

In a number of experiments made at different Stations it has been shown that sulphate of ammonia, in a mixed fertilizer with the muriate of potash, acts as a plant poison. In fact, in certain conditions of the soil, it seems that sulphate of ammonia is about as likely to do harm to the crop as to benefit it. Even when the sulphate of ammonia is simply mixed with stable manure it has given decidedly injurious effects. When mixed with the muriate of potash there is a combination of the chemicals and the chloride of ammonia is formed, which is injurious to vegetation. Another source of organic nitrogen which is available to the farmers in some localities, is the sea weed which accumulates on the sea beach after storms, and which is largely used by the farmers near the ocean. The sea weeds decay rapidly and furnish large percentages of nitrogen and potash, but are lacking in phosphoric acid. They are so rich in potash that some authorities rank them among potassic manures, and when mixed with a due percentage of phosphates they furnish a fairly complete fertilizer. One great advantage in the use of sea weeds is the fact that they bring to the soil no weed seeds. The salt which they contain may act as a solvent of matters in the soil of value to plant life, and be to some extent serviceable in destroying fungi and insects in the soil.

BARN AND STABLE MANURES.

The greatest source of organic nitrogen on the farm is, of course, the manure made from the droppings of domestic animals. The care and proper use of the home-made deposit lies at the very foundation of successful farming. No purchase of commercial fertilizers can fully atone financially for a waste of this home-made article. And yet there is no one thing on the farm generally so badly managed, and subjected to so much waste, as the barnyard and stable manure. It has been estimated that if the manure annually produced by all the domestic animals kept in the United States was properly saved, its total value would be over two thousand millions of dollars. Prof. Roberts of Cornell has estimated that on a farm on which are kept 4 horses, 20 cows, 50 sheep and 10 pigs, there should be produced during seven months of the winter and colder part of the year at least $250 worth of manure, valuing it at the rate paid for phosphoric acid, potash and nitrogen in commercial fertilizers. And it is further estimated that one-third of the value of all the manure made is annually lost through bad management. This means an annual loss of nearly seven hundred millions of dollars in the United States, or an average annual loss on each farm of $83.33. This means that to keep up the waste made from selling crops this loss makes necessary the purchase of that much more of plant food to replace the loss, if fertility is to be maintained. Every ton of hay sold from the farm removes plant food to the value of $5.10 if bought in a commercial fertilizer. Every ton of wheat carries off from the farm plant food to the value of $7.75. Or, as Dr. Armsby has said, "A farmer who sells, for example, $10 worth of wheat sells with it about $2,58 worth of the fertility of his soil. In other words, when he receives his $10 this amount does not represent the net receipts of the transaction, for he has parted with $2.58 of his capital, that is, of the stored up fertility of his soil; and if he does not take this into account he makes the same mistake a merchant would should he estimate his profits by the amount of cash which he received and neglect to take an account of stock." But if, instead of selling all the products of the farm, a large part is retained and fed thereon to animals and the droppings carefully saved, a large part of this fertility is retained on the farm. Then, too, where the entire product of a farm is not only fed upon it, but some food which was grown on other land is purchased for animals, the farm may be kept improving without the purchase of plant food in any other way. Such, however, can seldom be the case except in limited localities where the butter dairy is the sole business.

Hence, in the great majority of cases, it is necessary to supplement the home-made accumulation with commercial fertilizers. But the farmer who neglects to save and care for in the best manner all the home-made manure is neglecting the true source of riches on the farm. A great deal of the neglect of home-made manure has doubtless arisen from the ease with which fertilizers can be gotten on the market, and over large portions of the country, especially in the Cotton States, there has been an utter neglect of stock feeding, and an entire dependence on the commercial fertilizers. Year after year the same crop is planted on the same land, and the chances are taken as to the result from the dribbling of a little fertilizer in the furrows. This gambling in fertilizers has brought ruin to many a fair acre in the South, where proper farming and the feeding of cattle would have brought fertility and riches to soil and farmer. The constant use of commercial fertilizers on the soil, and the clean culture of the crop, has robbed the soil of its humus, and put it into a bad mechanical condition, in which the fertilizers no longer have the power to produce the results they would under different soil conditions. One of the greatest values of barnyard manure is in the humus-making material combined in it, which makes it more retentive of moisture, improves its mechanical condition, and furnishes food for the microscopic plants that carry on the process of nitrification in the soil and prevent its becoming a dead soil. Into this lifeless condition much of the cotton land of the South has now been changed, and men say "we cannot grow good crops because our land is poor," when it is poor farming which has made it poor. If the farm ever was fertile, the acknowledgement that it is now poor is evidence that the owner is responsible for its condition.

But there are various qualities of the farm manure as well as of commercial fertilizers. Manure from half starved animals and those fed on low grade foods that merely serve to keep life in them, has very little value. The quality of the manure made varies with the quality of the food fed. Rich food makes rich manure, and *vice versa*. The dried excrement of horses and cattle is nearly one-half the amount of the dry food consumed. One hundred pounds of dry matter in the food consumed by horses will make 210 pounds of manure, containing 77.5 pounds of moisture. Add to this the weight of the bedding, about six and one-half pounds per day, in order to get the total amount of the manure. It has been estimated that a well fed work horse will produce 50 pounds of manure per day, or six and a half tons per year, that can be saved. The manure of cows and neat cattle will contain on an average 87.5 per cent. of water. A steer, weighing 1,000 pounds and consuming 27 pounds of dry matter per day, would produce about 20 tons of manure a year. A sheep will produce about three-fourths of a ton of manure yearly, and a pig from two to three tons. The following table gives the analysis of the various manures and their value per ton:

	Water	Nitrogen	Phos. Acid	Potash	Value per ton
Sheep	59.52 per cent.	0.768 per cent.	0.391 per cent.	0.591 per cent.	$3.30
Calves	77.73 per cent.	0.497 per cent.	0.172 per cent.	0.532 per cent.	2.18
Pigs	74.13 per cent.	0.840 per cent.	0.390 per cent.	0.320 per cent.	3.29
Cows	75.25 per cent.	0.426 per cent.	0.290 per cent.	0.440 per cent.	2.02
Horses	48.69 per cent.	0.490 per cent.	0.260 per cent.	0.480 per cent.	2.21
Hens	56.00 per cent.	0.80 to 2 per cent.	0.50 to 2 per cent.	0.80 to 0.90 per cent.	7.07

These figures will not represent the value of ordinary manure allowed to leach away its value under the eaves, but of manure from highly fed animals, carefully preserved, liquid and solid, and protected from rain and firing. The urine is the most valuable part of the excrement of animals. The solid manure contains the undigested part of the food, and matter that is in a more or less insoluble state, while the urine contains the matters that have been fully digested and which are in a soluble condition. The composition of the urine, like that of the solid portion, varies with the age of the animals and the quality of the food consumed. There is a far higher percentage of nitrogen in the urine and less phosphoric acid. In fact, the urine of horses and cattle contains hardly any at all. But it abounds in potash and soda. It is always best to use it mixed with the solid manure, which contains phosphates. Water that has leached from a pile of mixed manure is always a better fertilizer than urine alone, as it has taken up the phosphates with the other constituents. As we have said, the composition of the manure depends largely on the kind of food used. If the food is of a nitrogenous nature and is easily digested, the nitrogen in the urine will greatly predominate; but if the food is imperfectly digested, the larger percentage may be in the solid dung. A horse fed on poor hay will show more nitrogen in the dung than in the urine. But a small portion of the nitrogen, phosphoric acid and potash supplied in the food is assimilated and retained in the animal body. Hence the value of the manure depends very largely on the nitrogen content of the food and its richness in the other forms of plant food. With animals which have completed their growth and made their bony skeleton, and which are simply holding their own as regards weight, neither losing nor gaining, the manurial constituents of the food are practically all returned in the manure. Figuring from this base, it has been shown that the manure from feeding a ton of wheat bran will have a value of $12.50, and fed to milch cows will have 75 per cent. of this value. While no such value is ever recovered, even with the best treatment of the manure, these figures show the importance of the best care, since the most costly part, the nitrogen, gets away so rapidly. The chief value of the home-made manure is in the nitrogen it contains, and in the capacity it has for the nitrification of its organic matter in the soil. It is this organic matter in the stable and barnyard manure which gives it its chief advantage over the commercial fertilizers. We can get nitrogen in a far more available form in the fertilizers, but will lose the beneficial mechanical effect of the organic matter in the manure. Still, although admitting the great value of the home-made manure as a source of nitrogen, and the importance of saving it in the best manner, I have long been of the opinion that there is too much of a disposition on the part of some writers to make a sort of fetich of a manure heap, and to advise the application of more labor than the manure is worth to the piling, turning and composting of manure. The manure of the farm, while a valuable thing, and an article not to be wasted, has not a value that will repay the putting of the amount of labor on it which some advise. Take care of the manure, and get it as soon as possible, out on the land where plants are waiting to use it. On a farm on which a proper rotation is practiced there is always a place to spread the manure. In the North, where it is impracticable to haul out the manure during the winter months, the best way to save it is to have all animals in box stalls, or in covered barnyards, with plenty of litter, allow the manure to be packed down under foot, and let it remain undisturbed. In this condition it will not heat seriously and will lose less than in any other way. But, by all means, abandon the silly practice of throwing it out the stable windows, in piles, to heat and wash away in the rain.

The extent to which the keeping of live stock and the saving of manure is neglected in the South Atlantic Cotton States would be amazing to the farmers of the North and West, who have so long been brought up to consider the feeding of stock and the handling of manure a necessary part of farm life. Thousands of cotton farms in this section have no stock on them but the mules that till the crop, and in many cases even the provender for these is bought and hauled to the place. There is evidence in many sections, however, of improvement in this respect, and these conditions are usually found among the tenant "croppers" rather than among the farm owners. Still, the great need of the South Atlantic States is live stock. It has been stated by competent authority that the States of North and South Carolina grow three bales of cotton for every cow kept, while Texas, which produces the largest part of the cotton crop, raises three cows to every bale of cotton she produces. Until the farmers of the South Atlantic cotton country change all this and get to the same proportion between stock and cotton there will be no real and permanent advancement in the development of their agricultural capabilities. No matter how valuable and convenient the commercial fertilizers may be, nor how much they may accomplish for the improvement of the soil in the hands of the wise farmer, they will never, with the great mass of the farmers, avail as much for permanent improvement as home-made manures.

The great evil connected with the failure to grow forage and feed live stock in the South, is the continuation of the ruinous credit system. If our farming was more diversified and systematic, and there was not that sole dependence on the cotton crop, which is still largely the case, notwithstanding the great improvement made in many places; there would be sources of income from the stock that would enable the farmer to get on a cash basis in his farming, and thus immensely reduce the cost of the cotton crop to the grower. In a section where the most valuable forage crop is at the same time a soil improver, and where nature has been lavish in the great variety of food crops that can be produced for the feeding of cattle and the accumulation of manure, the cities and towns are supplied with beef from the west simply because there are no cattle on the farms to make beef from. The cotton farmers are annually buying nitrogen in their fertilizers because they neglect the sources from which they could get nitrogen without money and without price; and not only get it free of cost but make a profit in the getting of it. Millions of dollars are spent in the cotton states of the Atlantic border for nitrogen, which, if spent for live stock and the growing of the cow pea, would remain to bless the land with fertility and swell the purse of the farmer. While an individual may here and there be able to show a profit in his crops grown without the aid of the domestic animals; the result on the community at large is poverty of soil and purse. Then, too, farm life without stock loses one of its chief attractions to the young, for boys, as a rule, are fond of animals; and if we want to keep the boys on the farm and to have them devote their energies to the improvement of the land, we must make homes instead of mere cotton fields, and a farm without cattle and other stock is far less homelike than one on which due attention is paid to these sources of profit and pleasure. We do not blame a boy for wanting to get away from a farm where he has only a mule to drive and a pair of wheels to ride on, and the greatest difficulty we have in inducing young men to study scientific agriculture lies in the fact that they have never seen any real farming done at home, and they have come to consider the life of the farm hopeless; so the young blood of the South, more than of any other section, is rushing away from the farm to the factories and workshops, and the men who should be the means of building up the waste places are abandoning the farms to desolation and the negro. If this book is instrumental in any way in inducing some of these farmers to adopt a different method, it will be well worth all the labor that has been expended upon it.

NO NEED FOR BUYING NITROGEN.

While the saving and using of all the nitrogenous manures made on the farm is an important part of the farm economy, the farmer who farms intelligently and practices a proper rotation of crops, need never buy an ounce of nitrogen in any shape for the ordinary farm crops. In the case of the market gardener, on limited areas, and with crops of greater value, it is, of course, important to heavily fertilize his acres. But in grain and grass farming, the farmer who realizes what the legumes will do for him need never expend a penny for nitrogen, and in fact, can not only get all he needs without cost, but can make a profit in the getting of it. And here is the main use that the farmer has for the commercial fertilizers, to enable him better to practice the true method of acquiring the nitrogen that is so plentiful in the air, over every acre, in all localities. No part of the country has a monopoly of the ærial nitrogen. The air is just as rich over the poorest acre in the land as over the most fertile, and the farmer on the poor farm can get it just as readily as the man whose acres are already supplied with it. While nitrogen is an essential thing to plant life, and crops cannot be grown without it, it is the only element of plant-food that we can get without buying, and the one that costs the most when we do buy it in fertilizer. Then, when we can, by a proper course of culture, get this costly article which is so much needed, and can put money in our pockets while getting it, is it not passing strange that farmers should spend money for it?

LEGUMINOUS PLANTS THE TRUE SOURCE OF NITROGEN FOR THE FARMER

For many years farmers knew that in some mysterious way clover and other plants of the pea family, did not only furnish forage for feeding animals, but that the land was better for having grown the crop. Only within the past few years, have scientists studied closely the way in which these plants help the soil, and even yet very little is accurately known of the exact way in which the work is done. For our present purpose, however, it is enough to know that all the legumes have the power, by means of little microscopic plants, which inhabit certain swellings or nodules on their roots, to get the free nitrogen of the air combined and stored in the form of organic matter in the soil. We will not enter into a discussion of the exact way in which they do it; the fact is that no one knows just how it is done. But it is enough for the farmer to know that it is done, and that he can, by the growing of these plants, get a supply of material in the soil, that in its decay will give nitrogen to the succeeding crop in abundance. But the very plants that do this nitrogen catching for him, are the greediest of consumers of the other two important elements of plant-food needed in most soils, phosphorus and potash. While the careful saving and using of the farm yard manures is an important help in the getting of nitrogen in the soil, the manure is always in an insufficient supply, and is poorer in the other elements than is desirable. Therefore, the most important elements which a farmer must buy in order to keep up the productivity of his soil, are phosphorus and potassium in some form. These are essential to the growth of all plants, and are especially serviceable in encouraging the growth of the legumes, and the enabling them to get more of the costly and fleeting nitrogen for us. The various experiment stations have done so much work in the study of the manurial requirements of plants, and the effects of fertilizers, that there has grown up an impression among farmers that for every crop planted, some complete mixture of fertilizers must be applied. There is no doubt that the annual application of commercial fertilizers will increase the crop usually grown; but true farming is the getting of good crops at the least margin of expense consistent with the keeping up and improving the condition of the soil. It is not merely growing big crops, but the most profitable crops, too. If a farmer spends $10 for a fertilizer that gives him $10 worth more corn, he is simply buying corn at the market price. He would better have left that $10 worth alone and bought it for less labor.

CHAPTER VII.

PHOSPHORUS, ITS SOURCES AND USE IN PLANT FEEDING.

The second important element in the nutrition of plants and the maturing of crops is phosphorus. This element, like the other elements which enter into the feeding of plants, is never used as a pure element, but always in the form of phosphoric acid. This is a highly oxidized compound of hydrogen and phosphorus, and forms, with alkaline bases such as lime, etc., salts known as phosphates. The most commonly available form is the phosphate of lime. This is a large constituent of the bones of all animals, and is found in nature in the phosphatic rocks and coprolites. In the basic process of steel making, large amounts of phosphates are separated from the iron ore and left in the furnace slag, and this slag is one of the important sources of phosphoric acid for fertilizing purposes. In many of the sea islands where there is a heavy rainfall, the guano deposits have been largely composed of the phosphate of lime, the nitrogen having been washed away. Large deposits of phosphatic rock are found all along our South Atlantic coast, and in the Mississippi valley and elsewhere. The origin of these deposits has been a matter of much discussion among geologists. The idea generally prevails among most farmers that these are the petrified bones of extinct animals, but this is far from being correct, though there are certainly many fossil remains found associated with the phosphatic rocks. Phosphatic guano is certainly the remains of the excrement and food refuse of sea birds, and coprolites and phosphatic nodules are thought to be the remains of animal excrement. But, whatever their origin, the importance of the deposits has long been recognized; for the replenishing of our soils with phosphates is one of the greatest of the problems that confronts the cultivator, since in all cultivation, and in the raising of domestic animals, the phosphates are continually being removed from the farm. Unlike the nitrogen we cannot get phosphates from the air, and there are but two ways in which the loss to the farm in phosphates carried off from it can be made good. We must either feed on the farm food grown elsewhere, or we must buy the phosphates when they are deficient. Inasmuch as the localities are few where the feeding of purchased food can be made a profitable part of the farm economy, the renewing of the phosphates in the soil becomes a very important matter. There has long been an impression among farmers that phosphoric acid from animal bones is more valuable than phosphoric acid from rock phosphates or other sources. But this is not the case. A superphosphate made from bones will contain some nitrogen, and hence, will have that additional value; but its phosphoric acid is not a whit different from the phosphoric acid from other sources. The only point of importance to the farmer is the percentage of the phosphoric acid which is soluble in water, and is hence immediately available for plant feeding. In the natural state, the phosphoric acid of bones, rock or furnace slag is insoluble. Then if the rock is finely pulverized, and the bone (if finely pulverized), the bone will be the more quickly available of the two, because of the readiness with which it decays in the soil; and the fact that the raw bone carries with it a considerable percentage of nitrogen, while the phosphatic acid rock has none of this. But when treated with sulphuric acid and made soluble, the acid of the rock is just the same as the acid of the bones treated in the same way. But the prejudice in favor of the bones is such that it is a common practice among the manufacturers of fertilizers to call their articles bone phosphate, when, in fact, no bones have ever been used in its manufacture.

The great source of the phosphates used in this country is the phosphatic rock mined from the land or dredged from the river beds in South Carolina. Large quantities are also mined in Florida, which are classified as "soft," "rock," "pebble" and "bowlder" phosphates. There are also "apatites" from Canada, and a very fine quality of phosphatic rock from Tennessee, and recently a deposit has been found in the Juniata valley in Pennsylvania.

When treated with sulphuric acid to render them soluble these are known as acid phosphate, and this forms almost the entire source of the phosphoric acid used in the making of fertilizers, though some are still made from the refuse bone charcoal which has been used in the refining of sugar. A minor source, as we have said, is the slag from the manufacture of steel by the basic process. This is known as "basic slag," "Thomas slag" and "odorless phosphate." The quantity produced in this country of this last, is yet too small to have any great effect on the market. Much of the tankage from the Western slaughter houses has large percentages of bone associated with the nitrogenous matters, and this, too, is frequently treated with acid to render it soluble. Untreated tankage is more valuable for its nitrogen than its phosphoric acid. Bones are also some times steamed, by which means a large part of the nitrogen is extracted, which has the effect of increasing the percentage of phosphoric acid in the product. Steamed bone may contain as much as 28 per cent. of phosphoric acid and very little, if any, nitrogen. It will, therefore, have a larger percentage of phosphoric acid than raw bone meal, but far less nitrogen; and if the phosphoric acid is what we are after, the steamed bone is better than the raw, and the absence of nitrogen should make it cheaper. But it must be remembered that the phosphoric acid is not in an immediately soluble condition, though through the rapid decay of the bone it may soon become so.

The Florida soft phosphates are not available .n the manufcture of acid phosphates, and hence, many efforts have been made to get farmers to use them in an untreated state. An article called "Natural Plant Food," was some time ago largely advertised. This consisted almost entirely of the Florida soft phosphates, with some insoluble potash, such as is found in the green sand marl of New Jersey. It has been found that on a soil abounding in humus, and in an acid condition, the pulverized phosphatic rock sold under the name of "floats" acts very well, especially on clover and other legumes, but that liming the soil, which helps the success of the clover, renders the phosphate less effective. In some stations the insoluble phosphoric acid is given no value whatever, while at other stations it is rated at 2 cts. per pound, with the soluble at four and a half cents. What we wish particularly to impress upon the farmer, is the fact that phosphoric acid from any source is identically the same thing, and the only question that concerns him is what percentage of the article is in a soluble state, for it is this which is to give him immediate results in the crop.

BONE MEAL AS A SOURCE OF PHOSPHORIC ACID.

We have stated that phosphoric acid is one and the same thing no matter from what source it comes, and that the only thing to regard is the percentage of soluble acid. On this point the investigations of the Massachusetts Experiment Station show the following conclusions:

1. The superior VALUE which has hitherto been accorded to undissolved bone meal as a fertilizer is due solely to the nitrogen it contains.

2. Undissolved bone meal, as a phosphate fertilizer, is no more valuable than the raw mineral phosphates (floats).

3. Hereafter it must be classed with the latter, rather than with the high grade phosphates containing available phosphoric acid.

4. As a phosphate fertilizer it yields no better results than the mineral phosphates, whether tried alone or with superphosphate, on loams or sandy soils, on soils rich or poor in phosphoric acid, whether with grains or with turnips, mustard or other cruciferous plants; either in the first or second crop.

5. The various kinds of bone meal show no essential difference in these results. In experiments made by Wagner at Darmstadt, Germany, the phos-

phoric acid in the form of acid phosphate gave 100 pounds in the crop to every 59 pounds from the Thomas slag, and 8 pounds from the same quantity of bone meal, and in three years the results from the bone meal application were only 17 per cent of those from the acid phosphate. It has been argued by those who favor the use of bone meal that, while not so immediately available, the after results would more than make up for it. Wagner shows that even after three years it only reached to 17 per cent. of the crop produced at the same time from soluble phosphoric acid. This is an important matter to the farmer, since bone meal is a far more costly article than superphosphate.

Aside from the fact of the slow availability of the phosphoric acid in bone meal, there is the further fact that it is very hard to get a perfectly pure bone meal except in States where the inspection is very rigid. The writer once passed an establishment in a large Eastern seaboard city, where the sign announced "pure bone meal." There was a "no admittance" sign at the door, but hearing machinery in operation I ventured to peep in. An Irishman who was tending a machine grinding oyster shells warned me to keep out, but I had seen all that I was after, and noted the place as one to avoid in buying bone.

THOMAS SLAG, SLAG MEAL, BASIC SLAG AS A SOURCE OF PHOSPHORIC ACID.

These names, and also the name "odorless phosphate" are applied to the phosphate obtained from the slag made in the process of making steel by what is known as the basic process. There is not enough of it made in this country for it to compete with the rock phosphates. The article is reduced to a fine powder and is not treated with acid. It contains usually about 20 per cent. of phosphoric acid in the form of phosphate of lime, or the same form in which it is found in the pulverized phosphate rock. Whether the phosphoric acid in this slag meal is any more readily available than that in the pulverized phosphate rock, or "floats," is a matter not as yet well settled. In most of the country the rock phosphates are cheaper.

MARLS AS A SOURCE OF PHOSPHORIC ACID.

The name marl is applied to certain earthy deposits which are found along our Atlantic coast. These vary in composition from those consisting almost entirely of the carbonate of lime from the decomposition of marine shells to those like the green sand of new Jersey and the Virginia marls, some of which contain notable percentages of phosphoric acid and some potash. Phosphatic marls have phosphoric acid in the form of the phosphate of lime as it exists in the phosphatic rocks, and it is in a similarly insoluble state, while the potash is in the form of a mineral known as glauconite, and is also insoluble at once. Mr. Ruffin, of Virginia, whose book on calcareous manures was for many years the standard authority on the subject in this country, attributed the effects of marl, which he used largely on his lands in Southeastern Virginia, to the lime it contained. But it has been shown that in every instance the most valuable marls are those which contain the largest percentages of phosphoric acid, though shell marls are also valuable as a source of lime for certain soils.

PHOSPHATIC GUANO.

After the exhaustion of the rich deposits of guano in the Peruvian islands, large quantities of phosphatic guano were brought from islands in the Carribean Sea, where the soluble nitrogen had been washed out by rains, leaving only the insoluble phosphate of lime. These guanos are used to a considerable extent in a pulverized state, and answer about the same purpose as the Florida soft phosphates of recent days. Most of these guanos are not adapted to the making of acid phosphate, and they are now little used since the discovery of the great deposits of phosphatic rock in North and South Carolina, Florida and Tennessee.

THE GREAT PHOSPHATE ROCK DEPOSITS

The phosphatic rock that has entered more largely into the manufacture of acid phosphate is the South Carolina rock. This is pulverized and treated with sulphuric acid, and the result is the article called acid phosphate, which contains usually about 12 to 13 per cent. of soluble phosphoric acid, a smaller percentage of what is called "reverted" phosphoric acid, or acid not soluble at once in water, but soluble in citrates. The soluble and the reverted phosphoric acid are added to make what is called the "available" phosphoric acid. Then there will always be a small portion of the phosphoric acid which is insoluble. Some Station chemists assign no value to this in their valuations of fertilizers, while others value it at 2 cents per pound when the available is rated at 4 cents. This is the fairer valuation, since there is evidence that it does finally become available in the soil, just as the pulverized rock does.

Large deposits of phosphatic rock are found also in Florida, much of which is known as "soft" phosphate, and is not available for dissolving with sulphuric acid, and strenuous efforts have been made to get it into use under the name "Natural Plant Food." It has value, if one has time to wait on it. Another important deposit of phosphate rock has more recently been discovered in Central Tennessee. This has a high percentage of phosphate of lime, and will become the most important point from which to get phosphoric acid in the Central Western States. Another deposit has been discovered in the Juniata Valley of Pennsylvania, but whether it will assume any commercial importance is not yet known. Hard phosphate rock, which will yield on dissolving with sulphuric acid a good, drillable acid phosphate will always be of more agricultural value than those not adapted to this purpose.

While phosphoric acid may exist in the form of iron phosphate and of aluminum phosphate, the only form in which it is available in the manufacture of commercial fertilizers is the phosphate of lime. This is the form in which it is found in phosphatic rock and in animal bones, and hence manufacturers, whose product does not contain a solitary animal bone, are very fond of printing on their bags the statement that the percentage of phosphoric acid in it is "equal to bone phosphate;" thus leading the farmer to imagine that there are bones used in it, as they think that farmers value phosphoric acid from bones more highly than the same thing from some other source. I cannot too often repeat that it is the percentage of availability that the farmer is concerned with, and not whether it came from bones or rock. All untreated phosphates are insoluble in water, and untreated bone will become available more readily than untreated rock phosphate, because it decays more readily, provided both are in an equally finely pulverized state. Many farmers have declared that they get as good results from the pulverized phosphates as from the acid phosphate, and in certain soils this may be the case, for the character of the soil has much to do with the rate in which the phosphoric acid in an untreated phosphate becomes available. In a soil abounding in humus, or vegetable decay, the phosphates will become soluble more readily than in a heavy, clay soil deficient in organic decay. In the porous soil, filled with humus, the oxidizing influences of the air have free access, and decay proceeds more rapidly, while the acidity of such soils also favors the change. For general purposes it is far better, however, to use the acid phosphate than the lower priced pulverized rock or the iron phosphate. Professor Voorhees well says that, "In any case, animal bone, or finely ground mineral phosphates, cannot be depended upon to fully meet the needs of quick growing crops for phosphoric acid, but may answer an excellent purpose where the object is to gradually improve the soil in its content of this constituent, as well as to supply such crops as are continuous, or that grow through long periods, as, for example, meadows, pastures, and orchard and vineyard crops." That is to say, that where you can afford to wait and where you want long-continued, slow availability, it may pay to use the more slowly available forms of phosphoric acid, but where you want the effect on the immediate annual crop you had better get the dissolved rock or acid phosphate. With most farmers, the question of immediate returns for the expenditure is the most important point.

SOME ERRONEOUS POPULAR NAMES.

In some parts of the country farmers call all commercial fertilizers "phosphate." This is an error which all should rid themselves of as quickly as possible. The term phosphate is applicable only to compounds of phosphoric acid and a base, making what is called a salt. Thus the phosphate of lime is a salt composed of a certain number of parts of lime with phosphoric acid. A commercial fertilizer in which the phosphoric acid is only one of the constituents cannot correctly be called a phosphate. It is simply a fertilizing mixture in which phosphoric acid is one of the constituents. The proper term to apply to all mixed goods is commercial fertilizer.

Then, too, the popular name "acid phosphate" as applied to the dissolved phosphate rock is not strictly correct. Phosphate is the original condition in which the phosphoric acid is found in the rock. When dissolved in sulphuric acid it becomes a superphosphate. But the term "acid phosphate" has become so fixed in popular use that it answers all purposes, and suits our American liking for brevity better than the longer word, superphosphate. Superphosphates, whether made from rock, bones or bone charcoal, are identical, varying only in the percentage of phosphoric acid with the amount in the article from which they are made. Hence a superphosphate made from bones will have a higher percentage of phosphoric acid than one from rock, but one per cent. in the one is just as good as one per cent. in the other. Acid phosphate is always better when freshly made than after being stored for a long time, since there is a tendency to reversion to a less soluble form in long standing, and there is a decrease of the soluble and an increase of the form soluble only in ammonium citrate. Acid phosphate, then, which has been kept over a season, is less immediately available than a freshly made article. This takes place more readily in superphosphates made from the mineral phosphates than in those made from bones or bone charcoal. Superphosphates made from bone and bone charcoal are more uniform than those from mineral phosphates, and their phosphoric acid is nearly all soluble, while those from mineral phosphates may run all the way from 12 to 14 per cent. in the South Carolina, to 16 or even 18 per cent. in the Tennessee. Superphosphates from raw animal bone usually have about 12 per cent, available phosphoric acid, and about 5 per cent. insoluble, but having also a percentage of ammonia, they have a higher value commercially than the dissolved rock, but their agricultural value may be no higher.

The writer has frequent inquiries from farmers who are anxious to know whether the free sulphuric acid that they are told remains in the acid phosphate from the rock, will be injurious. The fact is there is seldom, if ever, any such acid in a well-made superphosphate, and even if there was it would at once seek some base in the soil and be changed to a neutral salt, either the sulphate of lime, potash or magnesia, according as one or the other may be present in the soil.

It has been found that where superphosphates have long been used freely the phosphoric acid will accumulate in the soil to such an extent that further applications have no effect. This has been the case in a large section of Eastern North Carolina, where the farmers say that they no longer get any returns from the application of phosphates to their cotton crop. The fact is that the soil holds on to phosphoric acid longer than anything else in the way of plant food, and does not allow it to leach away as the nitrogen is apt to do, but keeps it there till the crops call for it. Hence it is easy to see that in making liberal applications of phosphates, whether merely pulverized bone or rock or dissolved phosphate, we are in no danger of serious loss, but can depend on any surplus staying there till wanted by the crops. Professor Voorhees well says, "The real object of making it soluble is to enable its better distribution. If it were possible to as cheaply prepare the dicalcic (or reverted) form as the soluble, it would, perhaps, be quite as useful from the standpoint of availability. After the soluble is distributed in the soil, it is fixed there by combining with the lime and other minerals present." It is thought that it at once assumes the reverted form, and that in the presence of an abundance of lime may even become insoluble. The solubility of the phosphoric acid lasts much longer in a light soil deficient in organic matter, but even there it is fixed rapidly enough to prevent serious loss. Chemical analysis of the drainage waters seldom shows any loss of phosphoric acid.

THE VALUE OF INSOLUBLE PHOSPHATES.

In the valuation of commercial fertilizers, as we have noted, some of the Experiment Stations place no commercial value on the insoluble phosphoric acid in a fertilizer. We have long been satisfied from our own experience that this is an error, at least so far as the agricultural and crops-producing value of the insoluble phosphate is concerned. Years ago, in farming on a large scale, we found that we did get the happiest results from the use of the phosphatic guanos from the Carribean islands in which the phosphoric acid was all insoluble. True, we did not get the same immediate results as from the use of the dissolved acid phosphate, but the final result was as good and more lasting, and when these insoluble forms of phosphoric acid were used on the wheat crop, we never failed to get large returns in the luxuriant stands of clover that followed, though the effect on the wheat crop direct was not so apparent as when the acid phosphate was used. But we invariably had more difficulty in getting a good stand of clover after the use of the acid phosphate than we did after the use of the insoluble phosphoric acid. In our case stock and stock food was the chief interest, and the wheat was only regarded as a means for paying the expense of getting the land in clover. Where immediate results only are sought it may be best to use the dissolved phosphate, but where final results in the clover and grass are of more importance, then it will be far cheaper and perhaps better to use simply the pulverized rock, or what is known as "floats." As we have often said, where one can afford to wait for the results he can get them with less expenditure of money in the use of pulverized rock than in the dissolved article. This experience has been verified by some experiments made at the Maryland Agricultural Experiment Station and published in a recent bulletin of that Station. They state that the best results were obtained, in the long run at least, from the use of the insoluble phosphates. Not having this bulletin at hand we cannot quote from it direct, but believe that we have given the sum of their results. The fact is that no chemist can discover just what is taking place in the soil, even with what may be put there in what he calls a perfectly soluble state. The soil is a wonderful laboratory, in which the forces of nature are always at work, making new combinations and bringing about changes in what we put there. The carbonic acid of the rain water is nature's great breaker up of combinations and former of new ones, and what exists in the soil in one state today may be in a very different one tomorrow. It is always safe, then, for the farmer to question his soil and to accept the results it gives him, for he can find thus, for himself, things that no chemist can discover. In certain sections of Eastern North Carolina observant farmers have long since found that they got no results for the use of phosphoric acid in any form, but that nitrogen and potash always gave them good results. Subsequent investigations by the Department of Agriculture have demonstrated that these farmers are right, and that on their lands the chief need is for nitrogen and potash. Then, since by good farming with the legumes they can get all the nitrogen they need, the farmers on lands where phosphatic marls and rocks are found, are in that happy condition where they need to purchase but a single form of plant food in order to make and keep their lands perennially productive. There may be other sections North and South, where similar conditions prevail, and this makes it all the more important that farmers should experiment to determine the manurial needs of their soils. How this is done we have tried to explain elsewhere.

CHAPTER VIII

POTASH.

Potash is the result of the oxidation of the element potassium, which is one of the metallic elements. In former days all the potash available for manurial purposes was that which is contained in the farm manures and in wood ashes. These are still valuable sources so far as they go, but they are totally insufficient for the demands of modern agriculture. It is a wonderful fact in the economy of nature that stores are provided to come into use as the demand for them arises. The vast deposits of coal were not discovered so long as the forest met all the requirements of man for fuel, but as the demand came the supply was at hand to meet it. Just so with the potash. With the great call for this material for the feeding of plants on our long cultivated soils, there was discovered a vast deposit of potash in the salt mines of Germany, in the form of sulphates and chlorides of potash. These mines are now the great source of the world's supply of potash, and it has been found that the deposit extends over a much larger area there than was formerly supposed, and that the supply is practically inexhaustible. Doubtless if the German supply should fail there will be discovered other deposits, to redeem the promise to mankind that seed time and harvest shall not fail.

POTASH AN ESSENTIAL PLANT FOOD.

Experiments, carefully conducted, have shown that potash is one of the things which plants cannot grow without. In a soil or a solution entirely free from potash a seed will germinate and grow to the extent of the potash stored in the seed itself, but when that is used up the plant perishes. In the cultivation of farm crops it has been found that potash is more slowly exhausted from the soil than other forms of plant food, since its office mainly consists in the building up of the woody structure and cellular parts of the plant, and hence is found in the straw, corn stalks and other materials that usually are kept on the farm, and returned in the manure; and not because it leaches away from the soil less rapidly than phosphoric acid. The great office of potash in the plant seems to be the structure of starch, since it is found that while all the conditions needed for the assimilation of carbon from the air (the process through which starch is formed), may be present, the starch is not formed without the presence of potash in sufficient quantity. Now, as all woody structure is formed from the starch, it is evident that potash is an important matter in the building up of the plant. Plants like potatoes and corn, which make large surplus quantities of starch to store away in tubers and grain, require large percentages of potash in their food.

SOILS WHICH NEED POTASH MOST.

Light, sandy soils near the coast are more apt to be deficient in potash than the heavy clays, especially the clays that are the result of the decomposition of granitic rocks, which naturally contain a larger percentage of potash. But even in some of these soils the application of potash may be found profitable, because the potash may be, and commonly is, in the form of an insoluble silicate, and this becomes very slowly available to plants through the action of the carbonic acid in the rain water. Black, peaty soils, resulting from the decomposition of vegetable matter, are very commonly deficient in potash, and it is a common remark on the South Atlantic coast that a certain soil will grow upland rice, but will not make a crop of Indian corn. This is mainly because of the deficiency of mineral matters, chiefly of potash. It is a common and almost universal practice among the manufacturers of fertilizers to make the phosphoric acid much larger in proportion than the potash, and it has been shown by experiment that the average commercial fertilizer has, as a rule, too small a percentage of potash in proportion to the nitrogen and phosphoric acid. The plants, like peas and clover, which give us nitrogen free of cost, are great consumers of phosphates and potash, and they can do far more of their important work if well supplied with the mineral elements of plant food. The average complete fertilizer mixture contains not more than 1 to 2 per cent. of potash, while for tobacco, potatoes, and corn and some other crops the potash on light soils should be as high as 10 per cent. for the best results. Therefore, it is important for the progressive farmer to make his own fertilizing mixtures, so that he can vary the proportions to suit the different crops grown; and if he practices the best rotation, he will find little use for the complete fertilizers, will finally buy nothing but phosphoric acid and potash, and will use these freely for the purpose of getting more of the nitrogen fixed in his soil.

WHAT IS THE BEST FORM OF POTASH?

As we have said, the potash mined in Germany exists in the forms of sulphates, chlorides and carbonates. There is little difference in the rate of availability to the plant of any of these forms, but the effect of the particular form on the different crops is an important matter. It has been found that while the muriate (or chloride) of potash will produce a heavy crop of tobacco, it seriously impairs the quality of the leaf, and hence in a tobacco fertilizer it is important to use the sulphate, which is free from chlorides. In some sections it has been found that the Irish potato crop is damaged in quality by the use of muriate, while in other sections the muriate is used exclusively on this crop. The nature of the soil seems to have a great deal to do with the form in which potash is of use to the Irish potato. In the great early-potato growing section of the South Atlantic coast, the muriate has been found to give the finest crop; while in the North and on a heavier soil, the sulphate is of importance in giving quality to the product. On a clay soil and in a Northern climate we should use the sulphate for potatoes. Crops that have sugar as an important constituent are always more favorably affected by the sulphate than the muriate. Sweet potatoes, sugar beets, strawberries, tomatoes and such should always have their potash in the form of a sulphate free from chlorides. Indian corn and grasses, wheat and oats, are indifferent to the form in which the potash is furnished.

CRUDE POTASH SALTS.

As mined in Germany there are two principal forms of the salts in a crude state. These are kainit and sylvanite. There are other forms, but these are about the only ones exported, and by far the larger part of the crude salts that come to this country are in the form of kainit. While the potash in kainit is in the form of a sulphate, it is mixed with such a large percentage of chloride of sodium (common salt) that its action is the same as the chloride, or muriate. Containing so low a percentage of potash, generally a little over 12 per cent., it is a costly form in which to buy potash at any distance from the port of entry, since the freighting of so large a proportion of useless material rapidly runs up the cost of the potash to the farmer, which is the only thing in it which is of any great importance to him. It is also dangerous to use in large quantities in immediate contact with seed, or young plant roots, because of the salt it contains. Some time ago a farmer in the tobacco section of North Carolina wrote to me that he had bad success with the home mixing of fertilizers from a formula we gave him, and that the quality of the tobacco was very poor. We asked him to send a copy of the bill of materials he had bought. He purchased them from a large manufacturer of fertilizers, and it was evident, as soon as we saw the bill, that he had been imposed upon purposely in order to discredit the formula. I prescribed sulphate of potash in the mixture, and he ordered it. On the bill was charged "sulphate of potash," and then added, in small letters, "low grade kainit." The cause of the poor quality of his tobacco was evident and we wrote to him that he had simply been cheated, as he should have had the high grade sulphate free from chlorides, and it was evident that the fertilizer man was after killing his home mixing.

MANUFACTURED POTASH SALTS.

These are products which have been treated to remove the excess of other constituents and to concentrate the potash. The most common form and the form most generally used in this country is the muriate (or chloride) of potash. It usually contains about 50 per cent. of actual potash. Dealers frequently confuse unlearned buyers by giving on their bags the percentage of muriate instead of the percentage of actual potash. Thus they will say, "muriate of potash, 80 per cent." and lead the farmer to believe that there is 80 per cent. of potash. If you get an article with such a percentage stated, it simply means that it has that much of the muriate, and you can tell how much potash it has by multiplying the percentage of muriate by the fraction 0.632. Thus a bag marked muriate of potash 80 per cent., would have 50.56 per cent. of potash. In the same way the dealers will mark the sulphate of potash (the high grade) 98 per cent. sulphate of potash, and you can find the actual potash by multiplying this by the fraction 0.54, so that a bag having 98 per cent. of sulphate of potash will contain 52.92 per cent. of actual potash. As we have said, the sulphate is important for some crops for which the muriate is not well adapted, but its cost is greater than that of the muriate, and where the muriate is adapted to the crop it is always the most economical to use. The higher cost of the sulphate leads manufacturers of fertilizers to use the muriate where the sulphate should be used. One of the largest tobacco growers in North Carolina told the writer that he sent a formula to a large manufacturer in which he specified sulphate of potash. They agreed to make it by his formula, and when the goods arrived he sent a sample to the State chemist for analysis, and this showed that the muriate had been used instead of the sulphate. He therefore very properly refused to receive the fertilizer. Tobacco growers who buy ready mixed fertilizers cannot be too careful as to the source of the potash in them. There is another form of manufactured potash called " double manure salts," or the double sulphate of potash and magnesia. This is a lower grade, and contains from 23 to 26 per cent. of potash. From the lower percentage of potash this, like kainit, is more costly so far as the actual potash is concerned, and it is always more economical, especially where the goods are to be transported far from the port of entry, to buy the most concentrated article and thus avoid the freighting of useless matter.

CAPACITY OF THE SOIL FOR ABSORBING POTASH.

In some instances, near the coast, it is found that kainit is the cheaper form in which to buy potash. But to get the amount of potash needed by the early potato crop, for instance, would require an application that would be certain to be injurious from the amount of sodium chloride if directly applied to the crop. Fortunately it has been found that while the soil will release the chloride of sodium and allow it to leach away, it will hold on to the potash that was associated with it. Therefore, it has become the practice with a few growers near the coast to apply a heavy dressing of kainit in the fall, to the land they intend planting in potatoes in the spring. The injurious chloride is leached out of the sandy soil during the winter, while the potash remains. It also seems probable that the chloride in the leaching may render soluble other matters in the soil that may be of use, and thus help the crop. But this very fact may be a disadvantage, since there may be formed soluble chlorides of lime, and the heavy application of kainit may result in the exhaustion of the lime in the soil. But where this practice is followed, the abundance of marine shells at hand will soon remedy this, if used on the soil after burning. There are few localities, however, where kainit is the cheapest form of potash. The application of potash should in any event, be immediately worked into the soil, so that it may be equally diffused in the soil and not fixed merely at the surface.

DANGERS FROM POTASH.

The general opinion is that kainit is especially dangerous in contact with seeds or young plant roots, by reason of the large percentage of salt which it contains. This is true, but in our own experiments we have found that the muriate is far more damaging to germination of seeds with which it comes in contact, than kainit is. Carefully conducted experiments have shown that even when covered with an inch of soil, seeds placed above the muriate were seriously damaged. In fact, no fertilizer containing a large percentage of potash should be used in direct contact with the seed, and it is far better that both the potash and the phosphates should be applied broadcast, and some time in advance of the planting of the crops, so that they may become fixed and assimilated in the soil and their caustic effects prevented. Growers of frame lettuce in Eastern North Carolina know that in their sandy soil the crop needs a liberal supply of potash, and they usually give it liberally. A lettuce grower some time since sent me in the early fall some of his plants, which had the edges of the leaves turning red and evidently dying. He wanted to know the reason. Examination showed no insect or fungus attack, but the roots were evidently injured. The plants were set in a frame here and at once grew off and made fine heads. I found that the grower had applied a heavy dressing of muriate of potash in the fertilizer used on the frames, and this was doubtless the cause; for on taking up all the plants and re-setting the frames, after several good rains, he had no further trouble. Wheat growers commonly drill their seed with the fertilizer, and this may do where a very small percentage of potash is used, and the quantity is far less than that used by the truck growers.

POTASH IN WASTE PRODUCTS.

Farmers in the tobacco manufacturing sections, and tobacco growers, should understand the value of tobacco waste. The stems from which the tobacco leaves are stripped on the plantations are a valuable source, not only of potash, but of phosphoric acid and nitrogen as well. The stems from the stemming houses are still more valuable, and the dust from the factories where smoking tobacco is made is in a form that is very much more readily taken by plants than the stems. The field stalks of tobacco contain 3.71 per cent. nitrogen, 5.02 per cent. of potash and 0.65 per cent. of phosphoric acid. The stems from the stemmeries contain 2.35 per cent. of nitrogen, 8.20 per cent. of potash and 0.70 per cent. of phosphoric acid. So that with the exception of phosphoric acid they form a complete fertilizer of high grade.

But of course they cannot be compared with a soluble fertilizer of similar analysis, since before the nitrogen and other things can become available to plants the material must be completely decayed in the soil. Hence the finely divided dust from the smoking tobacco factories will probably be the more quickly available. Where these materials can be bought cheaply, the farmer may be able to get potash in a cheaper form than any other. We have at hand no analysis of the tobacco dust, and it doubtless varies a great deal owing to the amount of sand and other impurities in it. The percentage of potash may run as high as ten per cent., and the nitrogen as high as in most of the fertilizer mixtures. Part of the nitrogen in tobacco exists as a nitrate and is immediately available to plants. The remainder is organic nitrogen, which must go through the process of nitrification in the soil to become available to plants. Where the farmer is so situated as to be able to get these tobacco wastes, he should by all means avail himself of them, since they are rich in plant food and contain no deleterious matters. We have seen tobacco dust spread an inch thick on a lawn with the finest results. A ton of tobacco stems of good quality contains nitrogen equivalent to 500 pounds of nitrate of soda, and potash equal to 200 pounds of high grade sulphate of potash. Since these tobacco wastes can often be bought near the factories for $3 to $5 per ton it is evident that they are a very cheap source of nitrogen and potash.

COTTON SEED HULL ASHES.

The oil mills engaged in the manufacture of cotton seed oil in the Southern States use the hulls from the seeds largely as a fuel in their furnaces. The ashes resulting from this burning contain a large percentage of potash, and a fair percentage of phosphoric acid, with very little lime. Ordinary wood ashes contain so large a percentage of lime that they are not available for mixing in fertilizers, since the lime will have a tendency to drive off ammonia and revert the phosphoric acid. While cotton seed hull ashes are rich in potash, they vary greatly in the actual percentage of potash and their value cannot be predicted without an actual analysis of the sample. They contain from 20 to 24 per cent. of potash, nearly 9 per cent. of phosphoric acid, 9 per cent. of lime and 10 per cent. of magnesia. These ashes are an excellent source of potash and phosphoric acid, and the fact that they are not so rich in lime as ashes from the hard-woods is an advantage, and allows them to be used in compounding a fertilizer mixture where wood ashes would be inadmissable.

GREEN SAND MARL.

The green sand marls of New Jersey and Southeast Virginia contain a large percentage of potash, as well as a smaller percentage of phosphoric acid. But all these are in a form very slowly available. Their slow availability renders the marl applications lasting in effect, and as the green sand marl can be applied in very large quantities without injurious effects, its value as a mechanical amendment to the soil is very considerable. Marl has had a great effect on the lands of a section of New Jersey, and also in Southeast Virginia. A farm in Virginia which had an application of 400 bushels per acre 40 years ago was made permanently productive, and since then a further application of marl has not seemed to have any effect.

CHAPTER IX.

LIME AND LIMING LAND.

The substances of which we have been treating in the past three chapters, nitrogen, phosphoric acid and potash, are direct fertilizers, or plant foods. We come now to the consideration of the forms which are most useful as reagents, or, as we may say, stimulants to the productive capacity of the soil. While it is true that calcium of which lime is the oxide when freshly made, is one of the elements essential to plant growth, it is usually found in all cultivated soils in almost inexhaustible quantities for all the purposes of direct plant feeding. Yet an application of freshly slaked quick lime (or hydrate of calcium), will often have a marked effect on the productiveness of the soil, through its action in releasing other forms of plant food, particularly potash, from the insoluble silicates in which it occurs in the soil.

Lime is also important in a soil abounding in organic matter, as it corrects the acidity of such soils, and enables the nitrifying microbes to thrive and do their work in bringing the nitrogen of the organic matter into the available form of a nitrate. Hence the old proverb that "Lime enriches the father and impoverishes the son," for it enables us to get at the plant food in the soil, and if used with the notion that it is simply a manure we may soon find that its use has tended to exhaustion. Judiciously used, however, there is nothing that is a greater aid in the development of the farm. Lime also has an important mechanical effect on soils. It renders a heavy clay soil more friable by gathering it into small lumps, or flocculating it, as it is called. On a sandy soil it sinks and forms a compact layer below the plow, and thus renders the soil less leachy. But in many sections where there is a fertile soil well supplied with humus, the application of lime has at first produced such marked results that the farmers have jumped to the conclusion that lime is all they need to keep up the productiveness of their lands. After a while they find that the lime has less and less effect, and they are compelled to resort to commercial fertilizers for the production of crops. We recently had a letter from an old and observant farmer in one of th most prosperous agricultural sections of the State of Maryland, who deplored the fact that his neighbors had used lime to such an extent that their lands were less productive than formerly. He said that for over thirty years he had used nothing on his farm but acid phosphate and clover, with an occasional dressing of a moderate amount of lime to preserve the sweetness of the soil and to enable it to grow large crops of clover. The result was that he made 40 bushels of wheat per acre where his neighbors grew less than formerly. Now, in his application of acid phosphate every third year he applied in it 40 per cent. of the sulphate of lime, and adding a small dressing of freshly slaked lime every sixth year, he kept releasing the potash in his soil, and hence needed only the phosphoric acid in his fertilizer. His red clay soil contains an almost inexhaustible deposit of potash as an insoluble silicate, and the lime gradually gives him the use of some of this. How long he can keep up the productiveness of his land without adding potash will, of course, depend on the amount his soil contains. The wise farmer will, however, watch closely and stand ready to supply the deficiency as it occurs, but will not waste money in the purchase of what he does not at present need.

Limestone, from which lime is made, is an impure carbonate of lime, in many instances being mixed with a large percentage of magnesia, making what is called dolomite, or magnesian, limestone. As the magnesia is a useful plant food this is not a bad mixture for most soils. Where pure lime is wanted the purer the stone, even till it becomes marble, the better. Oyster shells are used as a source of lime in the coast region, and they are a pure carbonate of lime, and when free from earthy impurities, make a very pure lime. In some parts of the South lime is burned from the fossil shell rock and contains a small percentage of phosphoric acid. One of the greatest of the values of lime to the farmer is in enabling his soil to grow clover. It is found that the constant growing of clover and the accumulation of organic matter in the soil tends to create an acid condition. Under this condition, the microbes that enable the clover plant to collect nitrogen do not thrive, and the soil microbes that carry on the work of transforming the organic nitrogen into nitrate will not exist. The farmer finds that he can no longer grow clover with any success, for the land is "clover sick." This is generally the result of an acid condition of the soil. Lime will correct this condition and will usually cause the clover to grow luxuriantly. Most of the legumes are lime-loving plants. The great success of alfalfa in the arid regions of the West is largely due to the fact that the lime has not been washed out of the soil. In the Eastern States no great success with alfalfa has ever been had except from liming it. We visited a year or so ago the grass experiment farm of Peter

Henderson & Co., at Hackensack, N. J. We were shown there a luxuriant plat of alfalfa, and were told that the year before it had been very feeble, but in hauling lime to another part of the farm a little shook from the wagon on the corner of the alfalfa patch. At once that part assumed a stronger growth, and noting this, they applied a dressing of lime to the whole plat with the finest results. Shortly after this I visited the farm of a wealthy gentleman in North Carolina, who is interested in the dairy, and was trying to grow alfalfa. We advised him to give it a coat of lime, which was done. We passed the field but a few days ago and noted from the train that it was the most luxuriant growth of alfalfa we have ever seen in the East. The lime is not only to some extent direct food for the alfalfa, but it brings about changes in other matters that favor its growth. One of these changes is one of the most recent discoveries in science. We have seen that all green plants get their carbon from the air through the assimilative action of their green matter. Fungus plants have no green matter and hence, as a rule, are dependent on what green leaved plants have assimilated. But these microscopic plants in the soil, which carry on the work of changing the organic nitrogen into nitrates, though they are members of the great fungus class, have a power that no green plant is known to possess. They can get the carbon for their growth from mineral combinations like the carbonate of lime. Here, then, is another reason why the application of lime to a soil abounding in organic matter favors the nitrification, or formation of nitrates, for the use of green plants which must get their nitrogen from the soil.

Lime, to have its best effect, should be well burned, and slaked with water to a powder before applying it to the soil. If allowed to lie and get air slaked it is far less effective, since it gets, through the action of the carbonic acid in the air, into an insoluble carbonate, or returns almost to the condition in which pulverized limestone would have been. Stone lime slaked with water till it falls, should make three bushels of slaked lime for every bushel of fresh lumps. Oyster shell lime will slake two bushels for one. There has of late been quite a change in the ideas of thinkers in regard to the quantity of lime that should be used. Formerly it was the practice to apply lime in large quantities and at long intervals. In recent years it has been shown experimentally that a small application, frequently repeated, is far better than the heavy application, so that now it is seldom that more than 20 bushels per acre are used by the best farmers, and some even contend for a smaller application than this. With a short rotation of three or four years, in which there are frequent crops of legumes grown, the repeated application of small doses of lime every four or five years has been found to produce better results than twice the amount at a longer interval.

Experiments that have been long and carefully conducted by the Rhode Island Agricultural Experiment Station, have shown that the sweetening of an acid soil by the application of lime is not always an advantage, since there are some plants that seem to prefer the acid soil, or rather some that are more exempt from disease in such a soil. On the Irish potato crop, for instance, it was found that liming brought about conditions that were favorable to the fungus that causes scab in the potato, and while the resulting crop may be larger the market value was reduced by reason of the scab. Acidity in the soil is detrimental, it appears, to the lower forms of plant life rather than to green plants. Many people have jumped to the conclusion that their land has become infested with sheep sorrel because of its acidity. The fact is that while this is usually the case it by no means follows that the sheep sorrel gets its acid from the soil. The sheep sorrel is one of the plants that can abide the presence of free oxalic acid, while this acid is formed in other plants, the plant at once makes a combination of it with lime or potash and locates it in crystals insoluble in the sap at ordinary temperatures, and thus renders it harmless. The oxalic acid in the sheep sorrel, like other vegetable acids, is the result of the assimilation of carbon from the air, and it does not come from the soil. But sheep sorrel will grow in a soil too acid to allow the success of clover, and hence it is the common complaint that we cannot get clover on account of the sheep sorrel. An application of lime will bring about conditions favorable to the clover and enable it to smother out the sheep sorrel. Not that the liming kills the sheep sorrel, but that it enables the clover to grow and overcome it. Anyone can readily test the condition of his soil by getting a piece of blue litmus paper from a drug store, and burying it over night in the damp soil. If, on taking it up, it is found to have turned to a pink color it is evidence that the soil is in an acid condition, and as our most valuable crops thrive best in a soil of a feebly alkaline nature, an application of lime to such soils will usually be beneficial. While most legumes, and especially red clover, are greatly benefited by an application of freshly water slaked lime, there is one important legume which is not thus helped. The cow pea, the greatest legume for the Southern farmer, is positively damaged by a dressing of lime. Hence one reason why the cow pea will thrive on a soil too acid to permit the growth of clover. It seems probable, too, that the microbes that exist on the roots of the pea, and enable it to get the free nitrogen from the air, are better able to exist in an acid soil than those of the clover; for it is well known now that each legume has its own particular microbe, and that some of them may be inimical to those of other legumes, and it is rare to find one species of legume doing its best immediately after the removal of another of the same order from the land. This is only another reason for a still further development of rotations of crops. Lime will never make poor land rich if regarded simply as a manure, but, used aright, there is no means available to the farmer that will more efficiently aid in the building up of the productivity of his land.

SULPHATE OF LIME, OR PLASTER.

The sulphate of lime is a natural deposit found in certain sections, and mined under the name of gypsum or plaster. Pure gypsum contains 32.5 per cent. of lime, 46.5 per cent. of sulphuric acid, and 21 per cent. of water. It is frequently burned to form what is called plaster of Paris, which, when mixed in water, rapidly hardens and is used for various purposes in the arts. The pulverized rock, known as plaster, has been largely used as a soil application. Like lime, the plaster has the power to release insoluble potash in the soil, and it sometimes has a marked effect on soils containing a large percentage of potash. As in the case of lime, farmers seeing the effect that an application of plaster has on their soil, have at times jumped to the conclusion that plaster was all they needed to make their soil rich. But, as in the case of lime, they have soon found that the continued application soon fails to produce the effect that it once did, and that its continued use has so impoverished their soil that they have been compelled to resort to the commercial fertilizers to restore the mineral constituents they have removed by their short-sighted policy.

While on some soils plaster has had this marked effect, there are other soils on which the application of plaster has never had any marked effect. Sandy soils near the coast, which are deficient in potash, seldom respond favorably to the application of plaster. In an experiment made by the writer a number of years ago, two fields adjoining in clover of the second spring from sowing, were dressed with lime and plaster of the same money value. Both made a handsome growth, but the effect of the freshly slaked lime was decidedly more marked than that of the plaster, and the subsequent cropping of the land showed that the limed field had collected far more nitrogen than the one treated with plaster.

A great deal has been said and written in regard to the use of plaster in arresting the escape of ammonia from manure, and some seem to suppose that dry plaster scattered about a stable will absorb ammonia and prevent its loss. The fact is that plaster has little or no effect in preventing loss of ammonia unless it is thoroughly mixed in the manure and moistened, for no chemical recombination can take place in the absence of moisture. Plaster, being the sulphate of lime, may, when well mixed with manure and moistened, change the volatile carbonate of ammonia to the less volatile sulphate and thus retain it in the manure. A more efficient agent for this purpose, that can be mixed with the manure, but should not be used under the animals, is kainit, or the low grade crude sulphate of potash. The large amount of salt it contains helps to keep the manure moist, and it has the same effect of replacing the carbonate of ammonia with the sulphate and at the same time adding potash, which is usually deficient in the manure in proportion to its nitrogenous content. Years ago in the southeastern part of Virginia, where there are extensive deposits of plaster rock and also extensive salt deposits, the salt manufacturers got up what was known as the Holston mixture, made of plaster, ashes and salt, and this mixture for a long time had a great reputation in Virginia. Its beneficial effects on crops were largely due to the ashes, and, on some soils, to the plaster, while the salt, though not a fertilizer at all, may have had some effect in the solution of matters of value in the soil. As a rule, where a farm is cultivated in a good rotation and lime is used in connection with the growing of clover there will be little or no use for the plaster, unless it may be in a section where plaster is a remarkably cheap article, and even then it could hardly take the place of lime.

GAS HOUSE LIME.

Near the city gas houses this lime is commonly offered so cheaply that farmers are tempted to use it on their land. We have seen some disastrous results from the use of this lime as it is freshly brought from the gas works. It contains, while fresh, sulphides that are positively poisonous to plant life, and while it may be used with some good effect after a long exposure to the air, even the small percentage of nitrogen it contains in the form of sulphate of ammonia may be positively harmful, so that while it contains a good percentage of lime, we cannot advise its use. Far better pay a reasonable price for fresh quick lime than have the gas house lime for the hauling.

SULPHATE OF LIME AS A WASTE PRODUCT.

Sometimes the manufacturers of fertilizers, in order to make a more concentrated article of superphosphate, remove a portion of the sulphate of lime, which contains a small percentage of phosphoric acid. This has been sold at about the price of common plaster, and when in a good mechanical condition it is a good substitute for plaster. One manufacturer offers this under the name of "stable dust," and recommends it for sprinkling manure to prevent the formation of the volatile carbonate of ammonia and a consequent loss of nitrogen. Of its proper use in this we have already written.

AGRICULTURAL SALT

The packing houses have large quantities of refuse salt which they are glad to get rid of at a low price, and there is a persistent effort to persuade the farmers that it is valuable as a manure. The editors of agricultural papers are continually applied to by their readers for information in regard to the value of salt as a manure, and there are some writers who are continually claiming that soda, of which salt is largely composed, can be profitably used as a substitute for potash. Though experiments have continually shown that this is not the case, and that soda cannot take the place of potash, the subject seems to be a perennial one for some. Salt, or chloride of sodium, furnishes in itself no element of plant food essential to vegetation, and whatever good effect may result from its use is due to its action in aiding the decomposition of organic matter in the soil, "increasing the absorbing power of soils, and, by its reaction with lime, acting as a solvent for phosphate." Prof. Voorhees, in his work on fertilizers, well says, "There would seem to be no good reason for paying from $4 to $6 per ton for this substance, when practically the same effect can be obtained from the salt contained in the crude potash salt, kainit, one-third of the weight of which is common salt. This, too, may be had free of charge, or for the handling, as the market price of the kainit is based upon its content of potash."

SHELL MARLS.

The shell marls of the Atlantic coast are almost entirely carbonate of lime, and can be used for about the same purpose as the air slaked lime. Properly used in connection with the culture of legumes, these marls have a value, but it must not be assumed that, like the green sand marl, they will furnish other forms of plant food, and, when applied heavily to soils deficient in humus, their effect may be disastrous to the fertility of the land for a long time.

TAN BARK ASHES.

These are another waste product about which inquiries are continually being made. Farmers, knowing the value of hard-wood ashes, are apt to conclude that the ashes from the spent oak bark will have considerable value. While good hard-wood ashes may contain from 5 to 7 per cent. of potash, the tan bark ashes seldom have over 2 per cent. of potash, associated with a small percentage of phosphoric acid and about 30 per cent. of lime. They are not valuable enough to pay for hauling any great distance if they have to be paid for. Where they can be had for the hauling a short distance it may pay the local farmers to use them.

SWAMP MUCK, OR PEAT.

Many years ago an enthusiastic chemist wrote a book entitled the "Muck Manual," and talked learnedly about gein and other things, and showed that muck mixed with spent ashes was identical in composition with cow dung. But the muck swamps of the country have not yet been transformed into cow dung, and there is far less talk about the virtures of muck than there was in the writer's boyhood. The introduction of commercial fertilizers has so reduced the labor of furnishing plant food to the soil that few are willing now to undertake the great labor of digging and handling peat. There is no doubt that a good quality of swamp muck, when well dried, is a good absorbent of liquids in stables and barnyards, and that it will put a good deal of humus in the soil; and that finally there may be some release of nitrogen from its organic matter. But raw muck spread on the land can have very little effect in increasing its productiveness, and may do positive harm. If the muck is to be applied directly to the land the best way would probably be to pile it in the fall in flat heaps, and cover every six-inch layer with freshly slaked lime. After lying in this way during the Winter, it will make a much better application for the soil. But, as Prof. Voorhees well says, if the swamp can be drained, it is far better to leave the muck there and drain the land for cultivation.

CHAPTER X.

MIXING FERTILIZERS ON THE FARM.

A great deal has been said and written of late years in regard to the mixing of fertilizers on the farm. The manurial requirements of the different crops vary to such an extent that the same fertilizer is not always best for all, and it is of great advantage to vary the proportions of the various constituents to suit the crop grown. It is difficult and expensive to do this by buying the ready mixed articles. Then, too, it has been shown that for the soil of many sections of the country, particularly in New England, the ready made fertilizers all have too large a proportion of phosphates to the potash and nitrogen used.

In the reports of analyses of commercial fertilizers by the Agricultural Experiment Stations it is a common practice to give the commercial value of each. This value means that the plant-food in the mixture can be bought at retail on the market for the price named. But the commercial value of a fertilizer and its agricultural value are two entirely different things. It must not be assumed that because a fertilizer is rated high in commercial value it is also the best for all soils and crops. The agricultural value depends on the needs of the land on which it is to be used, and in buying by the commercial valuation the farmer may be buying matter which his soil does not need, and hence will be wasting money in the purchase.

If there is no need for the purchase of nitrogen, for instance, the farmer can save at least half the cost of the fertilizer by buying an incomplete fertilizer, containing potash and phosphoric acid only.

The various Experiment Stations have given a great deal of attention to the investigation of fertilizers, and their unanimous conclusion is that the farmers can buy the materials and mix their own fertilizers more cheaply than they can buy the factory mixed, and at the same time get just as good results from their use on crops.

In regard to the valuation and selling price of commercial fertilizers, the Vermont Station (Bulletin No. 71) says, from an analysis of 137 brands made by eighteen different companies, "two-fifths of the brands carried no water-soluble nitrogen. Laboratory methods seem to indicate that somewhat inferior forms of nitrogen were used in certain cases, notably in some low grade goods, and by some companies. The phosphoric acid was, in some cases, quite largely in the insoluble or reverted forms, indicating apparently either imperfect manufacture, old goods, or more or less use of (agriculturally) inferior forms of this article. Sulphate of potash is claimed to be present in nine-tenths of the brands, but was actually found in less than one-eighth of the entire number.

The average selling price approximated $28.75, and the average valuation $17.39. Two dollars in every five paid for fertilizers met costs of manufacture and sale. The same amount of plant-food which cost a dollar might have been bought at retail for cash at the seaboard for 56 cents in average low priced goods, for 61 cts. in average medium grade brands, and for 66 cts. in average high priced goods. In one-third of the entire number of brands a dollar was charged for amounts of plant-food which might have been bought, in the manner above stated, for 55 cents or less. Cheap fertilizers are usually the most expensive to buy. Buying mixed goods on time is a far more costly method of getting plant-food than is home mixing or buying on special order."

Low grade fertilizers, or complete fertilizers sold at low price, are always the most costly to the farmer. Several years ago a dealer in one of our cities, who was having fertilizers made for his trade by a chemical firm, sent me a package of the burnt sand and iron oxide left in the manufacture of sulphuric acid from iron pyrites, and wished to know if it had any fertilizing value, as he found that the manufacturer was using 500 pounds of it in a ton of low grade goods made for his sales. I, of course, told him that it was perfectly valueless. The farmer who bought these goods was attracted by their apparent low price, when, in fact, he was paying a high price for all the article contained of value, and was then paying freight on one-fourth of the bulk in an article that was of no use to him whatever.

In some States, notably in North Carolina, the law in regard to fertilizers is so rigid and so strictly enforced, that manufacturers are compelled to fully come up to the guarantee printed on their bags, and in these States the farmer is pretty sure to get what he buys, and the only objection is that the prices charged are entirely too high.

The great argument which the manufacturers of fertilizers have used against home mixing has been that the farmer cannot mix the goods as well as they can with their machinery, and that if he could do so, they could with their machinery mix them more cheaply. The fact is that with the materials at hand, the farmer can mix in any proportion fully as well as the factories mix the goods, and at a cost that will not be felt at all. According to the organ of the fertilizer makers the cost of mixing and putting their goods on the market is about $6 per ton, and the same paper figures up this cost by adding up drummers' salaries, postage, telegrams, travelling expenses and a lot of other items, none of which the farmer mixing his own goods would have to pay, but which are really paid by the manufacturers and those who buy from them ready mixed goods. So the fact is that the farmer can not only get the materials at retail for less than they are charged for them in the ready mixed articles, but he can also mix them far cheaper than the factories can. The same bulletin to which we have referred above, says in regard to the guarantees and claims of the fertilizer makers: "Guarantees are often designedly confusing and convey wrong impressions. Nitrogen, phosphoric acid and potash are what make fertilizers agriculturally and commercially valuable. They are often expressed, however, in guarantees as ammonia, bone-phosphate of lime and sulphate of potash. This is done to make a semblance of giving large percentages of plant-food. Thus nitrogen equivalent to ammonia 2.50 per cent. promises really only 2.06 per cent. of nitrogen; available phosphoric acid equivalent to bone-phosphate of lime 21.80 per cent. promises but 10 per cent. available; and potash (sulphate) 3.70 per cent. but 2 per cent. of potash." Buyers should remember these facts, and ignore in the guarantee everything except the lower figures for nitrogen, (not ammonia or nitrogen equivalent to ammonia), available phosphoric acid and potash (not sulphate of potash, or potash sulphate, or potash equivalent to or equal to sulphate). The law in the State of North Carolina, which in most respects is the best in the country and the most rigidly enforced, allows no sliding scale of percentages on the bags, but requires that the sack shall have printed on it the actual percentage of nitrogen, phosphoric acid and potash. Only this and nothing more. If all the States would pass a similar law there would soon be an end to the long so-called analyses printed on the bags, simply for the purpose of befogging the farmer into the belief that the sack contains a great deal more than it does.

We have at hand from a correspondent a sample of a commercial fertilizer, on which is printed the following:

GUARANTEED ANALYSIS.

Ammonia	**2.10 to 2.50 per cent.**
Total phosphoric acid	**8.50 to 9.50 per cent.**
Available phosphoric acid	**7.40 to 8.40 per cent.**
Potash (actual)	**2.15 to 2.65 per cent.**
Equivalent to potash sulphate	**4.10 to 5.25 per cent.**
Magnesia, organic matter, etc.	**60 to 70 per cent.**

Now all this means that the article has in it, if the analysis is correct, nitrogen 1.73 per cent., available phosphoric acid 7.40 per cent. and potash 2.15 per cent. All the rest is put there to make the farmer think there is a great deal in it, while it is, in fact, a very low grade fertilizer. The "organic matter, etc.," is probably "filler" put in to make bulk. This is but a single sample of thousands of similar "analyses" on fertilizer sacks all over this country. The manufacturer who cannot state just what his article contains must be a poor manufacturer, or puts the sliding scale there to crawl out on. If you see a sliding scale of percentage you may be sure that the lowest figure comes nearest to what is the actual per cent. But there is a great deal less of actual swindling in fertilizers since the laws for the inspection have been adopted in nearly all the States, and the farmer dealing with firms of reputation can usually depend on getting what he orders. The great objection to the ready mixed goods is not their quality, but the fact that they are sold at too high a price, as is evident from the fact that buyers at retail can get the same plant-foods for less money. Bulletin No. 139 of the New Jersey Station, says in regard to home mixing of fertilizers: "Home mixing has been carried on with entire satisfaction by a number of farmers for several years. The Station has encouraged these efforts as of value to the individuals themselves and an object lesson to their neighbors, since it renders them familiar with the kinds and forms of plant-food, teaches them to think of pounds of nitrogen, phosphoric acid and potash, rather than tons of a particular phosphate, and in general unfolds the mystery which envelopes the make-up of fertilizers in the minds of many."

Bulletin No. 53 of the Maine Station well says: "That which transcends everything else in the purchase of fertilizers is to know *what* you want and then get it—get it as cheap as you can and still get the plant food needed. No one would think of buying salt for sugar because it can be obtained at a lower price, but the writer has knowledge of the purchase of nitrogen when potash was needed, simply because the trade value of a nitrogenous fertilizer as printed exceeded its selling price."

In Bulletin No. 132 of the New Jersey Station, a number of analyses are given of fertilizers mixed by farmers for their own use, and the results show that the proportions of the different constituents was as well maintainded as in the manufactured goods. "As a method of economical purchase of fertilizers, either mixing them at home, or having them especially compounded at the factory, seems to be equally recommended by the experience here reported. This opportunity of saving in the purchase of fertilizers is open to all who will study their crops and soils, learn what they need, and secure it by the more business-like method. It is a combination of comprehension, co-operation and cash that effects these reductions in the cost of fertilizer supplies." This is the secret of the whole matter. The prices of ready mixed fertilizers have to be kept high because of the long credits and bad debts, and the men who buy them have to pay these bad debts of others in advanced prices. Buying the materials for cash in wholesale lots through a combination of neighbors will always result in a great saving. It is far better to borrow the money to pay cash for fertilizers than to pay the credit price.

Bulletin No. 65 of the Vermont Agricultural Experiment Station, says: "Home mixtures made in this State furnished from 30 to 50 per cent. more plant-food at the same cost than did average manufacturers' mixtures."

Dr. C. W. Dabney, Director of the Tennessee Experiment Station, writes: "Farmers who take their life work seriously and study earnestly the experimental work of the State Stations, for the purpose of informing themselves with regard to the useful ingredients of fertilizers, the proper mode of applying them and such matters, are getting more and more into the habit of buying the raw materials for fertilizers and mixing them themselves, or else they have a compound mixed at a factory according to their own formula and from materials of their own selection."

Farmers' Bulletin No. 84, U. S. Department of Agriculture, treats of the various objections raised to the practice of home mixing. "Farmers are persuaded that the compounding of fertilizers is an intricate and difficult matter, requiring extensive acquaintance with chemistry, costly machinery and great technical skill. The case well illustrates the old adage, that a half truth is a whole falsehood. The production and manufacture of fertilizing materials—that is, the selection, quarrying, grinding and acidulation of phosphatic rock; the drying and grinding of slaughter house refuse, the production and refining of such materials as nitrate of soda, sulphate of ammonia and muriate of potash—all these are distinctly manufacturing processes, which require chemical or technical knowledge, skill in manipulation, and expensive machinery. But these operations are entirely separate and distinct from the compounding of mixed fertilizers. Each of the materials named comes from the manufacturer in condition to be used by itself as a fertilizer, and each one is so used for special purposes. The compounding of these materials under a proprietary brand into a mixed fertilizer, is no more a manufacture than is the mixing of a ration of corn meal and bran to be fed to a cow. The only difference is that the ration which is designed to be distributed uniformly to thousands or millions of plants requires to be more carefully mixed than that fed to a single cow. If we were feeding each plant by itself no mixing would be necessary, or if we were giving the different elements of a ration at different times; as for instance, when we apply superphosphate and muriate of potash to wheat in the fall and follow with nitrate of soda in the spring. This point, of the essential difference between those operations which are legitimately called manufacturing and those which are simply mixing, should be clearly understood. When the farmer learns that he can mix his own fertilizers and thereby materially reduce their cost, the use of fertilizing materials will be largely increased, and the final outcome will be a benefit and not an injury to the legitimate trade in fertilizers."

This is just what the writer has been insisting upon through the agricultural press for years, but such is the short sighted policy of the manufacturers of fertilizing materials, who are generally at the same time mixers of the materials in any number of fancy brands, many of them identical except in name, that they put all sorts of obstacles in the way of the farmer's getting the raw materials for mixing his fertilizers at home, and constantly endeavor to make the farmer think that their process of putting these materials together is a matter of great skill and experience, and cannot be done without the use of expensive machinery.

Machinery is used, of course, in the mixing on a large scale, as a matter of economy, and to increase the profit to the mixer.

Bulletin No. 173 of the New York (Geneva) Station showed that the average selling price of mixed fertilizers in that State per ton averaged $6.25 more than the separate ingredients could be bought for *at retail.* Inasmuch as this was far higher than the actual cost to the large mixer, it can easily be seen that the profits of mixing on a large scale must be large, and that the wise farmer can easily save, even in buying in retail quantities, a considerable sum.

Bulletin No. 45 of the Maine Station says; "One of the claims which fertilizer manufacturers are making for the superiority of their goods over home mixed fertilizers is that the former are manufactured. This should mean, if it means anything, that the goods are more evenly mixed, and therefore, more uniform. In the tables given on the previous pages it will be found that in some instances in which two samples of the same brand have been taken and analyzed, that they differ from each other quite materially. The samples were taken with a great deal of care by experienced men from a large number of packages. It would not seem difficult to make home mixed fertilizers which should run as uniformly as some of the brands here reported upon.

Bulletin No. 79 of the Kentucky Station says in regard to the selection of the proper fertilizers, "Their profitable use will depend upon a knowledge of the needs of the particular soil to which they are to be applied, and the requirements of the crop to be grown. The latter knowledge has been gained once for all for most farm crops by a scientific study of these crops, but the needs of the soil must in most cases be learned by the farmer himself, either from systematic field experiments, or by observation and experience. If it is necessary for a farmer to use commercial fertilizers, and he is working upon a kind of soil that has not already been tested, we believe it will pay him to learn its needs by carrying out systematic experiments with fertilizers. The experiments made at this Station amply illustrate this. It would be very unprofitable to buy phosphates for use on soil like that of the Station farm, but potash salts could be profitably used there on most crops. This is because the soil is already rich in phosphates. But if it were deficient in phosphates, as is the case with many soils in this State, it would be unprofitable to use potash salts alone, and one would have to supply phosphates. It is, therefore, necessary in purchasing a commercial fertilizer to consider, first, what our soil needs for the crop to be raised, and then to look for the fertilizer containing most of these substances, in an available form, as shown by its chemical analysis and guaranteed by the manufacturer, at the least cost. It is well to bear in mind, also, that nitrogen compounds are the most expensive constituents of commercial fertilizers, and if we can keep up our nitrogen supply by means of clover, cow peas, or other leguminous plants, or by barnyard manure, and purchase only such phosphates and potash as may be needed, we will have accomplished a great saving." Here, too, is a strong argument for home mixing, since it will rarely happen that we can get a ready mixed fertilizer exactly suited to our soil and crops without buying at the same time something we do not need. Bulletin No. 80 of the Vermont Station shows that in the past spring (1900) the average price of mixed fertilizers was $28.73, and the average value, based on the retail price of the ingredients, was $18.08, another evidence of the saving to be made in home mixing.

But the most complete investigation of the value of home mixing of fertilizers has been made at the Ohio Agricultural Experiment Station. It is claimed by the factory mixers of fertilizers that in using tankage as a source of nitrogen they have a great advantage in the fact that they treat their tankage with sulphuric acid to render it more soluble, and hence far better than the untreated tankage used in the simple mixtures. It was shown by the experiment at the Ohio Station that this causes great loss of nitrogen from fall application to the wheat crop and "it follows, therefore, that if the treatment of tankage with sulphuric acid serves to make its nitrogen as soluble as that in sulphate of ammonia—and this is precisely what is claimed for it—then such treatment is injurious and not beneficial to him who would use tankage in the fall as a carrier of nitrogen to wheat.* * * * Our experiments do not support the claim that the acidulation of tankage is necessary, unless the tankage has been adulterated with leather scraps or similar material; they rather show that it is a disadvantage. * * * The sulphuric acid used in acidulation costs only about one-third as much per pound as the fertilizer is sold for. In point of fact, the manufacturer can very well afford to pay $6 to $8 per ton for sulphuric acid to be sold again at $20 to $30. * * In the field experiments of this Station factory mixed fertilizers, made by firms of high standing, produce no greater crops than home mixed fertilizers of equivalent composition. The cost of the factory mixed fertilizers was greater by 50 to 90 per cent. than that of the equivalent home mixtures. Physical and chemical examination of the two forms of mixtures show that the factory mixed fertilizer is not more homogenous in its character than that mixed by the farmer. Fertilizer materials may be as perfectly mixed with a shovel on a barn floor or in a large box as by the most elaborate mixing machinery."

HOW TO MIX FERTILIZER.

There is a widely prevalent idea that the chemical constituents of a fertilizer must have a "filler" mixed with them to make bulk. This notion has arisen from the fact that fertilizer mixers commonly use worthless materials for fillers in low grade goods, so as to be able to sell them at an apparently low price, while still getting full prices for all that is of value in them. The various fertilizing constituents are already combined in such a way that no further filler is needed, and they only need to be mixed in the desired proportions. This mixing we have shown can be as well done on a barn floor as by the most elaborate machinery.

Having determined from a formula the proportions in which the articles are to be mixed, is is a simple matter to spread them out in layers on the barn floor, and then having set up an ordinary sand screen to shovel the mass through the screen repeatedly, beating up all the lumps, till a perfect mixture is made. After the mass has been shovelled through the screen two or three times it will be sufficiently mixed for all practical purposes. In fact, if we could distribute the materials over the land in the exact proportions needed, there would be no necessity for mixing them at all, but this would take a great deal more labor than mixing and spreading at one going over the ground.

We give elsewhere a series of formulas adapted to various crops on different soils. These are largely for complete fertilizer mixtures containing due proportions of nitrogen, phosphoric acid and potash. But it must not be supposed that these are in every case necessary or profitable. They have been devised from the study of the manurial requirements of the various crops, assuming that the soil needs them all. But we will try to show how, by good farming and a proper rotation of crops, we can avoid the constant application of commercial fertilizers to every crop grown. The Experiment Stations have devoted so much time and labor to the study of the manurial requirements of crops that farmers are apt to imagine that all they have to do is to suit a fertilizer to the crop in order to make it.

CHAPTER XI.

THE MAINTENANCE OF FERTILITY.

The maintaining and increasing of the productive capacity of the soil in a profitable manner should be the ultimate aim in the use of manures and fertilizers of any kind, and not the mere speculating on how much sale crop we can get through the use of a certain fertilizer mixture. This has been the course over large sections of the country, especially among the cotton farmers of the South, until with the majority of the farmers the first question asked is, "How much and what kind of fertilizer shall I use to get a certain crop?" Men frequently write to me that they have a certain field which last year made, say, ten bushels of corn per acre, and they want to know what and how much fertilizer they shall apply to that same field to make it produce 50 bushels of corn per acre. We have to reply, of course, that it cannot be done in that way. The physical and mechanical condition of the soil has as much to do with its productivity as the amount of plant-food it may contain. When a field, through a long course of bad treatment, has been deprived of its humus, and has gotten into a bad mechanical condition, no amount of fertilizer will at once restore it to its normal state of productiveness. It took years to complete the robbery of the soil and years of proper farming will be required to restore it.

USING FERTILIZERS IN CONTINUOUS CROPPING.

There are many men in the South who imagine that they are farming profitably by growing cotton year after year on the same ground with an annual application of fertilizers, simply because they show some profit over the cost, and not reflecting that they could secure greater profits by proper rotation and a smaller expenditure of fertilizers. As compared with real farming, their cultivation can easily be shown to be unprofitable. Especially is this true when the crops are the cereal grains. At the Ohio Station a long series of experiments have been made with various rotations and also with cereal crops grown on the same soil year after year with the use of commercial fertilizers. They thus summarize the results of the continuous cropping. "At the prices at which mixed fertilizers are sold in Ohio the attempt to furnish all the nitrogen, as well as all the phosphoric acid and potash, required to produce increase in cereal crops grown in continuous culture, has invariably resulted in pecuniary loss, although very large increase of crop has been thus produced." "The rotation of cereals with nitrogen gathering crops, therefore, has been shown to be absolutely essential to the profitable use of commercial fertilizers in any form."

This confirms all that we have found through a long experience in the cultivation of the soil. The constant use of complete fertilizer mixtures for the production of sale crops only, has brought poverty to the soil over large sections of the country, and of course poverty to the cultivator. It is for the purpose of aiding in the bringing about of a change in this respect, and of showing how fertilizers may be used profitably for the improvement of the condition of the farm and the farmer alike, that we have undertaken the work of writing this book. The writer is a Southern man, born and raised in the South, and it has been his life's work to do all that he can to aid the farmers of the South especially, to the adoption of better methods, for he is convinced that the wasteful use of fertilizers and the continuous cropping of the land in sale crops is responsible for the sad condition of farms and farmers in the South. And it is not only in the South, but in other parts of the country, where the farmers are just beginning to realize that their soil is becoming run down, and needs help, that there is danger that they, too, will imagine that in the bag of fertilizer they can find all that they need, and they are beginning to start in the same road towards "old fields" that the South has travelled. The old, down hill road has been an easy one to follow, and required little thought; the new one calls for careful study and experimentation on the part of the farmer. He can no longer succeed by the old, happy-go-lucky methods, but must become a student and a book farmer to a great extent. By maintaining the fertility of his land he can alone hope to succeed. This cannot be done by an annual gambling in fertilizers and the growing of a single crop year after year on the same land. No matter what the crops are, whether wheat on the plains of the Northwest, corn on the prairies of the Middle West, tobacco in Virginia or Ohio, or cotton in the South, single cropping everywhere tends to soil exhaustion and the depletion of the farmer's resources.

One characteristic of the Northern farmers in contrast to their brothers in the South, is the readiness with which they see errors in their work and make a change for the better, while the innate conservatism of the Southern farmer holds him longer in the old ruts than his Northern competitor. The great decrease in the wheat crop on the plains of Dakota showed plainly that the wheat growers there were, as we have said, straight on the road to "old fields" as those of the South have long been. But of late, the farmers of Dakota are realizing their error, and are going into cattle. They can do this all the more profitably now that the sheep have driven the cattle from the great ranges of Colorado, Utah and other sections where cattle formerly were raised in immense numbers. These great ranges of public land no longer carry their herds of cattle, for sheep have gotten possession; the cattle of the future will not be raised on the free ranges, but on the lands belonging to the farmer, and the cattle feeding of the Eastern States will once more become profitable. The Dakota wheat growers are wise enough to see the error of their one-cropping, and to take advantage of the changed conditions in the cattle industry. Having taken this step before the "old fields" were present in all their hideous barrenness, the Dakota farmer will have the great advantage of his Southern brother in the unexhausted condition of his soil and its capacity for the production of grass. But if the farmers in a section where cattle must be housed and fed for nine months and where great storage must be made of winter feed, can produce beef cattle at a profit, what should the farmers of sections which can produce the finest of forage plants in the greatest abundance and where the cattle can roam in the fields nearly every day in the year, do? We cannot too often insist that there can be no real prosperity on the farm, no real home making and nowhere near the profit in farming, with one crop, and selling that in the raw state. The growing of forage crops and the keeping of live stock lies at the very foundation of all rational methods of soil improvement and the maintenance of the fertility of our acres. The farmer who transforms some of his raw products into a more finished product always realizes a larger price for his product than the man who constantly sells only the raw product. Some years ago the writer made a visit to Nebraska for the purpose of studying the growth and manufacture of beet sugar as practiced there. We were struck with the beauty of the wide spread of corn fields, and took occasion to talk with the farmers not only about their beet growing, but in regard to other crops. Asking one German farmer what corn was worth per bushel, he replied that he believed it was about 20 to 25 cents, but that he did not sell corn as some of his neighbors did. His corn went into hogs and they carried themselves to the depot, and he got 50 cents a bushel for his corn and had the manure left, though he seemed to care little for that, for like most farmers on the new prairies, he thought the soil inexhaustible, like those further east who are now buying fertilizers. I said to this man that his course was wise, but that he might go still further, for I had noticed that in the thriving young city near him the grocery stores sold only the packed hams and bacon from Chicago, and that his pigs had paid the freight both ways and a profit to the packer, and that he could do some home packing and sell the bacon as well as they and probably get a better price than the packer's meat brought. The German seemed to catch the idea and remarked that he believed he would get 75 cents for his corn. As I write, the hams of the packing houses can be bought at retail here for 10 to 15 cents per pound, while at the same stores the famous hams of the Southeast Virginia farmers are selling for 22 cents per pound. By the production of a superior quality of cured product, the farmer can realize large prices for his grain and not have to take what the market offers for the raw product. Lay it down as a law that no country or community ever became permanently rich by the sale of its raw products only. To some extent the South is beginning to learn this, and all over the country cotton mills are being built and run at a profit and the labor drawn to them from the farms has to be fed by the farms, and a new inducement is offered to the Southern farmer to produce food crops, as his market is growing more rapidly than its supply.

WHY A SHORT ROTATION IS BEST.

The Ohio Station, in the series of experiments undertaken for the purpose of demonstrating the best method for maintaining the fertility of the soil, arrived at the following conclusion: "Thus far in these experiments, the surplus nitrogen accumulated by a crop of clover, the roots only being left in the ground, has not been more than sufficient to satisfy the demands of the one crop immediately following the clover.* * * * It appears to be clear, therefore, that under the conditions of this experiment, which is made on soils of reduced fertility, and on which there has been no systematic culture of leguminous crops previous to the beginning of this test, we are not maintaining in the soil a supply of nitrogen sufficient for maximum crop production by simply growing one crop of clover in five years, the roots of which only are left in the ground, the tops being made into hay and removed from the land." Hence it is evident that where it is desirable to have a rotation extending over five years there must be another leguminous crop introduced in order that the supply of nitrogen may be maintained for the production of maximum crops. This can easily be accomplished in a three or four year rotation, and farmers in sections where it has long been the practice to run the land in grass as long as the mowing could be kept good, before going back to corn and small grain, are beginning to realize that they have been losing greatly by the practice, and that permanent pastures and a short rotation in the cultivated land are the things to be sought for. The reason for the desirability of the short rotation and the more frequent bringing in of the legumes is obvious if we reflect on the nature of the nitrogen. Most of the nitrogen collected by the legumes is in the form of organic matter in the roots left in the ground. We have shown that green plants do not use nitrogen till in the form of a nitrate. Hence this organic matter must go through the process of decay, and of change in the soil into a nitrate. This is, as we have seen, accomplished through the agency of the nitrifying microbes in the soil. When these have done their work, the nitrogen contained in the clover or pea roots is transformed into a nitrate, and if not then at once used by the plants it is rapidly washed out of the soil. Therefore, if there is a long interval between the crops of legumes, we cannot keep up the supply of nitrogen in this way, and will have to resort to the purchase of complete fertilizers, which a short rotation would render needless. But as organic matter accumulates in the soil, forming humus, it is probable that the complete nitrification may be slower by reason of the increasing acidity which is less favorable to the activity of the nitrifying organisms. Then it is that the use of lime becomes an important adjunct and restores the favorable conditions for nitrification. With a three year rotation, a light dressing of lime once in each alternate round of the rotation (or once in six years), will be found a great aid in the development of the productivity of the soil. Or even a still lighter application every round of the rotation may prove best.

A SHORT ROTATION BEST FOR SPECIALIZED FARMING.

While we are convinced that the greatest evil in farming has been continual cropping with a single crop, and that the only way towards the improvement of the soil is through a diversified farming, this does not mean that a farmer should grow a little of everything his climate will produce. He should study his conditions carefully, and find out what is the best money crop for his section and his land, and then should contrive a rotation intended to best promote the success of his money crop.

The wise farmer will always have a specialty, to the increased production of which he will bend all his energies, while endeavoring in every possible way to reduce the cost of its production by making his subsidiary crops aid in the defraying of the expenses. His specialty may be cotton, tobacco, wheat, corn or any other particular crop, and his aim should be to grow the money crop more cheaply and at the same time to greater perfection than anyone around him, if possible. It is not always the sign of the best farming for a man to grow a specially large crop of something on a small area of land. The phenomenal yields of corn, for instance, which have been produced in competitions for premiums, are interesting mainly as showing what can be done with heavy feeding and good culture, but they are usually financial failures. What we should aim at is to get the widest possible margin between the cost of the crop and its sale value. This calls for skillful management of the land, and the best of cultivation, as well as a wise selection of what is to be sold from the farm. Some of our Southern friends have imagined that the way out of the old one-crop farming is a diversification by which the farmer shall grow someting of everything his climate will allow, and shall not buy anything which he can grow. This sort of aimless diversification is not what we want, but a systematized agriculture suited to the conditions under which the farmers live. The cotton farmer in the warm soils of the Southern seaboard could doubtless grow some wheat, but he will soon find that he can buy all the flour he needs more cheaply and of better quality then he can grow the wheat and have it manufactured on a small scale. The farmer in Southern Maryland could doubtless grow a little cotton, as they once did under the old home manufacturing practice, but he would soon find that he had better stick to his wheat or tobacco and buy his cotton goods. The same rule holds good in all parts of the country. The money crop of each section has become such through the operation of natural laws, and none can afford to ignore these.

SOME OF THE MISTAKES MADE.

When a farmer moves from one section to another having an entirely different soil and climate, he needs to study his new conditions well. He will in fact, have to unlearn a great deal and to learn things that he did not formerly need to learn. Going into a new section, one is apt to imagine that he can do a great deal better than the people already there, and as he has been a good farmer in his old location, he is apt to think that the same methods which were best there will be the best in his new location. The people among whom you have come may not be farming as well as they do in the section where you formerly lived, but there will always be practices in every old settled section which are the outgrowth of experience in that particular soil and climate, and which a newcomer cannot afford to ignore. Northern men coming into the cotton belt, as a rule, always want to grow something else rather than cotton. They see that under the old methods, the cotton farmers and the cotton farms have grown poor, while the fertilizer manufacturers have grown rich. They therefore jump to the conclusion that cotton and fertilizers are bad things, and are wrong in both conclusions. The warm coast plain of the South could have no better money crop than cotton, and the commercial fertilizers, while bringing disaster to the farm and the farmer when used in the wasteful way in which they have been used, can be made, in the hands of a good farmer, the most potent means for building up the fertility of the soil. For a man to go into the cotton belt and engage in general farming and ignore cotton would be a great mistake, for no farmer, as a rule, can afford to ignore the money crop of his section, unless he has some specialty which takes him out of the list of general farmers. It is true that there are large sections of the Southern uplands where cotton is grown and where it should never have been grown, and there, with the growth of knowledge in regard to farm methods, the farmers will soon learn that their lands are better adapted to grain, grass and stock than to cotton; and in other parts of the country the methods are undergoing a gradual change so that each particular section is finding out what it can best do, and what it should let alone. Specialization, with a properly arranged rotation, is the road to success. The growing of a single crop year after year on the same land, no matter how much commercial fertilizer you may buy, leads finally to poverty of soil and of the farmer, too.

No matter what the crop the result is pretty sure to be the same. In the great peach growing section of Maryland and Delaware, the men who have been, as a rule, most successful in the long run, have not been the men who put their entire land into peaches; but rather those who recognized the adaptability of their soil and climate to peach culture, who made the short-lived peach trees simply a part of their farming and gave them the best attention, knowing that in a few years the orchard must go back to crops of a different nature, and must be kept up in its fertility to correspond with the other fields when one of these was taken for the orchard. Prof. Roberts in his book, "The Farmstead," says, "Many farms in Western N. Y. have been almost exclusively devoted to the raising of grapes, which, when abundant, or moderately so, sold at ruinous prices. It is noticed that where only an eighth or fourth of a farm was devoted to vines, the yield was not only proportionately larger, but the quality better than where nearly all the land was used as a vineyard. Where diversified agriculture was carried on to a limited extent and plantations were restricted, the low price of grapes made no serious inroads on the income. Where all the land was given to grapes, work was intermittent, the farmer being overtasked at one season of the year and idle at another. The demoralizing effect on the farmers and their families of this army of unrestrained youths and loungers of the city, which, for a brief period, swarms into the districts devoted to specialized crops, as grapes, berries and hops, is marked." Single cropping is destructive to home life wherever it is practiced.

In the cotton growing sections, the negro tenants, who grow no other crop, are idle during the winter; as it takes about all their share of the crop to pay the merchant who carried them during the summer, they are in a measure forced to live upon the country, and the whole system is an encouragement to vice. If the tenants were compelled to farm in a systematic manner it would tend towards the building up of the land and the increased prosperity of the tenant. There is no hope for the permanent improvement of the Southern cotton lands so long as the "cropping" system prevails.

CHAPTER XII.

HOW TO USE COMMERCIAL FERTILIZERS FOR THE MAINTENANCE OF FERTILITY.

The whole of the cotton growing section of the South Atlantic States furnishes an object lesson of the ruin that comes about through the injudicious use of commercial fertilizers, and the growing of cotton on the same land year after year. This is most plainly seen on the rolling, red clay uplands. Steep hillsides, which a wise agriculture would have left in the protecting forest cover, have been cleared and cultivated in cotton. As the humus in the soil was exhausted, the red clay tended to wash into gullies under the great down pour of summer rains that prevail. Year after year the gullies have been made larger till cultivation became impossible, and now all over the upland country of the South these ruined and irreclaimable hillsides are staring the traveler by rail in the face, and giving a bad impression of the whole country; and all the rivers run loaded with the wasted fertility of the soil. Thousands of acres of these gullied hillsides can only be redeemed by a restoration of the great forest cover, which should never have been removed in the first place. The soil and the thousands of dollars' worth of fertilizers which have been wasted in the culture of these hills are both gone, and the land has been literally used up for a few crops of cotton.

Under former conditions, when the large plantations with their army of slaves were in their prime, a notion prevailed that cotton was the one crop that would not fit into an improving rotation. Before the introduction of commercial fertilizers the practice was to cultivate a piece of upland as long as it would pay to grow the crop, and then to take up another piece, letting the first grow up in pines.

With the change in labor conditions, and the introduction of commercial fertilizers, it was found that the old land could be made to produce a crop, and then the farmers imagined that all they had to do to get a crop of cotton was to use commercial fertilizers. These have been mainly purchased on credit, with the invariable result that the manufacturers, in order to protect themselves against loss, have been obliged to charge high prices for their goods. So long as the cotton only, was sold, and the seed was returned to the land, the depreciation was slower. But of late years the great demand for the seed in the manufacture of oil has led to many selling the seed outright, imagining that they were making an additional profit from the crop. While it is true that some farmers exchange their cotton seed for meal and oil to advantage, there are thousands who sell them regularly. This is especially true of the tenant croppers whose interest in the land is less than their interest in the immediate crop. The oil, being one of the products of the plant which was derived from the assimilation of carbon from the air, has no value as a manure to the farmer, and where a fair exchange can be made, it is better for the farmer to make the exchange and get the more readily available nitrogen in meal, while the hulls will make a good absorbent of manure. It is true that they are largely used as food for stock, but they are at best only a makeshift of the poor farmer, for there is not a section in all the cotton belt where far better food may not be grown, while at the same time the crop that furnishes the food will help the land.

One of the saddest sights one sees daily in this cotton country is a farmer, or rather a man who is cultivating the soil, hauling home from the city oil mill, baled cotton seed hulls to feed his mules with. And this in a country where the finest crops of the best hay in the world can be grown from the cow pea, and the land made better for cotton production by reason of the forage growth. The whole crop, seed and all, was sold, and now the farmer buys back the poorest part of the crop to feed the mules. And this is not the worst of the whole sad business, for the cotton must not only pay for the mule feed, but for the mules themselves, for the idea of keeping a breeding animal never seems to enter the minds of the men who are working in the one crop of cotton; the cotton must carry the whole burden while the soil gets poorer and poorer. I write of these things particularly because they are daily before me, but there are farmers whose interest is in other crops, who are doing as badly as the cotton farmers. We recently traveled and spoke at Farmers' Institutes in the State of Maryland, in sections where the farmers are improving in many respects, and are paying attention to stock and the dairy, and over the wide, level fields where the corn binder could run with profit, I saw the old time method of topping the corn and stripping the blades still practiced, and the stalks and husks left in the field; thus sacrificing a large amount of food that the shredder would have turned to profit in the feeding of cattle. In the great corn growing sections of the Central West, too, we see the same waste of food and lack of interest in the complete utilization of the greatest forage crop of America, the Indian corn crop. There is not a section of all the corn growing belt where there is not much of this waste, and where thousands of cattle could not be fed instead of the hundreds that are fed. And even in the greatest corn growing sections of Ohio, Indiana and Illinois, there are farmers who write to us asking for fertilizer formulas for the restoration of the productiveness of their lands; while they are annually wasting food that would turn them a profit in feeding, and give manure for the acres that are hungry for it. Properly managed, there is no part of the corn plant that cannot be profitably utilized as food for stock, and the greatest leak today in American agriculture is in the waste of corn stover all over the land. No farmer, no matter how fresh and fertile his soil, can afford to plow corn stalks into his land, when, by proper treatment that will largely increase the stock supporting capacity of his farm. While commercial fertilizers are useful and even indispensable in these high pressure days, no farmer can afford to neglect the manurial resources of the farm itself, or waste what would give him profit if rightly handled and fed.

THE ROTATION FOR THE COTTON FARM.

In all the true cotton country, the sandy and level lands along the coast and extending one or two hundred miles or more inland, and the widespread prairie lands of Texas, cotton can be grown in an improving rotation as the special money crop to the greatest advantage. In all the South Atlantic coast country the use of commercial fertilizers in some way has become a necessity. The Texas cotton growers as yet may not feel the need of them, but it is only a question of a few years when they will need them, unless a wiser method of farming with cotton is adopted. The Experiment Stations in the cotton country have spent a great deal of time and labor on the study of the manurial requirements of the cotton crop, and far too little time on the demonstration of the most economical methods of meeting these requirements. Formulas without number have been devised for cotton and other crops, until the farmer has been led to suppose that all he needs to grow the crop is a formula for a fertilizer. While the investigations of the Stations have demonstrated the needs of certain plants in the way of food, with great precision, there is now a great need for the demonstration of economical methods for the bringing about of these conditions in the soil. While it has been demonstrated that the cotton plant needs nitrogen, phosphoric acid and potash in certain proportions, it by no means follows that these should be purchased annually for the purpose, if by proper farming we can accumulate any of them in the soil for the crop. The great need in all the cotton country, the need that no purchase of fertilizers will ever fully meet, and without which the development of the productive character of the Southern uplands must be slow; is the keeping of cattle and sheep, and the growing of forage crops for their feeding in a profitable manner. "But," said a cotton farmer to the writer, when he was urging the feeding of cattle as the very foundation of profitable farming, North or South, "I do not want to be pestered with cattle, for I can buy a lot of fertilizer every spring and make a profit out of it in the growing of cotton." This man, fortunately, has a large body of very fine land, well supplied with humus, and on which commercial fertilizers act very finely; doubtless what he said was true and that he does make a profit in cotton farming with heavy doses of fertilizer on his land. But it would be easy to demonstrate that the profit would be much larger and the outlay for fertilizers much less by *farming* instead of merely *planting* his land. But there are thousands of farms in the South which have been so completely run down by bad culture that even the application of fertilizers by a Station formula gives no profit. It is a common practice among the larger cotton farmers to figure everything by the mule. The area of land does not enter into the calculation, but only what they can clear from each man and mule in the cotton field. At ten cents per pound, a man and a mule can make, on land yielding half a bale per acre, about $600 worth of cotton. This $600 must pay for the fertilizer used on the land, and must feed the mule and the negro for a year, while the same land probably could be, in a little while, brought to the production of a bale per acre with less direct expenditure of fertilizers, is farmed instead of being merely planted. In all of our Southern cities the refrigerator cars from Chicago are daily bringing beef for our consumption, in a country where more and better forage can be grown than in the West; and where men are planting thousands of acres in cotton with hardly a hoof on the land except the mules which work the fields in summer and loaf all winter.

A proper rotation for a cotton farm involves the feeding of stock. The feeding of stock requires forage and grain. The growing and harvesting of forage and grain and the feeding of stock in winter, requires regular labor from year's end to year's end, and gives steady employment and a better class of laborers by reason of the steady work. It means cash coming in at different seasons, which enables the farmer to buy for cash, and thus lightens greatly the expense falling on the cotton crop. It makes the farmer a reader and a student, and in this way has its influence on the home, for when people get interested in books they soon improve in the home making.

During the late depression in the price of cotton the writer was continually being appealed to by cotton farmers for information in regard to the culture of one crop or another, which the writers wanted to put in in the place of cotton. They had always been giving cotton too large a place, but their only idea of farming seemed to be the "making of a crop" of some kind to sell. Some wanted to go into broom corn, some into sunflowers for the oil, some into hops or some other crop about which they knew nothing, and many of which were entirely unsuited to the Southern climate, as the hop is. We have tried earnestly to impress on the writers that the only hope of the South lies in better farming with the staple crops we have, and an utter abandonment of the cotton cropping idea. "But I cannot afford to put my land in crops that will pay me less money than I can get from the land in cotton," is what we are continually being told by men whose cotton costs them 6 to 8 cents per pound, when by better farming and the growing of forage and feeding of cattle they could grow the cotton for half what it now costs them, and this, too, with a more liberal expenditure for fertilizers than they now use, but used in a different way.

WHAT IS THE BEST ROTATION FOR COTTON?

Bulletin No. 43 of the Georgia Station makes the following statement in regard to the rotation practiced there. "At the beginning of the existence of the Station, nine years ago, a regular system of rotation was inaugurated, and with occasional modification, it has been continued to the present time. This system is what would be called a three year shift, and is as follows: First year: Oats, liberally fertilized, followed by cow peas with 200 pounds of acid phosphate per acre. The cow peas, as a rule, were made into hay.

Second year: Cotton, liberally fertilized.

Third year: Corn. At the beginning liberally fertilized, but later, moderately fertilized. Cow peas were sown in the corn, sometimes in hills at second plowing, but generally broadcast at the third plowing. Peas gathered for seed supply. A part of the corn for several years past has been cut down, stalk and all, and put into the silo. After the corn, the land was again sown in oats in October or early November, thus commencing a second round of the three year rotation. The Director does not hesitate to say (and in this opinion he is sustained by the Agriculturist), that the increased productiveness of the farm is due more to the adoption and maintenance of a regular system of rotation of crops, than to any one policy or practice." The bulletin further states: "On most small farms that are devoted to cotton and corn and minor crops, and where very few animals are kept, there will not be more manure from this source than will be required by the kitchen garden and the truck and forage patches around the residence and barn. For the outlying fields, more or less remote from the house, reliance should be placed on the system of rotation already outlined, in which small grain and cow peas are leading features, aided by a judicious use of concentratetd fertilizers. As the system develops, and after it has been in operation a few years, the necessity for these concentrated fertilizers will be less urgent, a smaller quantity will be required, and increasing profits will accrue."

In the main there can be no great objection to the plan of the Georgia Station. What we do object to, however, is the statement that on small farms there will be proportionately less manure made than on a large one. If the rotation advised is followed, there will be a considerable amount of forage produced in the shape of oats straw, corn fodder and pea vine hay, and, whether the farm be large or small, this should be fed on the place, to cattle, and the result will be that there will be as much manure in proportion to the area under cultivation on the small farm as on a larger one under the three year rotation. A long experience in the culture of Southern lands has shown us that the great advantage of the three year rotation lies in the more frequent bringing on the soil of a leguminous feed crop, and the practicability of finally making manure enough to broadcast one-third of the area annually. Dribbling a little manure around on the better lots about the barn will take a long time to restore the fertility of the farm, the produce of which is being used only on a limited area. The small farm is the place for the manure spreader with all of its manure-spreading economy.

In practicing a good three year rotation with cotton, and feeding all the forage grown, as well as the corn and oats, the cotton farmer can make live stock an important part of his profits while increasing his manure accumulation. Another point of importance in the Georgia rotation is the fact that every crop grown is supplied with commercial fertilizers in large or small quantity. At the usual market price for corn we have never been able to get back the cost of a complete fertilizer applied to this crop. The corn field is the place for the manurial accumulation of the farm, and a well arranged three year rotation will, in a few years, enable the farmer to make manure enough for his corn. Growing through the long heated season, when the nitrification is most active in the organic matter, corn can make a better use of the manure than any other crop, while at the same time there will be a residue well incorporated with the soil that will carry the oats through without the further addition of commercial fertilizers. Then with a more liberal application of acid phosphate and potash to the oat stubble the great nitrogen-collecting crop of the rotation, the cow pea, will make a great crop of forage, and leave in the stubble nitrogen enough to carry the succeeding cotton crop, with the aid of the seed made by the preceding crop, or the meal exchanged for the seed. For a few years in the first start of the improvement of a worn cotton farm it may be necessary to add some acid phosphate to the cotton seed meal; this, too, can soon be dispensed with, and the only commercial fertilizers that need be bought through the whole three years will be the acid phosphate and potash for the peas. When you reach this point cotton growing becomes profitable, even if the price goes lower than the ordinary cropper can grow it for. Your well fed cattle will pay all the expenses of your farming, and leave the manure and the cotton crop as profit. This is no mere theory, for it is being done successfully, and in the hands of some enterprising men the crop of winter oats has assumed an importance from the great crops grown that makes them, too, an important money crop. The way out of the slavery of the cotton farmer to the fertilizer mixer lies through the growing of forage and the feeding of cattle, and the working of his land in a systematic rotation contrived for the best success of the cotton crop through making the best success with the forage crops. A permanent pasture for summer is an important part of the improvement of a cotton farm. Fortunately there is the Bermuda grass, a plant admirably suited to the needs of the cotton farmer. It suits his soil, it suits his climate, and it grows in perfect defiance of heat, and will enable him to carry through all the cattle he needs for feeding in the winter.

With a permanent pasture of Bermuda grass, the cotton farmer never needs to pasture his fields where his crops are grown, but can keep them at all times growing something either for sale or feeding. A profitable and practicable rotation, then, for a cotton farm, will be to begin with land that has yet to be improved and gotten into a more productive condition.

First year: Cotton, with a good dressing of a complete fertilizer broadcast, at rate of 400 pounds per acre. In September sow among the cotton 15 pounds per acre of crimson clover and one bushel of rye. If the clover fails, the rye will make a green cover crop to ward off waste in winter. During the winter get out and spread all the farm accumulation of manure on the rye and clover.

Second year: Plow under the rye and clover with the manure for the corn crop. Turn them under deeply, and then work the crop rapidly and frequently, but perfectly level and shallow and avoid all earthing up with a plow. No turning plow should ever be allowed in the corn or cotton field. At last working, sow cow peas all through the corn. Gather your seed from these for the next year's sowing. Cut the corn and cure in shocks and disc the peas over and sow winter turf oats.

Third year: Cut the oats and at once plow the land well and harrow in 300 pounds per acre of acid phosphate and 50 pounds of muriate of potash, and after a rain has followed the harrowing drill in one and a half bushels of peas per acre. When these are mature, and the first pods are turning yellow, cut them for hay and cure for feed. Disk the stubble over and sow Crimson clover in September to be plowed under for cotton in the spring. It will be well to sow a little rye as a shade to the young clover. With a good stand of clover and rye you will need little fertilizer for the cotton crop that now begins the rotation over again, but for a while it may be well to use a little acid phosphate on the cotton. One of the best plans for using the cotton seed is that devised by a good farmer in South Carolina. This is to bury the cotton seed in a furrow down the middles. If any seed sprouts it can easily be destroyed in the cultivation of the crop, and the seed will be rotted and ready to feed the plants when fruiting time comes and the roots are searching across the rows. After two or three rounds of this rotation you will find that the only place where you will need any commercial fertilizers is on the land to go into peas after oats. Year after year you will be getting more and more forage to feed cattle and can make more and more manure, till finally you will have no difficulty in getting enough to cover the corn-tend, if uniformly spread with the machine. And, better than all, you will have the cattle to bring in money in the spring, so that you can get upon a cash basis and reduce expenses through buying for cash.

The general experience at the Stations in the cotton belt has been that the use of commercial fertilizers is of special value to the cotton crop in hastening its maturity, while in some instances the use of stable manure had the effect of delaying the maturing of the crop. The corn crop on the farm can use the crude manures from the stock to better advantage than the cotton crop, and by the time the land comes around in cotton again, the manure is better assimilated with the soil, and is in better condition to suit the cotton plant. In the continuous planting of cotton on the same land there has been noticed a cumulative effect from the previous dressings where these have been in liberal amount. In Alabama and Arkansas it was found that nitrogenous manures increased the yield the second season without additional fertilization, but had lost their effect by the third season. In Alabama the phosphatic fertilizers increased the yield for three seasons without further applications, and in Eastern North Carolina there seems to have been so much accumulation of phosphoric acid that acid phosphate no longer has any effect when applied as a fertilizer to most of the lands that are cultivated in cotton. In Alabama the application of pulverized rock phosphate, or what is commonly called "floats," in which the chemist finds that the phosphoric acid is all insoluble, increased the yield for two successive seasons, and farmers are gradually finding out that this material, when placed in the soil, rapidly becomes soluble enough for plants to get the use of it, and since it can be sold for half the price of the dissolved rock it will be well for farmers to experiment with it, and see if the cost of fertilization cannot be further decreased. Several Stations report that the effect of kainit, or crude potash salt, is to prevent rust in the cotton, aside from the value the potash may have as a fertilizer, but it also seems to have the effect of retarding the opening of the bolls. In South Carolina it was found that the application of marl alone, or in connection with the commercial fertilizers, is of no direct value to the cotton crop. But when marl is used as an application to leguminous crops in storing up organic matter in the soil for the cotton, it has a very great indirect value. In Alabama it was found that air slaked lime mixed in the drill with acid phosphate had no apparent effect on cotton; in fact, it would seem that it might have an injurious effect in making the phosphate less soluble. Nitrate of soda has been profitably applied at two dressings between planting time and June 1st. Better results have been had from fertilizers worked in shallowly than those buried deeply for cotton. From the various experiments of the Stations, the Office of Experiment Stations reaches the following general conclusions, in regard to the cultivation and fertilization of the cotton crop, taking also into the account the experience of successful cotton growers. It is evident that cotton is a plant that responds promptly, liberally and profitably to judicious fertilization. The practice general in the South we do not regard as judicious, since under it the productiveness of the land has gradually been decreased, until the soil is not in the best condition to apply lilberal quantities of commercial fertilizers, by reason of the exhaustion of the humus supply in the soil, through the continuous planting of cotton aided by scanty supplies of fertilizers. But by judicious fertilization with these same commercial fertilizers in connection with proper farming, the maturity of the crop may be hastened and its period of growth shortened so as to materially increase the area northward where the cotton crop may be profitably grown. But this judicious use of fertilizers involves the antecedent preparation of the soil. A soil deficient in humus, or decayed organic matter, is not only in a bad mechanical condition, but is in a poor condition to receive liberal applications of commercial fertilizers, since it is more subject to drought by reason of the absence of the moisture-retaining humus, and hence, cannot dissolve the fertilizers. Therefore, the higher "tilth" we get our lands into, the heavier application of fertilizers we can profitably use. The culture of the cow pea as a renovating crop is essential in the cotton belt to the restoration of those new ground conditions which all planters have noticed are so favorable to the profitable culture of cotton. On lands newly cleared from the forest every cotton farmer has noticed that the crop is not only more certain without the fertilizers, but that a heavier application of fertilizers can be more profitably made than on an old field that has so long been in the crop that it has lost the black humus that the new land has so plentifully. Therefore, the effort of the farmer should be towards the keeping up of these soil conditions where they exist and the restoration of them where they have been exhausted, and in no way can this be done so economically as through the culture of the "clover of the South," the cow pea. Not that the cotton farmer should sacrifice a valuable feed crop as manure direct to his land, for the cutting of the hay and the feeding of it to stock is far more business-like and profitable than the burying of the whole growth at once in the soil. The roots and stubble contain a large amount of the manurial value, and by saving the manure carefully the land loses little of the tops, while feeding can be made an important part of the farm profits. Barnyard and stable manures are more profitable to the cotton planter, as a means for the bulking up of his soil with organic matter, and for the formation of the important humus, than as manures direct to the crop; for we have seen that crude manures may tend to delay the ripening of the crop. Dribbling a little manure or compost of manure in the row is not the best way to get a stand of cotton, and is far from being the best way to improve the soil. All home-made manures, and all woods-mold collected, should be spread broadcast over the whole soil. As we have said, the place for these crude manures is on the corn crop following the cotton and preceding the oats or wheat, so that by the time the field comes around again in cotton, in a three-year rotation, the remaining manure has been reduced to a state of humus and aids the commercial fertilizer applied to the cotton crop in doing its work. The editor from whose work we glean these conclusions, says that cotton may be wisely assigned a place in a judicious rotation, and suggests a rotation of small grain, followed by corn with peas, and then cotton; and adds that each crop should be properly fertilized. To this rotation we see the objection that there are no peas for mowing and making hay for stock, and no mention of making manure. Now, as the feeding of live stock is at the very foundation of all rational farm improvement, in the cotton as well as the corn field, the rotation that does not provide a forage crop other than corn is defective. Then, too, while an application of fertilizer to every crop grown may produce an increase of the crop, it is not always profitable farming. One of the chief values of a good rotation, to my mind, is to enable the farmer to increase the productiveness of his soil, while gradually using less of the purchased fertilizer, until he needs to buy none but phosphoric acid, and perhaps potash, and these for the pea crop alone; for by a proper rotation and the production of a plentiful supply of forage crops, that will go to make together a balanced ration for cattle, he can supply his soil all the nitrogen needed; and can accumulate fertility in the land till his money crop is produced in its highest excellence, without any direct application of commercial fertilizer. The investigations of the Stations in the study of the manurial requirements of the various crops, have had the effect of getting farmers to think that for every crop planted they must have a special fertilizer. Good farming with cotton or any other crop does not mean merely the production of large crops; but in the production of crops at the lowest possible expense, while increasing the fertility of the soil. It is not good farming to teach farmers that they need make an application of fertilizer to every crop planted, and we will never get them to see the value of a rotation, till we show that a rotation can do what we have said is good farming. One of the labor-wasting practices long in vogue among cotton farmers in the South, is what is called composting. Having but little manure from the few cattle kept, and that of poor quality from the poor and scant feed, they go to work to haul a lot of soil from woods and fence rows and mix with the manure, and turn and chop it down with the notion that they are making the whole good manure. And then this laboriously made pile of dirt, is dribbled in a parsimonious way, in the furrows under the cotton; the only use it has being to enable the plant to use better the fertilizer they add to it. It takes our farmers a long time to realize that it is far cheaper to grow the organic matter all over the soil, ready spread, than to pile and turn it and haul to the field; and that far more of it can be grown there than can be hauled there by any one. The rotation we prefer for a three-year rotation with cotton has already been given, and the experience of those who have adopted it has abundantly proved its correctness. While in the first stages of the building up of a poor piece of cotton land, it may be advisable to apply some fertilizer to each crop planted, the farmer who strictly follows the three-year rotation we have given, will soon find that all the commercial fertilizer he needs to buy will be acid phosphate and potash for the peas, and the peas will do all the rest, if they are properly fed to stock; while, at the same time, they are feeding the soil direct. Our Editor of the Office of Experiment Stations further says, that, on the great majority of the soils of the Cotton States it is advisable to use as a concentrated fertilizer, a complete manure; that is one containing soluble phosphoric acid, available phosphoric acid and available nitrogen, rather than a manure containing only one or two of these ingredients. This may be true if the farmer is to continue to grow cotton continuously without rotation, but it is not true for the farmer who feeds stock and grows forage to feed them with from the cow pea and the corn plant. In fact, what a farmer should use will depend on the nature of his soil, for, as we have already seen, there is a considerable district in Eastern North Carolina where phosphoric acid is not needed in the soil, and there are other districts where potash is needless, while in all the cotton belt the nitrogen needed can be had in larger quantity and more cheaply in the cow pea than in a commercial fertilizer. While analysis may show that the cotton plant needs a complete fertilizer, this does not show that we need buy all the constituents of such a fertilizer, for all our soils and all conditions of culture. The editor well adds, afterwards, that the nitrogen may be omitted where it is supplied through animal manures, or what he in the language of the press calls green manuring. And right here I would repeat what I have often said, that what is called in Northern latitudes "green manuring," is not applicable to Southern conditions. In the cooler climate of the North and the heavy clay of the glacial drift, it may be practicable to plow under green crops; in the sandy soil and warm climate of the cotton belt, such a practice would be simply suicidal to the interests of the cotton farmer, for he would not only sour his soil, but he would cut short the work the legumes are doing for him before they had fairly completed it. Hence, for the South at least, we should drop entirely the misleading phrase "green manuring," since no such practice is applicable to Southern conditions. But while green manuring cannot be practiced in the South as it is in the North, there is an even greater need for the growing of the green manure crops, for the purpose of getting forage and making manure, and for getting the nitrogen collecting work of the legumes completely done. While soluble phosphates, like acid phosphate, are best for their immediate effect on the cotton crop, there seems to be no doubt that the insoluble floats may be profitably used after a while in the promotion of the growth of the pea crop, and to accumulate there for the use of the cotton crop, that should follow the peas. Kainit, muriate of potash and sulphate of potash present the potash to the cotton plant as fertilizer in an equal manner, and the only difference is in the cost. Kainit, while of special value aside from its use as a fertilizer, in that it has a tendency to prevent blight, is, in most places, the most costly form, since it has but 12 per cent. of potash, and its use involves the freighting of a large amount of useless material; while the muriate has 50 per cent. of potash and a smaller quantity need be freighted to get what potash we want. As a nitrogenous manure for cotton, the cotton farmer can usually get all that he needs by exchanging his cotton seed at the oil mill for meal and hulls, and while he may use, if he chooses, a little nitrate of soda as a starter for the cotton, the organic nitrogen will usually be the best form for the sustenance of the crop during the season. Therefore, it is more than ever apparent that the organic nitrogen from the pea roots is the best form of nitrogen we can get. Much work has been done by the Stations in the Cotton States in the study of the proportions in which the various constituents of a complete fertilizer should be used. In Georgia they claim that the proportion should be nitrogen 1, potash 1, phosphoric acid 3½. In South Carolina, nitrogen 1, potash ¾, phosphoric acid 2¼; while in North Carolina, where in a large part of the cotton belt phosphoric acid is not needed, the law requires that a complete fertilizer allowed to be sold must not contain less than 8 per cent. of phosphoric acid. This law is about to be changed now, however. Quoting further from the Office of Experiment Stations we find it stated that the amount of concentrated fertilizer which may be profitably used per acre on the cotton crop, varies widely with the nature and condition of the soil, the seasons and other circumstances. For an average soil in fairly good condition, perhaps the maximum amounts indicated in Georgia—nitrogen, 20 pounds, potash, 20 pounds, phosphoric acid, 70 pounds, or South Carolina —nitrogen, 20 pounds, potash, 15 pounds, phosphoric acid, 50 pounds, or an approximate mean between the two, would be the maximum limit of the profitable application. This would mean the application of over 800 pounds per acre of an average cotton fertilizer, an amount which, if applied to the worn uplands of the cotton country, would do more harm than good, but which can be used only on soils of a moist nature and well supplied with humus. While 700 to 800 pounds of a complete fertilizer may be used on such lands, the larger part of the old lands of the upland country, in the Cotton States, could not safely apply more than half that quantity, until through good farming and the accumulation of organic matter in the soil they have prepared the land to receive such a liberal dressing. Quoting from the same source we find it stated that the concentrated fertilizer should be applied in the drill and not broadcast, at a depth of not more than three inches, and well mixed with the soil. To the first part of this statement we have a serious objection, and there is every reason why the fertilizer should be applied not alone in the drill but broadcast. Cotton spreads its roots far and wide, and as the feeding roots' hairs are out near the tips of the roots they soon get away from the little that is directly under them and are foraging in a poor soil, so that at the most critical time of the crop, the fruiting time, the plants have less food at their command than at any other time. Then, too, if as large an application as 700 to 800 pounds per acre of a complete fertilizer is used, the application in the drill alone of that amount would probably be disastrous to the getting of a stand of cotton, for it would burn the roots up. Then, further, it is stated that all things considered, it is best to make the application all at one time, that where the land is in superior condition and a large application is used it is probably profitable to apply half at planting and half at the second plowing. Then this second half would certainly not be in the drill, but would be just where we would have put it in the beginning, in the middles of the rows.

We have quoted thus largely from a review of the work of the Experiment Stations in the Cotton States, to show that the experimenters themselves have not been able to get away from the old traditions of the cotton field. They have done a great deal of work in determining the food requirements of the cotton crop, but are as badly in the ruts in regard to the culture of the crop as the planters themselves. All the old practice of fertilizing in the furrow and making a bed of soil above it, plowing first, second or third times, are all relics of the old ruts from which it is time cotton growers were getting out. Fertilizing in the furrow is not the way to bring up the productiveness of the land for any crop. Deep preparation of the soil, planting on the flat surface, and then shallow and perfectly flat culture should be the rule. There is no more need for a plow in the cotton field after the crop is planted than there is in a corn field, and the methods that are best for the one are of equal advantage for the other. Cotton was grown here the past season on well prepared land perfectly flat. It was cultivated with a smoothing harrow and a weeder till over six inches high and then with a small tooth cultivator the rest of the season, and never hilled in the slightest degree; and that cotton went through a season of unprecedented drought and heat better than any plowed and hilled cotton around it. Then, too, the everlasting directions that have been given the farmers about the particular amount and kind of fertilizer that should be used have confused them to such an extent that they think that all they need is a formula for the preparation of a fertilizer. There is much need of energetic work on the part of the Stations in the Cotton States to show the farmers the best methods of improving their soil for the production of the cotton crop, and the means through which they may be relieved from the necessity of buying a complete fertilizer for every crop they plant. Good farming is needed more in the Cotton States than any more knowledge regarding fertilizers, for those who get to doing good farming will naturally use what fertilizers they need in a more liberal manner. Then again, the experiments in fertilizers with any crop on the soil of the Experiment Station, at one point in a State as large as Georgia or North Carolina, can hardly be of much use to a large part of the farmers in those States, who are growing cotton on a different soil, and to give to farmers the proportions in which they should mix their fertilizers to make a complete cotton fertilizer is pure quackery, and should not be indulged in by men engaged in scientific investigation. The methods of culture need more improvement than the fertilization of the crop, for these are the same they were a hundred years ago, and the everlasting fertilizer investigations at the Stations are only keeping up the old practices. The Southern cotton grower needs to be taught more about economical methods in farming than he does about mere application of fertilizers, and he needs to be taught the most economical, and at the same time most liberal, way to use these fertilizers, in the building up of his soil rather than in the squeezing out of a little more sale crop.

CURING THE PEA VINE HAY.

In farming for cotton in this way, the pea vine hay is an important item. There has long been a notion that the vines are hard to cure. We have proved year after year that there is no hay more easily cured, and none better for any stock kept on the farm, from the pig to the horse. The methods in common use heretofore in the South have usually resulted in the loss of the leaves, the best part of the hay, and in the production of a mass of hard sticks, instead of the hay that can be made. We have time and again given our method of managing the hay crop. It is hard to give directions that will fit all conditions of the plant, and the weather. Peas that have grown rankly on fertile soil will make great, thick stems that are more slow to cure, and in such case the sowing should be made thicker so that the stems will not get so stout. Ordinarily one bushel of seed per acre is enough, but on strong land, where they are apt to grow too rank, the seeding of one and a half bushels per acre will make a finer hay.

When the first pods are turning yellow, but none dry, cut the hay with a mower with the track marker off. If the weather is bright and warm, let them lie for 24 hours and then rake into windrows. Next day turn the windrows in the morning and dry them off. If the weather is still hot, the hay may get dry enough to haul in that afternoon. The test as to its dryness is to take a handful and give it a hard twist. If you can see no sap run to the twist it will do to go in the barn, provided there is no external moisture on it. Store in as large a mass as possible, and the tighter the barn the better, but it will cure in a rather open barn. While curing in the barn do not disturb it on any account, as you will cause it to mold if you let the air into it while hot. Let it strictly alone and it will cure all right, will be perfectly green in color and sweet for the stock. Now this is no theory, for we do it every year without a failure, and yet we have had farmers write that their hay molded. I suppose it requires some judgment and experience, but I have tried to give the method that has been a success with me, and can see no reason why it should not be a success anywhere. If rain falls on the hay in the field, spread the windrows and dry off well before housing. Rain will do little damage, far less than it would to clover hay, but it will darken it and should be avoided if possible. Once catch on to the right way and you will have no difficulty in making the finest hay in the world. Farming for cotton without the cow pea, the clover of the South, will always, on our worn uplands, be a losing business.

RESTING THE LAND.

There has long been a practice in the cotton country of "resting" the land, by allowing it to grow up in weeds and grass each alternate year. Feeling that constant annual cropping in cotton was bad, the farmers came to the conclusion that the soil was "tired," and needed a rest. Of course the accumulation of organic matter through the idle season added a little to the land, and the resting was better than the constant culture without systematic rotation. But intelligent farmers all over the South are rapidly learning that the best way to rest land is to keep it at work growing something of value between the sale crops; something that will help recuperate the land better than a crop of weeds, and the wise farmer now keeps all land, vacant of crops in Summer, covered with peas.

ANOTHER COTTON ROTATION.

We have given what we consider the best rotation for a large part of the coast country of the South. But there is a large section of the upland red clay country where cotton is still the money crop, and where wheat flourishes well. There the same three year rotation can be made a success by putting wheat in the place of winter oats. But where both crops are wanted, the rotation can be extended to four years and another crop of pea hay gotten in. In this case the peas after oats will be followed by wheat, and this again by peas fertilized with potash and acid phosphate, preparatory to the crop of cotton. One of the chief ideas in a rotation is to keep the land covered as much as possible by growing crops. Our Southern soils have lost fertility as much by lying bare in the winter as by the summer cropping. Never let the land lie all winter without some green cover crop. This will not only add humus-making material to the soil, but it has been found that where the land is covered with green plants in winter there is little if any loss of nitrogen, but where it lies bare there is a great leaching of nitrates. A cover crop is of far more importance in the South than in the North. Here we have more rain than hard freezing, and the soluble nitrates are rapidly washed out of the bare soil. What we would especially impress on the cotton farmer is the fact that thorough preparation of the soil, clean, flat culture and a good rotation, are far more important to success than the kind and amount of fertilizers he may apply to the crop. I would like to help the Southern farmer out of the slavish dependence on fertilizers, merely for the purpose of getting a little more out of the soil to sell, and to show him that the true place for the plant food in the fertilizer is where it will encourage the crops that feed his stock, and through them feed his farm. Used in this way you may use the fertilizers liberally, and in no other way do they so well supplement the home-made supply of manure. We hear a good deal about making the manure go as far as it will and then supplement it with fertilizers, but the true way to supplement the manure is to use the fertilizers for the manure-making crop. The phosphoric acid and the potash are then retained on the farm and their use enables you to get a far greater supply of the costly nitrogen.

A very intelligent South Carolina gentleman recently wrote to me: "You are continually urging our farmers to grow more peas and to cure them for cattle, but you overlook the fact that they have not the cattle to feed them to, and they have not the fences to enclose the cattle;" and he might have added that in their single cropping they have gotten so dead poor that they cannot buy the stock nor build the fences they need. But even to these men the pea will bring help if not utilized as it should be, for we must never lose sight of the fact that the great value of the pea in the South and of clover in the North, lies in the accumulation and maintenance of humus in the soil, and that the greatest value of humus, aside from its furnishing some nitrogen, lies in its making the soil more retentive of moisture, and thus enabling the farmer to use commercial fertilizers more profitably. The most successful cotton farmers we know are the men who are growing cotton on the level black lands of Eastern North Carolina. These men are able to use an amount of fertilizer per acre that would be destructive to the cotton farm on the dry uplands. They apply from 600 to 800 pounds per acre of a complete fertilizer, and claim that they make it pay. They certainly grow fine crops. They are able to use this amount of fertilizer because of the superior capacity of their soil, which is well supplied with humus, for the retention of moisture for the solution of the fertilizers applied. Hence the plants get the use of it in the best manner. The single cropper on the uplands could not grow the crop the coast farmer does with any such application. The chances are that he would burn his crop instead of benefiting it. This is because his soil has lost its humus and lacks the capacity for the retention of moisture which the low farm has. Here, then, lies the secret of the improvement of the upland farm; the growing of the pea purely for the benefit of the soil, even if not fed, as it should be, to stock, for through its agency he not only gets added fertility from the air but added capacity for using increased applications of fertilizers; for it is a fact that the use of fertilizers is more profitable on a fertile farm than on a dead poor one. The past hot and dry summer was one of the most remarkable illustrations of the truth of this we have ever seen. All over the State on the thin and dry lands the crop was remarkably short, and the fertilizers applied were almost entirely wasted by reason of the fact that the plants could not get them in the dry soil. But here and there were men who have been practicing pea culture for the benefit of their land, and have thus increased its moisture retaining character, who made a good crop and got the benefit of the fertilizers they applied to the crop. It is evident, then, that even where the cotton farmer is not wise enough, or is not able to feed stock, the peas are still the best means he can employ for the improvement of his crops and the maintenance of the productivity of his soil.

CHAPTER XIII.

WHERE WINTER WHEAT IS THE MONEY CROP.

A study of the manurial requirements of the wheat crop, at more than one Station, have shown that potash applied alone to the crop, has, on a typical wheat soil, hardly any appreciable effect. At the Virginia Station it was found that nitrogen gave some increase of yield, but not enough to pay the cost of the application. That potash and nitrogen applied together gave no better results than when applied separately. Their combination was inferior to the results obtained from a separate application of phosphoric acid. Phosphoric acid doubled (or more than doubled) the yield of straw and grain every year, and gave profitable returns. In combination with either potash or nitrogen it was unmistakably effective. It gave better results in combination with nitrogen than with potash. These experiments were made on a fertile limestone-valley soil. The Delaware Station found that the combination of phosphoric acid and potash was most effective on their soil. Many years ago the farmers in the upper counties of Maryland and Delaware, on the Peninsula, found that on their soil they got as good returns in the wheat crop, from the simple application of acid phosphate, as from the use of a complete fertilizer, when they used a short three year rotation. For many years, in the finest wheat growing section of Maryland and Delaware, hardly any fertilizer except acid phosphate, has been used by the best wheat farmers. The Delaware Station has tried to show them that a small addition of potash would be an advantage on their soil. But few have been induced to change their practice. An old and intelligent farmer of Queen Anne county, Maryland, recently wrote to me that he had used no other fertilizer than simple acid phosphate, for twenty or more years, and that with his rotation the wheat crop had steadily improved, and he said that now his last crop was 40 bushels per acre. I have seen, the present Summer, lands in Maryland on which 50 bushels of wheat per acre were grown the present season, where no nitrogen has been bought for many years.

The wheat farmers of Maryland have learned that they can get all the nitrogen they need without buying it in the form of a commercial fertilizer. And this is a lesson for wheat farmers in all parts of the country where winter wheat is grown. The important thing to the wheat grower is, while getting a fair growth of straw to avoid an excessive growth, but at the same time a full crop of grain. An excess of nitrogen tends to an excessive straw growth and a consequent weakness and liability to lodge.

While all the studies of the manurial requirements of the wheat crop show that the greatest yield is where there is applied a complete fertilizer, with a due proportion of phosphoric acid and nitrogen and potash, it by no means follows that it is necessary to buy all of these in a fertilizer. We should also bear in mind the fact, that on a soil where legumes have not been regularly grown in a rotation, some years must elapse before the nitrogen collecting crop will gather more than is needed by the immediately succeeding crop, unless further addition of nitrifying organic matter is, in the mean time, added to the soil. Hence a short rotation again comes in as the best under most conditions.

ROTATIONS FOR THE WINTER WHEAT CROP.

For many years, and long before the use of commercial fertilizers became general, the best farmers of the Middle Atlantic States, whose money crop is wheat with stock feeding, practiced a rotation in which the land was seeded to clover and grass with the wheat, mowed for several years and then pastured, and finally the sod plowed for corn, which was followed by oats the following Spring and the oats stubble fallowed and prepared for wheat again. Keeping a large number of cattle and raising a goodly quantity of manure, these farmers managed to keep their lands to a fair state of productiveness, with a long rotation, on farms divided up into very small fields with a vast amount of needless fencing. This practice has since gradually given way to a four year rotation, with clover standing but one year, and the land again returned to corn. The fault of this rotation is that the important money crop, the wheat, comes on the oats stubble, and nearly two years after the clover has been plowed under, hence does not get the best use of the clover. The Delaware Station proposes to remedy this by introducing there the early varieties of the Southern cow pea, after the oats are cut, as a preparatory crop for the wheat. In sections like Delaware, where winter oats can be successfully grown, this plan will probably be a success; as the winter oats should there come off the first of July or earlier, and give plenty of time to make a crop of peas, from the varieties, like the Warren Extra Early, which will make a matured crop in 60 days from the sowing. The rotation would then be, wheat, with a good application of acid phosphate and seeded to clover. Clover mown twice, or once and pastured. Home-made manure hauled out on the clover sod during the winter and all plowed under in the spring for corn. Oats sown in September and followed by peas cut for hay, and stubble prepared for wheat again, with acid phosphate. This will give two nitrogenous forage crops every year and largely increase the feeding capacity of the farm.

In other sections, where the oats crop is of less importance, great success has attended the use of a three year rotation of corn, wheat and clover, the only fertilizer used being acid phosphate on the wheat, and an occasional dressing of lime on the sod for corn. It may be argued that the corn stubble is not the most favorable place for the wheat, and under former conditions it was not. But where the farm is stocked to its full capacity for feeding cattle, and a large amount of manure is made and applied broadcast to the corn crop, the corn stubble, with the help of acid phosphate, is not an undesirable place for the wheat crop; as is evidenced by the regular increase in the wheat crop where this rotation has been practiced. As in the three year rotation with cotton, this can be best carried out with the aid of a permanent pasture, and thus save all interior fences on the cultivated land.

In all the rolling uplands of the Upper South, in North Carolina, South Carolina and Georgia, there are elevated lands that the owners have persisted in growing cotton upon which are naturally better adapted to wheat. Some years ago, when traveling through the upper section of South Carolina on the Southern Railway, a gentleman, evidently a farmer, boarded the train, and as I am always interested in talking with the farmers I picked up an acquaintance with him and made some inquiries about the country through which we were traveling, between Spartanburg and Atlanta. I found that my friend was an intelligent farmer, who had come there from a wheat growing section in the North and had been farming for a number of years in this Piedmont section. He said that having been a wheat grower all his life, he determined to continue to grow wheat and clover, as he could not see why they should not thrive in that elevated and beautiful section. He said that the first year when he sowed wheat he was laughed at, and told that wheat would not make much of a crop there. He made, the first year, only 6 bushels of wheat per acre, but as his land was in a badly run down condition he was not surprised at this and simply kept on following a rotation which he had planned for the improvement of the land. Last season he said that his wheat crop, on the same field that once made 6 bushels per acre, was 35 bushels per acre, and that he was satisfied that wheat could be as successfully grown on the Southern uplands as anywhere. But this farmer had been wise enough to adapt his farming to the conditions of his environment. He had found that in the sunny South red clover is a very uncertain crop, and that its place could be well taken by the Southern pea. Accordingly he had adopted a rotation in which the pea took the place of clover, and enabled him to make more crops in a short rotation than he could with clover, which remained on the land a whole year. His rotation was corn, with peas planted among it and all the manure of the farm applied to it. Corn cut off at the ground, cured in shocks and the stover all saved for feed. Land well disced, the peas chopped up, and winter oats sown. Next spring the oats are harvested and the land at once prepared for peas, with a dressing of acid phosphate and potash. Peas are mown for hay and the land again disced only, and the surface made fine and sown to wheat. After the wheat is harvested the land is plowed and peas sown again and another crop of hay made. Rye is then sown as a winter cover, and during the winter the manure is gotten out, spread on the rye and all turned under in March for the corn crop; and the rotation begins again. At first he found that it was better, in the poverty stricken state of his soil, to plow under all the meagre growth of peas for the wheat and corn, but later on, as the growth became heavier, he found that this would not only be a waste of feed, but that the land could not be so well prepared for the wheat crop. He then got to feeding more cattle and utilizing the forage he was growing so largely, and found that the feeding was a profitable part of his farming; and that his land was constantly improving while the farms around him, which were being worked in the old way, in cotton alone, were washing and wasting. There is no reason, however, that a similar rotation should not be fully as good for those upland farmers who wish to adhere to the cotton crop. In their case the rotation could be made, corn with all the home-made manure, followed by wheat, with commercial fertilizer without nitrogen, peas after the wheat is cut, and these made into hay, and rye sown on the stubble as a winter cover, and plowed under in early March for cotton. Commercial fertilizers used on the cotton, and crimson clover sown among the cotton in September. Then, during the winter, get out all the farm manure on the clover, and in March plow all under for corn and begin the rotation over again. In this rotation, the wheat, coming directly after the corn, to which the manure and clover was applied, will have the best chance, will need no fertilizer except acid phosphate; the cotton following the peas and with rye plowed under, will need only acid phosphate and potash, with perhaps a small percentage of nitrate of soda, to give it an early start. Then, if the peas and corn and corn stover are utilized in the feeding of stock, there should, in a few years, be manure enough raised to cover the entire corn tend.

In this connection, though not directly in regard to wheat growing, yet in this same line of soil development through the feeding of the abundant forage that every Southern farm will produce, I would call attention to the results obtained at the Tennessee Agricultural Experiment Station, connected with the University of Tennessee at Knoxville. The Tennessee Station has made a series of experiments in the feeding of cattle, primarily to determine whether the native stock of the country could be fed at a profit for beef, and in the second place to determine whether a home grown ration could not be made to profitably replace feed that they would have to buy. They used, in the experiment, two groups of four steers each. The experiment began on the first day of January, 1900, and continued uninterruptedly for 98 days. The first group were fed all the shredded corn stover they would eat and also 6 pounds of cow pea hay and 3 pounds of corn meal. The second group were also fed corn stover *ad libitum,* and for part of the time had 6 to 16 pounds of cotton seed bran and 4 to 7 pounds of cotton seed meal, and then were changed to 6 pounds of the cotton seed bran, 3 pounds of cotton seed meal and 4 pounds of corn meal. The cotton seed bran is the finely ground cotton seed hulls, which is being largely advertised in the South for cattle roughage. But the experiment showed that it has little food value, is heavy and indigestible, and does not answer for roughage as well as the crude hulls themselves; and these, in our opinion, are little better than pine shavings. These rations were gradually increased, until, at the close, the first group received 10 pounds of cow pea hay and 11 pounds of corn meal, and the second group had 7 pounds corn meal and 5 pounds of cotton seed meal. Without entering here into the details of the experiment we give the conclusions arrived at:

1. Tennessee is admirably adapted to the production of stockers, which can be successfully fed on the products of the rich valley farms. 2. Stock husbandry has valuable effect on soil fertility, as 90 per cent., and over, of the fertilizing ingredients in the foods consumed, are available for the restoration of soil fertility . 3. Cotton seed bran is too expensive for roughage and has an unfavorable effect on digestion, producing impaction of the rumen. Tennessee farmers cannot afford to use it in this form, and all the roughage needed in cattle feeding can be produced more cheaply on the farm than anywhere else. 4. Cow pea vine hay made an admirable substitute for cotton seed meal. As it is not so rich in protein, however, it should be fed at the rate of two to

three pounds of the former to one of the latter. 5. It is seen from these tests that a home grown ration of shredded stover, cow pea vine hay and corn meal, can be fed with success to a fair type of native cattle. This means much to the farmers of Tennessee. Tennessee is admirably adapted to the production of the cow pea. On good land two tons of this plant can be produced per acre, yielding 431.6 pounds of protein, costing 4.63 per pound. Besides this it stores up in the soil nitrogen which it gathers from the air. In view of its value in feeding it should be cultivated much more extensively for this purpose. 7. Cotton seed meal gave the better results when combined with corn meal, in proportion of one pound of the former to one and a quarter pounds of the latter, than when fed alone. 8. This experiment indicates that native steers can be successfully fed at home at a fair profit. It further indicates that all the corn stover now wasting in the fields should be shredded and fed. 9. The tables bring out the importance of individuality in the animal, and show the necessity of improving our feeding stocks by crossing with pure bred sires. 10. The results of this experiment favor the use of a ration of corn stover, cow pea vine hay and corn meal, in preference to one of shredded corn stover, cotton seed bran and cotton seed meal. 11. Conformation and uniformity of type are important in cattle feeding, as they materially affect the selling price. 12. The average gain in live weight in group one was 1.99 and in group two, 1.75 pounds per day. The best individual gain was 2.50 pounds, and the poorest, 1.53 pounds. 13. The average cost for food for group one was $9.25; for group two, $12.63, a difference of $3.38 in favor of home produced rations. 14. The net cost of a pound of gain with group one was 2.65 cents; with group two, 4.21 cents. This was chiefly due to the difference in market prices of the foods fed. 15. Group one consumed an average of 7.70 pounds of dry matter; group two, 9.32 pounds; group one consumed an average of 5.27 pounds of digestible matter and group two, 5.10 pounds of digestible matter for a pound of gain. 16. The average amount of water consumed by group one per day was 42.90 pounds, and by group two, 43.51 pounds. The highest amount consumed by any one individual was 50.36 pounds, and the lowest, 39.09 pounds. 17. The average live weight of group one was 956 pounds, and of group two, 950.2 pounds. The average dressed weight of group one was 527.6 pounds, and of group two, 529.5 pounds. The percentage of valuable meat in group one was 55.75, and in group two, 55.52. The highest percentage of valuable meat with a single individual was 59.13 and the lowest 53.56. This is considerably below the standard for good cattle, but a single cross would materially improve these results. 18. The average net increase by feeding was $8.37 with group one, and $7.71 with group two. 19. The average cost of a pound of gain was 4.82 cents with group one, and 7.12 cents with group two. 20. The average net gain, allowing for care at 3 cents a day, was $6.15 with group one and $3.62 with group two. The average net gain, less care, was $8.98 with group one and $5.93 with group two.

We have given these results here in full for the purpose of showing that in other sections of the South, where the cow pea flourishes far better than in the upland country of East Tennessee where these experiments were made, farmers can produce an abundance of the finest of cattle food, and can, in the feeding of beef cattle, make a larger profit than most of them are now making with cotton; and can, at the same time, be growing a crop that will improve their soil for the production of cotton and other crops. While we appreciate the great value of commercial fertilizers as fully as anyone, we cannot too often repeat that the feeding of stock lies at the beginning of all rational farm improvement, either in the North or the South; and the sooner the Southern farmer learns the wonderful advantage he has in the cow pea the sooner will permanent prosperity dawn upon him. If the feeding of native cattle on the foods so easily produced in all parts of the cotton belt can be made profitable in Tennessee, it can be made even more profitable in the soils of the Atlantic border where the cow pea flourishes far better than in East Tennessee. To one who has studied these things through long years of farm experience it is amazing to note how slow the farmers are, not only in the South, but throughout the wheat growing section of the Middle States, to seize upon the means that will enable them to prosper as they have never done. The experiments at the Tennessee Station simply corroborate those made at the Delaware Station in feeding cow pea hay to milch cows as a substitute for the bran the dairymen are continually buying. It was shown there with cows, as it was with the beeves at the Tennessee Station, that the protein needed in a ration can be more cheaply supplied by the cow pea than by purchased food; for it was shown in Delaware that cows that had been for a time fed on a ration in which the protein was furnished by the bran, did not shrink in milk when taken from that to one in which cow pea hay furnished the protein, but that when they were put back from the pea vine hay to the bran again, there was a shrinkage in the milk yield. The significance of these results to the wheat grower in the Southern and Middle States is plain. It shows that while improving their soil through the growing of the pea, they can at the same time produce a food that will take the place of costly purchased food, and will enable them to turn out the finished products at a far less cost and consequently at a greater profit. The cotton grower may imagine that he can do without stock, but the wheat grower who does not keep and feed cattle is even more shortsighted than the cotton man.

FERTILIZERS FOR WHEAT.

It will not do to assume that because in certain sections the farmers have succeeded in greatly increasing their wheat crops through the use of phosphatic fertilizers only, that the same practice will insure success on all wheat soils. As a rule, most of our best wheat soils of the winter wheat section of the Atlantic slope, are not deficient in potash to the extent that they are in phosphoric acid. It is these two which most concern us, for, no matter what the soil, a proper rotation with legumes will give us all the nitrogen needed by the crop. But every farmer, no matter what his crop, should find out for himself what his land especially needs. He must be an experimenter if he hopes to farm successfully and economically. How these experiments should be made will form the subject of a special chapter. Lime, of course, is useful in wheat farming, but we do not class lime and plaster as fertilizers, but as reagents, for bringing about chemical changes in the soil. The place for lime in the three year rotation for wheat is on the clover that is to go in corn the next season, and the time to put it there is in the early spring of the season in which the clover is to be cut. Once in six years is often enough to use lime unless the application is very light. But we would use phosphoric acid, or phosphoric acid and potash, on the wheat, not only for the benefit of the wheat but for insuring a better stand and growth of the clover. The practice of using the farm manure as a top dressing for the wheat in winter, may be a good practice in some cold sections as a preventive of winter killing; but, on strong land, it tends too much towards the getting of a rank growth of straw at the expense of grain, and increases the danger of lodging. The place for all the farm manure is on the sod that is to be plowed for corn in the spring. During the summer's cultivation of the corn crop it gets mingled with the soil, and much remains untouched below, to feed the wheat that follows the corn. In the more northern section of the winter wheat belt it is doubtless necessary to put the wheat in earlier than corn land will allow, and there a longer rotation is needed.

WHAT A CROP OF WHEAT REMOVES FROM THE SOIL.

An average good crop of wheat of 20 bushels per acre, will remove from the soil in the grain alone—and this is all we need be concerned about since the straw will go back to the land—28.32 pounds of nitrogen, 10.68 pounds of phosphoric acid and 7.32 pounds of potash. It will be seen, then, that the relative importance of these food constituents is pretty much as they stand. But, so far as the nitrogen is concerned, we will have left over in the organic matter of the clover and manure applied to the corn crop in a three year rotation, all the nitrogen the wheat will need; and we need but consider the needs of the crop as regards the phosphoric acid and potash, and to ascertain what the needs of the soil are as regards these. The maturing of the seed of the plant draws more heavily on the phosphoric acid in the soil than it does on the potash, and hence the relative greater importance of the phosphoric acid in the fertilizer. Then, too, we find that in order to get best results from an application of potash it is essential that it be accompanied by a due proportion of phosphoric acid, since neither potash nor phosphoric acid will have as good effect applied alone as in combination. With nearly all the cereal grains it will be found that phosphoric acid is the controlling factor in any mixture. But in clover the proportion of potash is considerably larger than that of phosphoric acid. Then in devising a fertilizer for the wheat crop on which we propose to sow clover it will be wise to regard the needs of the clover for potash, and supply it; for we may rest assured that the soil will hold on to it for the clover, even if the wheat does not need it. A crop of two tons of clover hay per acre will require for the hay alone 82.82 pounds of nitrogen, 15.2 pounds of phosphoric acid and 88 pounds of potash. The nitrogen it will get largely from the air, but the potash must be in the soil. In this we take no account of what is in the roots and stubble, as that goes into the soil, but the amount of potash in the hay is seen to be large, and must be supplied to make the best crop.

THOROUGH PREPARATION OF THE SOIL AS IMPORTANT AS FERTILIZERS FOR WHEAT.

A hard lump of phosphatic rock may lie in the soil for generations and produce little effect on the vegetation. But let that rock be pulverized to an impalpable powder, and scattered through the soil, and the effect will soon be apparent. In a similar manner, a hard lump of soil may have in it a store of plant food, but the roots of the plants cannot get at it; and the lumpy character of such soil renders it liable to dry out rapidly and thus prevent the proper solution of the plant food that may be in the soil, either naturally or applied in the fertilizer.

While deep plowing is as essential to wheat growing as to that of any other crop, the fine, searching roots of the plant require that the soil should be in a completely comminuted state, and well settled, so that the plant food can be released; and capillary attraction set up in the soil to keep up the regular supply of moisture from below. If wheat is sown in a dry soil during dry weather, and the soil particles are but slightly broken up and the clods lie loosely, there is every chance, in our dry autumn weather, that the wheat will fail to germinate, while if the soil is plowed early, and thoroughly fined and settled by repeated harrowings and rollings, the wheat may be sown in a very dry time with every chance in its favor. It takes little observation, when passing through the country after wheat seeding, to see the difference in the stand on well prepared fields and on hastily plowed and seeded ones. On a good wheat soil we had rather take the chances for a good crop on soil thoroughly prepared and with no fertilizer, than on a hastily prepared and late plowed field with the best of fertilization. We cannot too often repeat, that the homogenous condition of the soil, made by thorough preparation, fining and packing, is the great essential to a good crop of grain.

GREEN MANURING FOR WHEAT.

For many years writers in the agricultural papers have recommended the plowing under of clover or peas as a preparation for the wheat crop. In the heavier glacier clays of the North this may probably be done without harm, but in the South, especially on a light soil, such a practice is often more productive of damage than good, from the evolution of organic acids in the hot soil and warm season. A heavy vegetable growth can be safely plowed under in the early spring when the soil is to be stirred for a hoed crop, but in the warm season the plowing under of any green mass is apt to produce disastrous results. And even where there may not be as much danger from the souring of the soil as there certainly is south of the Potomac, the burying of a large amount of organic matter in the soil, just before wheat seeding, will prevent the proper firming and uniform condition essential to success with the wheat crop. One of the worst failures I ever saw was from the burying of a great growth of cow peas in September. The mass was so heavy that it could not be well buried, and the soil did not get the preparation it needed. The wheat grew off well, and there was a fine stand of grass, which was the thing mainly wanted. In the spring the growth of wheat was enormous from the rapid nitrification of the organic matter in the soil, but as soon as headed it all fell flat, and the result was a very poor crop of wheat and the grass was smothered out, so that the whole thing had to be done over. This was in Maryland up near the Pennsylvania line. Here in the South such a plowing under would probably have resulted in such a souring that nothing would have grown at all till the land was heavily limed to restore its sweetness.

I once addressed a Farmers' Institute in North Carolina, and was trying to show the farmers the advantage of growing the cow pea. I soon found that my audience hardly agreed with me. But when I showed them the danger of plowing under the peas green, I saw that I was getting more attention. When I closed, a farmer rose in the audience and said: "We thought that you were going to advise the plowing under of the peas. Some years ago Prof. — came down here and urged us to grow peas as a green manure crop. Some of us tried it and soured our land so that for a year or two it would hardly produce anything, and since that we have been afraid of peas." From that day's talk, however, the farmers of that section realized the true value of the cow pea, and now they are grown on every vacant spot during the summer. One of the leading farmers in the upper Piedmont section of North Carolina, in a good wheat growing section, assured me that he had had disastrous results from the plowing under of a heavy growth of rag weed on a wheat stubble, in preparing the land for wheat again. The instances are so numerous in the South of the evil results of plowing under green vegetation in hot weather, there cannot be any doubt of the danger of such a practice.

But even where the plowing under may not result as badly as it does in the South, the plowing under of a great mass of vegetation is a bad preparation for the wheat crop, as it prevents the proper firming of the soil so essential to the success of the crop. But the main reason why green manuring, as it is called, is a bad practice, is that it is wasteful, and not in accordance with true business principles. The great reason for the growing of a crop of clover or peas is the acquisition of the nitrogen of the air and the storing of it in the soil. Now if the clover or peas are plowed under at midsummer, they have not done anywhere near what they would do for us in the way of getting nitrogen, for this is mainly done during the later period of growth approaching the maturity of the plant. If the crop is allowed to fully mature, there will be about as much left in the roots as the whole crop contained at an earlier period of its growth. Then, too, the feeding value of the pea crop is fully $20 per acre, and it must be an extra valuable crop that will warrant the use of food of that value as a manure direct, especially when by feeding it and carefully saving the manure, we can recover a large part of the manurial value in the droppings of the animals. Hence, we insist that green manuring, either North or South, does not mean the burying of the legumes as a whole; but the fertilization of the crop as food for cattle and the careful saving of the manure. Grow legumes as a matter of course, and allow them to do all the nitrogen gathering they are capable of doing, but do not cut short the work they are doing because of the theories of men who have only a theoretical idea of the subject. Legume growing is the most important thing in connection with the improvement of the soil, but the term "green manuring" is misleading to the inexperienced, and is one which should never be used.

WHEAT AFTER A HOED CROP.

Farmers in many sections have gotten a prejudice against "corn ground wheat," because of the old common practice of plowing in the wheat on the corn land. Where the land has been properly plowed and prepared for the corn or tobacco crop, and has been rapidly and well cultivated in a shallow manner, it has, by the time wheat should be sown, gotten into a fine condition for the best success with wheat; and if the corn is taken off the ground and the wheat drilled directly on the well cultivated soil, the crop is apt to be a good one. Putting in wheat after a hoed crop has the advantage that the legume crop and the home-made manure can be used for the corn crop, and will, by seeding time, have gotten well mixed and assimilated to the soil, and there will not be an excess of the nitrifying organic matter, but plenty for the wheat, and only phosphatic and potassic fertilizers will be needed. A three year rotation, in which the wheat comes after a hoed crop, will, in the long run, be the best for the improvement of the soil and the development of the wheat crop.

A summer fallow may at once give a better crop of wheat, but it will be made at the expense of the best interests of the soil; far better have for a while a smaller wheat crop and be building up the soil. Pasturing a crop of clover till the bare ground shows all over the field, and then at midsummer turning the soil up to the sun and preparing it for wheat, may give you a wheat crop, but the land will be losing humus and running together hard, the corn crop will be dwindling, and, finally, the wheat crop will be grown mainly by the application of a complete and costly fertilizer. Far better stick to the short rotation, have a permanent pasture and never graze the cultivated fields. We saw the evil results the present summer in the fine wheat lands of Talbot Co., Maryland, of the practice of close grazing. They get fine wheat crops, but the land runs together and needs humus badly for the best results with the other crops. In travelling over the northern section of Indiana late in the fall a few years ago, I was struck with the vivid green of the strip between the railroad fences and the bare and brown fields on either side of the track. The farmers were evidently running too long a rotation and robbing their soil of humus by close grazing. A short rotation would give far more forage for cattle and would save the great waste of fertility that is going on there. Ere long those lands will reach the point where wheat will grow only by liberal fertilization, the necessity for which could be avoided by a timely method of systematic farming. The old notion that stock and dairy farming require a long rotation, and the keeping of the land in grass till the grass runs out, hence, dividing up the farm into a multitude of small fields to be pastured in their turn, is fast giving way to a more rational system in which the great American forage crop, Indian corn, plays an important part; and the silo becomes the means for increasing the manure deposit, and the fertility of the soil. Feeding the whole corn crop, stalks and all, in the most complete manner, and using the legume crop to balance it, enables the dairy farmer to become a wheat grower as well, and to greatly increase the productive capacity of his soil for his money crops of grain and the dairy. Growing wheat in a three year rotation, with legumes and Indian corn, gives the dairyman two strings to his bow while increasing the strength of both.

CHAPTER XIV.

FERTILIZERS FOR THE PERMANENT PASTURE.

Most of the so-called permanent pastures are rather poor excuses for pasturage. In many cases the land selected, and properly so, is a piece too steep or rocky for cultivation, and it is expected to produce food for cattle year after year, with no help whatever but the droppings. Big weeds are allowed to sap its fertility and run out the grass, and no return is made to the land for the food taken away. The idea of giving fertilizers to the pasture does not seem to be thought of; and yet there is no part of the farm that will so well repay feeding. In some sections, where grazing on the hill lands has become a feature of the agriculture of lands practically worthless otherwise, it has been found that an annual top dressing of commercial fertilizers has brought up the hill land to a capacity for feeding stock formerly undreamed of.

To keep up the productivity of a pasture it must, in the first place, be kept clean of anything but grass. Clipping of the weeds and regular scattering of the droppings will do much towards the keeping of the grass good. But we must remember that in the milk and in the bones of growing animals there is going on a constant waste of the phosphates, and these must be replaced. Then, too, nitrogen is needed for the best success with grass, and as we are here making no rotation with legumes for gathering it, we must add some in our fertilizer. For the permanent pasture we have never found anything so good as finely ground raw bone meal. This has about 4 per cent. of nitrogen, and the most of the remainder is a bone phosphate of lime in which the phosphoric acid becomes available by degrees, and is better adapted to the keeping up of a uniform herbage than a more readily available form. Once in six or eight years a moderate dressing of lime will be a great help, especially if the grass is mainly that known as Kentucky Blue grass, which, being a limestone loving grass, is greatly improved on other soils by an occasional dressing of lime. I have seen steep hills which have been pastured annually for a generation and thus top dressed, which to-day feed more cattle than they did 40 years ago, though they have not been plowed in all that time.

GRASSES FOR PERMANENT PASTURE.

While not directly connected with the subject of fertilization, there is so much interest in various parts of the country in the matter of permanent grass pastures, a few words in regard to the best grasses will not be amiss. All along the Atlantic border, from Maryland southward, the Bermuda grass, or *Cynodon Dactylon,* has established itself; and has, in many places near the northern limit of its growth, become a source of much annoyance to the grower of wheat and other small grain, through its persistent and rapid growth often choking out the sown grain. The farmers of this section know this under the name of wire grass, and in Northern Maryland it meets and mingles with the Northern quack (or couch) grass, and both go under the common name of "wire grass." In that section, and in the upper country of the South, Bermuda grass is only a nuisance. But coming South along the coast plain, on the sandy lands devoted to cotton culture, it attains an increased importance and becomes the most valuable of all grasses for permanent pasture. It is true that it is a hot weather grass only and makes no show in winter; but if mixed with Texas blue grass (*Poa Arachnifera*), which is purely a winter growing grass, there is nothing to be desired so far as a permanent pasture is concerned, and the two together will make, on the most sandy lands of the cotton belt, a sod equal to that of the Blue grass of Kentucky.

But in all the upper red clay lands of the South we do not advise the use of the Bermuda, for in these lands the orchard grass and mountain blue grass (*Poa Compressa*) will be found better adapted; and the white clover, and in shaded places, Kentucky blue grass, will come in naturally if the fertility of the soil is maintained by an annual dressing of bone meal. In the sandy soils of the coast region the Bermuda and Texas blue grass have no rivals, and here the fertilizer should be varied, and a good percentage of potash added to the dressing. The Bermuda, left alone, makes the densest of sod, since its running stems spread in every direction, burying each other by growth above till the stems below die and decay and gradually accumulate a mass of decayed organic matter, and the sod gets "hide bound." To restore it, put in a strong team and plow the sod so as to merely turn it over about four or five inches deep, and harrow and roll. Then apply a coat of freshly water slaked lime at rate of 20 bushels per acre. Do this in the spring about corn planting time, and you will at once have a fresh and strong growth as the soil warms up, and when well under way apply the bone and potash dressing at rate of 200 pounds of bone to 50 pounds of muriate of potash. Plowed and renewed in this way once in eight or ten years, there is nothing that can surpass the Bermuda and Texas blue grass, on the lands to which they are suited and in the climate where they belong.

In the upland red clay soils of the Piedmont section of the South, the best grasses we have ever tried for a permanent pasture are orchard grass, red top, Kentucky blue grass and white clover. Of the three grasses we would sow 10 pounds each per acre, and then scatter about 4 pounds per acre of the white clover. The orchard grass and red top will at once make their appearance, and while the red top will not be a permanent grass on the uplands, it will furnish the first green and will help to protect the coming of the blue grass among the tussocks of the orchard grass, and if the land is dressed and limed as heretofore advised, the blue grass will finally become the main sod of the field. In the southern part of the upland region of the South I would leave out the Kentucky blue grass and substitute the mountain blue grass (*Poa Compressa*). This grass is almost as persistent as the Bermuda, and forms a dense sod, and should never be allowed to encroach on the cultivated fields, since on heavy and moist land it is as hard to get rid of as the Bermuda. But it is far better adapted to Southern conditions than the *Poa Pratense,* or Kentucky blue grass.

It seems probable from experiments that have been made that the Smooth Brome grass (*Bromus Inermis*) will be a valuable pasture grass on the lighter lands of the South, and it is well worth experimenting with till its true value is determined.

From the mountains of Virginia, all over the Southern uplands, there are now thousands of acres of worn and wasted land, washed into gullies and in some places irredeemable, which could be put to use as pasture if properly treated. These lands now, where there are no deep gulleys, are generally covered by the broomsedge that nature puts on every wasted spot in the South. The broomsedge itself is not a bad pasture in the early spring but it soon gets tough and worthless; and if these hills are to be utilized as pasture we must get something better than broomsedge on them. An experiment I made years ago in the mountains of Virginia showed that this can be done easily. I had a rough and rocky mountain side that had never been plowed, and that was really too rocky to attempt to plow. But it was near the barn and would make a convenient place to turn the cows at night rather than drive them back to a distant pasture or keep them in the yards all night, which last was not to be thought of. About that time I noticed that all along the railroad coming from the South, the Lespedeza, or Japan clover, was creeping in. It had not reached us, but I found that it had reached the top of the gap through which we passed the Ragged Mountains to the Southern Railway. Seeing it growing on waste places by the hard roadside and among the rocks, I concluded that a plant that could thus spread itself was a good thing for my waste land. I sent to Louisiana, where there were parties saving the seed, and bought some. This was sown in the early spring, all among the broomsedge on the rocky hillside. Only this and nothing more. The land was fenced and the cows went there at night only after being pastured, and fed in the stable at milking time. By the next winter there was no more broomsedge on that hillside. The Japan clover had complete possession and I had a pasture for the summer worth far more. And not only this, but with the droppings of the cows which were scattered over the land, and the cows really ate very little there during the night, the white clover made its appearance, and the mountain blue grass *(Poa Compressa)* came in, and by the next year I had a pasture without broomsedge and composed of far better plants. Not being too closely pastured the herbage increased and today that hillside is as good a permanent pasture as one will find anywhere in a similar situation. It could have been improved by an annual topdressing of raw bone, and I know of no dressing for the permanent pasture that so completely fills the bill as raw bone meal. The slowness with which its phosphoric acid becomes available is an advantage in such a situation, and the nitrogen to be found in a good sample will encourage at once the growth of the herbage. On one occasion, on a visit to the Mississippi Agricultural College, I was shown a field distant from the barn, where there were fifty fat beeves. The land was the thin, worn-out, red-clay hill land to be seen all over the South, and there was absolutely no growth on it except the Japan clover an inch or two high. The cattle were in fine order, and I was told that they were not fed anything besides the Japan clover they were grazing upon. Evidently here was the plant to cover the waste lands of the South. Not a plant that can be profitably taken into a rotation on cultivated land, but a plant to make a pasture where none was before, and which would reproduce itself year after year and grow better while doing it. While not to be advised on lands that can be plowed and prepared for grasses it is evident that for lands where nothing else can grow, the Japan clover will prove a valuable pasture plant. If the hills are then pastured with sheep there will gradually be an incoming of better herbage, till these washed and gullied hills become clothed with grass and flocks.

CHAPTER XV.

FERTILIZERS WHERE HAY IS THE MONEY CROP.

There are many who will hold up their hands with horror at the idea of selling hay off the farm. Of course there are few who are so located that they can make hay the most profitable money crop, but where a man is so located that he can make more money in selling hay than in feeding it on the farm, there is no good reason why he should not sell hay as well as any other crop he grows. A crop of timothy removes in each ton 25.2 pounds of nitrogen, 10.6 pounds of phosphoric acid and 18 pounds of potash. A crop of wheat of 20 bushels per acre will remove 28.32 pounds of nitrogen, 10.68 pounds of phosphoric acid and 7.32 pounds of potash, in the grain alone; which is the only part usually sold from the farm. The manurial constituents of a ton of timothy can be replaced in the form of commercial fertilizer for a little over $5. Then if the farmer cannot realize more from the feeding of the hay than the market value of hay on the farm, he had better sell the hay and buy the fertilizers, especially as we have shown that in a proper system of rotation he will not need to buy the nitrogen, which is more than half the manurial value of the timothy. But, says one, the manure is a profit, even if the feeding does not return more than the market value of the hay on the farm. It is true that a careful saving of the manure may recover a large part of the manurial value of the hay, but when the labor of caring for the stock is taken into the account, and the great labor of handling the manure over that required for the commercial fertilizers, it will be seen that this apparent profit is really made at a loss. Of course, as we have said before, we consider that the feeding of stock and the making and saving of the manure lies at the very foundation of successful farming in most places; still, we believe in farming for profit, and we could never see the reason for a farmer making a sort of fetich of a manure pile, and spending more feed and labor on its accumulation than the accumulation is worth. We believe in applying common business-like sense to all the operations of the farm, and in localities where it pays better to sell the timothy than to feed it, I would by all means sell the hay, and depend on fertilizers and legumes to keep up the fertility of the soil.

FARMING FOR HAY.

But farming for hay does not mean running the land in meadow till it will hardly produce any hay worthy the name. A moderately short rotation is as good for the hay crop as for any other, and the growing of a legume crop is just as important as in a rotation for grain or cotton. Whatever the crop, the rotation should be planned so as to give that crop the best opportunity in the rotation. Hence, in a rotation for grass, the grass should come in when the soil is best supplied with the nitrogen accumulated by the legume crop. In the Upper South, this legume crop should be the cow pea, and the best crop to seed down to clover and grass will be the winter oats crop, following corn among which the peas have been sown.

The corn will have had all the manure accumulation possible on the farm, and the oats will get some benefit from this and more from the peas, and hence will need a good dressing of acid phosphate and potash as much for the clover and grass as for the oats. Seed to clover and grass with the oats in the fall, mow the oats stubble after the rag weeds start in the summer, and the following spring give the clover and grass a dressing of freshly water-slaked lime at rate of 20 bushels per acre. Mow two seasons, and the second season in the early spring give a top dressing of nitrate of soda and acid phosphate, 50 pounds of the first and 200 of the last per acre. In the South, orchard grass and tall meadow oat grass should take the place of timothy, which does not thrive well here. After the first cutting of hay the second year plow the sod and sow in peas again. Cut these peas for hay to feed on the farm, and during the winter get all the manure out on the stubble for the corn crop the following year. Wheat may, of course, take the place of the winter oats where more profitable. This is only adapted to the upper country of the South and not to the cotton belt, where hay making from grass can hardly be made a profitable part of the farm rotation, and where the legumes will be of more value on the arable lands than meadow grasses.

But in the North, and near the large cities, where hay from timothy grass is always in demand at fair prices, and where the farmer will haul his own hay to market, he can always haul home the manurial value of the hay either in the city manure, or fertilizers, at a considerable profit in the transaction. There, a four or five year rotation, with corn, wheat, clover and timothy will usually be the best. Of course he will keep some stock, but he will make the best use of the commercial fertilizers in the production of his hay. Even with the best of management it will be found at times that it will pay the hay farmer to buy some nitrogen, in the form of nitrate of soda, for a spring dressing, and it will usually be found that the most profitable use he can make of his manure accumulation will be on the sod that is to go into corn the following year, after mowing the spring crop. This will give a good second crop and will prepare the sod better for the corn. Getting a good price for hay, it will pay him to be liberal with the top dressings of commercial fertilizers, and, for a rank growth of grass, nitrogen in the immediately available form of nitrate of soda will usually be found the cheapest and best. Farming for hay does not differ from farming for grain in the need of keeping up the productivity of the land through fertilizers and a good rotation, and under the conditions we have named, hay farming may be the most profitable method of farming that one can adopt; while under the conditions prevailing in most parts of the country, and on cheap lands, the rule to feed all coarse forage on the farm is a good one. We have simply endeavored to show that one may be so situated that hay will be the best money crop he can grow.

Then, too, there are places where the straw on the farm commands a better price at the paper mills than hay sells for in most places. The straw has little manurial or feeding value, being mainly useful as an absorbent of the manure. Then, where a man can sell wheat straw for $6 per ton, as is done in some places, he can do better to sell it than to feed it, provided he returns the value in plant food to the soil. In that case the soil will be the gainer, as the wheat straw has no such fertilizing value.

One of the greatest advantages the market gardeners on the South Atlantic coast have is the ease with which they can grow a large crop of hay the same season in which they cultivate the land in vegetables. Crab grass, which is classed as a pest in the North and elsewhere, develops here a value that is unsuspected elsewhere. On the moist and fertile lands where the early truck is produced for the Northern markets, if the land is simply put in good order after the early truck crops are removed, there comes in a wonderful volunteer crop of crab grass, which attains a height and luxuriance unknown elsewhere and often cuts two tons per acre of excellent hay. It is curious to notice, too, that not only the size of the crop is increased on these fertile lands, but the quality of the feed is also improved. Crab grass hay from a poor piece of land is hardly worth the saving. A friend in South Carolina once told me that he cut some crab grass from a thin piece of land, thinking that it should be saved, and a little later he cut a heavy crop from a truck patch and put it into the same barn. His horse thrived well on this, but later on he suddenly found his horse was falling off, though fed as usual, and he found that they had gotten down on the poor land hay and that it would hardly support life. But the true hay crop for the market gardens, as it is elsewhere in the South, is the cow pea. Sown after the truck crops are off it makes a wonderful growth on the rich soil, and has with it a great mixture of the crab grass that will not down, and the two together are more easily cured than the peas alone. If there is a man anywhere who can afford to sell hay, it is the Southern farmer with cow pea hay; for, in selling it, he leaves behind in the soil an accumulation of nitrogen for the succeeding crop, and where it commands the price it did last summer in South Carolina, of $18 per ton, it may pay better to sell than to feed, provided the money from the sale of the pea vine hay is returned to the soil in the form of commercial fertilizers, to enable it to grow a larger crop of hay. And the advantage in the growing of cow pea hay for sale is that only the mineral forms of fertilizers are needed for it, and, not like grass, demanding large supplies of nitrogen. Hence it is possible in the South, in particular localities where hay commands these high prices, for a farmer to profitably grow a hay crop while improving his land in doing it, and thus get fertilizers for all his crops without cost. I say this is possible in some localities, but as a rule the South needs live stock worse than anything else, and only a few farmers will be situated near a market that will take their hay. Right here there could be a good profit made in this way, since, in the city of Raleigh, the people who keep cows are reduced to the necessity of buying either Northern timothy hay at $20 per ton, or to feed on cotton seed hulls at $5 per ton, and these are perhaps a little better than the pine shavings, but not much; and for the milch cows the timothy hay is but little better and much more costly. It would be an easy matter here to grow two tons per acre of cow pea hay, and then an easy matter to sell it at at least $15 per ton, and if the $30 per acre were invested in good fertilizers for the farm, the sale crops could be greatly increased, by the fact that only the cheaper forms need be bought, as the sale crop of hay would leave the nitrogen as a profit. Where a man, then, is growing cotton near such a market for hay, and will not keep the stock he should, this opens a way for the improvement of his soil in an effective and economical way. The danger in all this selling of hay, however, lies in the temptation to keep, for other purposes, the money received and to let the land suffer. But a ton of cow pea hay would remove from the land only about two dollars' worth of phosphoric acid and potash, and a sale of thirty dollars' worth of hay, if invested in fertilizers, would return to the farm far more than was taken from it, to take no account of what remains in the roots left in the soil. While the selling of hay as a general practice is not the best thing most farmers can do, it is, nevertheless, true that farming is business and not a sentiment; and the farmer should grow and sell that which pays him best, taking the future of the soil into consideration.

CHAPTER XVI.

WHERE TOBACCO IS THE MONEY CROP.

The traveler from the North, passing through the upper country of Virginia and North Carolina, and seeing everywhere the old, worn fields growing up in pines, is apt to jump to the conclusion that tobacco is responsible for all this waste of fertility. Indirectly, of course, it is, but there is no more reason why tobacco should result in soil exhaustion from its growing than any other crop. But Northern farmers coming South rarely want to engage in the culture of either tobacco or cotton, as they charge the poverty of the Southern soils to these crops, and overlook the fact that bad farming and not the particular crop, is responsible for the waste lands and the old fields. Tobacco, more than than any other crop grown, is affected by the soil and climate in which it is grown, and tobacco growers in all parts of the country have learned what sorts of tobacco are best adapted to their soils and climates. These differences in the varieties of tobacco grown have been the result of long experience and study, by cultivators, of the capacities of the various soils, and no one can afford to ignore the results, or to try to grow a variety on a certain soil that has not been found suited to it. The growers of the Zimmer Spanish, in Ohio, are too wise to try to grow the gold leaf tobacco which the North Carolina farmers use, and the North Carolina farmers are too wise to waste time on the White Burley of Kentucky or the black tobacco of the Virginia Peidmont country. The growers of Connecticut seed leaf would only lose money by endeavoring to grow plug manufacturing tobacco. In some sections of the tobacco growing parts of the country the growers insist that a systematic course of improvement of the soil would be disastrous to the quality of the tobacco they grow. This is largely the case in the bright, cigarette tobacco section of North Carolina, and the growers generally adhere to the practice of growing tobacco solely by the use of a moderate amount of fertilizers, insisting that a heavier fertilization made the tobacco coarser and later. Some years since a grower in one of the tobacco counties in North Carolina, wrote to me asking for a formula for a tobacco fertilizer, as he knew that I had been conducting a series of very extensive experiments in the fertilization of this crop. I gave him the following formula, and advised him to use 700 pounds of the mixture per acre. Acid phosphate, 900 pounds; dried blood, 600 pounds; nitrate of soda, 100 pounds, and high grade sulphate of potash, 400 pounds. He took my advice, and when his crop was marketed sent me the report of the commission merchant who sold it, showing that his tobacco brought the highest average price of the season. Soon after this a man from the same county wrote to me for a formula, and I gave him the same. He wrote me that 700 pounds was an amount entirely too large and could not possibly make fine tobacco. I sent him the report of the man from his own county who wrote me that his success was so marked that he intended to increase the quantity of fertilizer.

There is a widespread impression among the growers of bright tobacco that the use of peas or clover on their lands is detrimental to the quality of the tobacco. I believe this to be an error, and believe that the development of the fertility of any soil will enable the grower to grow a larger crop of the same tobacco for which his soil has been found suited. In one of the eastern counties of North Carolina, some years ago at a Farmers' Institute, I advocated the use of the cow pea as a preparatory crop for tobacco. The growers objected, and said that they had always understood that peas would spoil the quality of the leaf. Two years after that I was again in the same county holding an Institute, and stopped over night at the residence of the largest tobacco grower in the country. To my surprise I found that he not only had every vacant spot on the plantation covered with peas, but was planting a hill of peas between every hill of tobacco as soon as the priming off began; tobacco there being cured by pulling the leaves as they ripen and not cutting the whole plant, so that by the time the crop was gathered he had a luxuriant field of peas to enrich the land. The land then in peas was to be planted in tobacco the next year, while corn took most of the tobacco land with its growth of peas, to be followed by winter oats, and these by peas again for tobacco. The appearance of his 150 acres of tobacco fully warranted the success of the practice. In the upper Piedmont country of Virginia, the farmers have been very successful in the growing of a black wrapper tobacco, by practicing a rotation on the land where they grew tobacco, different from that part of the farm where they grew most of their corn and other grain. On their tobacco land they practice a three year rotation of clover, tobacco and wheat, and use no fertilizer whatever; depending entirely on the clover for the tobacco crop, no clover being cut and no pasturing done on it. They have found that on their deep, red-clay soil this rotation has been a great success. One grower wrote that his wheat crop averaged 28 bushels per acre and his tobacco cleared him $145 per acre. How long such a rotation can be successfully run it is hard to say. Their soil in that section is very rich in potash, in the form of a silicate, which is gradually made available by the carbonic acid of the rainfall and the humus which they so lavishly grow in the clover; and as the tobacco crop makes a light draft on the phosphoric acid of the sod and the clover furnishes large amounts of nitrogen, it may be a long time before they will need a change. But the wheat straw is being used to help the manure pile which is used on other parts of the farm, and the land will probably ere long show an acidity that will make it "clover sick." I have advised one of these growers that I am satisfied that his rotation can be improved by cutting the clover for hay, using a good dressinng of acid phosphate on the wheat, and then using the manure (made from feeding the clover hay) on the sod before turning it for tobacco. A heavy application of acid phosphate to the tobacco crop direct, might have a bad effect on making the leaf "bony" or thick-veined, but applied to the wheat and clover it would not have any bad effect on the tobacco. In Lower Virginia, where the heavy shipping tobacco is mainly grown, a similar rotation would be good. But there it would be advisable to use both acid phosphate and potash liberally on their lands, and in some sections to substitute peas for clover in the rotation. I would not make a separate rotation for the tobacco lands, from that practiced on the rest of the farm, but would put corn and tobacco in parts of the same field; alternating their position in each round of the rotation. Thus, corn and tobacco the first year, the corn to have the manurial accumulation of the farm, and the tobacco liberally supplied with the fertilizer mixed by the formula already given. Corn and tobacco both to be followed by winter oats or wheat, with 300 pounds per acre of acid phosphate, and on the portion following corn to have 50 pounds per acre of muriate of potash added. The wheat or oats on the part where tobacco was heavily fertilized will need a much lighter dressing of the acid phosphate. Sow crimson clover on the stubble after harvest, and the following spring plow it under and seed to peas to be cut for hay. During the winter get out all the manure on the part intended for corn, where tobacco grew before, and repeat the rotation; in each round putting corn where tobacco grew in the last round and tobacco where the corn grew. Treated in this way, and a complete fertilizer used liberally on the tobacco, the peas and corn fed to stock to make manure, the productive capacity of the soil will rapidly increase; and the wheat crop can soon be grown without additional fertilizer if manure enough is raised to cover the corn tend. While the demands of the tobacco crop for nitrogen and potash can only be fully met by the use of a complete fertilizer, we should endeavor to lessen the amount needed, by the growing of legumes and the accumulation of humus in the soil. But, at the same time, any parsimony in the use of fertilizers when needed will result in loss to the tobacco grower, since only by the most liberal feeding can the maximum crops in quality and quantity be produced. Hence the tobacco crop, instead of being an impoverishment to the farm, can be made, by the systematic rotation of crops and the liberal application of fertilizers, the means for its rapid improvement.

FORMS OF FERTILIZERS FOR TOBACCO.

While heavy fertilization is needed for the tobacco crop, there is no crop more sensitive to the shape in which the plant food is presented to it. Nitrogen and potash are its chief needs. But it is not merely potash that is needed, for it is essential that it be free from chlorides; hence only the high grade sulphate should be used. The muriate will make a heavier crop, but a crop of inferior value, and, in fact, a crop worthless for manufacturing where it is to be burned in pipe, cigarette or cigar. A year or so ago I gave the tobacco formula, already printed, to a farmer in the bright tobacco belt of North Carolina. He wrote afterwards that his crop was of very poor quality, and he wanted to know what was the matter with the fertilizer. He bought the materials from a large firm of fertilizer makers in Norfolk, and he sent me their bill. Where I had designated high grade sulphate of potash they had put in low grade, or kainit. In the bill was charged "sulphate of potash," and then, in small letters in bracket, "kainit." It was evidently done for the purpose of disgusting the farmer with home mixed fertilizers, for any manufacturer knows that kainit should never be used in a tobacco fertilizer. The cause of the poor quality of his tobacco was plain.

Then, too, the form in which the nitrogen is presented is of some importance. We have found that a moderate amount of nitrate of soda, as a starter, and a good supply of organic nitrogen in the form of dried blood, have given better results than cotton seed meal or fish scrap. Fish scrap is apt to contain some chlorides, and is objectionable. Tankage might do if it was pure meat tankage and not largely mixed with bone; but the character of the tankage is too uncertain for reliance. Any excess of phosphoric acid tends to render the tobacco "bony," as it is called, or thick veined, with a thin, papery leaf, lacking body. The formula we have given is the result of long study and experimentation with various mixtures, and we believe it can hardly be improved upon. The full amount of 700 pounds per acre will probably not be needed where a systematic rotation is practiced, and do not let any story of the injurious effects of clover or peas deter you from their use as preparatory crops to tobacco. The story of their injurious effects has been handed down, and accepted as a fact, by those too ready to get an excuse for bad farming. Some peanut growers have the same prejudice against the legumes, probably because someone sometime had a poor crop after a crop of peas, and at once the word went out that peas are destructive to peanuts; and the tale has been believed by men too lazy to investigate for themselves. Many more of the old wives' tales in farming have grown up in the same way.

CHAPTER XVII.

FERTILIZERS FOR THE CORN CROP.

While, like tobacco, the chief food needs of the Indian corn plant are nitrogen and potash, and a complete fertilizer will always produce a great increase in the crop, we have never yet made an experiment in which the increased crop paid for the outlay in fertilizer at the usual price for corn. Inasmuch as the larger part of the cost of the complete fertilizer is in the nitrogen, it may be practicable to profitably use a commercial fertilizer on the corn crop if the nitrogen needed is supplied from legumes or manure made at home, and only acid phosphate and potash are used in the mixture applied. Indian corn is one of the essentials in any rotation in American agriculture, from the Great Lakes to the Gulf. It is the chief of all feed crops grown in this country, and lies at the very foundation of all of our national success in the production of beef and pork. We hear a great deal of wise talk about the "great corn belt," and some seem to suppose that success with the corn crop is confined to the area included in the black prairie lands of Illinois, Missouri, Iowa and Kansas, and nothing is more common than to hear poor farmers excuse themselves by saying that it is no longer possible, in the East, to compete with the Western farmer, in the production of corn or wheat. The fact is that good farmers all along the Middle and South Atlantic coast are growing as good corn and wheat crops as the Western farmers, and at a better profit, because of their nearness to the great markets. In the wheat growing section of Eastern Maryland a good farm rotation has brought up the production of wheat from 10 or 12 bushels per acre, to 35, 40 and even 50 bushels per acre. At the same time the great wheat farms of the Dakotas have decreased in productiveness, for the reason that one-crop farming will fail anywhere. The Dakota wheat growers are as straight on the road to "old fields" as ever were the tobacco and cotton growers of the South. The exuberant fertility of their soil may delay the final failure, but it will surely come unless better methods are used. Then, too, with the Indian corn crop. Recently, in Illinois, premiums were awarded to corn crops of 55 bushels per acre, while in poor old Virginia, North Carolina and South Carolina good farmers are growing from 80 to 163 bushels of corn per acre. The greatest corn crop ever grown, not, however, an evidence of good farming, but of extravagant expenditure for the result, was the crop of 254 bushels per acre grown in Marlboro Co., S. C. Near the ocean, in Southeast Virginia and Northeast North Carolina, there are wide areas of reclaimed swamp lands, on which the owners have for generations been growing corn only, just as some have been doing on the black soils of a similar nature in Illinois; both have been selling only corn, and sending off the fertility of their lands. But most of the farmers of the Illinois black lands have discovered the profit to be made in turning their corn into beef and pork, while the Southern coast farmers, with land just as productive and right at the ports from which the Western cattle go to Europe, still stick to selling corn, though they could compete at a great advantage with the cattle feeders of the West.

But the greater part of the farmers in the country east of the Mississippi River, are farming under conditions which make it essential that some systematic method be used for keeping up and increasing the productiveness of their lands, in corn as well as in other crops.

HOW SHALL WE UTILIZE THE CORN CROP AS A FOOD CROP?

Since in the case of far the greater number of farmers in the East the corn crop is not produced as a sale crop of grain, but as a means for feeding stock, and through this to raise manure for their crops, while making a greater profit from the stock fed than they could possibly get from the sale of the grain, the question of the best method of utilizing the corn crop on the farm becomes a matter of prime importance. The great labor of gathering the grain and saving the stover as dry food has led to many experiments for economizing the labor and putting the crop into better shape for feeding.

THE SILO AND ENSILAGE.

No method for the utilization of the entire corn crop as food for stock has ever been devised that has equalled the cutting of the matured crop, while still succulent, and storing it in air-tight receptacles known as silos. A work devoted to the feeding of plants would not be complete without some consideration of this great method of making the corn crop one of the greatest of fertilizing crops grown on the farm, and removing it from being an exhaustive crop merely, to one of the greatest of crops for the building up and increasing the productiveness of the farm, through enabling the farmer to feed more stock than was possible under the old plan. Having had a wide experience in the making of silage, from the first experimental stages to the present more perfect method, the writer feels qualified to speak with some certainty of the results to be attained through the practice of ensiloing the corn crop. There has been a great evolution going on, not only in the production of the corn crop for the silo, but to a greater extent in the silo itself. In our first experiments, we sowed the corn so thickly that few ears were made, and the immature product was, with the greatest haste, cut into great underground pits, walled with cement, and constructed at a great expense. It was tramped and packed and made as tight as possible in the silo, and when the pit was full, a cover of a foot of cut straw or chaff was placed over the top, and then a board cover fitted over the whole and tons upon tons of rock piled on to further compact the mass. The result was a slow fermentation and a very acid product from the immature corn stored. Doubting men called it "saur kraut," and properly, too. It was found that the sour mass was greedily eaten by the cows, but the ill smelling stuff gave the dairy product a bad name with some of the establishments buying the milk, from which some of them have not yet recovered. A process, however, that has in it the germs of good, cannot go backward. Nothwithstanding the fact that some of the best thinkers prophesied that ensilage would soon be a forgotten fad the evolutionary process went on. We soon came to the conclusion that a better crop must first be grown, as the foundation of the silage, and chemical analysis showed that the stage in which corn had the largest feeding value was when the ears were fully grown, and that to make a really good silage we must have a well grown crop of corn. We began to plant more thinly and to give the corn the same attention we would to make a crop of grain.

Then began the study of methods and silos. We found that on taking off the load of rocks and board cover, there was a black, stinking mass of rotten straw. We got to thinking about the reason for this decay, and soon arrived at the conclusion that the shutting down of the moisture arising from the heating mass, and confining it right at the surface, was a bad thing. We cut our first crop of well matured corn for the silo in the Summer of 1886. The crop was a very heavy one, and we cut it in more slowly than we had ever done, often letting it lie for 24 hours or more to settle while filling. When our silos were full we determined to make one more big change, and though we knew everyone else was still piling rocks on board covers, we boldly left off all but the cover of cut straw. The result was our first "sweet ensilage." Of course there was some acidity, but, as compared with the old product, it smelled like a good article of New Orleans syrup. Since then we have never put boards or rocks on a silo.

Next began the study of the silo itself. We found that in an underground pit with cemented walls, there was always a great condensation of moisture on the walls, and this damaged the ensilage along the sides. We found, too, that corn cut in rather slowly and allowed to settle without much packing, heated more rapidly and cured better than that packed tightly; as the evolution of carbonic acid gas drove the air out better than any other method we could use. But the damage along the walls bothered us. Then, too, it was hard to persuade the farmers around that they could make ensilage profitably, for they looked at the pits we were using, which cost thousands of dollars, and they came to the conclusion that silage was not for the average farmer, since the silo cost so much money. About this time we visited the silos built by a wealthy cattle man in Southwest Virginia, which were simply made with posts set in the ground and sheathed horizontally on the inside, and then vertically, with dressed and matched stuff, and the gable ends of the roof left entirely open. We found that these silos were keeping thousands of tons of silage in better condition than ours, and at a tenth of the cost per ton.

It was evident, then, that the wooden silo above ground, with air-tight sides and bottom and free ventilation above, had solved the whole question of successfully ensiloing corn.

The first improvement made in these was to cut off the corners, making them somewhat octagon in shape, as it was found that the corners were the places where it was most difficult to exclude the air. This led gradually to the round silo, and finally to the simple stave silo made like a railroad water tank, but with perpendicular sides, and with windows one above the other for the easy unloading of the building.

Prof. J. H. Grisdale, of the Dominion Experimental Farm, Canada, gives the following table of dimensions and silage content for stave silos. As 35 pounds per day is a fair average feed, it will be easy from this table to estimate the size needed for the farm stock kept.

Depth in feet.	Inside diameter in feet.									
	15	16	17	18	19	20	21	22	23	24
20	58	66	75	84	94	104	115	126	138	150
21	62	71	80	90	100	111	123	135	147	161
22	67	76	86	96	107	119	131	144	158	172
23	71	81	92	103	115	127	140	154	168	183
24	76	86	97	109	122	135	149	163	177	194
25	80	89	103	116	129	143	158	173	189	206
26	85	97	109	123	137	151	167	183	200	218
27	90	102	115	129	144	160	176	194	212	230
28	94	108	122	136	152	168	186	204	223	243
29	99	113	128	143	160	177	195	214	234	255
30	105	119	134	151	168	186	205	225	246	268

Tons capacity.

MAKING THE ENSILAGE.

We frequently see statements in the agricultural papers, from men who are evidently new hands at ensilage making, that it is totally needless to cut the corn, and that corn packed in the silo uncut keeps as well as the cut. We have seen this uncut silage, and do not want any of it. It is false economy, even if the product was as good, since to feed it economically the food must be cut, and it is a far harder job to cut the fermented mass than to cut it while fresh and green. One brilliant genius published a statement that he had found it needless to use a cutting machine, as he found that if the stalks were chopped in six-inch pieces with a hatchet they kept just as well. What sort of a mind the man must have who would put a hatchet in competition with a power cutter we cannot understand. Cut the corn into the silo in inch pieces, and merely keep a hand in the silo to keep it level and to prevent all the grain from running to the edges. Cut when the corn is fully in the roasting ear stage. The harvesting is best done with the binder, which cuts and binds the stalks in a shape easily handled. Be in no particular hurry about the filling, but allow it to settle a while at times. If it rains no matter; it will do just as well cut when wet as at any other time. If the corn is over ripe, it is well to spray it with water as the silo is being filled. In fact, if the silo is air-tight at sides and bottom, and has free ventilation at the top for the steam to pass off, it is far easier to keep the ensilage than it is to spoil it.

THE FEEDING VALUE OF ENSILAGE.

The storing of the cut corn in the silo does not add any value to it as a food that it did not already possess, but it puts it into a shape in which we can get the full feeding value better than in any other way, and in a shape where it is succulent and palatable to the stock. On one occasion, when I was engaged in cutting a fine growth of corn into a silo, a neighbor expressed the opinion that I was wasting a fine crop of corn, as he thought it would make at least 50 bushels per acre. I showed him that corn was rarely worth over 50 cents per bushel there, and that generally I could buy corn in the Fall for 40 cents per bushel. But putting my crop at 50 cents per bushel, there would be $25 worth of corn per acre, and the cutting of the crop and husking it out would cost more than the cutting and putting in the silo. There would be a great waste of fodder in the field curing, and the stover would not be as valuable dry cured as ensiloed, as a large part of the feeding value would be lost. The corn made me 20 tons of silage per acre, which carefully conducted feeding experiments had shown me was worth $3.00 per ton to my cows. No one would estimate that the feeding value of the dried stover would bring up the $25 worth of grain to the $60 value of the silage. Then, aside from the actual feeding value of the dry matter in the silage, its succulence and palatability added a value which made it equal to green pasturage for the cattle, and which the dry fodder would have entirely lacked.

MANURE FROM ENSILAGE FEEDING.

One of the great advantages of feeding properly cut and cured ensilage, with clover hay and cow peas to balance it, is the great value of the manurial deposit made, and the fact that it is in a mechanical condition that will allow of its being taken out and spread at once where wanted. One of the greatest mistakes made by otherwise good farmers, is the worship of a dung pile, and wasting of labor in turning and returning and piling manure, either under cover or outside. Manure kept in the barnyard, covered or uncovered, is all the time losing value. But some will say "It will lose if hauled out and spread on the surface." The fact is that it does lose very little when thus spread. It dries out moisture, of course, but does not lose a tithe of what it would lose in a pile, or spread thickly in the barnyard. The rains will wash the soluble part into the soil and the soil will hold it, and under the surface cover the nitrification of organic matter will go on rapidly. An experiment was published some years ago by the New Hampshire Station, which showed that on one plat manure was hauled out in the Fall and spread on the surface. On another plat the manure was spread at the same time and plowed under at once. On a third plat the manure was spread the following spring and plowed under. All the plats were then prepared and planted to corn. The result was that the plat on which the manure laid on the surface all winter gave the heaviest crop.

In the South, on our warm soil and in our sunny climate, the nearer we can keep the manure to the surface the better. I have made numerous experiments in this regard, and have always found the best results from having the manure at the surface, where it will act as a mulch, rather than have it below in a light soil. The difference is not so marked in a hoed crop as in the case where the manure is used on fall sown grain. There it not only acts as a manure but as a protective mulch in winter.

The silo favors the getting out of manure rapidly, before it loses much of its value, and it returns a larger part of the crop to the soil in good shape, than any other method of using the corn crop.

SHREDDING THE FODDER FROM CORN CROP.

Our chief objection to this is the extra expense of handling the crop. Then, too, there is no advantage for feeding in the dried and cured corn that the ensilaged corn does not possess, and there is the temptation to sell the grain instead of feeding it. Wherever we can add value to a crop by further handling and feeding it is always more profitable than selling the raw product. For many generations the South sold raw products only and other people manufactured their staple. The result was, as it always is, that a people selling only raw products never get permanently rich. Adding labor to a product rapidly increases its value.

Some years ago I visited a section of Nebraska for the purpose of studying the sugar beet industry. I talked there with an old German farmer, who was evidently a thrifty man. I asked him what was the usual price there for corn, as corn seemed to be their main reliance aside from little patches of beets. He told me that it was then worth 25 cents per bushel. I expressed the opinion that there could be little money in corn at that price, and he quickly replied, "I sell no corn, but my neighbors do. I feed all mine to the pigs, and they carry themselves to the depot, and I get 50 cents per bushel for my corn." I told him that he was right, but that he might do even better, for I noticed that at all the grocery stores in the town near him they had no bacon except that from Chicago, some of it possibly made from his hogs and sent back there for sale; while I had no doubt that well cured home-made hams and bacon, properly smoked, would meet a ready sale at better prices than the Chicago meat, as was certainly the case where I lived. It evidently struck the German, and I have no doubt that he experimented in that line.

But to return to the shredding of the corn stover. I feel that it is a matter about which I have little business to write, as I never shredded any in my life. But from what I have seen I feel confident that there is in the practice no improvement on ensilage, and a great deal more labor involved in the storing and feeding, and more danger of loss in the shredded fodder than in the silage.

But, nevertheless, if I did not use the silo, I would certainly shred the fodder, as the next best way to get the full feeding value of the corn stover. What we are after is to feed in the most economical way, and get the best returns for the corn crop. On the fertile prairies of the West men may perhaps profitably sell corn as a raw product, but I am persuaded that in all the eastern section it is not the best use to make of the corn crop, and that we can not only get a larger price for the corn in the shape of animal products, but can thereby render the corn crop one of the greatest aids in restoring the fertility of our lands, and in saving the need for so lavish a purchase of commercial fertilizers. For, while acknowledging the great value of commercial fertilizers, when intelligently used, our farmers, particularly in the South, need to be taught true farm economy, and a less wasteful and thoughtless way of using them.

Mr. J. E. Wing, of Ohio, during some Institute work in Maryland in which we were both recently engaged, told me that he has been perfectly successful in stacking shredded fodder in the open air. This being the case, the matter of keeping shredded fodder becomes much more simplified, and there need be no excuse that the farmer has not barn room in which to store it.

CHAPTER XVIII.

TESTING THE NEEDS OF THE SOIL.

Farmers generally imagine that they can have a chemical analysis of their soil made, and thus find out what are its needs. Chemists have long ago found out that a soil analysis will be of little use in determining the needs of the soil for plant food. A soil may be entirely unproductive, and yet chemical analysis may show that it has in it all the elements of fertility; but they may be in such an insoluble form that plants cannot get them. Many have, therefore, paid more attention to the chemical composition of the different crops, and from these data have tried to compound fertilizers that are especially adapted to each crop grown. While this is an advance over the soil analysis it is not really what the farmer needs to know in regard to his particular soil. A certain crop may require plant food in a complete fertilizer in certain proportions, and yet the farmer buying such a fertilizer may be spending money needlessly if his soil is already sufficiently stocked with any one of these constituents.

Hence the only way to determine what the land needs is to experiment on the land itself. Plants in their growth on the soil will tell you what the chemist cannot tell. It will tell you what particular form of plant food it is deficient in and which you have no need for buying. Farmers generally buy fertilizers according to their commercial valuation, and while that may be their true value on the market, the value of the article on their land may be a very different thing, and they may be spending money for what they do not need and be buying too little of what they especially need. The farmer can find this out for himself, and no one else can tell him beforehand. The needs of soils vary so greatly, even on the same farm, that true farm economy indicates that the farmer must be himself an experimenter in order to discover what no Experiment Station can discover for him. But any of the Experiment Stations in the various States will readily help the individual farmers in their States in conducting these experiments. We would impress the fact that if the experiments are to be of value, and are to show what you want, they must be conducted with the greatest care and accuracy. There must be no guesswork in the measurement of the plats, no guesswork in the weighing of the fertilizers, in the application and complete mixing with the soil, or in the harvesting and weighing of the crop. Guesswork is the bane of much of our American agriculture, and if the farmer is to learn anything from his experiments he must start out with the determination to leave no room for error which it is possible for him to avoid. It is better to make the experiments with some spring planted crop, since some of the articles used, such as nitrate of soda, may not have its full effect if applied to a fall sown crop. Select a level piece of land which is fairly representative of your farm, and preferably select that which is as nearly as possible the natural condition of the soil and not altered by previous heavy manurings. Lay off accurately a series of plats 204 feet long by 10 feet 8 inches wide. Make ten of these plats and leave an alley four feet wide between each, to prevent the fertilizer from one plat affecting its neighboring plat. It is also important that the whole series be level for the same reason.

Plats of this size will contain as nearly as practicable, one-twentieth of an acre each. Place firm, stout stakes at the corners of the plats. On the first plat simply prepare the soil thoroughly and apply no fertilizer at all, as this is one of the plats to be used as a comparison. The fertilizer plats are to be numbered as follows:

Plat No. 1. No fertilizer applied, but same preparation as the rest.

Plat No. 2. Apply nitrate of soda 8 pounds (160 pounds per acre.)

Plat No. 3. Apply 16 pounds of acid phosphate (320 pounds per acre.)

Plat No. 4. Apply muriate of potash 8 pounds (160 pounds per acre.)

Plat No. 5. Apply no fertilizer at all.

Plat No. 6. Apply nitrate of soda 8 pounds and acid phosphate 16 pounds.

Plat No. 7. Apply nitrate of soda 8 pounds and muriate of potash 16 pounds.

Plat No. 8. Apply muriate of potash 8 pounds and acid phosphate 16 pounds.

Plat No. 9. Apply nitrate of soda 8 pounds, acid phosphate 16 pounds and muriate of potash 8 pounds, making a complete fertilizer.

Plat No. 10. Apply no fertilizer.

The series may be indefinitely extended, and the amounts of each constituent doubled or trebled alternately, but the above series will usually suffice. I repeat, that it is necessary to use the utmost care if results of value are to be expected. Get the fertilizers evenly distributed over the whole plat, but take care that none of any of them gets outside the limits of the plat. Thorough mixing with the soil is also essential, so that the amount for each plant may be uniform over the whole plat. The normal applications here given are liberal amounts, and they should be liberal in order to get the true results. In harvesting the crops from the plats there will be need for great care, so that the whole crop and no more is taken from each; and the subsequent handling and separating and weighing should have the most minute care. Study the results carefully and do not come to any hasty or wrong conclusions. It will take a series of seasons to give the final result, for the peculiarities of the season must be taken into the account. In using such large applications of potash it is very important that it should be well mixed in the soil, and that it does not come in contact with the seed in its caustic state, as it may seriously hamper the experiment to have the germination of the seed interfered with and a lack of uniformity in the number of plants on each. Each spring the whole series of plats may be plowed as one and then again laid off by the stakes that should be kept in place. The master's hand must be in this work, for it cannot be left to the ordinary farm hand if you are to reap any benefit from it. It is not essential that the plats be exactly the length and width stated, provided they contain 2178 square feet, as nearly as possible, as this is the content of the twentieth of an acre. But where practicable, long and narrow plats make a series more easily prepared than would square plats. The amounts suggested are from the circular sent out by the Department of Agriculture, and they are one pound (or the multiple of a pound) per square rod. Prof. Voorhees suggests that the plats be divided into square rods and the amounts applied to each, but we think that in plats of this size the fertilizers can well be applied broadcast with sufficient accuracy if proper care is taken. If, after proper study of these plats for a series of years, it becomes apparent that any one of the constituents does not give results of value it may well be inferred that the soil is not needing more of that, and the farmer should save his money by buying what he needs and not buying what he does not need. He may find that for a certain crop a complete fertilizer with nitrogen, phosphoric acid and potash gives the best results. But he need not at once jump to the conclusion that he must buy a complete fertilizer for that crop. He may find, for instance, that the complete fertilizer gives the best result on the corn crop. But in his regular farm rotation he may put that crop on a sod which has received the home-made manure, and its needs for nitrogen will be thus well supplied. But having found that his soil needs both phosphoric acid and potash, he will be wise to use these. But he may find, as many have found, that potash in his soil has little or no effect, and then for the corn crop he need buy only the acid phosphate. And there are soils still plentifully supplied with phosphoric acid which are deficient in potash and nitrogen, so that by providing nitrogen through legumes he need buy only potash. On the coast of North Carolina, intelligent farmers assert that phosphoric acid gives no good results on their cotton crop, while nitrogen and potash are very important. On the other hand, in the upper districts of the South, in Georgia and Northern Texas, potash is found of little importance, while phosphoric acid is the governing factor in all fertilizer mixtures. On the lower Mississippi, the river has evidently brought down plenty of potash, and the sugar planters do not need it. On the other hand, in New England generally potash is a leading deficiency. It will usually be found that in the upland red clay soils, along the eastern side of the Blue Ridge mountains, potash is little needed, while, as a rule, on the sandy soils of the Atlantic seaboard, potash is the most important constituent of a fertilizer. Prof. Voorhees states that in New Jersey, on good loamy soils, potash and phosphoric acid are of far more importance in the fertilizers for the corn crop than nitrogen; while on the sandy soils, nitrogen and potash are relatively of more importance than phosphoric acid. This agrees with experiments on similar sandy soils in Eastern North Carolina.

On land devoid of humus and in a low state of productiveness, it is safe to say that in the start of the improvement, a complete fertilizer containing a due percentage of each of the three important elements, is the thing to apply; while, as we accumulate humus and nitrogen through the use of leguminous crops, we can by degrees get rid of the necessity for the purchase of nitrogen, and it may be found that one of the other constituents is present in abundance and that the want of productiveness was not due to the lack of it.

CHAPTER XIX.

THE RESTORATION OF WORN OUT LAND.

There are few soils that are really worn out. Long, bad tillage and cropping have made them unproductive, and have depleted the stores of plant food within reach of plant roots, while right below there is a fertile soil untouched by the shallow plowing of the past. Of course, there are deep and leachy sands which never had much fertility to lose, and which become barren when their little store of humus on the surface is exhausted; and then become the hardest of soils to render productive and keep them so. In all parts of the country there are lands once fertile and productive, which have become unproductive through long years of bad plowing and incessant cropping, which could be completely restored through their own resources, if these were properly used. On level lying clay soils the first step in their improvement must be drainage. It is utterly useless to expend money on such soils for plant food until the air is permitted to penetrate the soil and oxidize the plant food already there. Some method of under drainage, with tile or boards or rocks or logs, must be the first step in the improvement of low lying clay soils. Then get some organic matter there, not only for the increase of fertility and the furnishing of nitrogen, but for the mechanical mellowing of the soil. In a section where red clover thrives there is nothing better, and in the Middle States and the South, the cow pea will be the best means. If the soil is so reduced in fertility that clover will not make a crop on it, there is a necessity at once for the use of mineral elements, phosphoric acid and potash, to enable the clover to grow. We often hear farmers say that their land is too poor to grow clover. Then it is too poor to grow anything! If you wanted to get it to grow a crop of wheat you would at once think of putting some fertilizer on it to help it. Then why not put the fertilizer on for the crop that is to improve the land? Is it not a little odd to see farmers, who do not hesitate to buy fertilizers for a crop which they are going to at once sell off the land, try to get clover to grow without any help from the plant food that is necessary to its growth, and which is either deficient or unavailable in the soil? The first step in the restoration of an unproductive soil, after drainage, if it needs it, must be the restoration of the conditions that existed in it when it was new and fertile. It had then an abundant supply of humus, either from the forest decay or the prairie sod, and long culture has exhausted this supply of food-containing and moisture-retaining humus. The restoration, then, of this humus, in an economical way, is the first thing that demands the attention of the cultivator. Given an old field that will not grow peas, let us ask why it will not? If the subsoil immediately under the old time plowing is a good clay, and the drainage is good, the next thing to do is to plow it and loosen the hard-pan with the subsoil plow. Do not plow much deeper than the old plowing at first, but try to loosen the hard subsoil as deeply as the team can pull the plow. The early autumn is the best time for this. Sow some crop like rye for a winter cover and it will be well to give this rye a dressing of a complete fertilizer mixture so as to insure a good growth. Turn the rye under as early in the spring as the ground can be plowed to advantage, and if you are in the North sow oats and Canada peas for a forage crop, and afterwards fallow the land for wheat, and give the wheat a liberal dressing of acid phosphate and some form of nitrogen in organic matter, such as tankage or cotton seed meal, and potash if needed. A good dressing for wheat will be 300 pounds per acre of a mixture of 1200 pounds acid phosphate, 600 pounds tankage and 200 pounds of muriate of potash, if you have found that your land needs all of these. The land will now grow clover, and once you get a good clover sod there will be no further trouble in getting the humus back. If the land is in the South then cow peas should follow the rye, and if the land is very deficient in humus it will pay to turn them under when dead and have finished their work; but as the fertility of the land increases it will always be better to cut and feed the peas. After the peas are cut (and we should have applied to them a liberal dressing of acid phosphate and potash) the land can be gotten in order for winter oats, and the oat crop followed the next summer with peas, again fertilized, and now cut for hay and the stubble disced and sown with crimson clover. Plow this under early in the spring for cotton, and the land will be found no longer dead poor, but will give a fair crop of cotton. Sow crimson clover or hairy vetch among the cotton, and during the winter get all the farm manure out on the land and put it in corn the following spring. Sow peas among the corn at last working, and then start with the Winter oats again in September. Every time the land comes in peas give them as liberal a dressing of the mineral fertilizers as you can afford, and you may be certain they will do the rest. You will then be putting the plant food where it will tell in the development of the fertility of your soil, and by feeding all the forage you can produce by well manured peas and manured corn, you can make your cotton crop a real money crop, clear of any incumbrance of a fertilizer bill. The governing idea in any plan for the improvement of the soil should be the liberal feeding of the renovating and humus making crops. Rye is a good starter for poor land, but it is on the legumes that dependence must be placed for all permanent increase in the humus content and nitrogen in the soil.

A similar course of improvement can be adopted in a more northern latitude, where clover will be the renovating crop. If the land is too poor to grow clover this defect can be remedied by the use of commercial fertilizers. There is hardly an old, worn piece of land in the Middle States that cannot be made to grow clover, if an application of a liberal amount of phosphoric acid and potash is given it. The land will not grow clover because of a lack of plant food in the soil. Supply this want, and remember that in the growing of clover in the North the same conditions that govern the improvement of land in the South with the cow pea will govern. You cannot expect something from nothing. If the soil lacks the plant food for the clover it cannot get the clover to gather nitrogen for it; but if the soil is supplied with what the clover needs, it will go to work and get the nitrogen from the air and locate it in the organic matter in the soil, so that subsequent crops can get the use of it. A three year rotation of corn, wheat and clover, with fertilizers applied to the clover at first and the wheat also, and the manure made from the feeding of the clover and corn stover on the land is returned to the clover sod for the corn, you will find that in a little while you need to buy only acid phosphate and potash, and put these on the clover, with an occasional light dressing of lime, and your wheat will be grown well without further fertilization; for when you come to the making of manure enough to cover the corn field, the wheat will have the best fertilizing possible.

CHAPTER XX.

HOW LEGUMES HELP THE FARMER.

We have said a great deal about leguminous plants and their great value in restoring and keeping up the fertility of the soil. We wish to make perfectly plain what the work of these plants is, and what we can expect from their use; and also to correct some erroneous notions in regard to them. The name legume, has been given to the family of plants to which the pea belongs, because they bear their fruit in the form of a pod, called by botanists, a legume. Hence, the name of the botanical order is *leguminosae,* or pod bearers.

It was noticed for many years that the members of this order of plants did, in some way, add fertility to the soil in which they grew, and that there was more nitrogen present than the soil possessed before the crop was grown. Scientists came to the conclusion that in some way they were able to get and use the free nitrogen, so plentiful in the air everywhere. Just how they did this was for many years the subject of earnest investigation, and is still a matter for scientific inquiry, for although we have learned a great deal in regard to the agency through which they are able to get the nitrogen, there is yet much to learn in regard to the exact process that goes on in the soil during the growth of the leguminous crop. For all the purposes of the farmer, however, it is sufficient to know that he can, through the medium of a crop of peas or clover, get enough of organic nitrogen stored in his soil to at least carry the following crop on the land, if not more; and that he can do this while growing the most valuable food crop for his stock.

NITRIFICATION IN GENERAL.

Nitrogen is found in all cultivated soils in three forms, of ammonia, nitrates and as organic matter containing nitrogen. Very little exists in the soil in the form of ammonia, as the process of nitrification rapidly changes any ammonia that may be there into nitric acid. Usually the nitrogen in the soil, in the form of nitrates of potash, lime or magnesium, is not over

5 per cent. of the total amount of nitrogen in the soil. By far the greater part of the soil nitrogen exists in the form of humus or organic matter containing nitrogenous matter. "This humic matter is a mixture of various bodies, the precise nature of which has been very imperfectly ascertained, owing to their general insolubility and the absence of well marked chemical properties. We will probably all agree that the nitrogenous organic matter of soils is a residue left by the incomplete oxidation and decay of the dead tissues of previously existing plants and animals, and that it has its primary origin in the capacity possessed by plants of assimilating various forms of inorganic nitrogen and constructing therefrom nitrogenous organic bodies containing nitrogen, carbon, hydrogen and oxygen, with the addition, in many cases, of a small quantity of sulphur." (Rothamsted Lectures. Warington.) It was found in the experiments at Rothamsted, in England, that in a meadow in grass for thirty years there was an increase of nitrogen in the surface soil at the rate of 50 pounds per acre per annum.

A careful account was kept of the manure applied to this meadow during the time; the meadow was mown annually and the hay weighed. It was manured with city manure from the London stables each alternate year, and had small annual dressings of superphosphate, sulphate of potash and nitrate of soda. After making a liberal estimate for the nitrogen in the manure, it was found that there had been a considerable gain in nitrogen over and above the amount applied in the manures. The total gain was not less than 32 pounds per annum, as the whole manure was charged to the field, and no account taken of the nitrogen lost from the soil or taken by the crop.

From the growing of the clover there was also found a still greater increase of nitrogen in the soil. Unmanured barley following clover, made 58 bushels per acre, while the part without clover and following barley made but little over 37 bushels per acre. In a four year rotation in which clover was used once in the four years for forty years, the average annual amount of nitrogen removed in the crops in excess of that contained in the manure was over 30 pounds per acre, while the fertility of the land has not diminished. Mr. Warington adds: "It must not be supposed that a leguminous crop necessarily leaves a soil richer in nitrogen than it was before its growth. The sensible increase in the soil takes place only when the soil at starting was not too rich in nitrogenous organic matter, and when the leguminous growth was abundant. * * * The rich kitchen garden ground at Rothamsted shows a considerable loss of nitrogen during the continuous growth of red clover. But in these cases the fact of the gain of nitrogen can probably be established if we regard the large amount of nitrogen removed in the crop, and take into consideration the serious losses of nitrogen which are always in progress in soil, and especially in a rich soil."

Some of the nitrogen in the soil comes from the ammonia and nitric acid in the air brought to the soil in rain or snow. In localities distant from large manufacturing towns this has been shown to be very small.

Some believe that plants can assimilate through their leaves the gaseous ammonia in the air, but this has not as yet been proved to be a fact, though the late Dr. Gray thought that they ought to do so, though he admitted that he had never proved that they do. Schlosing found, however, that moist soil freely exposed to the air, took up nitrogen at the rate of about 38 pounds per acre per annum in the surface, mainly in the form of ammonia. But as his experiments were conducted in Paris, the amount is entirely too high for the open country

TAKING FREE NITROGEN FROM THE AIR THROUGH PLANT GROWTH.

We have of late years learned a great deal in regard to the acquisition of nitrogen from the air by leguminous plants. All the scientists now admit that the microscopic fungous plants that form the tubercles on the roots of leguminous plants, do in some way not as yet understood fully, get the free nitrogen of the air and leave it in the soil in the shape of organic nitrogenous matter. The leguminous plant, like all other plants, can absorb nitrogen from the soil through the action of its root hairs, but it has the further advantage over other kinds of plants, that it can get, through the agency of the microbes in the tubercles on its roots, a still further and greater supply than the soil affords to other plants. The microscopic organisms may exist in the soil where there are no plants of clover or other legumes, but no experiments have shown that they can fix the free nitrogen of the air in the soil until they become attached to the roots of the leguminous plant. But, as we have said, there is no need for us, as farmers, to go into the investigation of the biological processes by which the plants do get the nitrogen of the atmosphere. Their life history has been too briefly studied as yet to demonstrate the exact process. Sufficient for the present purpose is the fact that the organic nitrogen is thus fixed in the soil and becomes available for succeeding crops.

NITRIFICATION OF ORGANIC MATTER IN SOILS.

Having located the free nitrogen of the air, through the action of the root tubercles of the leguminous plants, let us consider how this organic matter becomes food for the plants, or how any organic matter in soils is made to yield up its nitrogen to our crops. This process, by which organic matter has been so acted upon as to contribute to the growth of crops, has for many years been a subject that has engaged the attention and occupied the time of the scientific investigators all over the world. The conditions necessary to nitrification, or the formation of nitrates for the use of green plants, have been carefully investigated. The result of these investigations shows beyond doubt that nitrification in the soil is the work of a living organism, and of more than one kind of organism.

These organisms belong to that low order of vegetation just barely within the reach of the power of the modern microscope, and known by the general name of bacteria. Plants which have green matter in their tissues we have shown to have the power of getting carbon, which is essential to their structure, through the power their green matter has of decomposing the carbonic acid of the air and taking therefrom the carbon they need, while at the same time restoring oxygen to the air; and it has generally been assumed that the low orders of a fungoid character, having no green matter, were compelled to get the carbon to form their tissues from the organic matter of living or dead green plants. But one of the greatest discoveries in connection with the nitrifying organisms is the fact they are not dependent on organic mater for their carbon, but can get it from such mineral combinations as carbonate of lime; and this is one of the reasons for the importance of lime in promoting nitrification in a clay soil containing organic matter. The nitrifying organism can use organic carbon, but can also use the inorganic compounds containing carbon for its growth.

CONDITIONS ESSENTIAL TO THE FORMATION OF NITRATES IN THE SOIL.

While it is possible for the nitrifying organisms to get carbon from inorganic compounds, all investigations have shown that organic food is essential to their activity, and the work they are to do. They must also have a supply of oxygen. Nitrification will not take place in a soil saturated with water, excluding the oxygen of the air; hence the importance of drainage in a soil abounding in nitrifiable organic matter. Muck in the swamp does not nitrify, though almost entirely composed of organic matter; hence, too, the importance of tillage in promoting the aeration of a heavy, clay soil. Neither can nitrification, or the formation of nitrates in the soil, take place unless there is some base in the soil for the nitric acid to unite with. These bases are alkaline in their nature, and the process of nitrification requires a feebly alkaline condition in the soil. Not only is nitrification in muck prevented by the presence of water shutting out the oxygen of the air, but also by the acid condition caused by the humic acids present in the muck, and the absence of alkaline bases. The addition of lime to the soil furnishes this alkaline base, and nitrification will go on rapidly in the presence of an abundant supply of carbonate of lime. That is, a supply in proportion to the amount of organic matter present; for if in too great amount, the process may be checked almost permanently, as has frequently been experienced by our farmers who have used shell marl to excess on lands deficient in organic matter.

Another important condition for the rapid formation of nitrates is the best temperature. While it has been found that the process will go on at a quite low temperature, and, in fact, all winter in sections where the soil does not freeze deeply; it is far more active during the heats of summer, provided the temperature is not too high and there is plenty of moisture. It is entirely checked at a temperature of 131 degrees Fahrenheit, and in perfectly air-dry soil.

Strong light, such as direct sunshine, retards nitrification in the soil; shading the soil with any sort of cover promotes more rapid accumulation of nitrates. Hence the top dressing with manure not only makes a mulch to retain moisture in the surface soil, but also, by means of the shading, it promotes the nitrification of the organic matter in the soil, though, at the same time, there will be a check to the nitrification of that part of the manure fully exposed to the sun.

NITRIFICATION AND ITS PRODUCTS.

Nitrification, or the formation of nitrates in the soil, is the result of the power possessed by certain microscopic plants of the great class known by the general name of bacteria, to oxidize the ammonia, or organic matter, in the soil; and, through the energy thus produced, to get for their own use the carbon in combination in the soil. The result of the oxidizing influence of these plants is the production of nitric acid, carbonic acid, and water, but whether these are all the result of the activity of one form of mico-organism or not is as yet unknown. For many years some of the most accurate investigators in this country and in Europe have been engaged in the study of the organisms that transform organic nitrogen into nitrates. These investigations have proved that there is more than one kind of microbe engaged in the work. (Remember that a microbe, or bacterium, is a plant and not an animal.) One form feeds on ammonia and transforms it into nitrous acid. making nitrites, and can go no further. Another form then takes up the work of oxidation and from these nitrites forms nitric acid, and hence nitrates of the bases that may exist in the soil such as lime, magnesium or potassium. This last form has no power to attack ammonia, but must have a nitrite for its food, and the previous work of breaking down the organic matter and the release of ammonia must be done by other plants. Both of these organisms are present in enormous numbers in any cultivated soil, but most largely, of course, in those having a large amount of nitrifiable organic matter.

The work of both organisms goes on together. Nitrogen added to the soil in the form of ammonia must go through the oxidation process conducted by these minute plants, and be changed into a nitrate before our crops can use it. This shows the importance of having nitrogen present in a fertilizer in two forms. Nitrate of soda, for instance, is already in the form of a nitrate, and plants can use it at once if they are in active growth; if not used at once it soon washes from the soil. Then the supply of nitrogen must be kept up through the nitrification of organic ammonia in the form of cotton seed meal, fish scrap, castor pomace, tankage, etc., generally used in the manufacture of a complete fertilizer.

At Rothamsted, England, the nitrous organisms were found abounding in the surface soil and down to three feet from the surface in a clay soil, but the organism which makes nitrates from the nitrites is found in the surface soil only, although it may do its work in a sandy soil at a greater depth.

NITRATES ARE EASILY DRAINED FROM THE SOIL.

It was found at Rothamsted, that the drainage water from a field annually cultivated in wheat without manure, carried off 3.2 parts of nitrogen to every million parts of water, on an average, during the year. If this much is continually being carried off from a field that has been cultivated without manure for fifty years, how much greater must be the loss of nitrates from land regularly fertilized and left bare, as the cotton lands of the South have been for many generations. This loss from bare soil is one of the chief reasons for a proper rotation. In soils occupied by leguminous plants the subsoils become rich in nitrates drained downwards.

CROPS WHICH PREVENT LOSS OF NITROGEN.

"Cereal crops, whose growing period is confined to spring and early summer, are very poor conservers of soil-nitrogen." Continuous, clean culture will soon impoverish a good soil. Permanent pasture has been shown to be the best conserver of nitrogen in the soil. But all land cannot be kept thus covered, hence the importance of a rotation which will bring cover crops as often as possible on the land. The ease with which nitrates are washed out of the bare soil, and the fact that there is very little of this loss when the soil is covered with a growing crop, shows the reason why the cotton lands of the South have lost fertility, through the leaving of the land bare and fully exposed to the heavy rainfall in winter. In the South especially, there should always be shading crops of peas in summer, on all land not in cultivation with hoed crops; but the hoed crops should always be followed by crops that will keep a green growth on the land during the winter. In a climate where the soil is locked up with frost during the whole winter, there may be some advantage gained by fall plowing of a heavy soil, and letting it lie to freeze and mellow in a rough state all winter. But in the South, where there is always more rain than freezing, bare land will lose fertility faster in winter, so far as the nitrogen is concerned, than it will in the summer cropping. Fortunately we have crops especially fitted for a winter cover to follow the cotton or corn, and crops, too, that will be gathering nitrogen from the air instead of allowing it to waste.

NITROGEN FIXING CROPS AND THEIR PLACE IN A ROTATION.

We have pretty thoroughly discussed the subject of nitrification, or the change of organic ammonia into nitrates, in the soil, but we must remember that this is a different process from the acquisition of the ærial nitrogen by the microbes that live on the roots of clover, peas and other leguminous plants. These get the free nitrogen-gas of the air and leave it in the form of organic matter in the roots of the peas or clover grown on the land, and this organic matter must then go through the process of nitrification before plants can use it. This is a fortunate thing for the farmer, for if the work of the microbes on the roots of legumes was confined to only the formation of nitrates in the soil they would probably be all washed away before the next season's crop came on the land. Probably a considerable portion is thus formed and lost to the soil, for the exact process by which the microbes so transform the free nitrogen that the legumes can take it up, is one of the things of which little is known; but the larger part, perhaps, is left in the form of organic matter, which must go through the process of decay and nitrification before it can be used, and, hence, is held in the soil till the following crop has a chance to make use of it.

CHAPTER XXI.

THE BEST LEGUMINOUS PLANTS.

RED CLOVER.

For by far the greater part of the United States it is probable that the most useful nitrogen fixing crop is the red clover, and in all the great grain growing sections the development of the productiveness of the soil depends very largely on the success with which clover can be grown. There has, of late years, been a great deal of complaint all through the Northern States of the difficulty in getting a good stand of clover. We often hear farmers say that their land is "clover sick." Generally the truth is that it is sick for the lack of clover. The success of the microbes on legumes has been found to depend upon the soil being in a weakly alkaline condition. Where the soil is decidedly acid clover will not thrive. If, therefore, it is found that there is difficulty in getting a stand of clover, the soil should be tested for acidity. A piece of blue litmus paper can be had at any drug store; if this is placed in the damp soil, and is found to change to a pinkish color, it may be assumed that there is acidity in the soil, and that a dressing of lime will bring about a change. We once saw a field which had been long known as clover sick on which a dressing of lime at once cured the sickness and clover grew with great luxuriance.

THE PLACE FOR CLOVER IN A ROTATION.

This will depend on the character of the farming done, and which of the crops is the money crop of the farm. In growing wheat on a heavy wheat soil there is no doubt that, as a rule, the heaviest crops are grown on a clover sod summer fallowed after the first crop of clover has been cut for hay. Summer fallowing brings matters in the soil into an available state and results generally in a good wheat crop. But whether in the long run it is best we are very doubtful. We long ago came to the conclusion that the best average crops of wheat and corn are produced in a three year rotation where the wheat follows the corn or tobacco or potatoes, and crops are produced in place of a long summer fallow. In such a rotation the hoed crops would come on the clover sod, with all the winter accumulation of manure spread broadcast. The process of nitrification of the organic matter in the clover roots and the manure would go on rapidly through the summer in the hoed crops, and they would get part of the benefit, while there would still be enough nitrogen left to carry the wheat crop; and there would be no need on most lands for the use of any fertilizer on the wheat except a liberal dressing of phosphoric acid in the cheap form of an acid phosphate, or, on light soils, a dressing of acid phosphate and potash. In each alternate round of the rotation a light dressing of lime on the young clover, the next spring after the wheat is cut, will keep up the productiveness of the soil for the clover crop. In this rotation one of the most important matters for the improvement of the soil is for the land to go into winter with a thick mat of clover, preceding the spring when it is to be plowed for corn. No pasturing should be allowed on the lands under rotation, but a permanent pasture should be provided and kept in a productive condition by annual top dressings of fertilizers. We have noticed, recently, in one of the best wheat growing sections of Maryland, that the practice is to graze the clover to the bare ground during the summer. The result is that the heavy clay soil gets very deficient in organic matter, and while the wheat crops are good, the land runs together and bakes so badly that the corn crop is far from being what it should be. A good coat of clover leaves over the soil, especially in a mild winter climate, is very important to the maintenance of the nitrogen in the soil, and for the keeping up of a due amount of humus, or material susceptible of nitrification. If the clover is grazed to the bare ground during the summer and fall, there is less humus making material returned to the soil than should be, and there is not enough of green growth to prevent the great loss of nitrates during the winter. In a mild climate the clover may, of course, be mown twice, but all growth after the second mowing should be sacredly preserved for the good of the land.

CRIMSON CLOVER.

This annual plant has of late years attracted a great deal of attention, and there has been much diversity of opinion and experience as to its value. North of Central Pennsylvania there seems to be some reason to doubt its hardiness in certain soils, and in cold winters. But from Pennsylvania southward there are few localities in which it cannot be successfully grown. It is a plant particularly adapted to Southern conditions. All over the South, particularly in the cotton belt, the red clover has been found a very uncertain plant, as it burns out during the heat of the first summer. But the crimson clover, sown in the fall and making its growth during winter and early spring, has been found in most places of inestimable value. Its growth is made at a time when no crops are needed on the land, and it keeps up the fixing of nitrogen in the soil during all the mild winter weather, and makes a fine preparatory crop for either corn or cotton. It furnishes the cotton farmer a crop to cover his fields that would otherwise be bare all winter, for it can be sown among the standing cotton, and thus provide a fine preparatory crop for the corn that follows the next spring in a three year rotation. With crimson clover in winter and the cow pea in summer, the cotton farmers have a team of legumes that cannot be equalled in other parts of the country, and which enables them more rapidly to improve their lands than can be done anywhere else.

In the South there has grown up an impression that crimson clover succeeds best when sown on land without any preparation whatever. This has grown out of the fact that we have had uniform success in sowing the seed on a wheat or oats stubble, and it is not the absence of preparation, but the shading of the stubble that has protected the young clover from the sun. Sown among corn after the last working, and before the ground has at all crusted, will usually be successful. The same may be said of sowing among cotton at last working in August. When sown on well prepared land and fully exposed to our hot August or September sun there is frequently a loss of the entire sowing, if the seed germinates after a summer shower followed by a hot sun, which scalds off the young plants. One of the best nurse-plants is a light sowing of buckwheat. This germinates quickly and makes a shade at once. Fall oats will also answer very well in the South, and the whole can be mown together in the spring as soon as the clover is fairly in bloom. This is an important point, if the clover is intended for hay, for if the heads are allowed to mature the stiff hairs on them make the hay a dangerous food for horses. As I write this the following wise editorial comes to hand in the *American Agriculturist*:

"A few years ago seedsmen began pushing crimson clover and insisting that it could be grown almost anywhere. After careful investigation *The American Agriculturist* warned its readers, in cold climates, to avoid sowing extensively with the expectation of carrying it over the winter. We pointed out the benefit which might be derived from seeding in spring or mid-summer and plowing under as green manure. The past five years experience proves that our position was the correct one. North of the south line of Ohio this clover will soldom winter, except in some of the coast States. In the South where the soil is rich enough, it winters well and is a great nitrogen gatherer. In the North, orchardists, small fruit growers and some general farmers testify to its great value as a soil enricher, even though it must be sown anew each season. All this goes to show the wisdom of first trying new things on a small scale."

This we believe to be the true statement of the case, and we are satisfied that this clover can be made a valuable catch crop in sections where it will not usually winter, by sowing on stubble where the red clover has failed, and thus prevent the loss of a nitrogen gatherer on the land. On the Atlantic coast we have no doubt that it will succeed further north than it does in the Mississippi Valley. On the northern limit of its culture the seed should be sown early in July. From Virginia southward September is the best month for the sowing, and the place for it is either among corn, or cotton, or on the stubble where peas have been mown. Fifteen pounds of seed should be sown per acre. This year we have sown some among standing corn at last working in July, and it is yet too soon to state whether it will be a success or not. At the present writing (August 9) there is a good stand*

COW PEAS.

The greatest of all nitrogen gatherers, at least for all the country south of the Potomac, and for a good area north of that line on the Atlantic coast, is the Southern cow pea. The name pea has led to a great deal of misunderstanding among our Northern friends in regard to the nature of the plant, and we often have inquiries as to whether the Southern pea will do to sow with oats as the Canada pea is sown. The Canada pea is a true pea, but the Southern cow pea (*Vigna Catiang*) is more nearly allied to the bean, is a tender, hot weather plant, and will not grow till the soil is warm. Hence it cannot be used in connection with oats, since the oats will not thrive if sown at the time peas should be sown, and the peas will not grow if sown at the time the oats should be put in the ground. The only pea to associate with oats in spring is the Canada field pea, of which we will have more to say hereafter. The great advantage of the Southern cow pea is the ease with which the soil can be covered with a nitrogen gathering crop, after the crop of small grain has been harvested, and the immense crop of the most valuable forage, which can be mown the same season. We have often said that the Southern farmer does not need to regret the fact that red clover does not thrive on his lands, for in the cow pea he has a plant that will do all that the

*The intense heat of September killed it.

clover can do and will do it in a tithe of the time it takes clover to do it, and which will, at the same time, give him a crop of forage of unequaled value for stock of any kind.

We have been fighting the battle for the cow pea for a generation, and its value as a hay crop is being recognized in localities far North of where we formerly thought it possible to successfully grow it. This has largely been brought about by the introduction of early maturing varieties, like the Warren Extra Early, which ripens in sixty days from the sowing; and thus gives the Northern grower an opportunity to get the crop almost as well as the Southern farmer. Especially in the West has its value been recognized. The cattle feeders of Illinois and Missouri have found that there is no hay which will compare with the cow pea hay in the fattening of beeves for the export trade, and the breeders of horses in Missouri, and even in the blue grass region of Kentucky and Tennessee, have found that pea vine hay will promote the growth of colts as no other feed will. The Missouri Experiment Station has advised the farmers there to substitute the cow pea for timothy as a hay crop. Its great feeding value taken in connection with its great capacity for getting the aerial nitrogen and fixing it in the soil for the succeeding crop, places the Southern cow pea at the very head of all forage crops, for all the country south of the 40th parallel at least; and in light, warm soils considerably north of this parallel. We have had letters from farmers in Southern Michigan and Vermont who are enthusiastic in praise of the value of the Southern pea for their lands.

But the true home of the cow pea is, of course, in the South, and especially on the sandy soils of the cotton country of the Southern coast region. In this region the cow pea flourishes as it does nowhere else, and produces a hay crop which for feeding value has no equal anywhere, and which, in connection with the corn crop and a permanent pasture of Bermuda grass (which also reaches its greatest perfection in the same region) enables the cotton farmer to feed cattle and sheep more cheaply than they can be fed in any other part of the whole country; and to feed them right where the beef cattle are shipped abroad.

When once the farmers of the cotton belt realize the great advantage which the cow pea gives them for the economical feeding of stock, they will get to farming better and to growing their staple more cheaply by reason of a lesser dependence on the fertilizer mixer. The cow pea not only makes the most valuable hay, but is the greatest of all nitrogen gatherers, and will enable the cotton farmer to build up his soil more rapidly than the Northern farmer can do it with clover. With the introduction of the early ripening varieties the cultivation of the Southern pea has been extended far north of what was formerly considered its limit for profit. Several peas are now to be had which will ripen seed in 60 days from the sowing, and will, in the South, make two crops in one season on the same land; while there is hardly a section of the country where 60 days of warm weather cannot be had. These early sorts are not as heavy vine makers as the later ones, and hence will not make as heavy a crop of forage, but they will make effective collectors of the free nitrogen of the air, and can easily be made in most sections to take for a time the place of clover on a wheat stubble where it has failed. As a food plant the greatest value of the pea will be to the dairyman, in saving for him the purchase of wheat bran, while at the same time aiding him in enriching his soil. Experiments made at the Delaware Station showed that cow pea hay would easily take the place of bran in a rotation for milk. It was found that when cows were taken off of a rotation in which wheat bran was a constituent, and the same amount of protein was supplied to them in cow pea hay they did not shrink in milk or butter production, but when they were taken off from the peas and returned to the bran they at once decreased in milk flow. The importance of the fact thus demonstrated can hardly be over estimated, for even as far north as the southern part of Vermont we have the same report from dairymen, who say that they find they can no longer afford to do without the cow pea. The substitution of bran, which calls for a cash outlay on the part of the dairyman, by a crop that helps him increase the productiveness of his acres while furnishing him the food that he needs, will give an increased profit to the dairy farmer that is hard to estimate.

To those in the North who are unacquainted with the Southern cow pea, we have to say that the plant is not a true pea, as they have long been accustomed to class peas. The true pea is a very hardy plant and well suited to Northern conditions. The cow pea is more nearly allied, in relationship and appearance of seed and plant, to the bean family, and is a hot weather plant which will not endure the slightest frost. And yet, while the plant is so tender, there are some varieties which are so hardy in the seed that they will remain in the ground in the South over winter and make a volunteer crop the next summer. This fact has led some in the North to suppose that the seed can be planted earlier than is usually advised. But it will generally be found that sowing the seed before the ground is warm will result in a very imperfect stand and a poor crop. We make these statements for the benefit of the large number of people who are continually writing to know whether the Southern pea can be sown along with oats as the Canada pea is sown. A little reflection will show anyone that this cannot be done. Sown at the time oats must be sown in the spring, the greater part of the peas would rot in the ground, and sown at the time peas should be sown, the oats would make a poor showing. The varieties of the cow pea cultivated in the South are almost innumerable. Those which make a heavy growth of vine are, as a rule, too late for cultivation north of Central Virginia. But one of the best forage makers, the black seeded pea, can be grown easily as far north as Central New Jersey, and the Whippoorwill or Speckled pea, which makes a fair growth of vine, and is a large cropper of peas, has succeeded well in Southern New England, and the Warren Extra Early has ripened seed up on the shores of the Great Lakes, and in Iowa. There are indications that all the varieties gradually acclimatize themselves if taken gradually northward. Some years ago we sent several varieties of our peas to Cornell University Experiment Station, and it was found that the Black and the Clay pea ripened there from North Carolina seed, while the same varieties from seed raised in Louisiana, failed to ripen. This shows the importance of getting seed grown as far North as possible if the crop is to be grown in a northen latitude.

A few years ago we had a letter from a gentleman in Iowa, who said that he moved there from Southern Missouri, and having been accustomed to the Black Eye pea as a table vegetable he thought he would try them there. Getting a few seeds from Missouri, he planted a row in the warmest part of his garden. They grew well but only one plant ripened any, and this made but three pods. He saved these and planted them the next season in his garden and every plant ripened a full crop. This gave him about a peck of seed, and he planted two rows alongside his corn field. That Summer drought and hot winds almost ruined the corn, while the rows of peas grew with the utmost luxuriance. One of his neighbors, a cattle man, came over to condole on the great damage to the corn crop, and was shown the peas. He begged the owner to save every pea, saying that they would settle the stock business for Iowa and furnish a safeguard against drought and hot winds.

A correspondent in Central Illinois wrote that the frost caught his peas before he had a chance to cut them, but a bunch of cattle turned on the dead peas got rolling fat before snow came, and he was satisfied that they would be of inestimable value, even if none were ever cut. And yet while this plant has been grown in a desultory way in the South for generations, the cotton farmers have been slow in waking up to the value of the plant they have at hand. In many sections the farmers, recognizing the damage that was being done in the annual culture of cotton on the same land, thought to help matters by what they called "resting" the land. That is, they allowed the land to lie idle one year and grow up in weeds and grass, to be plowed under for the next year's cotton crop. Of course, even this amount of organic matter returned to the land, and the summer shading of the soil, was a great help. But the natural growth was merely organic matter, and the weeds and grass had not the power the legumes have to gather the nitrogen from the air, and thus increase the fertility of the soil, while adding a valuable food crop for the keeping of cattle, which was impossible under the resting method.

Now, by degrees, the Southern farmers are finding out that the best rest which can be given to their land is to keep it busy, growing crops that will tend to build up its fertility, while at the same time enabling them to feed more stock and to raise more and better manure. And this is done, too, by a cleansing crop, instead of the rest crop of weeds and grass, which filled the soil with seed for future brow sweatings. The old time cotton farmers thought that farm rotation was a good thing for the North and the grain growing districts, but that cotton was the one crop which could not be fitted into an improving rotation; and to this day the same impression prevails among many of the tobacco growers of the South. While the fact is, that no crops so easily lend themselves to a regular and systematic rotation, whereby stock may be fed and the farmer made gradually more and more independent of the fertilizer mixer.

There has been a great deal of inquiry in regard to the quantity of seed of the cow pea that should be sown per acre. The quantity will depend on the fertility of the soil and the purpose for which the crop is to be applied. On strong land, where the crop is intended to be cut and cured into hay, if thin sowing is practiced the stems will grow too large and stout to cure well. Hence, for a hay crop, on strong land, the peas should be sown at the rate of one and a half bushels per acre if sown broadcast. If on thin land, and the crop is intended to be used as a means for soil improvement, they had better be sown in rows and cultivated and fertilized. In this case three pecks will be abundant seeding. On soil of only fair fertility and where the crop is to be used for hay, one bushel sown broadcast will be sufficient. There is a growing tendency among the most thoughtful farmers to plant the crop in rows and cultivate it, as many are satisfied that they can get a better crop either of peas or forage in this way, and one intelligent farmer in Virginia says that after years of experimenting he gets the best results from one peck per acre, drilled in rows and cultivated like corn. Since the seed is generally high priced it is important that none shall be wasted, and it will be wise for farmers to experiment on their own soils to test this point. While the cow pea can be used in the renovation of worn soils more easily than red clover, because of the fact that it will thrive on land where clover will not, still its growth can be greatly enhanced and the work it will do for us greatly increased by the judicious application of phosphoric acid and potash, and thus we can get more forage to feed while getting more fertility added to the soil. The experiments we have described at the Tennessee Station show how fully the protein needed in a ration for fattening beeves can be supplied by the cow pea for little more than half the cost of cotton seed meal, and better beef produced. From the products of his farm, then, and from crops that improve his land, the Southern farmer can make money in feeding beef cattle easier than the farmer of the North and West, and there will be no permanent improvement in the Southern farming until there is more of this stock feeding and less of spending money for nitrogenous fertilizers we do not need to buy if we farm aright. If one half of the millions of dollars the cotton States of the Atlantic seaboard spend every year for fertilizers containing nitrogen for the cotton crop, was spent on phosphoric acid and potash, and applied to the pea crop preceding the cotton crop, there would soon be a vast improvement in the cotton crop, half the money would be saved, and in a short time more than half could be saved by the feeding of the abundant forage produced. One intelligent observer has said that the difference between the Carolinas and Texas was in the stock feeding. Texas, with her empire of fresh soil, grows more cotton than any other State, and yet Texas raises three beeves for every bale of cotton she grows; while the Carolinas raise one animal for every three bales of cotton produced. Until, by the proper use of the great forage plant with which the South is blessed, the proportion is put in the same shape it is in Texas, there will be no permanent improvement in the soils of the Carolinas.

VETCHES.

Vicia sativa and some others of the same genus have become very generally naturalized in the South, and grow freely every winter in all vacant spots, and at times among grass and other herbage. These are rather light croppers, however. More recently attention has been directed to another of the species of this genus, *vicia villosa,* the hairy or sand vetch. This plant has been found to succeed under very diverse conditions, from the far North to Gulf States. Its rapid growth and its hardiness in a great range of climatic conditions renders that at present the most promising winter growing legume we have, and it will probably take the place we had hoped the crimson clover would take all over the country. While the value of the hairy vetch is not as yet fully decided, it is certainly the most promising plant for its place we have yet tried, and we trust that future trials will confirm this good opinion. If allowed to ripen seed, this plant will seed the land and reproduce the crop the following fall. But being a winter growing plant, it can never become a troublesome weed.

BURR CLOVER.

Another legume which has been attracting a good deal of attention of late in the South is the burr clover, *medicago denticulata,* a sort of annual alfalfa. This, like the vetch, seeds the ground and "volunteers" year after year. It is a winter growing plant and not a very heavy forage maker, but in the South will furnish stock a green bite at almost any time during the winter.

THE SOY BEAN.

This plant is a native of Southeastern Asia. Botanically it is called *glycine hispida,* and has gotten the incorrect name of soja bean. It is an important article of food in Asia, particularly in Japan, where there are as many varieties in cultivation as we have of cow peas in the South. Though the plant was introduced into England in the eighteenth century little interest was excited in it, and it was not till very recently that experiments have been made in this country and in Europe, which have demonstrated its value as a soil improver and a forage plant. The soy is an erect growing plant, growing in good soil to the height of five feet, and bearing a profuse crop of hairy pods. The different varieties are distinguished by the color of the seeds and the time it takes for the crop to mature. For a northern latitude and a short season, the Early White is perhaps the best, but it makes little forage and drops its leaves very early. Medium Early Green is about the best for hay making purposes, and there are later varieties which are valuable in the South. Like all other legumes the soy thrives best on a soil well supplied with phosphoric acid, potash and lime, and while it gives a heavier crop on strong soils, it will thrive on land too poor to make a crop of clover. In fact, the plant thrives on a great variety of soils. One of the most valuable features of the soy is its ability to withstand droughts that would kill corn. The upright habit of the plant makes it easier to handle in harvesting. The seed of the soy may be sown broadcast, but the best crops are usually grown where the beans are drilled in rows, like ordinary beans, and well cultivated. The Massachusetts Station found that while the soy, like other legumes, needs potash, it does best when it is supplied in the form of a muriate. When sown in drills, half a bushel of seed will suffice for one acre of land; when sown broadcast twice as much, or more, will be needed. When sown for hay the ordinary wheat drill will put them in about right, and the hay will be more easily cured when the plants are grown thickly. The crop should be cut for hay as soon as the pods are mature, but not dry and hard. Unlike the cow pea, the hard round seed of the soy admits of the crop being threshed for the seed with an ordinary machine, which would split most of the cow peas. A crop of two tons or more of hay can be made on land in fair state of fertility, and if the season is very dry the soy will make a heavier crop than the cow pea, but in our experience the hay has not as great feeding value as that from the cow pea, and there is far more waste of woody stems, etc.

We are inclined to believe that the soy bean is particularly well adapted to the making of silage, and that the mixing of it with corn silage will be found to be the most economical and profitable mode of using the crop. Another use that can be made of the soy is to feed it down by hogs on the land where it grows. If fed off by sheep and hogs, the plant will make a very rapid improvement of the soil, and it may be that under some conditions this may be the best use that can be made of either the soy or the cow pea. At the Storrs Station, in Connecticut, the analysis of the soy places it far ahead of the cow pea in manurial value, but the analysis is open to the objection that the soy there attained maturity, while the cow pea was not at its best. In the South, the fertilizing constituents in the two would not be far apart, and the weight of crop would usually be in favor of the peas. In the North it can be used as a green manure crop if accompanied with a dressing of lime. But, as a rule, green manuring is poor practice anywhere, and is ruinous to the soil in the South.

THE VELVET BEAN.

In general appearance this plant closely resembles the ranker growing varieties of the cow pea, but the blooms differ and the pods are very different from those of the cow peas, being shorter and thickly covered with velvety hairs, from which the plant gets its name. It is a member of the same great order as the cow pea, and, like it, can get nitrogen through the agency of its root tubercles. There is no plant of its class which makes an equal amount of growth to the velvet bean; and it will furnish more organic matter to the soil than any other plant in the same climate. But it is unfortunately a plant that requires a very long season for maturing, and can never attain the importance of the cow pea north of the Gulf coast. It will, in a favorable season, mature its seed as far north as Central-Eastern North Carolina, but to do this there it must be planted in April, and will then mature about the first of October. This long season precludes its use after small grain and among corn as the cow pea is used, and it will never compete with the cow pea north of Florida.

At the Alabama Station crops of oats were sown, after turning under velvet bean vines and velvet bean stubble, cow pea vines and cow pea stubble, and also after the natural growth of crab grass and weeds were turned under. Where the vines were turned under, the yield of oats was 28.6 bushels per acre and 1206 pounds of straw. Where only the stubble was plowed under, the yield was 38.7 bushels per acre and 1672 pounds of straw. Similar results were obtained from the plowing under of the cow peas. The average crop of oats after the velvet beans was 33.6 bushels per acre, and after the cow peas 31.6 bushels, while on the land where only the natural growth was plowed under, the crop was 7.1 bushels per acre. This is one of the most striking evidences of the value of the legumes that we have seen. We would call attention to the increase in the crop from the plowing under of the stubble rather than the whole plant. Not only was the crop of hay sacrificed, but the crop of oats was much smaller where the entire crop was buried. Another commentary on the folly of green manuring as commonly practiced. The turning under of a mass of vegetation in the fall renders it impossible to get the soil into the best condition for the winter grain, and no matter whether it be oats or wheat the result will always be better when the crop is saved as forage and only the stubble turned. The amount of nitrogen the velvet bean can get in a favorable climate is well shown in the Alabama bulletin. A field of velvet beans was grown on very poor land, with 240 pounds of acid phosphate and 48 pounds of muriate of potash per acre. The yield of green forage was 19,040 pounds per acre. The weight of the hay after five days curing was 8,240 pounds per acre. Samples were taken for analysis, and it was found that the hay and the roots stubble left in the ground there were 201.2 pounds of nitrogen per acre. This was equal to that contained in 2,800 pounds of cotton seed meal. "As the soil was very poor, the greater part of this nitrogen must have been obtained from the air. The yield of hay on this field was unusually large, but even if half this amount be taken as an average yield, we must have still a most impressive lesson as to the value of leguminous plants for storing up nirtogenous fertilizing material for the enrichment of the soil." It is evident, then, that it would be a waste for any farmer to buy nitrogenous fertilizer after the growing of such a crop. While the velvet bean will not mature seed with any certainty north of the Gulf States, I am decidedly of the opinion that as far north as Southeast Virginia the plant can be grown profitably for the reclamation of run down lands, but for hay purposes it cannot compete with the cow pea anywhere north of Florida.

THE PEANUT.

The peanut, while grown mainly as a commercial crop, is, nevertheless, one of the legumes; which, if it were properly used, would rank with the soil improvers and nitrogen collectors. We were shown, but a few days since, a plant of the common Virginia peanut, which had more nitrogen nodules on its roots than any we have ever seen. The whole of the roots of the plant were completely covered with these nodules. As commonly used the soil gets little of the benefit of this nitrogen collecting in the peanut crop, since the whole plant, roots and all, is removed from the soil. By a rational system of stock feeding on the peanut farms, and a good rotaion of crops, there is no doubt that the crop could be made to aid the farmer in the building up of his soil, instead of its depreciation. At any rate, it is evident that the peanut, like all other legumes, is able to get its own supply of nitrogen from the air. Nitrogen, as is well known, is the most expensive element when purchased in a commercial fertilizer, and the farmer whose money crop is one of the nitrogen collectors has a great advantage over those who have to get their nitrogen from plants that give a smaller cash return at the time being. If the peanut was grown as we grow cow peas and clover, and returned to the soil through feeding to animals, or by plowing the growth into the soil, it would be one of the best soil improvers; while, as it used, it is the means for reducing the fertility of the land on which it is grown. The chief source of the peanut crop of the United States is the crop grown in Virginia, North Carolina and Tennessee. Much of the soil in these States is admirably adapted to the successful growth of the crop, and for many years the crop was a very profitable one, but of late years there has been a combination of conditions which have made it far less profitable than formerly. The same causes which have brought unproductiveness to other crops of the South, the constant cultivation of the crop on the same land, the utter absence of a rational rotation of crops, and the complete removal of the plant, roots and top, from the soil, with a lack of attention of the proper fertilization, together with the commercial conditions which have placed the growers at the mercy of a combination, or trust, have all combined to make the crop unprofitable to the average farmer. Where crops of even 100 bushels per acre were formerly made the present average is put by competent authority, at 20 bushels per acre. The same causes which have made the average cotton crop in the older cotton States less than one-half what it would be with good farming, have reduced the average of the peanut growers. The tables of analyses of the peanut products, which we give in the Appendix to this volume, will show the great value of the crop, and the great drain it makes on the soil, by the present system, or rather lack of system, in its culture. The food value of the peanut is shown to be high, since the kernels have an average of 29 per cent. of protein, 49 per cent. of fat, and 14 per cent. of carbohydrates, which shows that they rank higher than most other concentrated foods like soy beans, cotton seed, etc. The tables show that the vines have a higher feeding value than timothy hay, while the hulls are far better feed than cotton seed hulls, which are so largely used for feed in the South. Peanut meal, or the ground product after the oil is extracted, is one of the most concentrated foods, ranking with cotton seed meal, linseed meal, etc., and commonly ahead of any of them. The kernels have a manurial value equal to that of cotton seed, and the vines are nearly as valuable for manure as those of the cow pea. And yet, like all legumes, the peanut draws heavily on the mineral constituents of the soil; and while getting the nitrogen in abundance from the air this is mainly lost to the soil through the mode of handling the crop. Then, too, the crop is saved at a late period of the year, and the clean, cultivated ground is left bare during the rainy winters of the South, and the nitrates that have formed are rapidly leached away.

VARIETIES OF THE PEANUT.

The most widely known and popular variety is the running variety known as the Virginia. This is the peanut generally sold for eating by the roasters. There is a bunch variety of the same grown in Virginia, the pods of which are very similar to the running sort. A white nut, similar to the Virginia, is grown in Tennessee, and also an early bunch red variety. The African variety grown about Wilmington, N. C., is smaller but heavier, and makes more oil than the White Virginia nut. The Spanish variety is also largely grown in North Carolina and elsewhere in the South. It grows upright and makes its nuts close to the root, and from being planted close can make a heavier crop per acre. This variety, growing its nuts all in a cluster near the base of the plant, is more easily harvested than any other. On a warm, light soil it is probable that the peanut will thrive where Indian corn can be grown, though the climatic conditions in the South Atlantic States are more favorable than northward and westward. It is essential that the soil be light and mellow, and of a light color to prevent the darkening of the hulls. Lime is an essential to the success of the peanut, and a regular rotation in which the application of lime is comparatively frequent is best for the crop. Land near the coast that has had heavy applications of shell marl is particularly well adapted to the peanut. Besides the application of lime on soils where there is not naturally a supply, the chief needs of the peanut crop are phosphoric acid and potash. The common practice, in some sections, has been to give heavy applications of lime, but it is evident that with a good three year rotation of peanuts, corn and winter oats, a moderate liming once in three years will be all sufficient. The growth of some winter growing legume, like the crimson clover or hairy vetch, will have a good effect in restoring the humus, which most of the peanut lands are very deficient in. With a corn crop following the peanut crop after the soil has had, during the winter, the growth of some kind of green matter, even if only rye, and all the home-made accumulation of manure is used on the corn crop, and cow peas are sown among the corn at last working, a good crop of oats can be harvested the following season, and the stubble planted at once in peas, to be cut for hay to feed the stock. Give the pea stubble a coat of lime and let it lie till time to prepare for the peanut crop. Then, with a liberal dressing of acid phosphate and kainit in equal parts, there is no doubt that heavy crops can be grown. Many of the peanut growers have a most unreasoning prejudice against the cow pea, because, we suppose, of some injudicious use of the pea as green manure in the past. But properly used, there is no reason whatever that the cow pea should not be as useful a help to the peanut grower as to the farmer in other crops. With such a rotation, and plenty of stock to eat the forage grown, there is no doubt that the peanut crop could be restored to its old time production, and be the means, like other legumes, of building up, instead of diminishing, the productiveness of the land. Various formulas have been proposed for fertilizers for the peanut crop, all of which give some form of nitrogen, such as cotton seed meal or dried blood. These may be useful in the present state of peanut culture, but with the rotation proposed there will be no need for the purchase of nitrogen for the crop. In some parts of the peanut section it may be desirable to lengthen the rotation and introduce cotton between the cow peas and the peanuts, and to use the cotton stubble for the peanuts. But whatever the rotation, let it be duly considered and adhered to, and attention given to the improvement of the soil as the best means for the improvement of the crop.

ALFALFA.

One of the most valuable of all the legumes, where it succeeds, is alfalfa, or lucerne, as it is sometimes called. Botanically the plant is *Medicago Sativa.* This plant differs from most of the legumes we have mentioned in the fact that it is a true perennial, and remains productive year after year for an indefinite period. Alfalfa seems to be peculiarly adapted to the arid regions of the West, and it has been suggested that its success there is largely due to the fact that the lime has not been washed out of the soils, as it is found that the plant uses lime freely, and will hardly succeed in the Eastern States without the application of lime. Another reason is the fact that the plant sends its roots down several feet in the soil, and can endure drought better than a shallow rooted plant. Experiments in the culture of alfalfa in the Eastern States have, as a rule, not been successful, but in some instances there has been great success. It seems evident that a soil underlaid with a compact clay subsoil is a poor place for alfalfa, since it cannot strike its long roots downward. Where there is a permeable subsoil, and the land has a sufficient amount of fertility, there is no doubt that good crops of alfalfa can be grown in the eastern part of the country. Mr. J. E. Wing, of Ohio, recently told me that he had found that the chief difficulty in getting a good start with it is the fact that in the first season's growth the plant is rather feeble, and the weeds are apt to crowd it to death; but that if, as the plants start and the weeds start, the mower is run over it, the plant takes on new life and energy, and success follows. He thinks it will inevitably fail if not mown off the first summer. Then, if in the fall a dressing of lime is applied, we are of the opinion that in any ordinarily fertile soil alfalfa may be made to succeed. But it is not a plant suited to use in a short and improving rotation, and should be allotted a place where it can remain permanently. The Colorado Station places the manurial value of the stubble of alfalfa, after the crop is cut, taking this to include six inches below the surface, to be $19.28 per acre. From the heavy stooling nature of the plant the stubble is heavier than in other legumes, and the Colorado estimate is based on the assumption that there will be 2.86 tons per acre of this organic matter. Rather a large estimate, it appears to us, but perhaps not too large for Colorado. Bulletin No. 35 of the Colorado Experiment Station is a very exhaustive treatise on the alfalfa plant, and can be referred to by those interested. After failing with the plant all our life we will try again with Mr. Wing's suggestion about the summer mowing, and hope to be able to have a patch of alfalfa.

We take the following from the Report of the Kansas Board of Agriculture for 1900. In regard to experience with alfalfa on thin, sandy soil the report quotes from the letter of Mr. Patch as follows: "Our soil is sandy, jack pine land, and badly run out of nitrogen and humus. I sowed two and a half acres to alfalfa, securing an even stand, which at first looked very promising. After a slow growth, it seemed to come almost to a standstill, with a sickly, yellow appearance. Before seeding, a strip of perhaps half an acre, was given a liberal dressing of lime. When winter set in, the plants had reached an average height of six inches, while on the unlimed portion they should scarcely average more than two inches. I searched in vain for tubercles on the roots. When Prof. King saw the field he offered to send some earth from the alfalfa field at the Experiment Station. It wintered with a slight covering of snow, enduring on two nights a temperature of 48 degrees below zero. When the earth arrived from Madison, I sowed some of it broadcast, and some I trailed in straight lines across the field, and some in contact with the roots of selected plants. In about two weeks the plants in places adjacent to the places of inoculation began to take on a healthy, green color and more vigorous growth. Digging about the plants I soon found tubercles. Some reached 18 inches in height by July, when it was cut. Our soil is evidently unfitted for the profitable growth of alfalfa, containing almost no lime, and too much iron." The report adds that "This is a condition of soil which is seldom found in Kansas, where the springs, wells and creeks are almost universally supplied with 'hard' water. It is possible that the failure of the bacteria to spread on the unlimed soil was due to an acid in the soil which needed to be neutralized by an alkali such as lime." We should have said that the experiments of Mr. Patch were made in Wisconsin, though quoted in the Kansas report. It shows what we have before said, that the great reason for the failure of alfalfa eastward has been the lack of lime more than anything else, and the failure to keep it mown the first season to keep down the weed-growth, and to invigorate the alfalfa. It seems probable, then, that as we learn the needs of the plant, that alfalfa will be made a success in the East to a far greater extent than it has been. The report states that alfalfa has been successfully sown in Kansas every month from March to September. When the ground is not weedy, spring seeding has been successful, but the preference seems to be for fall seeding. Alfalfa seed should always be fresh, and old seed is a common cause of failure. The advice is to use about 20 pounds of seed per acre, but as low as 8 to 10 pounds have been used with success. The mower should be run over the young alfalfa two or three times the first summer to keep down the weeds; if a good stand is there the second season it will be able to take care of the weeds. Alfalfa should be handled in hay making pretty much as clover hay is made, and should always be gotten in without rain and stored under cover, for no hay is more easily ruined by rain.

CHAPTER XXII.

SOME MINOR CROPS.

OATS.

The oat crop is seldom the money crop of the farm. Still it has a great value in the agriculture of all parts of the country, because of its value as a food crop for the farm teams and as a part of a well devised rotation. The oat is a plant better adapted to the conditions of a cool climate than a warm one, and hence the effort to grow oats in the South in the same manner as they are grown in the North generally results in failure, while observance of the needs of the plant would make the crop a success in the South as well as in the North. In all sections south of Washington, the oat crop should be a fall sown crop. It thus makes its growth during the cool season of the year and matures before the summer heat gets excessive, while spring sown oats in the South are checked in their growth by warm weather and fail to develop properly, making a light and chaffy grain. Long culture in this way, and "the survival of the fittest" have developed varieties of a more hardy nature, and better able to withstand the winter cold than the varieties commonly sown in spring in the North. Such is the hardiness of these varieties that many Northern farmers have of late years found that the Southern winter oats are better for their early sowing in the spring. Some time since a reader of one of the leading agricultural papers asked the editor for information in regard to winter oats. He replied that there were no such things as winter oats, and that the so-called winter oats were simply the common oats sown in the South in the fall. If that editor were to come into the Upper South and sow in the fall the same oats that the Northern farmers are sowing in the spring, he would soon find that there is some difference, for his Northern spring oats would be destroyed by a freeze that would not check the Southern varieties. Some years ago a friend of ours in Southern Virginia came to the same conclusion, and in the fall, instead of sowing the usual Virginia winter turf oats, he sowed some oats that he had bought from the

North to sell for feed in his store. The result was that the oats came up and looked beautiful in the fall and were killed before Christmas, while the Virginia oats all around him were as green as ever. Of late years there has been some inquiry in regard to winter oats in the North, and farmers there have been inclined to try them. In some winters when snow is abundant and the weather not too severe, they might survive, but the chances are that fall sown oats will not succeed where the mercury goes below zero in winter. Even in the South they are apt to be injured by severe weather if sown too late to get properly tillered and strong before the setting in of cold. Hence, while wheat in the South should never be sown till after frost, the oats crop should always go in the ground in September, if possible, for the best results. Sown at this time the crop is a reasonably certain one anywhere south of Washington City, and all over the South is far better than the spring sown crop.

In many sections the oats crop comes in as a part of the rotation of crops preparatory to the sowing of wheat. In many parts of the North the sowing of wheat after corn is not satisfactory, as it cannot be done early enough for the best success there. Hence the common practice is to sow the oats on the corn stubble in the spring, and to fallow the stubble after harvest, as a preparation for the wheat crop in the fall. While this fallow makes a good preparation for the wheat it might be a great improvement in the warmer part of the Middle States to sow cow peas after the oats, with a heavy application of acid phosphate and potash, cut them for hay in September and then at once disc the ground fine for the wheat crop. This will give a fine hay crop and at the same time put the land into better condition for a wheat crop than if the peas were not sown.

Then, too, there may be an improvement on the practice of putting the oats on the corn land in the spring. It is now generally acknowledged that the nitrates leach rapidly out of bare soil during the winter, but that if there is a cover of green vegetation in winter, the loss is slight, if any. Now, in leaving the corn stubble for the oats in the spring, the land is subjected to this loss of nitrates which might be held there in green cover plants. Hence, where the spring oat crop follows the corn, it would be far better to sow crimson clover among the corn at the last working, so that it will make for cover crop in winter, and a good crop for plowing under in the spring for the oats. The analysis of the oat plant shows that nitrogen plays an important part in its growth, more than it does in the wheat plant or other small grains. The clover, then, will have the further advantage of furnishing nitrifiable organic matter for the oats. During the brief period in which the spring oat crop holds the land this organic matter will become well advanced and ready to feed the crop following. Then when the oats are cut the land is sown in cow peas, and a good application of acid phosphate and potash will cause a fine growth of the peas, which can be mown for hay in September or October and the land at once well disced (but not replowed), for the wheat. Managed in this way we get two leguminous crops on the land between the corn and the wheat, and get a lot of excellent forage that we would not get if the oats stubble was merely summer fallowed.

The old plan of letting land lie out in sod year after year is fast giving way to the short rotation and the keeping of the land always at work, growing something either for feed or soil improvement. The old long rotation, so common once in Southeastern Pennsylvania, necessitated the division of the farm into a multitude of little fields, and made the keeping up of fences a serious item in the expenses of the farm, for fences are needed wherever long pasturage is practiced. But with the coming in of the short rotation and a standing permanent pasture, the capacity of the farm for the feeding of stock is immensely increased. It has taken our farmers a long time to learn that pasturage belongs to sections of wider area and cheap land, that where farms are small and land costly a different method must be practiced, and the greater value of the products will warrant a more intensive agriculture. This has led, of late years, to the giving of more attention to

SOILING CROPS.

While the places where an exclusive practice of soiling are limited to the high priced acres in the immediate vicinity of the larger cities, where dairying for milk can be profitably carried on and the product retailed, there is still much importance to the general farmer in the production of some soiling crops, and the practice, at times, of feeding cattle cut food green. There are always times in nearly every summer when the pasture is too short and dry to keep up the flow of milk, or even to keep cows in fairly good condition. If purchased food must be used to supplement the pasture it makes a costly addition to the expense account. Therefore it is to the interest of everyone who keeps cows (and of course that means all farmers) to provide from his own acres a balanced ration for his animals. The amount of food that can be gotten in a green state from a small area of highly enriched land would be a revelation to those who have never tried it. While soiling is adapted to every part of the country it is nevertheless true that the longer season in the Southern States gives the farmer there a wider range of crops for this purpose and a longer time for green feeding. While we do not believe in what is commonly termed "green manuring," or the plowing under of immature crops for manure, we are in hearty sympathy with the manuring through the feeding of green crops. We know of no way in which the manurial resources of the farm can be so rapidly enlarged as through the growing, during the summer, of a succession of crops for cutting and feeding. Not only the milch cows, but every animal that is kept on the farm can be greatly helped in summer by green cut food. We once saw a striking example of this in a village of North Carolina. The leading merchant of the place, who kept a number of horses and mules for hauling, and also cows for family use, had an acre lot adjoining his barn, which he assured me kept six horses and mules supplied with food from June till frost. The land was sown in clover in September, and that was cut in the spring for green feed and hay. Half the land was then manured and planted in corn, a few rows at a time. As fast as one planting appeared a few more rows were planted till the whole half acre was in corn. While this was coming on the second growth of clover on the other part was being cut and fed. When the first planted corn had tasseled and silked it was cut and fed and the rows at once replanted with corn, and so on in succession, the last rows being planted again in August. In September this part was manured and sown to clover, and the following spring after the clover was cut, the other half was taken for corn and treated as before. By constant manuring and the plowing of a clover sod, this acre of land made a product that was simply enormous, and furnished an amount of feed that one who had never seen anything of the kind could hardly realize as possible. We feel sure that even in this case the substitution of the cow pea for the second growth of clover would have given still greater results, for the green pea vines, in connection with the green corn, would have made a completely balanced ration, and would have been especially adapted to the needs of dairy animals. There are still other crops that can be used in a similar way, such as sorghum, which can be cut continuously, and reproduces from the sprouts, without replanting during the whole season. There is hardly a farm on which something of the sort could not be practiced with a small piece of land near the barn kept well supplied with manure, and the products of which would not only furnish the manure it needs, but would make a surplus for use elsewhere. In the South, the cow pea alone, following a crop of annual clover cut in early spring, could be made to keep up a succession of food from June till frost; for if not allowed to exhaust itself by blooming and seed making, the pea will give a succession of cuttings of green feed during the whole season. Even when pastured we have had the cow pea eaten down three times in one season. When pastures are parched and brown, the man who has had foresight to provide green food for cutting will be in a far better situation than the one who has not provided for this emergency, and he will be raising manure to help release him from the grasp of the fertilizer mixer; the most important matter of all to the Southern farmer. In the first starting of such a lot it may be necessary, in some places, from lack of fertility, to use a liberal supply of commercial fertilizer. In some sections crimson clover has failed from two causes, first lack of plant food in the soil, and, secondly, the absence of the nitrifying microbes in the soil. It has frequently been found that this clover fails the first season it is sown and succeeds on the same land the next season, simply because in the meantime the soil has become infected with the needed microbes. But while clover of any kind does not, on a fairly fertile soil, need any application of nitrogen, it nevertheless is greatly helped on a poor soil by an application of stable manure. In one section we have visited the farmers uniformly failed to get a good growth of this clover on their sandy soil. One fall a man in the adjoining town who had a livery stable, hauled out a good quantity of manure on one of his lots near the town, and sowed the land in crimson clover. The growth on that land was simply enormous, and revealed to the farmers around the reason for their lack of success. The same season of this success a farmer hauled out his manure from stall fed cattle and spread it down between his cotton rows after he had completed the cultivation of the crop, and then sowed crimson clover seed among the cotton, and had a great success. So where the annual clover is to make the starting point for a soiling crop it will not be amiss if the manure is at hand to help it in that way, and then to further supplement the manure with a good dressing of acid phosphate and potash, mixed in proportion of five parts of acid phosphate to one part of muriate of potash. Two hundred pounds of this per acre on land that has had a light dressing of manure will insure a remarkable cutting of clover. Soiling crops in summer, followed by the silage in winter will form the key to successful stock feeding and dairying in many sections of the country. Some place a great value on green rye as a soiling crop, because of its earliness. But rye is poor food for any animal and makes very poor and ill-flavored milk. The newly introduced hairy vetch will well take the place of rye in any section. It will give as early a growth, and a food material incalculably better than the rye, and it can be well used as the starting point of the season's soiling and be followed by cow peas and corn.

CROPS FOR HOGS TO GATHER.

Near akin to the soiling practice is the one becoming common in some sections, of planting certain small lots near at hand with crops that the pigs can gather for themselves. This, too, is a practice for which the long seasons in the South furnish especial advantage. While rooting their food from the soil is not conducive to rapid fattening, it nevertheless keeps the pigs in a thrifty condition during the early summer till there are cow peas for them to gather and peanuts to glean, and renders their keep very cheap till the time when they are fattened for slaughter, with corn. The Jerusalem artichoke is a favorite food with some, and on land of a sandy character, where the hogs can get them all out, they may have some advantages, being very hardy and furnishing food and exercise at a season when there is nothing else. But on a heavy clay soil, which would be seriously damaged by their rooting at the season when the tubers are available, and from which they could hardly glean the whole, the artichoke may become an intolerable weed, as we know full well. But in sandy soils they may well be used till clover comes in, and later on the ripening cow peas will be the place for the pigs. Sweet potatoes are sometimes fed to pigs in the South in this way, but in these days of quick transportation this crop has too great a value as a market crop to make the feeding profitable, except in the more remote neighborhoods. In more northern sections we would assume that the Canada field pea would be a valuable hog feeding crop till clover comes on. Where red clover flourishes, a special piece should be provided for the pigs so that they can live "like pigs in clover."

FORAGE PLANTS NOT LEGUMINOUS.

MILLETS.

While the millets belong rather to the botanical genus Panicum, the name has been applied to a number of plants of different genera. While most of the millets cultivated in this country belong to the Panicum genus, others belong to Setaria, or, as they now-a-days want us to call them, in the rage for changing botanical names, Chaetochloa. Only those who spend their whole time and energy in the upsetting of our old botanical nomenclature can give any reason for the change. The farmer can, however, continue to know these by the name of the Foxtail millets.

Millets are not a crop that will be profitable to take into a regular rotation, but there are times when they can be used as a catch crop, to fill out a gap in the forage supply, though in our opinion such conditions will be rare; for at the time the millets should be sown the cow pea can as well be used for the catch crop, and the resulting forage will be immensely superior to that of any millet grown. Millets require the richest of soil to make a good crop, while the pea will thrive on soil of moderate fertility, and help the soil while it makes forage. Millet hay is at best a poor hay. It is also a dangerous hay for horses if the seeds are allowed to mature in the heads. If you have some low lying land which is very fertile and which cannot be worked early, and is not suitable for leguminous crops, you may grow millet with some profit. The finest crops we ever saw were on the dyked marshes along the Delaware River near Wilmington, Del. It is only on such lands that we would grow these non-leguminous forage plants. On land that would require fertilization to grow a good crop of millet it would be better to let the millet alone and grow something better adapted to the soil and capable of making better feed. The main fertilizer requirement of the millets is nitrogen, which, as we have seen, is the most costly of the ingredients in a fertilizer, and which the legumes can get for themselves.

TEOSINTE.

This is a plant closely allied to our Indian corn, but which requires a longer season to mature seed than it can get in the larger part of the United States. It is said to mature seed in Southern Florida, but even for this we cannot vouch. As a soiling crop teosinte will give a large yield of green stuff, about as valuable for feeding as immature corn stalks, and so far as we have observed, not so good in feeding quality as the corn because of its immaturity. Those who look at bulk rather than quality will usually be pleased with teosinte. It can be cut several times during the summer on rich and moist land, and like the millets, should be grown on no other. Being of the same carbonaceous character as Indian corn and never reaching the mature quality of corn we cannot see any place in our agriculture for the plant; for on the same land Indian corn will give fully as much, if not more of real dry matter. It would be hard to find a plant of any kind that can approach our Indian corn for our purposes as a forage plant, to supply the carbonaceous elements of the ration. Corn is the king of this class of plants for the American climate, and can never be surpassed here in its special field. Other forage plants to have special value must be protein plants, like the legumes, and be supplementary to the corn plant. Any plant that simply takes the place of corn is certain to fail in the United States, at least east of the Mississippi.

KAFFIR CORN.

This is one of the non-saccharine sorghums, which has attained considerable importance west of the Missouri as a forage and grain producing plant. It withstands drought better than Indian corn, as all the sorghum family do, and gives quite a large crop of grain, which has value. It has attracted more attention in Kansas than anywhere else. As we have seen it grown here it does not anywhere near compare in growth and weight of crop with Indian corn or saccharine sorghum on the same land. It is probable that it is better adapted to the fertile soils and droughty climate of Kansas than to the east. Here we can grow far more and better feed from Indian corn on the same land.

SORGHUM.

Considerable attention has been given of late to the saccharine varieties of sorghum as forage plants. Treated solely as a forage plant and sown thickly, broadcast, there is no doubt that sorghum will make a very passable hay, but a hay very hard to cure. Some farmers of our acquaintance tried sowing sorghum along with their cow peas, with the notion that it would make the peas easier to cure. It had the opposite effect, for peas are easily cured without sorghum but very hard to cure with it. Sorghum is mainly valuable as a soiling crop, to tide cattle over a summer drought. As a forage crop it is of the same class and less valuable than Indian corn, the king of American fodder plants. While sorghum and Kaffir corn will stand drought very well, they both succeed best and make their best crops on low, moist land, with plenty of fertility. Both are exhaustive crops and neither of them yield a hay that can compare in value with that from the legumes, which are beneficial to the soil. In the present state of our agriculture, especially in the older States, we cannot see the advisability of growing these non-leguminous forage plants when we can do so much better with the legumes, both in the quality of the forage and the value of the plants to the soil. In certain sections of the South, like some parts of Texas, where the soil has exuberant fertility and the climate is droughty, the Kaffir corn and sorghum may have a special value; but in our thin uplands in other parts of the country, we consider it unwise for the farmer to waste fertility in growing forage inferior to that which he can produce while helping in the improvement of his soil. The same may be said of the grasses in a large part of the South. There are rich, low lands where grasses can be profitably grown, but though we may seem heterodox, we are fully convinced that the South, so far as the uplands are concerned, does not need the grasses as she does legumes; and until these uplands are built up in fertility it is a mistake to waste time in the effort to grow the grasses for meadow purposes. With a standing pasture of Bermuda and a good rotation with the legumes on our uplands, we can develop the productive capacity of our soils faster and maintain their fertility better without grass than with it.

CHAPTER XXIII.

COMMERCIAL FERTILIZERS AND THE MARKET GARDEN.

Forty years or more ago, it was assumed that the cultivation of market garden crops must be confined to the immediate vicinity of the cities requiring the supply, because it was thought that abundant supplies of stable manure were a first essential to the successful culture of garden crops. At that time, too, the rapid transportation from distant points was not established, hence all of our cities were dependent on the gardens of the immediate vicinity for their supply of vegetables, and from them supplies were sent to the smaller towns in their vicinity. But with the introduction of Peruvian guano, growers on the warm and sandy soils of New Jersey, outside of what had been the market garden region proper, began to produce certain easily grown and easily transported crops; but the market gardeners proper, with their few acres of high priced land, assumed that while peas and such things might be thus grown on cheap lands, they still would have the monopoly of the bulky cabbages, beets and other things for which they considered a supply of stable manure essential. For many years these market gardeners refused to take advantage of the commercial fertilizers, and adhered to their old time heavy applications of stable manure, believing that no real success could be had with the majority of vegetables without it. Even when the culture of early vegetables had extended to Norfolk, in the South, and was assuming an important position in the trade, such was the force of old habits that the first of the Norfolk gardeners spent large amounts in the freighting of stable manure, not only from their own city but from the North.

But gradually the fact became evident that in the easily transported commercial fertilizers was the true source of profit for those at a distance from their market, and that the easy solubility of the complete fertilizer mixture was a great advantage in the forcing of early crops. They also realized the fact that after their early crops were off, they could cover their land with the cow pea, and thus furnish it with all the organic matter that made stable manure valuable. With all the extension of rapid communication between the far South and the Northern cities, the great trade in early vegetables and small fruits could never have grown up but for the commercial fertilizers.

Farmers who have been accustomed to the scattering of a hundred or two pounds per acre of commercial fertilizers, find it hard to realize the lavishness with which the wide-awake market gardener uses these forms of plant food. Now, even the market gardeners near the large cities have found out that they, too, can more cheaply fertilize their acres with the chemical manures and legumes, than by the hauling of so much stable manure, and a very considerable part of the commercial fertilizers used nowadays is used by gardeners, who do not hesitate to use them by the thousand pounds per acre instead of the hundred of the farmer.

While the wise gardener will always stock his land with organic matter by the use of legumes, and will feed the same and make use of the manure thus made, he knows that he cannot, like the general farmer, depend on these alone as a source of nitrogen for his crops. There must be no lack of immediately available plant food to urge on the early and rapid growth of his crops, for upon their earliness and succulency depend the price he will get for them, and he cannot afford to take the slower means that may be all sufficient for the grower of wheat, corn or cotton. His crop has a higher value per acre, and he can afford to use the fertilizers in a manner that would be a lavish waste to the grain farmer. The great extension southward of the culture of garden crops for a time caused the growers near the large cities much uneasiness. When they saw their markets filled with Southern crops at a season when they were but just planting, they came to the conclusion that their occupation was gone. But time has proved that each section has now its own season in the markets, and that when the nearby gardeners bring in their fresh supplies the distant man must draw out; so that now, from the islands of the West Indies and Florida all the way to Canada, the great cities draw supplies continuously without break, and the seasons for certain vegetables and fruits run throughout the year. This great and continuous supply has been brought about, not only by rapid transportation, but more largely through the general use of commercial fertilizers.

COMPLETE FERTILIZERS ESSENTIAL TO THE PRODUCTION OF GARDEN CROPS.

While, as we have shown, the grain farmer can, through the use of legumes, avoid the purchase of an ounce of nitrogen, the market gardener must use fertilizers rich in all the elements of plant food. This is especially true of such crops as cabbages, cauliflower and other things of which the foliage above ground forms the important part, for we have seen that an abundant and readily available supply of nitrogen is essential to great leaf development. Then, too, with many of the crops of the market garden, potash is a very important element, and some liberal addition of this must be made, even in soils, which for the ordinary purposes of the farmer, are sufficiently supplied with this form of plant food. The size and starchiness of the potato depends rather on the presence of an abundant supply of potash than on the amount of nitrogen present, while many of the foliage crops, like lettuce, require liberal supplies of the same.

On the other hand the cabbage crop, while needing a plentiful supply of nitrogen, is especially benefited by a large application of phosphoric acid rather than of potash especially.

HOME MIXING ESSENTIAL TO THE MARKET GARDENER.

Owing to the varied manurial requirements of his crops, and the abundant supply which he must have, the home mixing of fertilizers is of far more importance to the market gardener than to the general farmer, though valuable to both. To insure success in the growing of vegetables, gardeners must understand the requirements of their crops as to the proportions of the various plant foods they need, and this proportioning can best be done by the gardener himself from the purchase of the various materials best adapted to his purposes. All the large truck farmers of the South Atlantic coast mix their own fertilizers, many of them using such large quantities that they have erected houses and machinery for the purpose. In the following chapters I will give my experience in the treatment of the crops usually grown by market gardeners, and their fertilizer requirements, North and South, since in this respect there will be some variation with latitude and climate.

CHAPTER XXIV.

ASPARAGUS.

There is no crop commonly grown by market gardeners which has been more uniformly profitable than the asparagus crop. This is largely due to the fact that a considerable expenditure must be made and some time elapse before a profitable crop can be had; hence the temporary men, who rush in from time to time with their inferior crops of the annual vegetables, and out again when they find such unprofitable, seldom attempt the asparagus crop. The market value of the crop depends so much on the thoroughness of the preparation of the soil, its suitability to the crop, and the skillful treatment and handling of it, that unskilled men are soon driven out; while the producers of a really fine article always find it a profitable crop, North and South. Its value, when grown especially early, is such that heavy transportation rates can easily be paid; while the price when those rates become prohibitive, is still sufficient to make its culture a profitable one near the points of consumption in the North.

GROWING THE PLANTS.

Asparagus plants are one of the supplies that every market gardener should produce for himself. Of course, they are offered at low prices all over the country, but really good plants are hard to get. Then, too, unless the packing is unusually well done, there is no plant more easily damaged by long shipment than asparagus roots. Cold and dryness will not hurt them, but too great a bulk and too much moisture will cause them to heat in the package and become worthless. Many years ago I bought from a nurseryman 30,000 roots of Conover's Colossal asparagus at the time when they were selling at $10 per thousand. They were transported but 50 miles, and were packed in one large crockery hogshead and one tierce, and had evidently been forced down with a screw press. They arrived during my absence, and my foreman received and planted them. On my return he told me that the roots were hot when unpacked and many of them moldy. Had I been at home they would not have been received. Out of the whole 30,000 not fifty plants grew, and I have never bought asparagus roots since. Some advise the planting of two-year-old roots as an advantage of a year's growth, but I have never found that there was any advantage in these unless they had been singled out and transplanted at one year's growth. Most asparagus plants offered for sale have been grown entirely too much crowded, the object being to get as many plants as possible per acre. The grower who produces his own plants can avoid this. One of the most important points in the production of good asparagus plants is to grow them in the richest and best prepared soil. Plants grown thinly in such soil, are far better at one year than the majority of the plants sold are at two years. The books will tell you that it takes three years to produce salable asparagus, and under ordinary conditions it does. On one occasion I prepared and heavily fertilized a piece of land already very fertile, for the production of plants for setting the following fall. They made a magnificent growth, and the season was very favorable. After planting what we needed there were about 50,000 plants left, and I proposed to sell these, and did sell a large number. To my surprise, when the plants began to shoot, the following spring, I found that in these nursery rows I had large and marketable asparagus, and did market quite a quantity but one season from the seed, and the transplanted roots gave me a very fair crop a year after setting. The abundance of plant food in the soil counts for more than age with the asparagus plant, and abundant feeding more than any special variety. There is one advantage to the grower in keeping his plants in the nursery rows till two years old; this is that he can then find and reject all the pistillate, or seed bearing plants, and it is a great advantage to have none of these in the plantation, since seed production is an exhaustive process to the plant and the crop will be larger if the female plants are taken out. This is another reason for the grower producing his own plants.

For the production of the plants I prepare a rich and rather moist piece of land, but by no means an undrained soil. If stable manure is abundant fill the land with well rotted manure, and add to it a good percentage of kainit or muriate of potash, for the development of strong roots depends on a full supply of potash in the soil in a soluble form. Sow the seed in shallow furrows and cover about two inches. Keep them as clean as an onion bed during the whole summer. The plants should stand about three inches apart to make fair roots, and if they come up too thickly, thin them when the size of a large darning needle and transplant them at good distances. These little plants transplant easily, and often make the finest of roots. In the South, the young roots can be transplanted as soon as the tops have ripened, but there is no particular advantage in fall planting except that we are apt to be less pressed by work at that time. The best time for making the permanent plantation, North or South, is as early in the spring as the land can be worked.

PREPARING FOR THE PERMANENT PLANTATION.

While the early spring is the best planting time, the preparation of the soil should be done beforehand. The best soil for the asparagus crop is a mellow, sandy loam. A deep, sandy soil will grow good asparagus, but will require more constant and heavier manuring on account of its leachy character; hence, while a sandy soil is earlier and better than a clay soil, it should be underlaid by a rather retentive subsoil for the best results, but it is important that it be thoroughly and naturally well drained. Land that has been heavily manured annually, and cultivated in garden crops, is in better condition for asparagus than a fresh soil, and it will be an advantage that it has grown a crop of peas or clover the year before. These should be plowed under in the fall, and the subsoil plow run in every furrow, so that the land is completely broken 15 to 18 inches deep. If stable manure is plentiful it can be used liberally in this preparation. Then sow on the land a winter cover crop of rye to prevent the leaching of the nitrogen, and plow this under before planting in the spring.

In planting run out furrows five feet apart, clean out as well as possible with the plow and then with the shovel until you have trenches ten inches deep, set the plants two feet apart in the rows and cover not more than two inches at first, tramping the earth to the roots. As the shoots begin to appear work the soil to them, always keeping the young, spindling shoot above the soil, till perfectly level. At each working in of the soil, also once before the cultivation begins and as soon as the planting is complete, apply 500 pounds per acre of the following mixture, until a ton per acre has been applied and the land is level: Acid phosphate, 900 pounds; pulverized fish scrap, 600 pounds; nitrate of soda, 100 pounds; muriate of potash, 400 pounds. Keep the plantation perfectly clean of grass and weeds during the entire season, and finally plow the soil in a ridge over the rows in the late fall, after the dead tops have been removed. The above mixture should be an annual application as growth begins in the early spring. With well grown plants, set in this way, some cutting may be made the second season, but should not be kept up late; the rows should be kept well hilled up in the fall, and the cutting made in the earth as soon as the shoots crack the surface. In some markets there is now a tendency to wish green asparagus; to produce this the roots should be planted nearer the surface, and the cutting made when the shoot is long enough above the ground. For our own use we always grow the green asparagus, as we do not care for the tough, white article. To grow this we transplant the young plants as advised in the thinning, and place them at once in their permanent quarters. Being nearer the surface, this asparagus starts earlier in the spring, and to our taste is far superior to that grown under ground. But the market gardener must cater to the requirements of his market, and so long as people want white shoots he must grow them.

CHAPTER XXV.

BEANS IN THE MARKET GARDEN.

Beans to the Southern trucker always means "snaps," or string beans; since these are about the only beans that it pays him to grow for Northern shipment. Snaps are one of the crops the profit in which depends on their earliness, and though a legume, it will always pay the market gardener to use some nitrogen in his fertilizer for the crop, since they are quickly grown and are off before the best of the nitrogen gathering begins. To the Southern market gardener the crop of snaps means a crop of hay, for as soon as the beans are shipped he turns the plants under, harrows the land smoothly and simply waits for his hay crop to grow. This is the ubiquitous crab grass, which at once covers every vacant spot in the Southern market garden in summer, and makes an excellent hay crop to follow some early crop. Hence it is better to give the bean land a fairly liberal dressing, as the hay crop will be all the better for what the beans do not use. It will be all the better not to use the common Southern method of putting the fertilizers in the furrow alone, but to sow it broadcast. For the bean crop, to be followed by crab grass hay, we would use 500 pounds per acre of the following mixture. The same mixture is equally good in the North, and the celery can follow the beans with additional fertilization: Acid phosphate, 1,400 pounds; cotton seed meal, 400 pounds; muriate of potash, 200 pounds, to make ton of 2,000 pounds.

LIMA BEANS.

These are a more important crop in the North than the South. The Large White lima bean so popular in the North, is a very poor cropper in the South, and hence the butter bean (or Seewee, the small lima) is generally used, and the early ripening form of this, the Henderson Bush lima is most generally used of late years. Lima beans differ from most other legumes in the fact that they are greatly benefited by liberal applications of nitrogenous fertilizers, and if well manured they can be kept on the same land profitably year after year.

For the production of the bush lima beans we have found that a liberal application of a complete fertilizer mixture is best, and the same mixture will be found equally well adapted to the large lima where it is grown. The great advantage to the market gardener in the little bush lima is its earliness, which enables gardeners in the far North to get lima beans where the large lima may be too late. It is very common to read that the large lima is of superior quality to the Sewee. Possibly it may be in the North, but here we greatly prefer the small lima, and we have had them cooked side by side. In the South the small lima is certainly the better bean, as well as far more productive. Of the larger class, the Potato lima, now known as Dreer's lima, is far more productive in the South than the Large White lima, but not as good quality as the Sewee. Five hundred pounds per acre of the following mixture will be sufficient for the lima beans on a fairly fertile loam: Acid phosphate, 1,000 pounds; cotton seed meal, 700 pounds; nitrate of soda, 100 pounds; muriate of potash, 200 pounds, to make a ton of 2,000 pounds.

FORCING SNAP BEANS.

The snap beans make a useful plant for growing on the side benches of the tomato house, and repeated crops can be produced during the winter. For this purpose we always plant the beans in six inch pots and fruit them in the same pots. We use our ordinary potting compost made rather light with sand. Two plants are allowed to stand in each pot, and the first planting is done about the time the tomato plants are taken in from outside. For this forcing crop we do not use the varieties commonly grown by market gardeners in the open ground, but varieties which have been used for forcing for generations. The earliest forcing bean is the one with pea green seeds, known as the Pride of the Frames, an English variety used there for frame culture in spring, and which could be grown here in the same way in early spring, whenever there is a vacancy in the frames, before it is safe to put the seeds in the open ground. This variety is an exceedingly dwarf and early sort. Planted at the same time with the old Yellow Six Weeks bean, we had in the same house beans fit to gather from this sort when the Yellow Six Weeks was fairly in bloom. Forced beans are tied in bunches, like asparagus, and sold by the bunch. They need only careful attention to the heat of the house, which should never go below 60 degrees at night, and a moderate supply of water. As fast as the crop is gathered refill the pots with fresh soil and replant, so as to keep up a constant succession during the season. Bailey, in the Forcing Book, recommends an English variety of bean called Sion House, but we have never tried this sort, and cannot say from experience in what way it may excel the variety above given. The bunches of beans to which we have referred should each contain fifty pods, as that is the regulation size. A crop of beans can well be taken from the benches of the cucumber house while the vines are growing and thus get something from space not in use. The proper temperature for the beans is about the same as for tomatoes, 60 to 65 degrees at night, and 15 or more degrees higher in sunlight. One good picking is about all that can profitably be expected from forced beans. They like a good bottom heat, hence the side benches over the heating pipes and near the glass is the place for them.

CHAPTER XXVI.

CABBAGES.

North and South, early and late, there is no crop of greater importance to the market gardener than the cabbage crop. From their bulky nature it was for years assumed that the cabbage crop was the one which the local gardeners would always have control of. But rapid and cheap transportation long ago settled this, and today the early cabbage crop is the leading crop of the gardeners of the South in the spring, as the late crop is in the North and in the mountain country of the South. The method of producing the early cabbage crop in the South is different from that pursued in the North. All the way from Baltimore southward, on the Atlantic coast, the plants for the early cabbage crop are set in November, on the south side of sharp ridges, formed by the plow, three feet apart. In the North, the plants are produced from seed sown about the same time as in the South, but when the Southern gardener is setting his plants in the field, the Northern gardener is setting his in cold frames to be protected by a sash during the winter, setting them so thickly that an ordinary 3x6 foot hotbed sash will cover 1,000 plants. The disaster that sometimes comes to the Southern gardener in the spring indicates that it would be wise for him to carry some over in this way, to cure losses that sometimes occur in the field.

There is no crop, if we except cauliflower, that requires richer soil or heavier fertilization than the early cabbage crop. The preparation should, as with many other crops, begin the summer before setting. After some early crop is off sow the land in cow peas. Cut these for hay, and at once prepare the land by applying, after plowing, a ton per acre of the following mixture: Acid phosphate, 900 pounds; fish scrap or tankage, 800 pounds; nitrate of soda, 100 pounds, and muriate of potash, 200 pounds. Mix all these but the nitrate of soda for fall application, and reserve that to be applied in the early spring, as active growth begins. In the North, where the plants are wintered over in frames, the whole ton can be applied at once, and in that case a winter cover of rye should be sown after the peas or other legume have been mown for hay, to be plowed under in the early spring. One thing which our gardeners have now learned from experience is that success with the cabbage crop depends on the pedigree of the seed sown, and on its being grown in the American climate. Seed produced in the moist climate of England will not head with any certainty in our sunny climate. There has been a great deal of talk of late years in regard to a Government seed control and the testing of all seeds sold. The only test of any value, however, is the test that all of our great seed houses now practice; testing them in the open ground under the same conditions with which the purchaser has to contend. A laboratory test of seeds tells only the percentage of them which will germinate, and gives no information in regard to the seed stock from which they came. In fact, it cannot even tell what variety they belong to. All gardeners know that the more we improve the character of our plants and develop their valuable qualities as table vegetables, and remove them from their natural wild condition, the lower will be germinating power. The wild plant, which is the survival of the strongest in the contest with other plants, has thrown all its strength into the production of strong seed for the perpetuation of its species, while the improved plant is not selected for its seed making power altogether, but for the production of characters valuable to mankind, and hence loses a great deal of the seed making vigor of the wild plant. So well is this fact known to skilled gardeners the man who understands the value of pedigree in a seed will prefer seeds of known origin with a low germinative power to those which are shown to have a far higher germination percentage but are of uncertain descent. This is particularly the case with our seed of early cabbages. While the imported seed may show in the laboratory a higher percentage of germination, the wise gardener will take the American grown seed even if it shows but half the germination. Good germinative power is, of course, important to the grower, but good stock is the thing that gives the most valuable crop.

The variety of cabbage used for the earliest crop in this country by our market gardeners North and South is the Early Wakefield, sometimes called the Early Jersey Wakefield from the fact that in New Jersey the American strain was first developed from the English Wakefield cabbage. The enterprise of our seedsmen has caused several strains to be developed from the original Jersey Wakefield, which for a long time was not a well fixed type, and now nearly every one of the leading seed houses has its particular strain of Wakefield cabbage, any of which are great improvements on the original. In the South, a particular strain is know as the Charleston Wakefield. It is similar to the regular Early Wakefield, but is larger in size of head and a little later than the type form. In the early days of the Early Jersey Wakefield cabbage the conical form of head, which is regarded as the type, was very where the production of late cabbages is a troublesome and uncertain matter. Winter cabbages, coming in on land that has been heavily manured for some early crop, will not need as heavy manuring as the early crop; still, it is important that there should be no lack of plant food. We have found that half the quantity advised for the early crop will answer the needs of the fall crop, provided they are urged along by two or three dressings of nitrate of soda at the rate of 50 pounds per acre at each dressing. In the North, the seed for the late crop should be sown in March or April, in a fairly fertile soil, and the plants grown to a good size before setting in June and July. There is, in some parts of the country, an old notion among farmers that the cabbages should not be worked during the dog days, and the consequence is that we often see a lot of weedy, and starved cabbages that get so stunted that they head prematurely and never make fine cabbages. Clean, rapid culture is as essential to good cabbages as to any other crop, and the man who watches the moon or the dog star, will never get the crop his more intelligent neighbors do. Cabbage plants from the very start should never be allowed to get stunted in any way.

LATE CABBAGES IN THE SOUTH.

In the States south of Virginia, the great difficulty in all the lower country has always been so great in getting good winter cabbages, that the people have finally settled down to the notion that none but the loose, open-headed collard is available to them. While it is true that a well blanched collard is not a bad winter vegetable, there is no reason why, with proper care, good, hard-headed cabbages may not be grown in the South. The chief reason for the general failure has arisen, we believe, from the fact that Southern gardeners have generally followed too closely Northern methods for the production of the plants, and have sown the seed too early to be carried through the long hot summers of the South. The drought of summer saps the vitality of the plants, and they succumb before the time they should be set for heading. Anywhere on the Atlantic seaboard south of Virginia late cabbage seed should never be sown till the first of August. Usually we have abundant rains in August, but the important point in the production of the plants is that they shall never lack for moisture. Hence the seed should be sown in soil naturally moist and very fertile, or there should be some arrangement for supplying them with artificial irrigation. The object is to get large and strong, short-stemmed plants by the first of September, which is early enough to set the plants. Hence the seed should be sown rather thinly, or the plants transplanted in beds when very small, to give them more room to develop. The soil for the late crop must not be a dry and thirsty one, largely mixed with plants that made round heads, and which were later. This mixture was a great annoyance to the gardener, as it caused the crop to hold the ground too long, and gave him fewer of the earliest ones which bring the best price. The selection of late years has been to separate the two types so that the round headed ones come in as summer, or succession, cabbages, following up the early ones in a uniform type. There are other extra early cabbages of similar type to the Wakefield, with small heads and earlier even than the Wakefield. The best of these which we have tested is the Extra Early Pilot.

SUCCESSION, OR SUMMER, CABBAGES.

While the first early cabbages should always be sown in the fall, whether they are to be wintered over in frames or set on ridges, we have found that the succession crop to follow these is always best sown either in boxes in the greenhouse or in hot beds in January, and hardened off in cold frames. Sown in the fall they are far more apt to disappoint the grower by running to seed in the spring than are the extra early sorts. The best method we have used with this class of cabbages is to sow the seed in the greenhouse in flats in January. As soon as the plants are large enough to handle, even before they have made anything but the seed leaves, we prepare other flats about three inches deep, by putting an inch of well rotted manure in the bottom, and then filling with good potting compost. The plants are transplanted into these about one and a half inches apart, and are kept in a cool greenhouse till they get started in the soil. We then place the flats in the cold frames, and protect them for a while with mats over the glass on cold nights, and later on give all the air practicable. They grow off rapidly and are ready to go into the field as early as the ground can be gotten into good condition. In the colder sections of the country, this plan is the best for the extra early crop as well, since the plants can be had of good size as early as it will be practicable to set them, and it is a great deal less trouble than wintering them over in cold frames. For a succession cabbage we use what is known as Summer cabbage, Succession, Improved Brunswick and Maule's Midsummer. Maule's Deep Head is a fine improvement on our old favorite, Fottler's Brunswick, and we are not sure but that it will take the first place as a succession cabbage for summer use.

LATE CABBAGES.

The late cabbage crop for winter use is a very important one in the northern parts of the country and in the elevated mountain sections of the South, where the late cabbage crop has of late years become an important matter commercially, as a crop for shipping to the coast country of the South, for all through the growth of the crop a plentiful supply of moisture is essential to success. With a moist and fertile soil and clean and rapid culture, it is easy, in the South to get fine cabbages to head about Christmas, and we never have any weather to stop the growth of the crop much before this date. Headed earlier they will not make large heads and will not keep in winter. Late sowing, rich, moist soil and clean culture will make good cabbages in the South, but for early fall cabbages the Southern coast cities will still have to depend on the North and the mountain country of the South. In the fertilization of the cabbage crop, early or late, the important factors are nitrogen and phosphoric acid. Potash is of far less importance than these, though a fair percentage is needed.

There are a great many varieties of winter cabbages offered by seedsmen under special names, but they all belong to the two classes of Drumhead or Flat Dutch, except the Savoys, which form a peculiar class to themselves. Of course the Southern, or Georgia collard, is a distinct species. It is the survival of the fittest in the South, as it can take care of itself and grow under conditions that would be destructive to the heading cabbages. No Southern garden seems complete without the collard, for it is always ready to come in and fill a possible failure of the cabbage. Then, too, as we have said. it is by no means a mean vegetable when properly frosted and blanched in winter, and in many country districts of the South they have so long been accustomed to the absence of headed cabbages in winter that they assume that the collard is better. We began some years ago to make the effort to develop a good heading strain of the collard, and after a while we hope to be successful and to get a collard that will head as hard and as certainly as the cabbage, of which it is merely a variety. One of the newest winter cabbages is the Danish Ball Headed, which, under favorable conditions, makes the most solid head of any cabbage with which we are acquainted. Whether it will be suitable to Southern conditions or not we are as yet unable to say. Our main dependence for many years past has been the Prize Flat Dutch, of which every seedsman offers his own particular strain. Of the Drumhead class the Prize Short Stemmed Drumhead, and the Stonemason are both excellent, and those who have grown Maule's Surehead claim that it is unsurpassed. Of the Savoys the Drumhead Savoy has always done best for us. The early Savoys are very uncertain in the South in our experience.

CHAPTER XXVII.

CAULIFLOWER.

Of all the crops grown by the market gardener the cauliflower is the one that calls for the highest skill and the heaviest fertilization. Good cauliflower can only be grown in the richest of soils, and the effort to produce it on a thin, dry soil, even with the heaviest application of fertilizers, will usually result in failure. Gorged with food, on a moist and retentive soil, and well cultivated, it will reward the grower either North or South. The only difference is that the Southern grower must be content with the early crop, while the Northern grower can produce the fall crop which the Southern man will uniformly fail to get, owing to the difficulty in carrying the plants through the hot weather. While on a suitable rich clay loam the gardener in the North can produce a good crop of cauliflowers with commercial fertilizers alone, if applied with a lavish hand, it is always better, where practicable, to have a fair supply of stable manure in addition, as a means for making more moisture in the soil and to supply the humus so valuable far this purpose. Twenty tons of stable manure plowed under for some early crop will make a good preparation for the cauliflower fall crop. For the direct preparation for the cauliflowers a ton or more per acre of the fertilizer mixture advised for early cabbages, should be well harrowed in before setting the plants, and after they start, several dressings of 50 to 100 pounds per acre of nitrate of soda will not be lost in the crop. The main point is to never allow them to get the slightest check in their growth, for the result of such a check will be the production of small buttons instead of heads.

EARLY CAULIFLOWERS IN THE SOUTH.

In the far South the plants can be treated in the same way we do the early cabbages, by setting them in the fall, but north of Lower Georgia it is better to grow the crop in frames along with winter lettuce. These frames may be covered with cotton cloth or glass, the glass being far better both for the lettuce and the cauliflowers. Our method of growing the winter crop is as follows, and we have been peculiarly successful in getting perfect crops of fine and solid heads. We sow the seed about the last week in September, in a very rich bed, and as soon as the plants are strong we set them in the frames, putting six plants to each three by six feet sash. The remaining space is then filled with Tennis Ball or Boston Market lettuce, which will come off late in December or early January. By that time the cauliflowers will begin to need all the room. We air them at all times when the weather is at or above the freezing point, slipping sashes entirely off in sunny weather, and covering only at night or when freezing threatens. By the middle of February the cauliflowers are crowding against the glass, and are finally hardened off and the glass removed to other frames to protect the tomato plants, early beets, etc., as the cauliflowers from that time on need no protection. If the plants have not been allowed to get any check from lack of moisture or lack of food during the winter, the crop will come off in April, at a time when they usually command a fair price. The crop is not so profitable as it once was, owing to the quantities that come from the far South, where they grow out side all winter, but it is still a fairly paying crop. The fall crop, as we have said, belongs to the Northern gardener, and when well grown is uniformly a profitable crop. An abundance of food and plenty of moisture in the soil to dissolve it, together with the best of culture, are the requisites for a good crop of cauliflower if the seed stock is all right. In localities where cotton seed meal cannot be readily had we would replace it in the fertilizer advised for cabbages and cauliflowers, with an equivalent percentage of nitrogen, in the form of dried blood or tankage, and would increase the amount of the acid phosphate to correspond. Where the acid phosphate is more costly than dissolved bone black or slag meal we would use either of these as a source for phosphoric acid, especially for the fall planted crop.

CAULIFLOWER SEED AND VARIETIES.

Cauliflower seed is little grown in this country, as our climate makes it an extremely uncertain crop, at least on the Atlantic coast. Nearly all the seed used in this country comes from Denmark. Of late years, however, some growers in the far northwest, on Puget Sound, Washington, have been producing a fine article. We have tried the Puget Sound seed and seed obtained direct from Denmark, and the result of a single experiment was that the Puget Sound seed was the better, since the plants grown from every one made a head, though some were set in ridges in the fall like cabbages and some were grown in frames. The winter, fortunately, was a mild one, and the plants set outside were just as good as those set in frames, but a little later. The seed lists give a number of varieties, but there is only one strain that we have found worthy of attention in this country. This is the selection from the Dwarf Erfurt, known as Snowball. This does so uniformly well that we can see no reason for needing any other, especially for the South. Some of the later sorts may do well in the North. but for the South, the only cauliflower is the Snowball.

CHAPTER XXVIII.

CORN.

The cultivation of garden corn (or sugar corn) is far more commonly practiced in the Northern States than in the South. There are two reasons for this. In the first place, little attention has been paid to the breeding of a sweet corn suited to the Southern climate, and the sweet corn from the North, like any corn brought far from its origin, generally fails to make a satisfactory crop. In the second place, the white field corn grown in the South is a far sweeter article than the Northern field corn, and the people failing to get good corn from the Northern sweet corn seed, have generally fallen back on their home field sorts, usually planting for an early crop the early corn grown in the high mountain regions of the South. Northern sweet corn lacks stamina for enduring the Southern climate, and succumbs to heat and drought. Stowell's Evergreen and the Mammoth Sugar are about the only sorts that are moderately successful south of Virginia. A number of years ago we undertook to breed up a sweet corn that would meet our Southern conditions. In order to get more robustness of stalk, and stamina, we started with a cross of the Leaming, a Western field corn of yellow color, on the Mammoth Sugar, a wrinkled white corn. We selected the yellow field corn so that the cross could be identified by the color, and because the corn selected was an earlier variety than the Mammoth Sugar. After seven years of selection of the yellow wrinkled grains, we finally got a variety well fixed in type and of fine quality, which would give us ears for the table by the middle of June. Being then compelled to move our plantation to a locality where we could no longer keep it free from other pollen, we made a wide distribution of the seed to farmers in all parts of the State and abandoned the effort further. Whether any of those to whom this corn was sent will preserve it in its purity or not we fear is doubtful. But we established the fact that by care and selection a sweet corn well suited to Southern conditions can be produced. The culture of sweet corn does not differ in any respect from that of field corn, and it is not necessary here to go into further detail in regard to its culture.

But it does require higher cultivation and heavier fertilization than the field crop of grain. It is a more valuable crop, and will better repay the heavy manuring than the common field corn, on which, at usual prices I have often said that I could never make an application of a complete fertilizer pay. Corn of all kinds needs nitrogen and potash as the most important constituents of a fertilizer mixture, and sweet corn needs richer soil and heavier fertilizing than the field crop; and as it is commonly grown for table purposes it will pay to be liberal in the matter of manuring. It is just as fond of humus in the soil as the common corn is, and is at home on a turned sod of clover, or grass, or a pea stubble, as other corn is. As a fertilizer mixture for sweet corn on good truck land I would suggest the following: Acid phosphate, or bone black superphosphate, 900 pounds; cotton seed meal, or fish scrap, 600 pounds; nitrate of soda, 100 pounds; muriate of potash, 400 pounds. On a good corn soil it will pay to use 500 pounds of this per acre, where the corn is grown for seed purposes or for selling green.

VARIETIES.

These are numerous. The very early sorts are seldom of much value anywhere, and are only of use in small gardens. The earliest good sweet corn is the Crosby, while in small gardens the Cory and First of All may be useful in the North. The Black Mexican is a dark purplish grain corn, and very sweet. For the market garden, however, the standards are Maule's XX Sugar, Stowell's Evergreen and the Mammoth Sugar. The last two named will do very well in the South if the seed is selected there for a few years. Country Gentleman has also proven valuable in the South, and from it a very fine Southern sweet corn might be selected. But so long as the Southern people depend on buying sweet corn raised in the North they will never get a good corn for their climate.

CHAPTER XXIX.

CELERY.

In no vegetable cultivated for the market has there been a greater advance in the methods used than in the celery crop. Formerly it was grown almost exclusively as a second crop in the smaller market gardens in the immediate vicinity of the larger cities, and it was assumed that this was a crop that would always be grown in this way. But the great development of the culture of early summer and autumn celery, in the peaty swamp lands at Kalamazoo, Michigan, first demonstrated the fact that the celery crop, too, could be shipped from a distance. As the conditions for its growth became better understood, it was found that for the late winter and early spring crop Florida and California had special advantages, and now the celery crop is kept in constant supply in all the cities from early summer till spring again, the supply being almost continuous throughout the year. People in the South have found out that it is useless for them to endeavor to grow the early celery, and those in the far North have also found that they cannot store and compete with the South and the Pacific coast in the late winter and spring celery; each section, therefore, has its turn at the market, and the crop is usually a profitable one when well grown.

The introduction of the self blanching varieties, while adding nothing to the real table value of the crop, has improved the appearance of the plants as table decorations, and has led to a new system of culture for the self blanching sorts, by crowding them into beds thickly and avoiding the earthing process, which is essential to the production of the best and really crisp and palatable article. But as celery is very largely used for its decorative effect, these white but tough sorts have their place.

While at Kalamazoo and other far northern points, celery may be blanched by hilling in summer, in by far the larger part of the eastern section of the country this cannot be done, owing to the heat of late summer and early fall. The crop that interests most of our readers, North and South, is that which comes in with the roast turkey and cranberry sauce, and lasts through the greater part of the winter.

METHODS OF CULTURE.

There are two general methods of cultivating celery. The first is that described by the late Peter Henderson, in his "Gardening for Profit." The publication of this book was the first intimation to many that the old practice of digging a deep trench in which to set the celery was no longer the practice of the men who had to make profit out of the crop. In getting the plants Mr. Henderson advised to sow the seeds in rows on a well prepared bed nine inches apart, then to tramp the rows with the foot, and cover half an inch by drawing the back of the rake lightly over the bed. This is to be done early in April in the latitude of New York. In our experience we have not succeeded well with this plan. We have made the following modification. We sow about the last of April on a well fined bed of light and rich soil. Lines are drawn about ten inches apart across the bed, and not over quarter of an inch deep. We then sow the seed thinly in these marks, and beat down the surface of the bed with the back of the spade. Then at once we cover the whole bed with a layer of gunny cloth, such as grain sacks are made of. This prevents the drying of the surface, and the seed germinates much more readily. As soon as they are seen sprouting, the cloth is raised off them and suspended on stakes so as to still shade the bed somewhat, and as the plants advance in growth and form their green leaves the cover is entirely removed. This sowing can best be done in an unused cold frame, after the sashes are stored away, as the cloth can easily be stretched over the bed. Having the plants in such a frame there is the further advantage that we can give them the varying shade of a lath screen during the hot weather. As soon as the plants are large enough to handle they are lifted and transplanted in the frame at about two inches apart each way, and the tap roots are shortened. We then make screens of building laths, tacked on a frame the size of the ordinary hotbed sash, about one inch apart, and place these over the bed. This gives an ever varying shade and sunshine, and prevents the rapid drying out of the soil after watering. Constant and regular watering is essential to success with the plants, and as they grow it is well to clip the tops at intervals, so as to make the plants stout and strong for their final transplanting. In the North, this will be for the fall and winter crop, from the middle of June to the end of July, and from Virginia southward, from the middle of August to the last of September. The first week in September is usually early enough in most Southern sections. In the far South, where success can be had in getting the seed started in August, good plants can be had for late planting to supply the demand for spring celery. But of late years, the Kalamazoo growers have made a specialty of growing late plants for Southern shipment, and, as a rule, it is safer for the Florida grower to buy his plants than to attempt to grow them in hot weather. The Northern plan, as detailed by Mr. Henderson, is to set the plants on land that has been heavily manured for some early crop, as a fresh addition of manure to the celery may do more harm than good. The plants are set on well prepared land in rows three feet apart and six inches apart in the rows, and the roots well firmed in planting, by tramping on each side of the row after setting. As the celery starts to grow the cultivator is run between the rows, and by the middle of August the plants are drawn close by hand and a little earth packed to them to keep them upright. Later on the earth is plowed to the rows, and the banking then completed with the spade for the celery that is to be used in the fall; very little banking being done to that for the winter, which is taken up and stored in trenches as deep as the celery is tall, and is gradually covered with hay or straw as the weather gets colder, so as to keep out the frost.

From Baltimore southward a different plan is used by gardeners. I once asked Mr. Henderson why he did not try our plan. He replied that he wished he could, but that their winters were entirely too cold to make it a success. The method is as follows. Selecting land, as in the North, that has been heavily manured for an early crop, we add some commercial fertilizer rich in potash, which the stable manure, which may have been used in the spring, lacked. The land is, of course, prepared, as well as possible. A line is tightly stretched along one side of the bed to be planted. A board is prepared one foot wide by six feet long, and the ends accurately squared. On each side of the board notches are cut six inches apart, beginning six inches from each end. The planter sets the end of the board square or perpendicular to the stretched line, and sets a plant at each notch on each side. The board is then moved another space and another row set, and this process is continued to the end of the bed. We then have a bed with rows crosswise a foot apart, and eleven plants in each row six inches apart. A space of eight feet is then left for earthing and another bed set in the same way, till the land is planted. Sometimes, when the beds are situated so that they can be irrigated, a rim of earth is raised around the edge of the beds so that the water can flow all over and be retained on the bed only. The setting is done early in September, and a month later the plants will have begun to spread their leaves. They must then be "handled." For this purpose we use two pieces of twine with sharpened pegs tied to the ends. A peg is stuck at the end of a row, a turn is made around each plant in the row, and finally the peg in the other end of the string is stuck at the other end of the row. A second row is then treated in the same way, and earth is shoveled in between them. The whole bed is gone over in the same manner and then the earth is packed tightly to each plant by hand. As the nights grow cool earthing is continued in the same manner, only that as each pair of rows is earthed the soil is drawn down level, and before loosening the strings a ridge of soil is laid between the rows and not pulled down, so as to keep the plants in narrow trenches nearly even with the tops, and thus induce them to draw up erect. At next earthing this ridge is pulled flat and another set up. While earthing up the rows the soil is carried up outside the ends of the rows six inches or more thick, so that when finally earthed up, the bed is six feet wide. The earthing is continued till late in December, and then, as far north as Baltimore, a thick layer of earth is placed over the whole and covered with straw or forest leaves, and corn stalks, for the winter. From North Carolina southward the final covering should be of pine leaves placed on thickly, with no earth cover on top; which will generally have to be increased during the winter as the hardy celery never really stops growing here. Celery is the most laborious crop of the market gardener, but at the same time, when well grown and put in market in good shape, it is one of the most profitable. I should have said that the eight foot spaces between the beds must be kept well cultivated and fine for shoveling.

OUR METHODS OF BLANCHING CELERY.

A practice has grown up in sections North, where the crop can be grown early in Summer, of placing boards on each side of the single rows, so that the celery is crowded for light and runs up tall and tender. This method is used only for early celery, since the boards would not be a sufficient protection against the cold late in the season. The self blanching varieties are used for this crop more than others, and, in fact, the self blanching sorts are only fit for such treatment, as they are far inferior in quality to those kinds that are commonly grown and blanched by earthing. They make beautiful, white stalks, but the quality is very inferior.

While in the northern parts of the country celery is largely grown on black, peaty, marsh land, where it attains a fine size and appearance, in quality this celery is far inferior to that grown on a moist and fertile clay soil; being more pithy and hollow stalked. The finest quality of celery is that grown from a good strain of seed on a clay soil of good fertility, and irrigated, as needed, in dry weather. While it may not be so large and showy as the product of the marshes, it is far superior in solidity and crispness, qualities essential to a fine celery.

In regard to the fertilizing of the celery crop the following from Bulletin No. 132 of the Cornell University Experiment Station will be of interest.

The land on which the experiments were made was flat, muck land, or half wild meadow, broken up that year. It had never grown celery nor had it ever received any fertilizers. The results of a series of various applications is summarized as follows: "All the records show that wood ashes gave the best results, although a combination of nitrate of soda, South Carolina rock and sulphate of potash promises to do well. Muriate of potash excelled the sulphate. Nitrate of soda, alone, gave poor results. The check plats, without fertilizers, were not worth the growing."

FERTILIZERS FOR THE CELERY CROP.

We have said that where the celery crop follows a heavily fertilized early crop on a good moist soil, there is little need for further manuring. But celery is especially fond of potassic manures and nitrogen. Hence if there has been any deficiency in the early manuring, there should be some commercial fertilizer applied. We would not use stable manure on the celery crop direct, because of its drying tendency in heavy applications. The following, used at rate of 1,000 pounds per acre, will be found well suited to the crop: Acid phosphate or dissolved bone black, 800 pounds; fish scrap or tankage, 800 pounds; muriate of potash, 400 pounds to make a ton. In all these formulas we give the component parts of a ton of 2,000 pounds. But of course the same proportions can be used in smaller quantities. The fertilizer should be applied at least a week before setting the plants, and should be well mixed with the soil by harrowing, as otherwise the caustic effects of the potash may injure the roots of the plants. Put the fertilizer broadcast, for either in rows or beds the plants will finally get it. The same fertilization will answer for the thick planting adopted with the self blanching sorts.

VARIETIES OF CELERY.

Formerly the giant sorts were commonly planted, and they are preferred still, in the South, to some extent. But by far the finest quality is found in the dwarf and half-dwarf varieties. Golden Heart or Golden Dwarf is the sort most generally popular. White Plume and Golden Self Blanching are the kinds generally used for self blanching. In the South the Giant Pascal is the most popular sort, and the Sandringham is also found to be excellent. The Boston growers use the dwarf sort known as the Boston Market, a very dwarf sort that makes a great many tender and crisp offshoots, and is a very good variety for bed culture. Pink celeries are sometimes praised as better than white, but the market does not care for them.

CHAPTER XXX.

CUCUMBERS.

Cucumbers are grown by the Southern market gardeners in great quantities for early shipment to the Northern markets. They are also very largely grown in the North by those who are not regular market gardeners, for the supply of the pickle factories late in the summer. Then there are large numbers grown near all the large cities in hot houses in winter; of this culture we will have more to say in the proper place. It was formerly thought essential for all the cucurbitaceous plants, such as cucumbers, melons and squashes, that the hills should be prepared with a liberal deposit of stable manure or compost in the hills, and there is no doubt that where facilities exist for this compost it is still an excellent plan. But, in growing the early cucumber crop on a large scale and at a distance from a supply of stable manure, it has been found necessary to use artificial fertilizers. As the value of the crop depends on its earliness the artificial manures are better for forcing this early growth.

A mellow, sandy loam, neither wet nor too dry, is the best for the early crop. The soil should be plowed very early in the season, shallowly, to destroy the hardy weeds that may be appearing, or the crop may be made to follow the crop of early cabbages which have been heavily fertilized, by planting hills in alternate rows. But a better crop can be grown by preparing the land especially for the cucumbers. In preparing the land for planting it is plowed in beds six feet wide, and a subsoil plow is run deeply in each dead furrow. The fertilizer is then applied in the dead furrows heavily, and a furrow is turned from each side so as to make a ridge (or list) over the manure. We then flatten this list with a hand roller, and sow the seeds while the land is fresh. The first cultivation is to plow the land to the rows so that the rows of plants will stand on top the lands and the new dead furrows are in the middles. This is done after a good stand has been secured, and the earth is drawn to the plants, so as to have the roots deep in the moist soil. The plants should be thinned to about one foot apart in the row. Subsequent cultivation is with the small tooth cultivator till the vines are running so as to stop further cultivation. The crop is always cut with a small piece of the stem attached, and the cucumbers are shipped in slatted crates. One thousand bushels per acre of marketable cucumbers is a common crop with the gardeners of the South Atlantic coast, and the same method of culture is equally well adapted to the crop in any section, but the planting season must follow the disappearance of frost from South northward, as the cucumber is a tender plant and must not be planted till the soil is warmed.

VARIETIES OF CUCUMBERS.

The standard variety with the market gardener is the White Spine. Every enterprising seedsman has his special strain of this variety, and it has never been superseded as a variety for field culture, and is also grown to a large extent under glass. For the late crop, for pickles, in the North, some of the strains akin to the Long Green are used. The Perfected Jersey Pickle is one of the best of these. There are some small varieties that are earlier than the White Spine, but they are of no value to the truck farmer and only of use in the private garden for their earliness. The little prickly Gherkin is also grown to some extent for pickling. The late crop of pickling cucumbers belongs almost exclusively to the Northern gardener and farmer, since the late crop is rarely a success in the South, owing to the drought and the borers. But in low, moist, bottom land they may be well grown even in the South. These pickles are planted in mid-summer, and commonly occupy land from which an early crop that was heavily manured has been removed, and no special manuring is given on such land.

FERTILIZERS FOR THE CUCUMBER CROP.

As this crop is fertilized, as noted, entirely in the furrow, the fertilizer need not be used heavier than 500 pounds per acre. Just as the plants appear through the ground it has been our practice to keep them dusted with fine bone meal, to keep off the bugs. This also helps the growth of the plants. For a fertilizer mix acid phosphate, 900 pounds; fish scrap or tankage, 700 pounds; nitrate of soda, 200 pounds; muriate of potash, 200 pounds. In localities where the phosphate made from bone black, or the Thomas slag phosphate, can be had more cheaply than the acid phosphate made from the dissolved rock, they can be used in place of acid phosphate in any of the formulas, and fish scrap, a good article of tankage, or dried blood, may be used indiscriminately without any serious change in the nitrogen content. Where cotton seed meal is used as a source of nitrogen it must be used in larger quantity. The tables appended in the back part of this book will show just what percentages of nitrogen and other ingredients are found in all of these things, and we will hereafter try to show how certain percentages may be made in the mixtures.

STARTING CUCUMBERS UNDER GLASS TO ADVANCE THEM.

In many works on gardening the advice is given to sow the seeds on inverted sods, place them under glass and water them; and then transplant to the field, sod and all. This may be made to answer where blue grass sods are plentiful, but it is at best a clumsy and inconvenient plan, and in the South, where sod is mainly Bermuda grass, it is totally impracticable. The market gardener should always be provided with an abundance of frames and sashes, and with flower pots of various sizes. These pots can now be had by the thousand so cheaply it will not pay anyone to go to the trouble of cutting sods for starting his plants. The method we have used successfully to get an extra early start with cucumbers and muskmelons is to use pots of the four inch size. These are filled with the regular potting compost used in the culture of greenhouse plants, and the soil well settled in them to within an inch of the top. They are then packed in cold frames evenly and level, and seeds are scattered on the pots, three or four to a pot, and the same rich compost is sifted over the whole.

This is done after hard frosts are over, and the cover of the glass sash will be sufficient protection. But some means should be at hand to cover the glass with a mat should an unexpectedly hard frost occur. The pots must not be allowed to suffer for water, and the plants should be thinned to two in a pot as the rough leaves appear. When the weather is settled and the ground warm they are easily knocked out of the pots, with balls entire, and set in the rows. We always set them a little deeper than they were in the pots and have had very great success in getting a perfect stand. We see at times all sorts of curious contrivances advised for the starting of plants, such as hollowing out turnips, cutting sods, and melting the tops and bottoms from tin cans. But the true gardener knows that none of these things are so good or so cheap as the regular flower pot. The four-inch size can now be had for about one cent each, and with care will last for many years, and are far cheaper and better than any of the troublesome substitutes advised. A gardener, like a farmer, should be a systematic and business-like man, and never a potterer or a piddler, spending more labor over a substitute than a real garden appliance would cost. Tin cans and hollowed turnips are on a par with the plant cloth which some gardeners think as good as glass on their frames. Good gardening calls for the best garden appliances, just as good farming calls for the best tools.

CHAPTER XXXI.

EGG PLANTS.

This crop is grown to some extent in the far South, in Florida, as a crop to ship North, but is grown very little in the Middle South; and again in the Northern market gardens it is rather largely grown. The gardener from the North, coming South, is surprised to find that in private gardens here it is rarely seen, and in the markets of the Southern cities is rarely called for. This is largely owing to the fact that, like the tomato, it is a more difficult crop to grow in the South than in the North, owing to the ravages of the blight, which is worse, if possible, on the egg plant than on the tomato. The egg plant is a very tender plant, and the methods used for the production of the tomato will hardly do for it, since any effort to harden off the plants in frames is sure to result in a stunted growth and comparative failure. Our practice is to sow the seeds about the last of February in a warm greenhouse or a hotbed under glass, and as soon as large enough to handle transplant to pots two and a half inches in size. As soon as the roots show around the balls in these pots they are transferred to four-inch pots and still kept in the house. Not until the ground is well warmed and vegetation active outside should they be transferred to the open ground. We have then found that no matter how much fertilizer may have been used on the land that a top dressing of stable manure as a mulch to the surface is always a great advantage, particularly if the land is a dry clay and inclined to bake. We set the plants three feet apart each way, and aim never to allow a crust to form on the surface. The plants need as close watching from the Colorado beetle as the potato plant. In fact, we think they are fonder of the egg plants than of the potatoes. Rather than use poison we prefer to pick the mature beetles and crush the orange colored masses of eggs on the under side of the leaves. If the crop is very early it will be a profitable one, but later the price goes too low for distant shipment. Many years ago in Northern Maryland, having an abundance of vacant frames after our tomatoes had been transplanted to the field, we set 600 sashes with two egg plants each, and kept the glass over them at night till June. In the rich manured soil of the frames they grew astonishingly, and were ready for market before the Charleston crop was in, and brought, for the first, $4 per peach basket; the largest price we ever got for egg plants. The gardener in the Upper South who is wise enough to invest largely in glass, can always compete on favorable terms with those south of him in the open ground.

VARIETIES OF EGG PLANTS.

The standard variety of egg plant in all the market gardens North and South is that generally known as the New York Improved. There are many strains of this. The Black Pekin is earlier, smaller and of fine quality. The Early Long Purple is the earliest of the older sorts, but not grown for market, as the market demands round sorts. We have grown this season, for the first time, a variety from Italy which seems to be a cross between the Black Pekin and Early Long Purple. It is of the same shape as the Long Purple, with the purplish foliage of the Black Pekin. It is very early and wonderfully productive, and so far has resisted the blight which destroyed our New York Improved to a plant in the adjoining rows. Its small size and odd shape will be against it as a market sort, but in quality it is ahead of anything we have ever tried in the egg plant family. It is common to see as many as ten fruits on a plant ready to cut and many more forming. The fruits are inclined to grow crooked like a crookneck squash. What the name of this is we do not know, as the seed was sent us by number for trial from the division of the Agricultural Department for the introduction of new plants. We believe, at least for the family garden in the South it is a valuable acquisition.

FERTILIZATION.

It is useless to try to grow egg plants unless the soil is rich and heavily fertilized. They can be set on the land where the crop of early peas has been gathered and the vines plowed under. But as the pea crop does not need the heavy fertilization of other garden crops there should be an application of not less than 1,000 pounds per acre of the mixture advised for the cucumber crop, and, if possible, in the South at least, a further mulching of stable manure on the surface after or just before the plants are set.

CHAPTER XXXII.

LETTUCE.

In all parts of the country, North and South, in the open ground and under glass, there is no crop that engages the attention of the skilled gardener more than the lettuce crop. This, of course, refers to the winter culture of the crop in frames in the South and in heated houses in the North. The outdoor crop, while an important one, is of far less profit and importance than that grown under protection. In Florida the crop is grown, all through the cooler part of the year, outside, and as we advance up the coast we find lettuce engaging the attention of the winter gardener in frames, protected either by awnings of cotton cloth rolled up and down on rafters, or in the regular cold frames with glass sashes. In the North acre after acre of steam and hot water heated houses is devoted to the winter production of the lettuce crop. And with all this production, there has never been a time when good head lettuce has failed to bring a good price during the cold months from November to April.

The gardeners along the South Atlantic seaboard use cotton cloth almost exclusively for the production of winter and early spring lettuce. We have long tried to show them that this is a mistake, but the first cost of the glass is so heavy that they hesitate to undertake a large area in glass. The cloth covered frames cost $500 per acre, and the cloth has to be renewed every second year. If a heavy snow comes, the gardener with cloth covered frames is in a bad way, for the snow will slide on his bagging cloth and press down on the plants, and hence must be removed. As cold always follows a snowfall. he then has not sufficient protection from the cloth and his plants get damaged. With the glass sashes a snowfall is a protection against the cold that follows, as it can be left on the frames. Experienced growers have admitted to me that they could grow a third more and better lettuce in glass frames, but they hesitate to make the expenditure of $3,000 per acre for the glass when the crop is worth that much per acre annually under cloth, and would be worth more under glass. In fact, here in the Upper South, we can produce in a simple cold frame, with mats for protection in unusual cold, as good lettuce in the dead of winter as the Northern gardener can get in his expensively constructed and heated greenhouse. The frames used in the South for the production of winter lettuce are made 12 feet wide and have a ridge pole running the length of frame, one-third the width, from the north side, so as to give a long slope to the south and a short one to the north. The canvas is sometimes on rollers, like awnings, and sometimes is merely stretched over the pole, and held in place by eyelets on hooks in the sides of the frame. Aside from the imperfect protection of the cloth there is the further disadvantage that the whole must be taken off to give the plants full sunlight, and in cold weather this cannot be done, and the plants get drawn in the partial shade; while under glass, when the weather is too cold to uncover, they are exposed to the full sunshine and grow sturdy and short stemmed and head far better. The frames for growing lettuce under glass are made about six feet wide, so as to admit a 3x6 foot sash. The back of the frame towards the north is made 18 inches high and the front 12 inches so as to give a slope to the sun. Some make the frames wider and have a ridge pole and a short wooden span to the north, but this makes the frames unhandy, and the lettuce under the wooden slopes is poor. The chief points to be observed in growing frame lettuce after the preparation of the soil of which we will speak, are to keep it as near 40 degrees Fahrenheit at night as possible and to give air in all sunny weather to prevent too high a temperature, which would result in a flabby growth and poor crop. At all times when the sun shines, and that is nearly all the time in the South, and the temperature is above 25 above zero, we admit some air, and when there is no frost we fully expose the plants, even at night.

CULTURE OF FRAME LETTUCE IN THE SOUTH.

The best soil for the lettuce crop is a sandy loam. This inside the frames should have a heavy coat of black leaf mold from the forest screened to remove all coarse roots and trash, and spread three inches deep in the frames. The frame is then ready for the application of the fertilizer. As this should be used without stint and should have, on such a soil, a large percentage of potash, it should be applied at the rate of a ton and a half to two tons per acre of area enclosed, several weeks before setting the plants, so that the caustic effect of the potash may disappear. On a clay-loam soil the fertilization is better with a heavy application of well rotted stable manure and a lighter dressing of the phosphatic and potassic fertilizers. The wide awake gardener in the South will always plan for two crops during the winter, by replanting as rapidly as the early (or Christmas) crop is out. For the first crop, to come off from the first of December to Christmas, seed of the Tennis Ball or Boston Market should be sown the last week in August, and will be ready for the frames a month later. These varieties can be planted six inches apart when the frame is occupied by lettuce alone, but when a crop of cauliflower is also grown in the frames they will occupy the place of ten lettuce plants and the sash will then hold 40 lettuce. Where the frames are to be used for a succession crop of lettuce it will not be practicable to grow the cauliflower and they must have room by themselves. But where practicable it is not best to replant the same frame in lettuce, as the second crop is apt to be more or less diseased. In fact, so much trouble has been had from this, that some of the largest growers now do not try to have an early winter crop, but plant entirely for the late winter and spring market, when the price is usually highest. But where practicable it will be found best to have extra frames for second crop of lettuce, and to leave cauliflower after the Christmas lettuce is cut, with only protection of mats or cloth in cold snaps, and to remove the glass to the extra frames for the later lettuce. These frames being prepared at the same time as the first will have gotten well sweetened by frost, and will make the finest of crops. Seed for the late winter and spring crop is sown late in September, in a sheltered spot, and a little later it is well to mulch the plants lightly with strawy manure as a protection, though they will usually winter fairly well here, unprotected. At the same time it is well to sow some seed of the varieties that are not grown under protection, so as to have them to set later in the field along between the rows of early cabbage, to be cut in the spring before the cabbages need all the room. For this purpose there is no better lettuce than the Improved Hanson. For the late winter and spring crop in the frames we sow the Big Boston and the California Cream Butter lettuce. The Big Boston is commonly used for both crops by our market gardeners here, but for the Christmas crop we prefer the Boston Market, as it heads compactly at an earlier period.

The growing of lettuce under glass in the North differs from that in the South only in the place where the plants are set. There the crop is grown in wide, flat-roofed greenhouses, in which a night temperature of 40 to 45 degrees is maintained, and free ventilation given in day time. The plants are set in well prepared compost on the benches of the houses, and require far more care and attention than the Southern frame crop, as the plants are more liable to disease and the attacks of aphides and other insects; but the crop is so generally profitable and the quality so fine that the area annually devoted to lettuce is rapidly increasing. Near Boston, where, in winter, the growers are troubled with long, sunless spells, it has been found profitable to string arc lights over the houses for forcing the crop. This is a refinement in horticulture that few will imitate. The culture of frame lettuce will be more fully treated in chapter on cold frames.

LETTUCE IN THE OPEN GROUND.

This is the crop that most farmers are more interested in than the forced crop. Anywhere from Virginia south lettuce plants can be safely wintered over outside with slight protection of manure in the northward section. In the North, however, it is best to winter the plants over in frames, as cabbage plants are there carried over. The market gardener, with his costly and fertile land will get the early outdoor crop from plants set between the cabbages, and will have it out of the way before the cabbages need all the room. Otherwise the plants are set as soon as the ground can be worked in the spring, in well enriched soil, and make a good crop to be followed by some tender plants, which cannot be set till the ground is warm.

THE MANURIAL REQUIREMENTS OF LETTUCE.

Lettuce, like most foliage crops, needs an abundant supply of nitrogen, and also in the soil it prefers, a light, sandy loam, a large percentage of potash with a fair proportion of phosphoric acid; though this is of less importance than the first two. Occupying the soil during the winter months, when there is not a great activity among nitrifying organisms, it is essential that the fertilizer be presented not only in lavish amount, but in a perfectly soluble form. Hence for frame lettuce we would make a mixture of acid phosphate, 900 pounds; dried blood or fish scrap, 600 pounds; nitrate of soda, 100 pounds, and muriate of potash, 400 pounds. The large percentage of potash renders it necessary, as we have said, that the fertilizer be applied some time before setting the plants, usually one month. But the nitrate of soda should be reserved and not mixed with the other ingredients, but scattered between the rows after the plants begin to grow. The first frame crop set in the South in October, will need no protection till the later part of its growth, in late November and December, but the protection should be at hand for the first cold snap.

VARIETIES OF LETTUCE.

The varieties used by the growers of winter lettuce are few. The markets of the Eastern States demand a well headed lettuce, while in the West the curled and loose headed sorts are popular. For the fall crop we prefer the Boston Market, since it can be set twice as thick as the Big Boston, but for the late winter and spring crop the Boston Market and California Cream Butter lettuce are superior, though they require a foot distance to the six or eight inches of the first named.

For the open ground crop to be set in the fall in the south, or in frames for wintering over in the North, there is no lettuce equal to the Improved Hanson. It is the largest and most solid heading of all lettuces, and can easily be grown to weigh ten pounds or more per head. For sowing in spring the New York and the Boston Fringed lettuce stand the heat better than others, but any lettuce will soon run to seed in warm weather, and late spring and summer lettuce is milky, bitter and of little value as compared with that grown in cool weather. There are long lists of varieties offered in the seed catalogues, but many are of little value to the market gardener. The best of the loose heading sorts is the Grand Rapids, which is popular in the West, but is little grown in the East. It makes very large bunches and is of fine quality, especially for decorative purposes.

To persons of discriminating taste there is no doubt that the Grand Rapids lettuce is far superior in quality to the heading or cabbage sorts, and if once a community is educated to the using of the curled sorts they will sell in preference to the cabbage varieties. But at present it will hardly pay the gardener in the eastern part of the country to try to educate people into taking what they are not accustomed to. If the crop is grown for any of the markets West, the Grand Rapids is the variety to grow, and perhaps after a while the Eastern cities may find out its superiority. In the meantime, if you are growing lettuce for home use, we would advise the curled sorts as of greatly superior quality and beauty to the cabbage lettuces.

CHAPTER XXXIII.

MELONS.

MUSKMELONS.

What has heretofore been said in regard to the manurial requirements of the cucumber will apply equally well to the muskmelon crop. This crop prefers a soil of much heavier texture than the watermelon, and delights more in moist conditions in the soil. We plant muskmelons in hills six feet apart, and make wide holes where each hill is to be, using to fill these holes a compost made of black earth from the woods and stable manure in equal parts, piled some months before in a flat heap and frequently turned until completely well mixed and homogeneous. Just before planting we scatter a small handful of any good complete fertilizer having a high percentage of nitrogen in it over this, and cover with soil before planting the seed. We use an abundance of seed, as it is an important matter to get a complete stand at once. As soon as the plants can be seen breaking through the soil we dust them over with fine raw bone dust, to keep off the striped beetles that prey upon them; the bone dust is also a good fertilizer. When the rough leaves develop and danger from the bugs is past, we thin to two good plants in a hill, and cultivate flat and shallow with a cultivator till the vines get in the way, after which weeds are pulled from among them by hand. Some large market gardeners adopt a different plan and use commercial fertilizers entirely. They plant the melons between the rows of the early peas, running a furrow down the middles, and applying a good dressing of high grade nitrogenous fertilizer all along the furrow. Two furrows are lapped on the first one, making a slight ridge, which is flattened down and a shallow furrow, in which the seeds are scattered, is made on the flattened ridge. As they develop they are thinned to stand about two feet apart in the rows, and when the peas are off the vines are turned under and the melons cultivated. They are also planted between the rows of early snap beans and treated in a similar way. The variety mainly grown by the Southern truck growers is the small early sort known as Jenny Lind. This is early and of a size easily packed in crates for shipment, and is more largely grown here than any other. Of late years there has been a great deal of interest in a variety known as the Rocky Ford, from the locality in Colorado where it has been largely produced and shipped East. The high quality of the Rocky Ford melons caused them to bring fancy prices in the East, and many have tried the variety here. But it has been found that the Rock Ford is the same variety that has been long grown under the name of Netted Gem, and that it seems to be the soil and climate at Rocky Ford that has given them their fine quality. Why the difference should exist between the Netted Gem in one section or another remains to be determined, and several of the Experiment Stations are entering into the investigation of the effect of soil and climate on this variety. In Europe there are a number of varieties of winter muskmelons grown. These mature late in the season, can be put away to ripen indoors and will keep till Christmas. For some reason these melons have never become popular in this country, but experiments are now being made with them, and it may be that there will be found some that suit our climate.

For a home mixture for muskmelons we would suggest the following: Acid phosphate, 900 pounds; dried blood, 600 pounds; nitrate of soda, 100 pounds, and sulphate of potash, 400 pounds, to make a ton. Where the concentrated fertilizer is used exclusively we would use 500 pounds per acre. As a dressing on hills of compost half this quantity will be sufficient. At the last working of the crop it is a good practice to sow cow peas among the rows, as they quickly grow up and make some shade from the sun, and after the crop is off there will be a field of peas to turn into forage.

WATERMELONS.

The watermelon is very similar in its manurial requirements to the muskmelon, but if grown in well manured or fertilized hills it can be profitably grown on poor, sandy land that would not make a good crop of muskmelons. The same making of a rich bed of compost in the hills is practiced with the watermelon, but the hills are much further apart than those of the muskmelon. Ten by twelve feet is a good average distance to plant, and the sowing of peas between the rows is of more importance here than with the muskmelon, as the watermelon likes to hide in the shade and is damaged by the hot sun. The crop, like the muskmelon crop, can be grown with commercial fertilizers alone. One of the best watermelon crops we ever grew was on a sandy piece of bottom land where the soil was deep and moisture always in reach. This land was plowed in twelve foot lands early in the spring and the dead furrows well plowed out. A heavy dressing of the fertilizer given above was then scattered along the dead furrows. Two furrows were lapped on this, making a sharp ridge in the dead furrow. This ridge was flattened slightly and a shallow furrow made on it in which the seeds were sown. The crest of this bed was then quite below the level of the top of the intervening lands. As the seeds appeared to germinate the bone dust was applied and when washed off by rain, renewed. As the plants developed they were thinned to three feet apart and but one plant left in a place. The first working was to throw furrows to the row from each side, and this process was continued until, when the cultivation was done, the rows of plants stood on top the lands and the dead furrows were between them. In this way the roots were gotten down into the moist lower soil. and flourished as I have never seen them since; and the crop was as fine as ever seen. About 700 pounds per acre of the fertilizer was used. This amount could not have safely been applied to sandy land at a greater elevation or on a dry hill, but on this soil, where moisture was always in reach, the fertilizer was completely dissolved and used by the crop. There are so many varieties of watermelons grown that it is hard to recommend the best. For growing for market and for long shipping, there is no variety equal to the round Kolb Gem. This is of fair quality and good appearance when cut, and has a tough rind that bears handling. But for home use and a near market it is far inferior to many others. Like a great many other things, the variety best adapted to shipping purposes is not of the best quality. In our experience we have found no watermelon that can equal in quality the McIver Sugar melon. It grows to a large size, has a thin rind and beautiful scarlet flesh, which never cracks in wet weather, as most other varieties are apt to do, and in quality it leaves nothing to be desired. Next to the McIver we would place the Jones, a very large, dark green melon of a round shape. It is a very productive sort and will make melons from 50 to 70 pounds weight, or even more. With these varieties we do not think either the market grower or the home gardener need look further, for they combine all that is needed in a watermelon.

CHAPTER XXXIV.

ONIONS.

There is hardly any culinary vegetable more largely grown North and South than the onion, and there is no crop to the perfection of which the commercial fertilizers are better fitted, because of the tendency of stable manure to introduce weed seeds, and there is no crop that must be kept more clear of weeds than the onion. "Clean as an onion bed," has grown into a maxim in culture. Our market gardeners grow onions very largely for bunching while green in the early spring, the main crop of onions ripened and sold in barrels are grown on lands especially adapted to the crop, and by farmers rather than gardeners. The methods for producing the crop are as various as the purposes for which it is grown. In Bermuda, and to some extent in Florida, the so-called Bermuda onion is grown by sowing the seed in the fall for the winter crop. Onions prefer a cool climate and a moist soil, and when grown in the South, they must be given the most favorable season in which to grow. Anywhere south of Virginia it would be perfectly feasible to sow onion seed in September for the early green crop in the spring. But we have found that our September weather is so uniformly dry that at that time getting a stand of onions from seed is very uncertain. Hence for this green crop we are compelled to resort to the use of sets.

GROWING THE SETS.

We use seed of the Queen onion for the growing of sets, since they are only used in the production of the green bunching crop, and we want a quick growing onion rather than a large one. Growers in the South, and even in the Middle States, have gotten so much in the habit of growing their onions entirely from sets, that growers in many section in the Northern States, make the growing of sets an important crop, and we find on the market sets of all kinds, white, yellow and red. But the Southern grower is fast finding that he does not need sets, except for the production of the spring bunching crop, and for this purpose he wants a white set. After a number of experiments we have found that the Queen gives us the best results for this purpose.

Since onion sets should be of small size, the thicker the seeds are sown the better. It is our practice here to sow seeds for sets the first of April, in rows, and so thickly that it will take about 60 pounds to sow an acre. Sown in this way they crowd each other and the product is a mass of bulbs about the size of small marbles, ripe here in early July. These are gathered and cured with the tops left on, for we find that they soon start to sprout when the tops are removed. Hence the tops are not taken off till we are ready to use or sell the sets. These sets are planted in September, as it is important that they get well started and a young bulb under way before cold weather.

EARLY GREEN ONIONS IN THE SOUTH.

We have long since found that while we can grow as fine onions from the black seed in the South the first season as can be grown elsewhere, and that for the purpose of growing a ripened crop the sets are practically worthless, we are compelled by the character of our autumn weather to use the sets for the early crop, which goes North late in winter and early in spring. The onion is one of the few crops which are better fertilized in the hill than broadcast, since the roots have a more limited range and are better nourished by having the fertilizer placed right below them. Therefore for this early crop we mark out furrows, early in September, two feet apart. In these furrows we scatter the fertilizer and then bed on the first furrow with two others, one from each side, making a ridge over the fertilizer. This we flatten with a hand roller, and mark out a small furrow on the bed in which the sets are placed so that when the soil is pulled away in late winter the bulbs will be on the surface. We set them rather deep in the bed as a protection till hard frosts are over. As the crop is pulled and bunched when half grown, the sets can be placed two inches apart in the rows. We have said that for this early crop we use sets of the Queen onion. We have succeeded very well with the Bermuda onion in the same way, and the white potato onion, or Multiplier, is being largely used for fall planting, as it stands the winter better than most other sorts and makes a short top. The fertilizer requirements of onions are mainly for nitrogen and potash. Analysis shows a very small percentage of phosphoric acid in the onion when compared with the other constituents.

Another way to produce the early onion crop in the South is to sow the seed rather thickly in August on land that is naturally mellow and moist, and which is heavily fertilized with a fertilizer mixture containing a large percentage of potash, the formula for which is given under the proper head. This crop should be well cultivated through the fall, and it will be found that if the fall weather is favorable some of the onions will grow to quite a size, and these it is best to thin out and use for pickling onions. Hence the reason for rather thick sowing. As cold weather comes on the earth is drawn to each side the rows as a winter protection and to be removed as the weather warms in early March, to give the onions a chance to bulb on the surface. In cold latitudes the cold frame can be utilized for the fall onion crop.

THE GENERAL CROP OF ONIONS.

When it comes to the growing of ripe onions for keeping and shipping there is no need for sets either North or South. It is simply a matter of earlier sowing and earlier ripening in the South. The onion prefers a moist soil abounding in humus, so that it can have uniformity of moisture during its growth. Hence reclaimed swamp lands are well suited to the crop and in many sections such reclaimed areas are being very largely devoted to the onion crop. At the same time, such soils are apt to be particularly deficient in the potash so essential to a good onion crop, and while the soil is apparently very rich, the onion crop would fail to bulb well. It will not do to assume that any soil is rich enough to grow onions without any fertilizer. With a crop that varies so largely in quantity all the way from a few bushels per acre to over a thousand bushels, it is evident that the presence of a lavish supply of plant food in a readily available form is essential to the production of onions. A buried clover sod or a pea fallow in the South are favorable places for the onion crop, if the soil is of the right mechanical make up. A mellow loam inclining rather to sand than clay is the best for the onion crop. The fertilizer is applied in the same way as advised for the fall planting of sets in the South. The beds are rolled nearly flat, but we find that it is a great advantage to have the seed drilled a little above the general level, and in all garden crops that are grown from seed direct, we always make these beds rather than drill on the flat surface. It is easy then to start the horse cultivation at once, and while the use of hand cultivators may be economical on small areas or high priced land we have always found it more economical to fertilize in the furrow, and to work the crop as far as possible with the weeder and cultivator, the latter, a small tooth many toothed implement, throwing hardly any furrow, but working the surface clean and fine. The seed is drilled as early as the land can be gotten in good condition in the spring, here during the latter part of February, and later with the advancing season, northward. The success of the crop depends on its having the longest part of the cool spring season for its growth. As in the case with sets, we have found that onions keep much better by being cured with the tops left on and stored in this way. We try to get them cured as rapidly as possible, but not too much in the hot sunshine, and above all things take care that rain does not fall on them before being stored. We place them in flats in the hottest place we have under cover, up near the barn roof, and when well cured store them in a cooler place. If spread out thinly and not disturbed while frozen a little freezing will not do any harm, but we prefer to keep them just above the freezing point.

VARIETIES FOR KEEPING.

We have tested a great many varieties of onions and while almost any of the sorts commonly grown in the North will keep very well, we have found that the best keepers to grow here in the South are the Southport White Globe and the New Opal. This last is a yellowish red onion introduced to our notice by Messrs. George Tait & Son, of Norfolk, Va., and it is the best keeper out of 16 varieties tried at the same time. Any of the Italian onions will make large crops from the black seed, but as a rule they are poor keepers. Their earliness makes them desirable in the South as they can be sent to market before the Northern crop comes in. The same may be said of the Potato onion grown from fall planted sets. These, when allowed to ripen, are ready for sale earlier than any other ripe onions and usually bring good prices. But they must be disposed of at once as soon as ripe, as they will not keep long unsprouted.

ANOTHER METHOD OF GROWING ONIONS.

Of late years a new plan has been proposed for the growing of early and large onions. This is by sowing the seed under glass and transplanting the young onions to their permanent quarters as soon as the weather will permit. We tried this method of culture with a large number of varieties, and have found that with the Bermuda, Spanish and Italian onions the method is a good one, but that it is of no advantage with the sorts commonly grown from seed by the large onion growers in the North. We have found it a very good plan with the Bermuda onions in this climate to sow the seeds in a cold frame in January (a greenhouse would be the place in the North), and to transplant the young onions when the size of a goose quill, to the rows prepared for them outside. The variety best adapted to this method is the large, yellow onion known as the Prizetaker. This can be grown to a very large size by this method, much larger than by sowing the seed in the open ground without transplanting. We have also had fair success with some of the Italian sorts by merely transplanting the thinnings of the rows that were sown in the open ground. Sowing under glass and transplanting is also a good method of getting the Bermuda onions early in the season. In the far South some advise the sowing of Bermuda onions late in fall and transplanting them for the early crop. This may be successful in Florida if the sowing is done not earlier than late December. If sown earlier we have had reports that the onions seem to stop growing as the milder weather of spring comes on, and do not attain a good size. This is at least the report of a good grower there.

FERTILIZERS FOR THE ONION CROP.

We make only one difference in the fertilization of the fall planted sets and the early spring crop, and this is that we use no nitrate of soda with the fall planted crop. Analysis of the crop shows that the demand of the onion as food is mainly for nitrogen and potash, and that phosphoric acid forms a very small part of what the onion removes from the soil. Hence the fertilizer for the onion crop should be rich mainly in nitrogen and potash, though the latter needs for its best effects that there be present a fair percentage of phosphoric acid. For the fall crop we would use the following mixture: Acid phosphate, 800 pounds; fish scrap, dried blood or cotton seed meal 800 pounds; muriate of potash, 400 pounds, to make a ton.

To the spring sown crop we would add a dressing of 50 pounds per acre of nitrate of soda as the plants start into vigorous growth. With the heavy application of not less than half a ton in the rows (and one and a half tons are profitably used broadcast when planted for hand culture) it is important that the fertilizer be placed in the rows and covered a week or more before the beds are rolled down and sown, as the large percentage of potash, while in a caustic condition, may have an injurious effect on the roots.

The onion is one of the crops that seems to prefer to be kept annually on the same land, provided the heavy applications of plant food are continued annually. The clean culture required gets the land clear of weed seeds. But as the crop is off early in the season, some soil cover crop, such as the Southern cow pea or crimson clover, should be sown on the land to keep up the humus content and to prevent the loss of fertility. Where the crimson clover will succeed this is by far the best, as it grows during the winter. If cow peas are used, the land should be sown in rye as a winter cover after the peas are dead. Treated in this way, the onion crop can be profitably grown on the same ground annually with increasing yield.

Six pounds of seed per acre are sown when the crop is in close rows for hand tools, but half that quantity will be an abundance when sown for horse culture. The sowing may be done in the North as late as the first of May, but from Virginia southward the crop will fail if sown later than March.

CHAPTER XXXV.

ENGLISH, OR GARDEN, PEAS.

These belong to the great family of legumes, of which we have already said so much. If sown on land that was manured the year before for garden crops there will be no need for any fertilization of the pea crop, but on most lands in the Southern market gardening section a light dressing of acid phosphate will be an advantage. In the Southern trucking section the marrowfat peas are sown in November, and needing some support it is a common practice to sow them alongside the rows of the dead cotton plants. These late peas are thus given a longer season to mature, as the extra early peas, which go to market first, are not sown till January and February. As to varieties, every seedsman has his special strain of the extra early peas, which are all really the same pea, the Daniel O'Rourks, which have been better rogued with than some others, perhaps, but all try to keep their special variety as pure and uniform as possible. Private gardeners with limited space, provide something for the peas to climb on, but the market gardener cannot afford this, and lets them tumble on the ground. In my home garden I use the narrow poultry wire, woven in large meshes, and find that this is not only the best but the cheapest way of supporting, not only the garden peas, but the lima and other climbing beans. I have in use now, wire netting that has been used for this purpose annually for ten years and it loooks as though it may last twenty years longer, and even in its first cost it is cheaper than the time of men and teams to go into one's own forest and cut brush. The little extra early peas are valuable for the market gardener, but while the fact that they give their whole crop at once is a valuable feature to him, it is not to the private gardener, who wants peas that last longer and are of better quality. For home use we never plant any of the extra earlies, but are content to begin with the Premium Gem, which is of better quality and lasts longer. We follow these with the Yorkshire Hero, Stratagem, and the Champion of England.

CHAPTER XXXVI.

IRISH POTATOES.

There is no crop grown by the farmer and gardener alike that is of more importance in all parts of the country than the potato crop. The farmer in the North makes it at times his main money crop, and the Southern market gardener finds it one of his great staples for shipment to the North in spring. Its manurial requirements therefore are of the greatest importance in all parts of the country. No crop has had its needs more studied at the Experiment Stations than the potato crop. Its peculiar liability to the attacks of fungus diseases and insects, has led to a great deal of study for providing the farmer with the means for combatting these troubles, and the result of these investigations has been to develop methods for caring for the health of the crop which are practical and profitable.

SOILS FOR THE POTATO CROP.

A mellow loam between a sandy and a clayey loam is doubtless the soil for the best success of the potato. It is important, too, that the soil be well stocked with decaying organic matter, and that it be rather in an acid than an alkaline condition; since it has been found that the fungus that causes the scabby appearance of the outside of the potato and thus decreases its marketable value, will not thrive in acid conditions, and that while the application of lime to such a soil may cause an increase in the bulk of the crop, the sweetening of the soil will encourage the scab fungus and injure its market value. Hard-wood ashes, having a large percentage of lime, will have a similar effect, and growers are rapidly learning that stable manure has the same effect, hence all large growers now confine the manuring of the potato crop to the artificial fertilizers. There is no crop grown for which the humus content in the soil is of more importance; hence it is found that newly cleared land will give fine crops, and that on our old lands the best preparation of the land for potatoes is to have legumes precede them. In the South this can be the cow pea the preceding summer and the hairy vetch in winter, the latter to be plowed under for the potatoes.

MANURIAL REQUIREMENTS OF THE POTATO.

Analysis shows that the Irish potato consists of 79.75 per cent. of water, 0.99 per cent. of ash or mineral matter, and it contains 0.21 per cent. of nitrogen, 0.07 per cent. of phosphoric acid and 0.29 per cent. of potash. Hence it is easy to see that nitrogen and especially potash play the most important part in its growth. Where the crop is planted on a soil abounding in organic matter or humus, there will be little need for an artificial application of nitrogen, in the northern part of the country, where the potato grows during the greater part of the season when the nitrification of this organic matter is most active.

But in the South, where the crop is grown in the spring months and earliness is the great point to attain, a more liberal application of immediately available nitrogen is important. In fact, the potato in the South is a market garden crop rather than a farm crop, as it is in the North, and as the value of this early crop is greater than that grown in the North, it will pay for more liberal fertilization than the farmer in the North usually gives. Any fertilizer mixture for the potato, North or South, must be high in its potash content, while but a moderate percentage of phosphoric acid is needed. The manufacturers make a great many names for their fertilizers and nearly every one of them has a special potato fertilizer, and nearly every one of them makes the phosphoric acid the leading constituent. In fact, if the farmer will take the trouble to examine the tables of analyses of commercial fertilizers published by the various Experiment Stations, he will find that many of the so-called special fertilizers recommended for different crops are really the same thing, and are probably bagged out of the same pile, and the only difference between them is that one is called "special potato manure" and another is "special manure for cabbage," or some other crop. When farmers learn to buy fertilizers by the analysis and not by the trade brand, or, better still, learn that they can mix their own fertilizers better and cheaper than they can buy them, this humbug will have had its day.

OTATOES AS A FIELD CROP IN THE NORTH.

Where the potato crop is one of the regular crops in an improving rotation the rule that the application of commercial fertilizers should be to the legume crop rather than the sale crop should prevail. With a proper rotation in which clover is brought in frequently on the land, and the home-made manures are used on the corn crop, there will be a rapid increase in the humus content in the soil, and there will be no need for the purchase of any nitrogen for the potato crop. For instance, suppose that the rotation is corn and potatoes in same field, wheat after both, with clover sown on the wheat. One year with clover and then the part that was in corn the previous round is put in potatoes, and the part that was in potatoes goes in corn. Each have part of the clover sod, but the corn is to get all the home-made manure, while the potatoes are to have the artificial fertilizers, if any are needed. We say, if any are needed, for we believe that it will be found most profitable to give the clover the acid phosphate and potash it needs, and to depend on the clover for the potatoes. Corn, as we have seen, also needs a good percentage of potash and nitrogen. But we have also seen that corn, as a field crop, never pays the cost of purchased nitrogen, and I doubt if the potatoes will. But when the clover the preceding year gets a liberal dressing of acid phosphate and potash, it not only gives a heavier crop of forage, but makes the farm manure richer in these things, and there will usually be no need for the purchase of fertilizers for the potato or the corn crop. We would alternate the potatoes and corn every three years, so that all the land will get, during the rotation, a dressing of the home-made manure; and as this is detrimental to the health of the potato crop if applied directly, it is not so when it has become assimilated to the soil, and is simply organic matter like the clover that is decaying around them. In the beginning of the improvement of a worn soil it may be profitable to use some phosphoric acid and potash on the potatoes, but if the proposed rotation is carried out we believe that the fertilization of the clover will be the better way to fertilize the potato crop.

In this case there is no better application to the clover than 400 pounds per acre of a mixture of equal parts of acid phosphate and kainit. For the direct fertilization of the potato crop in the North, where the crop follows clover, we would advise the mixture of 1,600 pounds of acid phosphate and 400 pounds of high grade sulphate of potash to make a ton, and would use 500 pounds of the mixture per acre; and put it all in the furrow under the potatoes, since the potato plant does not spread its roots far. The potato crop in the North depends to a great extent for its quality and starchiness on the form in which the large percentage of potash is given it. Muriate of potash is cheaper than the sulphate, and will make the larger increase in the crop. But the quality will be inferior to that of the crop on which the sulphate is used, as the chlorides seem to have a tendency to make the potato more clammy.

CULTIVATION.

It is not necessary in a work that deals mainly with the manurial requirements of crops to go at length into the familiar culture of the potato. Methods of culture will differ with the soil and climate, and a method perfectly correct under one set of conditions, will be found wanting in some respect under different conditions of soil and climate. In the conditions present on most farms north of the Ohio and Potomac, and in the mountain regions of the South where similar climatic conditions prevail, we would always practice rather deep planting and very shallow and constant cultivation; never, in fact, "laying by" the crop till it is made. Assuming that farmers everywhere have abandoned the old plan of planting in hills, we would plant the sets fifteen inches apart in the furrow. Whether large or small potatoes are used as seed should depend not merely on the size of the tuber, but on the conditions under which it was produced.

The potato is merely a bunch of stems under ground, surrounded by a mass of starchy matter, and the eyes are the terminal buds of the branches. Now if these tubers have been produced under conditions that did not favor the increase of the mass of starchy matter, and the small tubers are the best of the crop, they will make good seed. But if the small tubers are merely the immature little ones from a crop where there were very large and fine potatoes, they are small from lack of vigor in that particular branch and will inherit weakness of growth. But in selecting seed potatoes in the field I would rather take the small potatoes from a hill that made a great many than the large potatoes from a hill that made but two or three. Years ago, while digging potatoes, I found in a row of fine, large potatoes, one plant that made no large ones, but had, by actual count, 44 potatoes not larger than a walnut in the largest, and some still smaller. Here was evidently what gardeners call a "sport," or variation from the normal. The variety was the Beauty of Hebron, a potato which, in our experience, makes large potatoes, but not usually many in a hill. I saved the prolific hill and the next year it made potatoes about as large as the normal type, but far more in a hill, and, of course, a larger crop, and for years after I found this a superior strain of the Hebron. So it may be that small potatoes may be the starting point for an improvement.

But whether the potatoes are large or small, we cannot believe that small pieces are as good to plant as large ones. The starch in the tuber is put there by the plant for the sustenance of the young plant till it makes green leaves in the sunlight and is able to store its own starch. As the potato sprouts, the starch is changed into glucose for the food of the living matter. Potatoes that sprout in the cellar become clammy and sweetish to the taste because of this change; the sprouts use up part of the stored food, and the potato is weakened by the sprouting. We want for planting a good piece with well developed eyes and a store of food that has not been deteriorated by sprouting in the cellar. More plants can be had from single-eye cuttings, but we are satisfied that continuous single-eye cutting will eventually lead to a weakened stock. The principal thing after the potatoes are planted is to keep the spring moisture in the ground, by constantly keeping a mulch of finely pulverized soil on the surface and never allowing a crust to form. This can best be done with the weeder, in the early stages of the growth of the crop, going both ways over the land before the tops appear and afterwards as long as the tops will admit, and then finishing with the small tooth cultivator till the tops are mature.

EARLY POTATOES IN THE SOUTH.

The planting and cultivation of the potato for early shipment from the Southern States to the Northern markets, is a very different matter from the production of the farm crop in the North. Here it is the crop of the market gardener rather than of the farmer. The crop has attained to great importance in the South Atlantic States and also in the Lower Mississippi Valley. Florida, of course, comes into the market first, and close behind the crop from Bermuda. Of late years the crop from the South Atlantic States, grown in the fall from seed potatoes of the early crop, which are now used entirely in these States for planting the first crop, are often lifted in February and shipped North in barrels whitewashed in imitation of the Bermuda barrels, and sold as "New Bermudas," at a fine price, whenever there is a surplus over the local demand for the spring planting. Formerly the market gardeners of the South depended on Northern seed potatoes for the spring planting. But now it is the universal practice to plant the second crop seed of the previous year.

It is found that these potatoes, dug in December and planted again in February, are entirely unsprouted, and they start to grow more slowly than the Northern potatoes that have been trying to sprout all winter, and are less liable to be caught by frost after they are up than the Northern seed; and also that they seem to be more resistant to frost when up. Starting with the full vigor of the terminal bud, they make a stronger plant than the Northern potatoes that have been long kept out of the ground and have had the terminal sprouts rubbed off, hence start with a bunch of lateral eyes. The early potato crop in the South is never sprouted before planting, as they are planted so early that quick sprouting would be risky. The extent to which the culture has attained would astonish potato growers in the North, who, because they still supply the larger part of the winter table demand in the South, imagine that potatoes are not grown in the South to any extent But when they see single growers planting 700 barrels of seed potatoes it would seem that some potatoes are grown here. The early crop in the South needs different fertilization from that grown North. Planted at such an early period of the year and dug before hot weather begins, and before the nitrification is very active in the soil, there is a greater need for nitrogen and heavy fertilization to push the crop than there is in the North. Then, too, it is generally more valuable and the grower can afford to be more lavish with the feeding of the crop.

FERTILIZING THE SOUTHERN EARLY CROP.

The great need of the potato in the way of plant food is a complete fertilizer in which potash is a leading constituent. In some localities along the coast near the ports of entry, the growers have concluded that they can get the potash needed more cheaply from kainit than from the more concentrated potash salts, and they have adopted the practice to apply the potash needed by giving a heavy dressing of kainit to the land in the fall before the planting. They argue that in this way they get rid, during the winter rains, of the excess of chloride of sodium, and that in its leaching it renders available other forms of valuable plant food. But by far the greater number adhere to the application of potash in their fertilizer mixture in the form of muriate of potash at or just before the planting time. In some sections of the country it is claimed that the sulphate of potash produces potatoes of a finer quality, and more starchy and dry. But the Southern grower finds that the muriate gives him the best crop, and as no one expects to find these early potatoes dry and starchy like the mature Northern crop, he prefers quantity to quality.

One of the largest growers of early potatoes on the Atlantic coast uses the following mixture at the rate of one ton per acre: Fish scrap, 700 pounds; sodium nitrate, 300 pounds; acid phosphate, 600 pounds; muriate of potash, 400 pounds This, it will be seen, is a very highly nitrogenous and potassic compound, and the growers of potatoes have been compelled to make their own mixture because none of the factory made articles have the amount of nitrogen or potash which they wish. The above would be five and one-half per cent. nitrogen, seven and two fifths per cent. of phosphoric acid and ten per cent. of potash, and it forms a typical Southern early potato fertilizer.

This is spread by a machine made for the purpose, in and on both sides of the furrow made for planting, and is mixed with the soil by running a specially contrived narrow harrow in the rows before planting the potatoes. Since the roots of the potato ramble in a small space, the fertilization in the furrow is all sufficient, and the potatoes are simply covered in the fertilizer as the furrows are thrown over them from each side. The growers watch the weather reports closely after the potatoes begin to show above ground, and when cold is predicted, the field will be filled with teams plowing the earth over the tops as a protection. In the spring of 1894 there was a very disastrous frost late in March, after a long period of warm weather which had started the potatoes into a very strong growth. One of the largest growers, who had 125 acres of potatoes growing, told the writer that he started thirty plows covering the potatoes in the morning. But at noon it seemed so much warmer he thought the weather man was in error and stopped the plows. He said that he lost $1,000 by doing so, as all unprotected tops were cut down the following night, and the potatoes thus cut down came on late and in competition with the Norfolk crop while the covered ones were ready to dig the last of May and brought $5 per barrel. He said that hereafter he would depend upon the warnings of the weather service. The cultivation of this early crop does not differ in any respect from the early crop elsewhere. They are worked with harrow and cultivator and are laid by with a furrow from each side. This ridge drying out and getting warm early hastens the maturity of the crop, and great crops are produced by the best growers, crops that would be considered immense in the best potato sections North.

GROWING SEED POTATOES IN THE SOUTH.

The seed potatoes in the South are always grown from the potatoes of the early crop. There is some variation in the methods used, but the general practice is to keep the potatoes, after digging, in a place where they will get greened by light and not direct sunshine, and then to cut small pieces off the ends and place them under cover of straw on the ground to sprout. The sprouted potatoes are planted in a deep furrow the middle of August, and covered rather lightly till the leaves show, and then the earth is gradually worked to them till perfectly level and is kept so. This crop seldom matures fully, as the tops are finally cut by frost, though we have had them grow here unharmed till the first of December. They are dug early in December, buried in the field and covered with pine straw and earth till they are wanted, either for sale or planting. Many of them, as we have said, go to New York in February as new Bermuda potatoes, and bring $3 to $5 per barrel. The practice is not a bad one, as the potatoes are really better than the real Bermudas. This second crop is usually planted where some early crop was heavily fertilized and no extra fertilization is given it, as the potatoes are used mainly for seed and a very large size is not sought.

In the mountain regions of the South the methods for growing late potatoes as practiced northward are the rule, and much of the supply of table potatoes for the Southern cities in winter comes from the mountains of North Carolina.

POTATOES IN THE HOME GARDEN.

Many people in towns and villages, as well as some on the farm, like to have a small patch of early potatoes for the table planted in the garden. Old gardens are very poor places for potatoes unless they are carefully treated. It is quite commonly heard after experiments in potato culture in the home garden, "My garden is too rich for potatoes; they all run to tops;" and the fact that they have gigantic tops and quite small tubers is very apparent. Now the soil produced these great tops, and the great tops failed to perform their duty—for it is the top that makes the potato—and here were surely tops enough to have made a large crop, while the fact is the crop is miserably small. Why is it thus? We have shown that the carbonaceous matter in plants comes from the air through the power which the green matter of the leaves has to decompose carbon di-oxide in the air—take the carbon and leave the oxygen. After taking the carbon, the plant in the leaf makes the carbohydrates out of the carbon, oxygen and hydrogen taken from air and soil. The first carbohydrate is probably some form of sugar for the immediate sustenance of the living matter of the plant, and when this want is supplied the plant forms starch as a storage form of food to keep for future use. But it is found that the plant will not make (or cannot make) the change from sugar to starch except in the presence of an abundant supply of potash, in proportion to the nitrogen and phosphoric acid present. The effect of nitrogen is to form a heavy growth of all parts of the plant, but especially of the foliage. This heavy foliage ought to assimilate more carbon and store more starch than a weaker growth, and it will do it if there is a proper proportion of the mineral elements present. The old garden soil has grown big tops and small potatoes, not because it is too rich, but because it is too poor in phosphoric acid and potash. The soil has for years been manured with stable manure until there is an excess of nitrogen over the other elements and the great growth is there, but it is a poorly balanced growth, and the foliage cannot perform its part in the construction of starch, although there is a great activity in all the vital functions of the plant and a very rapid growth of tops going on, but the resources of the plant are taxed to keep up this growth and there is no surplus to store in tubers. Hence, if you are trying to grow potatoes in an old garden, do not put more stable manure on the land, for that will only increase the trouble, but give it a heavy dressing of a mixture of four parts of acid phosphate to one part of muriate of potash. Use this at rate of 500 pounds per acre and you will find that your old garden soil is not too rich to grow potatoes. It is simply suffering from an ill balanced food ration, and there is nothing that will sooner renovate and restore an old garden than a use of commercial fertilizers on it for a time. The old garden which has been heavily manured with stable manure for generations, has gotten into the bad habit of running everything to tops, and the only way to get it out of this habit is to restore the balance in the soil food elements. The commercial fertilizers will have a far better effect on such soil than they would on poor soil, because of the abundant supply of humus which the garden has acquired during the past years. This humus retains moisture and enables the soil to fully dissolve all the available food in the fertilizer, and the plants get the benefit of the application far more certainly than they would have gotten it in a poor soil incapable of retaining so much moisture. The old garden is not too rich, it is simply unbalanced.

VARIETIES OF POTATOES.

It is rather beyond the scope of this book to give detailed lists of varieties of the crops grown. There are so many fine sorts of Irish potatoes now offered by dealers that a list would simply confuse instead of enlighten. It is, however, curious to note that with the great increase of the introduction of new varieties, the market gardeners and the farmers to a great extent adhere to the old favorites. In the South the Early Rose and Bliss's Triumph almost equally divide the attention of the market growers of early potatoes, the Bliss being the favorite in the Mississippi Valley and the Rose still taking the lead on the Atlantic coast. A variety (or sport) of the Bliss's Triumph, known as White Skinned Triumph, has been produced, that some prefer as a more salable potato to the red skinned sort. Our enterprising seedsmen annually give us new potatoes, many of which are of surprising excellence, but it takes a long time for a new potato to become standard with the market growers. In Pennsylvania and for the far West the Burbank has become the standard potato for the main crop, and seems to satisfy the conditions where it has become so, until growers hardly think of any other. The Experiment Stations in some States give us the results of trials of long lists of varieties, while we are of the opinion that it would be far better to devote more attention to the development and improvement of the old sorts.

DO POTATOES RUN OUT?

Undoubtedly under careless culture a variety may become, in a particular place and with a particular grower, inferior in quality and productiveness. But we cannot agree that a good variety of potato cannot be kept up to the standard and even improved by the proper selection of seed potatoes. Farmers have long discussed the question whether small potatoes are as good as large ones for planting, and many seem to forget that the potato tuber is not properly a seed at all, but an underground development of the stem of the plant. If a planter chooses a potato simply because it is large and rejects another simply because it is small, he shows that he has not studied the laws of plant life. Planting large potatoes for no other reason than size will probably result in the planter getting larger than if he planted small ones simply because they were small and hence unsalable. But he is making the same mistake that he would in selecting any plant merely for the size of the product; he may get size at the expense of other desirable characters in the plant. We want good sized potatoes of course, but we want large crops of good sized ones, and to get both we want the best developed plant for the purpose. Conditions may make the potatoes in a hill, the plant of which has the desirable character of vigor and productiveness, small. But these small ones have a tendency to inherit the productive character of the plant and would make valuable seed stock for planting. On the other hand a large and handsome potato or two may be the entire crop on a plant with rather inferior character, and which simply formed one or two potatoes. These would inherit a tendency to reproduce similar conditions. Hence in the saving of potatoes for seed, the real student-farmer, who is ever on the lookout for desirable variations in the plants he grows, will study the growing plant; and will go through and mark those having the sturdy and well developed plant he seeks to perpetuate. Then, at digging time, he will study the results in each case, and will select from these the ones that have the greater number of desirable characters in the crop; those that make not only the greatest number of tubers but the greatest number in proportion of marketable tubers. Thus year after year he will be devloping and perpetuating the most desirable characters. His potatoes will never "run out," while those of the man who always plants small potatoes because they are small and unsalable and the man who always plants large ones simply because of their size, may find a deterioration in the vigor and productive capacity of his plants and will conclude that potatoes run out. There is no doubt that the constant planting of culls will more rapidly run out the crop than the constant planting of only the large ones.

The Southern grower of the second crop potatoes for seed to plant the following season will do well to make this selection from the early crop, and not do as many now do, plant only the refuse of the early crop. In the end such a course must finally lead to deterioration. Even now there are growers who say that they find it desirable to return to the Northern seed stock every five or six years. This would be entirely needless if the proper course of selection was made for the growing of the second crop seed potatoes.

SOME STATION INVESTIGATIONS IN POTATO CULTURE AND MANURING.

Bulletin 136 of the New Jersey Station gives the details of experiments with nitrogenous fertilizers on various crops. The experiments with the potato were to determine the relative effect of the three different and distinct forms of nitrogen, as well as the amounts of the same when applied to a light, sand soil, which lacked "condition" and was poor in respect to physical character. It is well understood that the usefulness to the immediate crop of the best forms of the fertilizer constituents is modified by the character of the soil to which it is applied, that larger returns per unit of application may be expected from soils which have been well cultivated and are in good heart or condition than from soils that do not possess these characteristics. The soil was, however, well supplied with phosphoric acid and potash previous to planting the potatoes, the former derived from acid phosphate and bone and the latter from muriate of potash.

Two experiments were included, each containing ten plats one-twentieth of an acre each, and the table shows the amount of nitrogenous fertilizers applied and the yields per acre of each individual experiment as well as the combined experiments, calculated on the basis of an acre.

Without giving the detailed table here we will summarize from the bulletin that none of the plats reached as much as 100 bushels per acre, though the relative increase in yield from the use of the different forms of nitrogen was quite considerable. The forms used were nitrate of soda, cotton seed meal and sulphate of ammonia in various amounts. There seemed to be little difference in the yield from variations in the amount used, the smaller quantity having been practically as efficient as the larger. With one exception the nitrate of soda was uniformly more effective than the other forms, the increased yield from the nitrate being on the average 84 per cent.; from the sulphate of ammonia, 77 per cent., and from cotton seed meal, 38 per cent. The experiment, it is stated, is chiefly valuable in showing that in growing potatoes on such poor soils the first need is for physical improvement, rather than for large doses of the best forms of plant food. That is, they should be made more absorptive and retentive of moisture by the accumulation of humus in the soil through the agency of legumes or the application of domestic manures, so that the applied nitrogenous materials may be more fully utilized.

Bulletin 137 of the New York Agricultural Experiment Station says that the experiments made at that Station furnish strong evidence that the potato growers of Long Island are annually wasting large quantities of valuable fertilizing ingredients. Market gardening is there carried on in the most intensive manner, and the fertility of the somewhat poor soil is supplemented by the use of surprisingly large quantities of commercial fertilizers, an outlay of $20 per acre for plant food of this character being not uncommon. Potato growers frequently apply one ton of high grade superphosphate per acre, while in the Station experiments the most profitable result each year was obtained by the use of only half this quantity of fertilizer, and the residual or second year effect was practically the same with the 1,000 pounds as with the 2,000 pounds. Heavier yields were obtained from the larger application, but the additional gain from the use of more than 1,000 pounds of fertilizer was at a greatly increased cost per bushel. We would note, however, that the soils at Geneva and those on Long Island are very different in their physical character, and the latter are far less retentive than the former. The plat on which no fertilizer was applied made 113.1 bushels per acre. An application of 500 pounds of fertilizer made an increase of 34.1 bushels of large potatoes, 1,000 pounds made an increase of 69.1 bushels of large potatoes; 1,500 pounds made an increase of 77.5 bushels of large potatoes, and 2,000 pounds made 78.7 bushels increase. It was found that the fertilizer formula based on the analysis of the potato, gave less results than the formula commonly used on Long Island, which contains 4 per cent. nitrogen, 8 per cent. phosphoric acid and 10 per cent. of potash in the form of a muriate.

The following table is given, showing the influence on the crop of the different fertilizers:

Amount per acre.	Plats.	Station Formula. Yield per acre.	L. I. Formula.		Increase in L. I. Formula.
			Plats.	Yield.	
None	8	113.1 bus.	8	113.1	
500 lbs.	4	125.5 bus.	4	163.8	38.3 bus.
1000 lbs.	4	166.2 bus.	4	184.7	18.5 bus.
1500 lbs.	4	166.8 bus.	4	189.5	22.7 bus.
2000 lbs.	4	178.4 bus.	4	190.4	12.0 bus.
Average	16	159.2 bus.	16	182.1	22.9 bus.

The Long Island formula gave better results with each quantity of fertilizer and produced an average of nearly 23 bushels per acre more than did the formula based on the composition of the tubers. The difference between the two fertilizers was strikingly shown by the appearance of the vines, for those upon the Long Island formula plats were one-fourth larger than those receiving the other formula, and in at least one instance the vines were of a darker green. The two fertilizers differed in the proportions of two ingredients only, the Station formula being richer in nitrogen and poorer in phosphoric acid than the Long Island formula, potash being the same in each. The variation in effect of the two combinations seemed greatest where the smaller quantities were applied, which may indicate either that the Station formula did not, in small quantities, furnish enough phosphoric acid, or that in large amount it contained an undesirable quantity of the nitrogen compounds. In either case, if future experiments substantiate the results of this trial, the claim that the composition of a crop should be the guide in mixing special fertilizers will be discredited. As the best form of potash the bulletin says that it has been thought, and has been supported by some experiments, that the liberal use of the muriate of potash tends to lower the percentage of starch and dry matter in the potato, therefore chemical analyses were made of tubers from each plat and comparisons were made of those receiving potash in the two forms of sulphate and muriate, in hope that light might be thrown on that question. Taking the average of 16 plats for each manner of treatment, it was found that where sulphate of potash had been used the potatoes produced more of both dry matter and starch than where muriate had been applied. But the significance of these results was utterly nullified by the fact that the tubers from the unfertilized plat adjacent to those differently fertilized differed in the same way, and to almost exactly the same extent, seeming to show that it was a natural difference in the soil of the plats rather than the kind of fertilizer used. The muriate in our own experience has always given the largest yield, and so far as table tests can go of fully as good quality as those grown with the sulphate, which is the more costly form.

This fact is borne out by the results at the Cornell University Experiment Station, where an application of 200 pounds of muriate of potash and 300 pounds of acid phosphate made 318.2 bushels per acre, and the same amount of fertilizer with the potash in the form of a sulphate made 310.5 bushels per acre. On two other plats the difference was still greater, for the plat on which the same amount of muriate of potash was used made 360.6 bushels per acre while the plat on which the sulphate was used made but 333.5 bushels. Potatoes that were cultivated thirteen times made a smaller crop than those cultivated nine times, and it was evident that nine cultivations will give the better crop in an average season. Still, as the bulletin well states, the effects of good culture are very plain, for in spite of adverse conditions the crop was an excellent one. The average yield of potatoes per acre in the State of New York the same year was only from 50 to 65 bushels per acre, while the average on the Station grounds was over 300 bushels per acre, on soil not naturally more fertile than the average, and, in fact, showing by analysis a lower fertility than the average. In a subsequent bulletin from the same Station it was found that six or seven cultivations gave the best results, and that success with the potato crop depends largely on the preparation given the soil before the potatoes are planted. Plowing should be deep, and at the time of planting the soil should be mellow and loose, the crop planted early and deep and the cultivation frequent and level. Harrowing before the potatoes came up gave marked results.

The Rhode Island Eperiment Station has done a great deal of work in the investigation of the effects of lime on soils. In regard to the growing of potatoes free from scab, the statement is made that on land in an acid condition and containing no lime, the potatoes may be grown practically free from scab, if only commercial fertilizers are used; that a gain in the crop may be made from an application of lime on such soils, but the prevalence of the scab is increased thereby. Wood ashes will also increase the amount of scabby potatoes. An application of the chloride of lime entirely prevented the scab, but injured the crop of potatoes. The sulphate of lime, commonly known as land plaster, is the only form of lime that was found not to injure the growth of the crop and at the same time did not favor the increase of the scab. Barnyard manure, owing to its alkalinity or the production of carbonates from it, has probably in and of itself increased the scab. Upon an acid soil, practical immunity from scab has been secured upon three successive crops by the use of fertilizers such as the ordinary commercial fertilizers, even when scabby tubers were used as seed and were not treated for the scab. On such soils the potatoes can be profitably produced by the use of commercial fertilizers.

At the Ohio Station it is stated that superphosphate has increased the potato crop to a profitable extent, the cost of a bushel increase being but five to six cents. There was not found much difference in the efficiency of superphosphate from the dissolved rock and from bone black, but slag phosphate gave lower results than the other forms. Wheat bran was a better fertilizer than linseed meal. Nitrate of soda and muriate of potash, when used singly, have not given much increase. Superphosphate, nitrate of soda and muriate of potash in combination have given better results than either alone, and the crop increase has been nearly in proportion to the quantity used up to 1,100 pounds per acre.

At the Maryland Station it was found that a complete fertilizer in which nitrate of soda and an organic form of nitrogen was used in connection with acid phosphate and sulphate of potash, gave the best results in the crop, making several bushels more than the same formula with muriate of potash used in place of the sulphate.

At the Pennsylvania Station it was found that the use of nitrogen resulted in a profit of from $2.17 to $9.56 per acre, according to the combination in which it was used. The use of phosphoric acid resulted in a gain of $7.72 per acre. The use of potash resulted in a gain of $17.39 per acre. The use of phosphoric acid and potash together produced a gain of $52.02 per acre, while a complete fertilizer containing nitrogen, phosphoric acid and potash made a gain of $56.88 per acre. Nitrogen alone made a gain of $2.17 per acre, showing a difference in the effect of an incomplete and complete fertilizer of $54.71 per acre. The conclusions arrived at were that on that soil potatoes especially needed potash, and to a somewhat less degree, phosphoric acid. The effect of nitrogen being shown to be small, it would seem that instead of purchasing costly artificial supplies of nitrogen, if potatoes are to be grown extensively, it would be better policy to secure the needed supply of nitrogen from the air by the cultivation of leguminous crops, either used as green manure or fed to animals, and to confine the purchase of artificial fertilizers to phosphate and potash. It seems altogether probable that such a method of treatment would suffice to keep the supply of nitrogen in the soil up to a point at which purchased mineral fertilizers would yield their best returns. A very important point is the using of phosphoric acid and potash together, for in one experiment, while the phosphoric acid alone gave a gain of $7.72 per acre and potash alone $17.39 per acre, when the two were combined they gave a profit of $51.02 per acre. In some other soils experiment has shown that while potash was as important as in these the next important element was nitrogen, and this is usually the case in the early crop of potatoes grown in the South in the early spring.

The Pennsylvania bulletin further states that it may be interesting to compare the amounts of nitrogen, phosphoric acid and potash applied in these experiments with those contained in the so-called "potato fertilizers" so largely offered by various fertilizer firms, the average of 47 samples of such fertilizers analyzed in that State shows the following percentages: Nitrogen, 1.86 per cent.; total phosphoric acid, 11.16 per cent.; potash, 5.55 per cent. Twelve hundred pounds per acre of a fertilizer of this composition would have contained the following amounts of these ingredients, as compared with those contained in the 1,200 pounds of mixed chemicals applied in these experiments:

	Average potato fertilizer.	Mixed chemicals.
Nitrogen	22.3 lbs.	48 lbs.
Phosphoric acid	133.9 lbs.	90 lbs.
Potash	66.6 lbs.	150 lbs.

That is, the average potato fertilizer would have supplied only 44.4 per cent. as much potash as was used with profit in these trials, while it would have supplied 148.8 per cent. as much phosphoric acid and almost exactly half as much nitrogen. This shows that for some soils the usual potato fertilizers are not properly compounded, and makes it all the more evident that the farmer should test the needs of his soil by experiment. The bulletin well remarks that the conducting of an experiment involving only the use of eight small plats, and not necessarily continued more than a year or two, would be a small price to pay for knowledge which may save the unnecessary expenditure of large amounts of money for fertilizing ingredients already present in the soil in more than sufficient quantity. No farmer can afford to spend his hard-earned dollars to purchase fertilizing materials without knowing, first, that he receives the value of his money in a commercial sense, and second, that the material which he buys at a fair commercial price is the exact material needed for his soil and crop.

At the Kentucky Station it was shown that an application of acid phosphate alone made a smaller crop than on the the plat where no fertilizer was applied. Potash applied alone greatly increased the yield, as did nitrogen alone to some extent, but the best results were from nitrogen and potash mixed.

At the Ohio Station a comparison was made between the second crop seed potatoes from the South and Maine potatoes. The potatoes from Maine and Wisconsin were considerably sprouted, while the second crop seed hardly showed any signs of sprouting. They were in excellent condition and of the best quality. The yield was slightly in favor of the Southern second crop seed except in the case of the Early Rose. The general average was a little in favor of the Northern seed, the average yield from the second crop seed being 170 bushels per acre and of the Northern seed 171 bushels per acre. In 1894 the average from the Southern seed was 105 bushels per acre and that from the Northern seed 102 bushels per acre. It seemed that for that latitude there may be no advantage in the Southern seed, provided the Northern seed is as well kept.

In regard to the use of fertilizers on the potato crop this bulletin says: "In the use of fertilizers the lowest cost per bushel of increase in crop has been attained in the use of superphosphate alone, but the greatest gain per acre has been with 1,100 pounds per acre of fertilizer containing phosphoric acid, nitrogen and potash. Muriate of potash and nitrate of soda, when used alone, have not given a profitable increase, but have proved beneficial in connection with superphosphate. Phosphoric acid seems to have been the controlling element in an increase in the potato crop in all of our experiments."

This shows the importance of testing the needs of the soil experimentally, for, as we have seen in the Pennsylvania experiments, phosphoric acid had less effect than potash alone, and the same was found to be the case in Kentucky. But in one co-operative experiment given in the Kentucky bulletin it was shown that on a soil different from that of the Station the same results were had as detailed by the Ohio Station, showing a great variation in the manurial requirements of different soils, even in the same State.

At the Texas Station it was found that potash, either as a muriate or sulphate, produced a paying crop, and that bone black was the best one-sided fertilizer. In regard to the Southern second crop seed potatoes the Texas Station says: "So far as our experience goes, it seems safe to conclude that second crop potatoes are as good, if not better, for planting, than Northern grown seed."

CHAPTER XXXVII.

SWEET POTATOES.

Our sweet potato is a member of the morning glory family and is not of the same family as the Irish potato. Unlike the Irish potato, too, it is a true root and not a tuber, though tuberous in form. The sweet potato delights in a warm, sandy soil, and will not reach its best condition in any other, though fair success can be had in heavier loams. Though differing in character from the Irish potato its manurial requirements are very similar. But as the plant grows through the long, hot season, when nitrification is active in the soil and is still further promoted by the rank cover of the vines, the crop needs far less nitrogenous manures than the early crop of Irish potatoes. In fact, any excess of nitrogen will lead to a rank development of tops at the expense of the roots, and while these rank vines are capable of storing large quantities of the starch and sugar so important in the tuberous roots, they cannot do this unless there is plenty of the mineral elements over and above that needed for the perfection of the top-growth. Hence phosphoric acid and potash are far more important for the crop than nitrogen, and the slowly available organic matter is better than the immediately available nitrogen of a nitrate. While on the northern limit of the culture of the sweet potato it may be desirable to use stable manure in its production, such would be rather a hindrance than a help in the South. The large market growers understand the requirements of the plant very well and they understand that the humus forming matter in the rakings of a pine forest are desirable as an application to the soil, not alone for their manurial effect but for the mechanical lightening of the soil and the retention of moisture. Therefore the skilled market grower of sweet potatoes uses the forest mold only, as the organic matter, and supplements it with liberal applications of the mineral elements.

MANURING FOR THE SWEET POTATO CROP.

There is no doubt that the organic matter needed by the sweet potato could be more cheaply grown on the land by a crop of legumes than by the laborious raking up and hauling and spreading of the forest mold, and it is hoped that the growers will soon find out this fact. There need be no fear that there will be an excess of nitrogen, provided it is balanced by a liberal application of phosphoric acid and potash. It is not the amount of nitrogen that is harmful but the excess in proportion to the other constituents, and a very rank growth of vines may produce a fine crop of roots if the food is at hand which is needed for the storing of starch and sugar. It is the unbalanced ration in the soil that does the harm and not the amount of plant food present. We have explained that in discussing the garden culture of the Irish potato in which similar conditions exist. The rotation of crops and the growing of legumes is just as important to the vegetable grower as to the farmer, and in no way can he so economically stock his soil with the needed humus as by the growing of legumes between sale crops.

But no matter whether we haul the rotten leaves from the forest or get the vegetable decay from a crop of pea vines, the getting of it in the soil in abundance is an important matter to the success of the sweet potato crop. Having this organic matter then there will be no need for the application of any nitrogenous fertilizer whatever, except in Northern localities where the short season requires that the crop be hurried. In such cases the top dressing along the rows of nitrate of soda at rate of 25 pounds per acre at two applications, will be the best. The general mixture for use in the Middle and Southern States will then be: Acid phosphate, 1,600 pounds; sulphate of potash (high grade), 400 pounds. Five hundred pounds per acre of this mixture will be an abundant dressing for the sweet potato crop.

GROWING THE PLANTS.

Sweet potatoes are always grown from plants sprouted in the spring from roots kept over for this purpose. That is, these plants are always used for the first planting in the South and for the entire planting in the North. The late crop in the South is produced from cuttings of the vines of the early planted crop. In the North it is the common practice to bed the potatoes in a hotbed under glass, and in the potato growing section of the Middle States fire-heated beds are often used. In the South the bedding is generally done in the open ground with a cover of straw to assist in keeping out cold. As the plants cannot be set in the open ground till it is settled and warm, it is useless to start the plants too early. There are few localities in the North where it will be available to set the plants before the last of May or the first of June.

We have adopted a method of sprouting sweet potatoes which we prefer to any other. We use the ordinary cold frame, and place in it a layer of clean sand. On this we place the small potatoes just near enough not to touch. They are then covered with clean sand about two inches above the top of the potatoes. The sand is settled with a sprinkling of warm water, and the sashes are put on and kept close until the potatoes begin to sprout, when they are opened a little every sunny day to keep the temperature from getting too high. This bedding is done the last of March. We prefer the frame to the manure heated bed, as it is less provocative of fungus growths that damage the plants, and though the sprouts are rather slower in appearing they are stout and strong, and in the sand get well rooted, far better than if in a rich soil. If the potatoes are sound and free from disease there will be little danger of "black shanked" plants, and they will be ready as early as it is safe to set them.

CULTIVATION OF THE SWEET POTATO.

A few days ago a gentleman from Georgia, seeing the low ridges on which my sweet potatoes were growing, was very much surprised. He said: "We throw up large beds with the plow and then go over them and pull them up higher with the hoe so as to have high beds to set the plants in." It is strange how long this useless practice has held its ground in the South, involving an unnecessary amount of labor and making a less valuable crop. The sweet potato is the one crop for which we always plow shallow, as we want a hard bottom right under the ridge in which they grow so that the potatoes will form short and stout rather than long and crooked. The upper four inches of the soil we prepare as thoroughly as possible, and then lay off furrows, three feet apart, in which the fertilizer is scattered. A furrow is thrown from each side with a single plow, so as to form a list over the first furrow. Just before planting the top of this ridge is flattened with a rake, leaving the ridges only about three inches high. Plants are carefully drawn from the bed so as not to disturb the potatoes, and are set at once with their roots in a bucket of water. They are set thus dripping, are placed so that only the tip of the shoot is above the ground, and the earth is pressed firmly to them. If the land is moderately moist this will be successful without any watering. If planted when the soil is very dry, it is better to pour a cup of water in each hole and at once drop the plant in and cover. Cultivation with the small tooth cultivator is begun as soon as the plants get hold of the soil, and is kept up shallowly till the vines cover the ground. The last working is after the vines get quite long. A hand goes ahead and throws the vines over into the adjoining space and the cotton sweep is used to throw a furrow to the row. Each alternate row is thus laid by and then the vines in the other rows are thrown over and the remaining rows earthed up. No hand work is done except to remove any grass or weeds that may appear in the rows. No effort is made to throw back the vines from the last working, as they can wander wherever they list. Some growers go through the field later in the season and pull the vines loose where they have rooted to the ground, but we do nothing of the sort as the labor in doing it is wasted.

PLANTING THE LATE CROP IN THE SOUTH.

The sweet potatoes from the spring planting of sprouts make the earliest potatoes, but it has been found that those grown later in the season are more easily kept in winter than the spring planted ones. Hence all large growers produce the winter keeping crop from cuttings set in summer from the vines of the early crop. This late crop is grown for two purposes. First, for the production of a crop for table use in winter, and, secondly, a crop of small potatoes for bedding in the spring. For the table crop a piece of land is selected from which some early crop which was fairly well fertilized, has been taken off. Furrows are run three feet apart, and cuttings a foot long of the tips of vines are laid along the furrow slice 15 inches apart, and another furrow is thrown on them so as to cover all but the tip of the cutting. Men follow and tramp the earth to the cuttings and the work is done. If the ground is rather moist and the weather favorable nearly every cutting will grow and they are worked just as the first crop. This planting is done early in July. For the seed crop cuttings about a yard long are made in August Ridges are made as for spring planting, the planter coils the long cutting around one hand, and inserts the whole coil in the ground so as to leave only the tip exposed. A cluster of small potatoes will form at every covered joint, and these "slips," as they are called, make far better and more productive seed for the spring bedding than the cullings from the main crop.

HARVESTING SWEET POTATOES.

The crop always grows till frost cuts the vines. When the first light frost has blackened the leaves, lose no time in taking off the whole of the vines from the hills, even if you do not dig them at once, for the decaying vines, if left on, will soon affect the roots. Choose sunny and warm, dry weather for digging. Throw a furrow from each side with a small plow and then take the potatoes out carefully in whole bunches, with the forked hoe. Lay them carefully along the rows to dry in the sun, and on no account allow them to thrown in heaps, as that will be sure to bruise them. Gather in baskets and haul to where they are to be stored, handling at all times as carefully as eggs. The storing is the most important thing in the keeping of the crop.

KEEPING SWEET POTATOES IN WINTER.

This has always been the great difficulty North and South. Where the crop is grown on a large scale there should always be a building especially constructed for the purpose of wintering the crop. With such a building as we will hereafter describe the keeping in winter is comparatively easy and certain. Late in August, 1900, I met a gentleman in South Carolina to whom I had given directions for a potato house. He told me that the house had been a great success, and that he was then feeding hogs on sweet potatoes a year old, grown in the summer of 1899. The common practice in the South is to keep the potatoes in "banks," or hills. When well done, and the potatoes are carefully handled before storing, this may be done with very good chance for success. Our method of hilling is as follows. The banks are made, if possible, under a shed open to the south. If no such shelter is available we make a shed at least to keep the rain off. A thick layer of pine straw, gathered in dry weather and kept dry, is laid on the ground, and the potatoes piled in conical heaps on this straw about 25 bushels in a pile. The piles are then thickly covered with the same dry pine leaves, and left till they go through the "sweat," which they are certain to take when stored. After they have dried off and the weather is getting cool, we cover the heaps with earth lightly, and gradually increase the cover as the weather gets cold, till they have a foot of earth over them. As the shed keeps the rain off the dry earth will keep out any frost, and if the potatoes were free from disease and were carefully handled in storing they will usually keep well.

CONSTRUCTION OF A POTATO HOUSE.

A heated building for the keeping of sweet potatoes is by far the best method for their preservation. Such a house should not be over ten feet wide, and may be as long as needed, but it will be better not to make it over fifty feet long, if heated by one furnace. Height of the walls is a matter of convenience. The side walls and the roof should be made double and packed with dry sawdust. Along the roof a ventilator should be made, which can be operated from one end with the same apparatus used in the ventilation of a greenhouse. Shelves should be made with slatted bottoms, on both sides of the house, four feet wide and far enough apart to store the potatoes a foot deep. In a shed at the north end build a brick furnace and take from it a brick flue straight through the middle of the house to a chimney at the further end. Planks can be laid above this flue as a walk in filling and to be removed before any firing is done. Put the potatoes carefully on the shelving, and then start a fire in the furnace and run the temperature up to 90 degrees until all the sweat is dried off the potatoes, keeping the ventilator open slightly all the time to let off steam. When the potatoes are thoroughly dry, close the house and then only in very cold nights may there be any need for more fire heat. So long as the temperature can be kept up to 50 degrees there will be no need for fire heat, and if the walls are well deadened, in the South this will be easy. In such a house it is perfectly practicable to keep sweet potatoes till the new crop of the following year is large enough for the table. The whole secret in keeping sweet potatoes is to handle them with care and then dry them off as completely as possible, then maintain a temperature of 50 degrees during the winter.

SWEET POTATOES NORTH AND SOUTH.

There is a wide difference in the character of the sweet potatoes preferred by people in the North and in the South. Those who grow potatoes for the Northern markets are compelled to grow potatoes which no Southerner will eat if he can help it. The Northern market demands a smooth, yellow potato, with very dry flesh, while the Southerner wants the sweeter sugary and jelly-like "yam." The Southern yam is not a true yam, but merely a sweet variety of the sweet potato. Tastes of people North and South have been largely formed by their different methods of cooking the roots. Northern people steam or boil sweet potatoes, and the Southern yam is worthless for any such cooking, while the dry and chokey yellow potatoes sold North are well adapted to such a method. A yellow Nansemond, or "Yellow Bark," as they are called in the South, if cooked by baking as the Southern people always cook sweet potatoes is such a chokey article that it is difficult to eat, while the Southern yam steamed, will lose its sugary character and be a mass of mush. If the Northern users of sweet potatoes would cook the Southern potatoes as the Southern people cook them they would soon find that the dry Nansemonds are becoming tasteless to them as they are to the Southerner. When well matured in winter the baked yam, with its jelly-like meat, is a delicious morsel, and far sweeter than any dry potato. But the market grower must consult the tastes of his patrons, and it will probably be a long time before there is a demand North for the vastly superior potatoes the Southern people eat at home.

VARIETIES OF THE SWEET POTATO.

The most popular potato in the great cities of the North is doubtless the Yellow Nansemond, which is largely grown in New Jersey and Delaware, and a similar potato known in Virginia as the "Red Nose," which is largely grown in the Peninsula of Virginia for the Northern market. All potatoes of this class are known as "Yellow Barks" in the South, and are there grown only by those engaged in shipping North. In some sections of Virginia a large, light skinned potato with yellow flesh, known as the "Hayman" or "Southern Queen," is grown both for home use and Northern shipment. It is intermediate between the yams of the South and the yellow barks. This was brought to North Carolina many years ago by a sea captain named Hayman, from Brazil; hence the name, Hayman. Years ago it got into the hands of a Northern seedsman, who introduced it as the "Southern Queen." It is one of the most productive of sweet potatoes, and is early and the easiest of all to keep in winter. Hence it is well adapted to Northern culture as it can be planted there late in June and make a crop. Of the distinctively Southern varieties the most popular are the "Pumpkin Yam" and "Norton Yam," with deep pumpkin colored flesh; the Barbadoes in two varieties, white and yellow, and the Jewell yam, of a yellow color. There is a variety known as "Nigger Choker," which would suit the Northern taste. It is a deep, purplish red on the outside, but the flesh is pure white and very dry, and hence not popular in the South. The most productive of all sweet potatoes is the "Peabody." This grows to a very large size and is used in the South largely for hog feed, on account of its productiveness. It is too dry and lacks the sweetness which the Southern taste demands, and is only eaten here when partly grown, because it reaches a table size earlier than others and is salable till better potatoes are on the market. There are many other sorts in different parts of the South, and a good deal has been said of late about the vineless yam. The fact is that there are a number of vineless sweet potatoes, or sorts that do not make a running vine, and we have had several varieties to sport into this character among the ordinary sorts. We have failed to see any particular advantage in the vineless sweet potatoes.

EVAPORATING SWEET POTATOES.

There is no vegetable grown that is so easily and rapidly dried as the sweet potato. Cut in slices and evaporated in any of the portable evaporators, they can be kept in sacks in winter without difficulty, and can be made into a variety of dishes and puddings, after being soaked over night to restore them; or they can be pulverized and used for the many nice dishes that the Southern housewife knows so well how to prepare. We have often thought that if some one would go into the business of evaporating and pulverizing the sweet potato, and then pack them in neat papers, such as corn starch is packed in the North, a large and profitable trade could be established, especially if the packages gave the recipes for custards and pies and such things that the sweet potato makes so perfectly. There is a great opening in the South for the investment of capital in such a business, for the potatoes can be contracted for as cheaply as Irish potatoes are contracted for at the starch factories in Maine.

YIELDS OF SWEET POTATOES FROM LARGE AND SMALL TUBERS.

The experiments at the Texas Station show that the sweet potato is just apt to produce large crops from small tubers, or rather tuberous roots, as from large ones. In fact, the small roots gave the largest yields. Cuttings of the vines set in June were usually smoother potatoes than those raised from the spring plants. They are also much less liable to disease, and hence are better for the seed for the following year. Early plants are set for the purpose of giving cuttings for the late crop.

The Texas Station also gives the following results from the application of fertilizers to the sweet potato crop:

Plat No.		Yield bushels.
1.	Nitrate of soda, 460 lbs.	128.33
2.	Muriate of potash, 150 lbs.	146.47
3.	Bone black, 300 lbs	207.66
4.	Sulphate of potash, 200 lbs.	208.79
5.	No fertilizer	201.17
6.	Cotton seed meal, 500 lbs.	194.67
7.	Barnyard manure and wood ashes, 20,000 lbs	179.85
8.	Special sweet potato fertilizer, 600 lbs	222.50
9.	No fertilizer	219.71
10.	Nitrate of soda, 460 lbs., sulphate of potash, 200 lbs	166.87
11.	Nitrate of soda, 460 lbs, muriate of potash, 150 lbs	170.77

12. Nitrate of soda, 460 lbs., bone black, 300 lbs............208.76
13. Bone black, 300 lbs., sulphate of potash, 200 lbs...........255.50
14. Nitrate of soda, 460 lbs., bone black, 300 lbs., and sulphate of potash, 200 lbs...................................173.36
15. No fertilizer.....................................170.58
16. Slaked lime, 4,360 lbs...............................250.14

It will be seen that the best results were from potassic fertilizers and phosphoric acid. Muriate of potash lowered the yield, and nitrate of soda increased it but once. The special sweet potato fertilizer contained a large percentage of phosphoric acid. The analysis of this fertilizer was: Total phosphoric acid, 8.5 per cent.; potash, 1.93 per cent.; nitrogen, 0.80 per cent.

From our own experience in the fertilization of the sweet potato we would say that this fertilizer was too low in potash for the best results, on the average sandy soil in which the sweet potato is grown in various parts of the country. It will be found that the sweet potato as grown in New Jersew will bear heavier applications of nitrogen than it will in the South.

CHAPTER XXXVIII.

TOMATOES.

There is no vegetable crop grown that has so increased in popularity in the past forty years as the tomato. The writer can remember when in the markets in the city of Philadelphia but a few bushels could be sold on each market day, and canning was then unknown and few people ate the fruit at all. Now the use of the tomato has grown to enormous proportions, and where fifty years ago a peck would supply a market stall, it would take many bushels today. In many sections the crop has grown to the proportions of a farm crop and extensive fields are planted for the supply of the canning establishments in all parts of the country. Starting in the winter in Cuba and South Florida, the tomato is a staple for the market gardener all up the coast to the most northern point where they can be ripened in the open air. And not only in the open air is the crop grown, but acres and acres of glass are devoted to the forcing of the crop in winter, when the superior quality of the forced fruit finds it a ready sale at prices far above that of the inferior product of Cuba and Florida. There is probably more capital invested in the cultivation of the tomato in the open ground and under glass than any other garden crop. Hence the varying conditions under which the crop is produced should have careful attention. From the tender nature of the plant and its tropical origin it might be supposed that it would be more successfully grown in the South than North; but, in fact, the reverse is true. The crop in the South is never so large per acre as in the Middle and Northern States. The plants are there subject to disease to a greater extent than in the North, and the early crop is generally suddenly cut short by the access of drought and extreme heat about mid-summer, so that while the South can produce an early crop, and can produce the forced winter crop more cheaply than the North, the general crop for canning purposes will probably be always mainly produced in the Middle States , East and West. While farmers in Maryland can grow the fruit on contract for the canning houses at $6 per ton, the man in North Carolina who undertook to do the same thing (outside the mountain country) would not make the cost of his plants. We write this to show that each section of the country has its particular season and crop from the tomato, and that climatic conditions which cannot be overcome, determine to what extent each shall grow the crop. Manurial requirements also vary in the different sections. The amount of manure and fertilizers that the crop absolutely requires in the South would be a disadvantage in its growth in the canning sections of Maryland.

GROWING THE PLANTS.

With the advancing season from Florida northward, the sowing of tomato seeds is done at different times. The Florida growers who depend mainly on the advantage of their climate, sow the seeds late in the fall and grow the crop during the winter, taking some risk of frost, of course. As we come up the coast, in sections where frost is certain and sometimes severe in winter, a different method must be used, and the only real difference in the plans of the gardener in the South and in the North is in the time when he sows his seed. In our experience there is nothing gained by sowing the seeds earlier than ten weeks before the time when they can safely be transplanted to the open ground. Every grower will know when this is in his locality, and can make his sowing accordingly. The seed can be sown, of course, in a manure heated hotbed under glass sashes, or in the far South in a cold frame, to be transplanted as soon as large enough to handle to other frames to develop size and to harden off for planting outside. But we find that when the facilities are at hand a greenhouse is the best place for the sowing of the seed, and every market gardener should have a greenhouse for the early starting of his plants of various kinds, since it is far less troublesome and far less risky than a hotbed. We find that here we can set properly hardened plants the first week in April. Hence we sow the seeds about the last of January in shallow boxes or flats in the greenhouse, where a night temperature of 55 degrees is maintained. They are sown quite thickly, and as soon as large enough to handle and even before they have any but the seed leaves, we transplant them to other boxes about an inch and a half apart and set them down to near the seed leaf. As soon as they begin to crowd in these boxes, they are again transplanted into other boxes about two and a half inches apart By the time they crowd each other in these boxes it will be about the first of March, and then they are transplanted to the cold frames, are given four inches beween the plants, and are set quite deeply in the soil. If severe frost comes, the frames are protected by mats, but the plants are exposed to the air at every favorable time until finally the sashes are left off at night and the plants fully exposed a week or more before finally transplanting. We find that the more frequently the plants are transplanted and the earlier they can be gotten out to stand, the earlier the crop. Tomato plants that are properly hardened off before transplanting will endure a slight frost without injury. Once, in Northern Maryland, we set 55,000 tomato plants in the open ground the last of April, which was a very early date for the latitude, above 39 degrees. But the plants were large and stocky, and had been carefully hardened off in the frames. In the early part of May we had a white frost that covered the plants. The stems turned blue-black, but they were not hurt, and the result of this risk was that I began to ship tomatoes the last week in June, or nearly three weeks ahead of the gardeners on the western side of the Bay in the same latitude, and for that time I had the Baltimore market for nearby tomatoes all to myself. Some years ago, here in North Carolina, we had an exceptionally warm March. All the earlier part of the month was characterized by hot, summer-like weather, and everything got to growing and the trees leaved out. Concluding that spring was here to stay, I set tomatoes March 17th. On the 25th the Weather Bureau reported frost coming severely that night. I went to work and bent each plant to the earth, covered it with hay and then piled a mound of soil on each plant. The next morning the mercury stood at 21 degrees above zero, but the sun soon warmed things up. The following night there was a light frost and the next day I uncovered my tomatoes and found them all unhurt, and the crop was a very early one. Setting as early as the first week in April we run some risk of frost, but it is far better to stand ready to shovel the earth over them than to keep them inside longer. The same plan can be made available in the North at a later period, and gardeners everywhere will find it a great advantage to get the plants in the open ground early, provided they have been well hardened in the frames where they were spotted out. The skill of the gardener is shown in getting ahead of the growers around him and getting nearby tomatoes on the market in competition with the inferior fruit shipped from the South.

FERTILIZING THE TOMATO CROP.

From the fact that the tomato in old and rich gardens sometimes grows so rankly as to be an inconvenience, and noting the occasional productiveness of volunteer plants that come in the corn field at times, there has grown up a notion that heavy manuring is a disadvantage to the tomato. An accurate study of the manurial requirements of the tomato plant at the various Experiment Stations has demonstrated the fact that special fertilization is of great value in the productiveness and the early maturity of the plant. Prof. Voorhees recites the results at the New Jersey Station in the use of nitrate of soda as a special fertilizer for the tomatoes grown for the early crop, and that the results showed that when used at the rate of 160 pounds per acre at one application, or 320 pounds per acre at two applications, it increased the yield materially and not at the expense of maturity, and this was also true when it was used in a complete fertilizer mixture, with phosphoric acid and potash. But when the whole of the 320 pounds was applied at once with a sufficient proportion of phosphoric acid and potash, the yield was increased at the expense of early maturity. It was found that nitrate of soda was better than barnyard manure or mineral fertilizers alone, but when used alone was less effective than when a component part of a complete fertilizer. We have found, here, that the best fertilizer application for the tomato crop is made by mixing acid phosphate, 900 pounds; dried blood, 600 pounds, nitrate of soda, 200 pounds, and high grade sulphate of potash, 300 pounds, to make a ton. Of this we would use 700 pounds per acre broadcast before setting the plants. North of Virginia we would reduce this to 500 pounds per acre. When growth is well under way, and fruit is setting, we find it an advantage here to give a further dressing of nitrate of soda at rate of 100 pounds per acre. On land that had been heavily manured the previous year for garden crops, or on which a crop of legumes had been grown the previous season, we would reduce the amount of the dried blood and increase the amount of acid phosphate proportionately, or would substitute cotton seed meal for the dried blood. A light, mellow loam inclined to sand is the best soil for the early tomato crop, and it is useless to try to grow it on a heavy clay or a cold and poor soil.

As to the source of the plant foods used, the nitrate of soda and the dried blood we prefer as the sources of nitrogen, and we think it an error to depend on nitrate alone for this crop if a continuous growth and productiveness is desired. The phosphoric acid can be supplied by superphosphate made from rock, or bone black, as may be most available in the locality, and the potash is best furnished by the sulphate free from chlorides. In any crop in which sweetness of the fruit is a desirable feature we have found the sulphate the best form in which to use potash. If it is desired to get the best use of the nitrate of soda it would probably be better to mix the other constituents and reserve this to be applied alongside the plants after setting. But the second application of the nitrate should be over the entire surface, since by that time the roots are running far and wide. Where stable manure is abundant and cheap we would greatly prefer here to plow under a heavy coat, mix it well with the soil, and then add simply the phosphoric acid and potash, with a light dressing of 50 pounds per acre of nitrate of soda at time of setting the plants, on the surface around them, but not in contact with the roots. No further dressing will be needed and for this climate this is far better than a heavy application of a complete commercial fertilizer. In old gardens that have been manured for years with stable manure, we would use no nitrogenous fertilizer whatever, but would use a good dressing of acid phosphate and potash, say 400 pounds of acid phosphate and 100 pounds of sulphate of potash per acre.

We would note that in the South the organic forms of nitrogen in a tomato fertilizer are of far more importance than in the North. Otherwise, in the very hot weather we are apt to have in June, the plants will fail if no nitrogen but that from the nitrate is at hand. In the North the case seems different, and it is found undesirable to keep up too much growth rather than devote the whole energy of the plant to fruiting.

THE FIELD CROP OF TOMATOES.

This crop is produced for the canning establishments, and earliness is not an object. The plants are grown in beds in the open ground and transplanted to the field when large enough, setting them in rows five feet apart and four feet in the rows. Cultivation is as for a crop of corn. The same fertilizer mixture advised for the early crop will do as well for the canning crop, but the second application of the nitrate of soda will not be needed nor profitable. On soil that will make a good crop of corn 500 pounds per acre of the mixture will be ample. We have found that for this summer crop a top dressing of stable manure between the rows is a great advantage in our dry and hot summers, as a mulch as well as plant food. Prof. Vorhees shows that a good crop of ten tons of tomatoes per acre, with their vines, would contain 57 pounds of nitrogen, 16 pounds of phosphoric acid and 94 pounds of potash. This shows very well the relative importance of the different food constituents, and that nitrogen and potash are the largest part of the food consumed by the tomato.

THE SOUTHERN BLIGHT.

While this work is not intended to take up plant diseases, which would take a volume for the proper treatment, we must, nevertheless, say a few words in regard to this terror of the Southern tomato grower. There is more than one blight which attacks the tomato, but the one known distinctively as the "Southern blight" is a bacterial growth in the tissues of the plant, and the first intimation of its presence which the ordinary observer has is the sudden wilting of a large plant full of fruit. If the wilted plant is allowed to remain, the disease extends to others till the whole may be destroyed. It is the great bane of the Southern tomato grower, but unfortunately no sure preventive has as yet been discovered. A year ago we gave a piece of ground, where tomatoes had blighted badly the year before, a dressing of lime at the rate of about 30 bushels per acre, and set it again in tomatoes. There was little or no blight that season. This year we set the same plat in tomatoes without any further liming; every plant died from blight. So it would seem that whatever influence the lime had in the prevention of the blight was but temporary. Hence the only advice we can give is to avoid land where tomatoes, potatoes or watermelons have been lately grown; as all of them, with the egg plant, are subject to the same disease. The soil gets infected and any remedy that is to be effectual must deal with the soil. Fresh soil from the forest should be used for the growing of the plants for the infection doubtless takes place at an early stage of the growth of the plant.

VARIETIES OF TOMATOES.

These are now so numerous that the inexperienced planter is often puzzled to know what sorts will be best for him to plant. The tomato yields so readily to selection and breeding that the varieties do not long retain their original character. The names of old varieties are continued on the lists of seedsmen, but they are far from being the same as they were when first sent out. One man forms an ideal of what he wants in a tomato, and works at it till he gets nearly what he is after, and the tomato is put into commerce. Then other growers go to work to produce it for the trade, but they work on entirely different ideals from the originator, and the variety in the hands of one grower is still further improved, and under the treatment of another is allowed to deteriorate; but both are sold for the same thing year after year. The Trophy tomato, for which we paid to the late Col. Waring $5 for twenty seeds, is still on the seed lists, but it is no longer the Trophy of Col. Waring; some stocks have run back while others have been selected to an entirely different type. The earliest and most productive tomato we have ever grown is the variety known as Maule's Earliest. Its fault is lack of smoothness, especially in the earliest specimens. We are at work on this tomato, and hope to evolve from it a tomato with a smooth skin and still as early and prolific as the present type. Fordhook First is another very early tomato of a different type. Atlantic Prize is early but small and unproductive. Early Ruby is very early but is also, in our experience, rough and a poor cropper. For the main crop and for canning Livingston's Beauty, Matchless, Crimson Cushion, Stone and Queen are all good.

FORCING TOMATOES IN WINTER.

There are few varieties well adapted for this purpose. The one known as Lorillard has been more generally used than any other. If we can succeed in getting a smooth type of Maule's Earliest it will leave nothing to be desired in a forcing tomato. Dwarf Champion, while not usually recommended for forcing, has, with us, always beaten Lorillard, and we are inclined to consider it one of the best. Tomatoes for forcing are sown about the last of August for the first crop. We sow the seed in the open ground and transplant them there once, to get them stocky. They are potted in four-inch pots late in September and transferred to a greenhouse where the night temperature is not over 55 degrees, if possible, at this season. They are kept close to the glass to keep them stocky. As soon as the balls are well covered by the roots, but before the plants got "pot bound" or stunted, they are transferred to the fruiting pots. We always grow tomatoes in pots. Some use large wooden boxes for them, and some plant out on the benches in soil over the hot water pipes. If the crop is being grown commercially, and the house is a narrow lean-to constructed for the purpose, the planting should be on the benches in a bed of soil and the vines trained on wires in the same way we train grapes under glass. But in a span-roof greenhouse, where the glass is used later in the season for other purposes, the pots are far more convenient and for the one crop fully as good. We transfer the plants from the four-inch pots to those of ten-inch size. Arranging for drainage at the bottom we place the plant near the bottom of the pot and fill around with soil merely to the height of the ball turned from the four-inch pot. Then, as soon as the white roots are seen running into the fresh soil, another inch of compost is added, and so on till the pot is filled enough. This gives the plant a very strong root system. When the pot is well filled with roots we give dilute manure water, or nitrate of soda one ounce to a two gallon can of water, weekly. The plants are trained to a single stem and all side growths rigorously pinched out. When placed in the fruiting pots the plants are put into a house where it is possible to maintain 70 degrees at night, though 60 is about the usual average. As soon as the blossoms set we go over the house daily at noon and brush the pollen on the stigmas with a soft camel's hair brush. This is more rapidly done and is far more effective than any effort to collect pollen in a spoon, as some advise. The early crop should begin to ripen about

Christmas and will continue into March. If the house is to be used for tomatoes entirely, another crop should be coming on to take the place of those that are exhausted, and the seed for this is sown in early December, and will make a crop to follow on till tomatoes are ripe in the open garden. With the proper structures for the purpose the winter crop of tomatoes can be made a very profitable one, as we have sold them right alongside the Florida tomatoes for 25 cents per pound, when the Floridas were selling for one-fourth the money. The superior quality of tomatoes grown under glass attracts attention at once.

There is no vegetable plant more generally forced than the tomato and none that has been more uniformly profitable when forced; nor is there any crop grown that so readily responds to commercial fertilizers. We have had a long experience in growing winter tomatoes and much prefer to use commercial fertilizers than stable manure for them. In fact, the only real failure we ever made was from using stable manure exclusively in our compost, and a liquid manure of cow dung instead of nitrate of soda. We got a tremendously rank growth but a very poor bloom and fruitage, and we have discarded manure in the culture of tomatoes under glass. If the potting material known as jadoo fibre was funished more cheaply we would prefer it to any soil mixture we have ever tried; but the commercial grower cannot afford to use it at the price charged. The best soil is made from sods from a mellow loam pasture, piled and rotted one summer in advance of use, and frequently turned till it is perfectly fine and homogeneous. We have always had better success with plants grown in ten or twelve-inch pots than with those planted out in beds. Wooden boxes may be substituted for the pots if desired. We sow the seeds for the winter crop about the last of August, and as soon as large enough pot them into three-inch pots and set them in a frame where they can be watered regularly. As they fill these pots they are transferred to four-inch pots and replaced in the frame. As the nights get cool we take the plants into the house and put them in their fruiting pots. In these pots we use plenty of broken crocks for drainage and cover the drainage with moss to prevent the soil choking it. The large pots are only filled enough to cover the four-inch balls at first, and as the roots are seen on the surface of the soil another layer is added until finally the pot is sufficiently filled. In this way the roots get complete possession of the soil. I should have said that in this soil we use a liberal mixture of raw bone meal, which furnishes nitrogen and phosphoric acid in sufficient quantity to keep up a fair growth. As soon as the plants show bloom we go over them daily at noon and apply the pollen to the stigma of the blossoms with a camel's hair brush If this setting of the flowers is neglected there will be little perfect fruit and what there is will be small and seedless, for under glass there are no insects to do this for us. As soon as the roots can be seen to have taken possession of the last layer of soil we begin to use liquid fertilizer, made by dissolving one ounce of nitrate of soda in a two gallon can of water, and give this once a week. Do not begin this till you see that the roots have possession of the soil, for there is otherwise a tendency to sour the soil. The plants are kept trained to a single stem and two feet square is allowed to each plant. Daily attention is needed in pinching out the side shoots and keeping the plants to a single stem. Pinch these out as soon as seen, so that all the strength of growth will be thrown into the main stem. The stems are trained to strings or wires from the roof above. When the stems have reached the height of the house the ends are nipped and no further development allowed. In the meantime, about the middle of December, sow seed for a succession crop to replace these as the crop is gathered. These succession plants can be grown on the side benches of the house until they are ready to take their places in the fruiting pots. The tomato house should be kept during the fall and warm weather, well ventilated, and when the nights get frosty a little fire heat is given, so that the temperature does not go below 55 degrees. As the plants get into bloom the temperature of the house should never be allowed to go below 60 at night and should be kept, by ventilation, at 80 or less in day time. The tomato under glass is subject to the attacks of fungus diseases, the worst being the *Cladosporium Fulvum*, which attacks the leaves, beginning on the lower leaves, and if not checked will defoliate the entire house. We manage to keep clear of it by painting the hot water pipes at times with a solution of the sulphide of potassium, and by keeping sulphur scattered around under the leaves in the sun, so that it gradually evaporates in the air. These precautions should precede any attack, for if the fungus once gets started it is hard to stop.

Some recent experiments have shown that when the tomato plants are planted in pure coal ashes and supplied with the proper fertilizers the resulting crop has been better than when grown in the most carefully prepared compost. Whether this will be true in all cases or not we cannot say, but there seems to be a sort of affinity between coal ashes and tomato plants, for the most wonderfully prolific and long lived tomato plant we ever saw grew in an old heap of coal ashes, where it started as a volunteer and was allowed to remain. While coal ashes have little of what is classed as plant food in them they do certainly assist in the mellowing of the soil and the retention of ıoisture. We have greatly improved a piece of stiff clay soil by heavy dress-ags of coal ashes, and nowadays we never throw them away, but always find Ti for them. One of the most valuable uses for coal ashes is for plunging poli plants in pots in the cold frames. A bed of coal ashes makes the best place in which to plunge pots to save watering and to protect them from frost. Pots set upon the ground soon get filled with earth worms to the detriment of the plants, but when set on coal ashes or plunged in them the worms have no chance, for they will not crawl through the ashes. Then, too, there is no inducement for the roots to run out through the hole in the bottom of the pots, as when they are placed on soil, and if any do get out they are easily removed from the ashes entire. Coal ashes applied to a sandy soil will make it more retentive of moisture and less inclined to be leachy.

THE FORCING HOUSE FOR TOMATOES.

For the purpose of winter forcing tomatoes we prefer a full even-span house twenty feet wide, with a space in the centre for setting the boxes of pots, and benches on the sides that can be used for the forcing of beans or other dwarfer growing plants, that need about the same temperature as the tomatoes; or for bringing on the second crop for the replanting of the house. The house should be not less than ten feet to the ridge in the centre, the glass should have a slope of 45 degrees, and the house should run north and south so that both sides will have sun at different times of the day. A narrow lean-to house may be used and the plants set on the front bench and trained on wires under the glass, as we do grapes, but in this case the slope of glass should be to the south. In a very narrow house of this kind, with the glass a steep incline to the south, the crop may perhaps be earlier in setting and the house more easily heated than in the span-roof house, and the second crop may be started against the back wall and get the sunlight after the front vines have been taken out; but we greatly prefer the span-roof house. In such a house, with each plant trained to a single stem and allowed two feet square of space, there should be, during the winter, a crop of two pounds for every square foot of space in the house. The crop here usually commands 25 cents per pound in winter, hence a house with 1,000 square feet of surface should produce 2,000 pounds of fruit, worth $500. Whether such a crop will be profitable or not will depend on the cost of heating the house, and here the Southern forcer will have a great advantage over the grower in the colder sections, in the fact that he needs to use less coal and has far more sunlight in winter, and sunlight counts for far more under glass than does fire heat.

It is probable that the best style of house, though we have never tried it for the tomato, would be that known generally as the Rose house, because it is the form generally adopted for the winter forcing of roses for cutting in winter. The shape of such a house is what is called three-quarters span; that is, there is a high back wall and a low front one, a short slope of glass on the back and twice as long a slope in front. Then if the benches are made at different heights the plants can be brought to uniform distance from the glass and all have an equal chance at the sunlight. Prof. Bailey says that he prefers to grow tomatoes on the side benches in 7 or 8 inches of soil and on benches, too, in the centre of the house. Our objection to this would be that the tomatoes on the side benches would too much shade those in the centre.

While in all the earlier stages of the growth of the plants the house should be kept moist, very great care is needed in the watering of the plants. We keep the walks damp at all times and water the pots only when needed, having no set time to do this, but varying with the state of the weather and the amount of sunshine. A slight thump on the side of a pot will tell if water is needed even when it looks moist on the surface. If the pot sounds hollow water should be given, if not, none. Moisture is maintained by watering the sand on the benches where the pots stand, and watering the walks, but sprinkling overhead on the plants is never done. Various plans have been proposed for the pollenation of the flowers, such as shaking off the pollen in a spoon or watch glass, but we have never succeeded in this, and find no difficulty in rapidly setting the flowers with a camel's hair brush. Prof. Bailey says that all varieties of tomatoes are more inclined to be irregular in shape under glass than in the open ground. We have found the very reverse of this to be the case. They always, for us, grew more smooth and perfect under glass than out doors. Perhaps the difference is climatic and due to our abounding sunshine, even in the coldest weather. He, too, claims that the Dwarf Champion is the least satisfactory under glass, while here it has always been one of the best, while the Lorillard, which is claimed in the North to be a special forcing variety, is an utter failure here every time it has been tried; the poorest crop we have ever had was with this variety.

Forced tomatoes are marketed in baskets similar to those used by the Florida shippers, and packed in what are known as Southern carriers. Each fruit should be wrapped in soft tissue paper, and the baskets lined with white paper, and with some clean excelsior shavings under the fruit to prevent jarring in transportation.

COMMERCIAL FERTILIZERS IN TOMATO FORCING.

Our own experience in the winter forcing of tomatoes has led us to prefer chemical fertilizers to stable manure. On this point we are glad to refer to the work done at the Connecticut Experiment Station as detailed in their report for the year 1895. "To those who are raising or contemplating raising winter crops under glass, the question of substituting fertilizers for manure, in part at least, is a very important one. Forcing house soil as usually prepared, consists of rich garden soil or rotted turf, composted with from one-fourth to one-half its bulk of horse manure. Aside from the labor of hauling and repeatedly working over this material to secure the fine mellow condition which is desired, the cost formerly was not great. But the introduction of electric cars enormously cut down the production of horse manure in the cities, which has been the main dependence of our market gardeners. In consequence, the preparation of suitable soil for forcing houses is increasingly expensive. Besides this it is found that even a rich natural soil cannot carry forcing house tomatoes to their highest productiveness, and therefore liquid manure is often used to water the soil after the plants have come into bearing. The admirable work on the use of commercial fertilizers on field tomatoes, done at the New Jersey Station, has proved that the ripening of the crop may be very materially hastened by the proper use of fertilizer chemicals, especially of nitrate of soda.

To hasten the ripening of crops under glass, where the expense of growing them is so much greater than in the field, must greatly increase the profits of the business. A further question also connected with these, is, whether the humus of rotted manure, generally regarded as necessary to regulate the storage and circulation of moisture in the soil under natural conditions, can be replaced by some cheap substitute, or dispensed with altogether in forcing-house culture, where the supply of soil moisture can be well regulated by artificial means.

"Our first endeavor was to find out how much nitrogen tomato plants raised under glass take from the soil, in their fruit and vines, and how much nitrogen needs to be in the soil to meet fully this demand of the plants. These questions we studied by raising tomatoes on the forcing-house bench filled with soil known to be practically free from available nitrogen, but believed to contain all other ingredients necessary for a maximum tomato crop. To these plats were added known quantities of nitrogen in the form of nitrate of soda. The weight of the fruit harvested, and of the vines which bore it, with the chemical analysis of both, furnish the means of determining how much nitrogen, phosphoric acid and potash a crop of tomatoes takes from the soil. Comparison of the quantities of nitrogen applied to the several plats, with the weights of the crops and of their nitrogen, gives some indication of the amount of nitrogen necessary to apply in order to secure a maximum crop." The house used in the experiments was specially constructed and was a three-quarter-span-roof house, 16x40 feet running east and west, with a partition across the centre, making two apartments. The house is heated by steam from a boiler that heats all the Station buildings with a pressure of five pounds The steam enters the house, passes overhead to the further end and then returns in pipes under the benches. Ventilation is by a continuous line of ventilating sashes along the south side, hinged at the top. North and south walls are both solid (without glass). The front wall is twenty-one inches above the top of the bench, and the back wall thirty-eight inches.

The experiments were made on the centre bench of the house at the east end section. This bench is nine inches deep, with a bottom of six inch boards laid three-fourths of an inch apart for drainage, the cracks being covered with coarse peat so that none of the soil could escape. Five plats were made, each three feet six and one-half inches by three feet eleven inches, having an area of 13.87 square feet. The soil was filled in to the depth of eight inches, leaving room for settling after watering, and six plants were set in each plat.

"The soil for each plat was separately mixed, as follows: 300 pounds of anthracite coal ashes, sifted to pass a wire screen with four meshes to the inch, were spread on a cement floor, and 9 pounds of peat moss, such as is sold in the cities for stable bedding, screened like the ashes, were scattered over them. To these were added three and a half ounces of precipitated carbonate of lime, to neutralize a slight acidity of the peat and give to the whole a mild alkaline reaction. These materials were shoveled over twice carefully and then spread as before.

"The fertilizers designed for the plat were sprinkled over this mixture and the whole carefully shovelled over twice again, to secure as perfect a mixture as possible of fertilizers and soil, and then carried in a hand barrow to the designated plat in the forcing house.

"The north bench in the same division of the house was filled with a rich soil prepared by composting good thick turf with one-third its bulk of stable manure. Plants were set in this bench mainly to make a rough comparison between crops grown on the two radically different soils. The exposure of the two benches is slightly different, that of the north bench being, perhaps, somewhat less favorable as regards light.

"Three varieties were used: Ignotum, Acme and Dwarf Champion, two plants of each variety being set in each plat, and all receiving the same treatment. The method of training adopted was the single stem system, which has been successfully used at the New York Cornell Station. By this system plants can be set closer, and while the yield may be much less *per plant* than under other systems of training, it is as large or larger per square foot of bench area devoted to the crop. The plants blossomed soon after setting. The first pollenating was done January 5th. Pollenation was effected by holding a spoon directly under each flower and gently tapping the upper part of the blossom with a pencil or small stick. Pollen is thus shaken into the spoon and at the same time the stigma is driven into the mass of loose pollen in the bottom of the spoon. The stigmatic surface which is on the end of the style is thus coated with pollen, and as flower after flower is visited on many different plants, cross fertilization is insured. Flowers were pollenated about every other day throughout the blossoming period."

All the plants grew finely for a while, though as early as the 8th of January there was observed a slight difference in the color of the plants in the plat which had received no nitrate of soda, and this difference of a lighter color increased during the season. First ripe fruit was on the 27th of February, being three Ignotums in one plat and one in another, both of the artificial soil, and two Ignotums and three Acmes from the natural soil. Temperature ranged from 60 to 65 degrees at night and often on warm sunny days 85 to 90 degrees Fahrenheit.

The following summary is given of the results:

1. A forcing-house tomato crop yielding about two pounds of fruit for each square foot of bench room, takes in the vines and fruit, for every hundred square feet of bench space, not less than:

	Grams.			Lbs.	Ozs.
Nitrogen	168	equivalent to	Nitrate of soda	2	5
Phosphoric acid	65		Dissolved bone black		13
Potash	362		Muriate of potash	1	9

Of this from a fourth to a fifth only is in the vines.

2. To enable the plants to get these fertilizer elements as required, there should be a large excess of them in the soil, perhaps double the quantity given above.

3. Every 100 pounds of tomato fruit takes from the soil approximately:

	Ounces			Ounces
Nitrogen	2.2	equivalent to	Nitrate of soda	14
Phosphoric acid	.9		Dissolved bone black	5
Potash	4.6		Muriate of potash	10

4. It is possible to grow a crop of forcing-house tomatoes, amounting to two or more pounds per square foot of bench space, perfectly normal in size color, taste and chemical composition, by the aid of commercial fertilizers alone, and in soil composed of coal ashes and peat.

In a further discussion of the subject the Connecticut report says that they are not ready from one experiment to recommend a departure from present methods, but they feel justified in calling attention to certain apparent advantages of the artificial soil for forcing purposes.

For every 100 square feet of bench space there will be required 2,200 pounds sifted ashes and 63 pounds of dried peat or leaf mold to fill the bench 8 inches deep, and experiments may show that the peat is not necessary About 10 pounds of commercial fertilizers are needed for this much bench space, costing at present ton rates less than 21 cents. In very many cases, then, the cost of filling the benches with the artificial soil will be very much less than the cost of filling them with rich garden soil or compost. The tomato plants grown in natural soil made much slower growth and were slower in fruiting than those in artificial soil supplied with nitrates. Another consideration is the freedom from insects and fungi in the ashes, which constitute 97 per cent. of the bulk of the artificial soil, and even the peat which is hardly needed, is not so apt to convey these as the rich garden soil. It was found that there was a special freedom from the nematode worms which cause root galls on plants. The rich garden soil becomes so infested with these that it cannot be used for tomatoes more than one season. In the artificial soil no nematodes were found beyond the ball of earth set with the plants, but they were very abundant in the natural soil.

We have given such full space to the tomato because, for both culture in the open ground and under glass, it is about the most important of our vegetable crops. It will readily be seen from the experiments of the Connecticut Experiment Station, which we have given in detail, that the manurial requirements of the tomato are mainly for nitrogen and potash, and it may be remarked that this is the case with a large proportion of our garden crops, few of which, if we except the cruciferous family, the cabbage and its allies, require such a large percentage of phosphoric acid as is usually found in the various brands of fertilizers sold ready mixed on the market.

SHALL TOMATOES IN THE OPEN GROUND BE PRUNED?

We have made a number of experiments in the pruning and training of tomatoes. In the house, before the plants go into the frames, we do not hesitate to top them if they threaten to get too tall, but we had rather not do this, and would try to keep them growing slower. In the open ground there have been numberless contrivances invented for the support of the plants, and we have tried different methods of training and pruning. The conclusions we have arrived at are these: When tomatoes are grown on a large scale for market it will not pay to prune them or to make any effort to support them. The rot is not caused by the tomatoes touching the ground, but from the attacks of a specific fungus disease, and if we ward off the attacks of disease, there will be no rot, even though the fruit may rest on the ground. I have often gathered the finest of tomatoes half buried in the soil. Begin the spraying with Bordeaux mixture as soon as the tomatoes are set, keep it up at intervals till the fruit is half grown, and there will be less rot than if they are trained off the ground and no spraying done. It is an advantage, of course, in small gardens where space is scanty, to plant close like we do in the forcing-house and train to single stems supported by stakes, and in this way a larger crop may perhaps be gathered from a limited space by the use of more plants. Where a support is used the best thing we have ever tried for the support of anything in the garden needing it, is the wire poultry netting, now sold in various widths so that it can be adapted to plants of various heights. Stretched to stakes along the row the tomato plants can be pruned to a single stem and set two feet apart in the row, there is always a point to tie to, and the leaves, growing through the meshes will of themselves aid in the support of the plant. While in the North it is perfectly practicable to carry the early forwarded plants through the whole season it is not so in the South, for the early plants of the garden are usually either checked badly or killed by the heat and drought we usually have about the last of June. If we then do not have a supply of fresh plants coming on from seed sown in the open ground in April, there is apt to be a cessation of tomatoes; so we always try to provide this set of plants, and these, too, will usually fail by the late fall; hence we have adopted the plan of sowing seed for a third crop about the first of June. These plants get the advantage of the rainy season we usually have during July and August, get into full fruiting in the fall, and are generally full of green fruit when frost comes. We usually get more tomatoes from these plants than from either of the other sowings, for when the frost comes we gather all the green tomatoes and wrap them singly in paper and pack in boxes and place in a room where they will be kept cool but clear of frost. Then a few are taken out from time to time and placed in a warm room, where they soon color up and are ready for the table. In this way we are able to keep up a regular supply of tomatoes for slicing, till the forced tomatoes of the hothouse are ready in January. On a large scale we are sure that this late crop might be made a valuable one in the South, as the fruit can be had in good condition for shipping, and better than the Florida crop, about the Christmas holidays when they will bring a good price. One would suppose from the tropical nature of the plant that the tomato would be a more successful crop in the open ground in the South than in the North, but, as we have shown, the difficulties in the growing of the crop increase as we come southward, and the quality of the product in the open air is not equal to that of the Northern crop. But in the forcing-house we have a great advantage over the Northern grower, and we have treated of this part of the subject fully because we believe that winter forcing in the Upper South is destined to become a great interest.

FURTHER REPORTS ON CHEMICAL FERTILIZERS IN FORCING TOMATOES.

In the report of the Connecticut Station for 1899 we find the following statements. In the season of 1897-8 two crops of tomatoes were forced, and the compost and coal-ash beds were made to alternate with each other through the house. To each plat of coal ashes and peat were added 411.64 grams of nitrate of soda, 700 grams cotton seed meal, 141.36 grams dissolved bone black, and 215 grams of muriate of potash. For the second crop the amounts of these removed by the first crop were added. The application was too heavy and the plants were injured by it. In 1898-9 nitrogen was furnished to the plats of coal ashes and peat with same materials and also with bone meal. The yield from the plats dressed with bone was below that of the others. The soil of coal ashes and peat made a heavier yield of tomatoes than the potting compost, and the same result was found in all the crops.

CHAPTER XXXIX.

SOME SPECIAL FORMULAS FOR TRUCK CROPS.

The following special formulas have been proposed by the North Carolina Agricultural Experiment Station for the various crops grown by the market gardener.

FOR CELERY.

		Pounds.			Per cent.
(1)	Nitrate of soda	300	yielding	Ammonia	6.9
	Fish scrap	800		Available phosphoric acid	5.5
	Acid phosphate	600		Potash	8.0
	Muriate of potash	300			
(2)	Nitrate of soda	250	yielding	Ammonia	7.2
	Dried blood	600		Available phosphoric acid	5.5
	Acid phospate	850		Potash	7.0
	Muriate of potash	300			

FOR IRISH POTATOES.

		Pounds.			Per cent.
(1)	Nitrate of soda	300	yielding	Ammonia	5.4
	Cotton seed meal	600		Available phosphoric acid	7.2
	Bone black superphos.	800		Potash	8.1
	Muriate of potash	300			
(2)	Nitrate of soda	300	yielding	Ammonia	5.4
	Fish scrap	600		Available phosphoric acid	6.8
	Acid phosphate	800		Potash	7.8
	Muriate of potash	300			
(3)	Nitrate of soda	200	yielding	Ammonia	6.4
	Fish scrap	900		Available phosphoric acid	6.6
	Bone black superphos.	600		Potash	7.8
	Muriate of potash	300			
(4)	Nitrate of soda	220	yielding	Ammonia	6.1
	Dried blood	500		Available phosphoric acid	6.8
	Acid phosphate	970		Potash	8.0
	Muriate of potash	310			

		Pounds.			Per cent.
(5)	Nitrate of soda	300	yielding	Ammonia	5.4
	Cotton seed meal	600		Available phosphoric acid	6.0
	Acid phosphate	800		Potash	8.3
	Muriate of potash	310			
(6)	Nitrate of soda	300	yielding	Ammonia	5.5
	Tankage	600		Available phosphoric acid	6.4
	Acid phosphate	800		Potash	7.8
	Sulphate potash H. G.	300			

This last will be best for the Northern sections of the country, where the starch content of the crop is a matter of importance, as the sulphate of potash makes a more dry and starchy potato than the muriate, but the muriate gives the heavier crop in the South.

FORMULAS FOR BEETS AND LETTUCE.

(1)	Nitrate of soda	300	yielding	Ammonia	6.2
	Cotton seed meal	800		Available phosphoric acid	4.9
	Acid phosphate	600		Potash	8.5
	Muriate of potash	300			
(2)	Nitrate of soda	200	yielding	Ammonia	5.9
	Fish scrap	800		Available phosphoric acid	5.4
	Acid phosphate	700		Potash	7.8
	Muriate of potash	300			

FOR CABBAGES, CAULIFLOWER, CUCUMBERS AND MELONS.

(1)	Nitrate of soda	200	yielding	Ammonia	6.0
	Cotton seed meal	750		Available phosphoric acid	4.8
	Acid phosphate	700		Potash	7.1
	Muriate of potash	250			

FOR SPINACH.

(1)	Nitrate of soda	200	yielding	Ammonia	5.2
	Fish scrap	650		Available phosphoric acid	7.7
	Acid phosphate	920		Potash	6.0
	Muriate of potash	230			
(2)	Nitrate of soda	300	yielding	Ammonia	5.0
	Cotton seed meal	500		Available phosphoric acid	7.6
	Acid phosphate	1000		Potash	5.6
	Muriate of potash	200			

FOR RADISHES AND TURNIPS

(1)	Nitrate of soda	250	yielding	Ammonia	4.6
	Cotton seed meal	550		Available phosphoric acid	6.5
	Acid phosphate	900		Potash	8.3
	Muriate of potash	300			

FOR ASPARAGUS.

	Pounds.			Per cent.
1) Nitrate of soda	200	yielding	Ammonia	4.9
Cotton seed meal	700		Available phosphoric acid	6.1
Acid phosphate	800		Potash	8.4
Muriate of potash	300			

FOR EGG PLANTS AND TOMATOES.

(1) Nitrate of soda	200	yielding	Ammonia	4.9
Cotton seed meal	700		Available phosphoric acid	6.3
Acid phosphate	840		Potash	7.4
Muriate of potash	260			

FOR ONIONS.

(1) Nitrate of soda	200	yielding	Ammonia	5.1
Cotton seed meal	750		Available phosphoric acid	5.1
Acid phosphate	750		Potash	8.5
Muriate of potash	300			

FOR SWEET POTATOES.

(1) Nitrate of soda	100	yielding	Ammonia	3.5
Fish scrap	400		Available phosphoric acid	7.8
Acid phosphate	1180		Potash	8.3
Muriate of potash	320			
(2) Nitrate of soda	100	yielding	Ammonia	3.5
Cotton seed meal	500		Available phosphoric acid	7.8
Acid phosphate	1100		Potash	8.3
Muriate of potash	300			

FOR BEANS AND PEAS.

(1) Nitrate of soda	100	yielding	Ammonia	2.9
Cotton seed meal	450		Available phosphoric acid	7.1
Acid phosphate	1200		Potash	6.9
Muriate of potash	250			

CHAPTER XL.

SOME STATION INVESTIGATIONS IN FERTILIZERS.

In a bulletin published in 1893 the Ohio Station, from a series of four years experiments, concludes: "While, therefore, these experiments demonstrate the possibility of producing a regular and certain increase in the yield of cereal crops by the use of a complete chemical fertilizer, yet they show that if such fertilizers are to be used in Ohio in the production of cereal crops with any prospect of profit and as a part of a regular system of agriculture, that system must provide for the accumulation in the soil of the largest possible quantity of organic nitrogen, through the culture, in short rotations, of plants which have the power of obtaining nitrogen from sources inaccessible to the cereals."

The following year the same Station made the following additional statement: "At the present prices of cereal crops and of fertilizing materials respectively the profitable production of corn, wheat and oats upon chemical or commercial fertilizers, or upon barnyard manure, if its cost be proportionate to that of the chemical constituents of fertility found in commercial fertilizers, is a hopeless undertaking, unless these crops be grown in a systematic rotation with clover or a similar nitrogen-storing crop; and the poorer the soil in natural fertility the smaller the probability of profitable crop production by means of artificial fertilizers."

All of which makes more emphatic what we have said in regard to the need for the renovation of the soil and the storing of it with humus, through the growing of cow peas or clover, thus making it not only richer in the nitrogenous matters, but making it more retentive of moisture for the proper dissolving of the chemicals applied. The richer the soil in humus the more lavish may the application of fertilizers be made with profit. And yet all over the South there are thousands of farmers dribbling a little fertilizer on soil almost barren, for the purpose of growing a little more cotton without ever inquiring whether or not the increase in the crop pays for the fertilizer.

The Rhode Island Station gives the following list of formulas for the home mixing of fertilizers, the following being for the Irish potato crop:

	Pounds.			Per cent.
Acid phosphate	850	yielding	Nitrogen	3.5
Nitrate of soda	150		Potash	8.0
Muriate of potash	300		Available phosphoric acid	6.0
Cotton seed meal	700			

Where a higher quality of potatoes was desired, the following was advised:

	Pounds.			Per cent.
High grade sulphate of potash	325	yielding	Nitrogen	4.0
Nitrate of soda	100		Potash	8.0
Sulphate of ammonia	100		Available phosphoric acid	7.0
Dissolved bone black	750			
Cotton seed meal	725			

The following formula was designed where a good quality of tubers was desired, and was at the prices then ruling, very cheap:

	Pounds.			Per cent.
Cotton seed meal	800	yielding	Nitrogen	3.4
H. G. sulphate of potash	400		Potash	10.2
Nitrate of soda	100		Available phosphoric acid	5.2
Acid phosphate	700			

The following formula contains a large amount of nitrogen in the form of nitrates. The bone comes slowly into use and that makes it best for a long season or successive crops:

	Pounds.			Per cent.
Muriate of potash	400	yielding	Nitrogen	2.5
Acid phosphate	500		Potash	10.2
Nitrate of soda	250		Available phosphoric acid	7.2
Bone meal	400			
Cotton seed meal	450			

Another Rhode Island potato formula:

	Pounds.			Per cent.
Acid phosphate	890	yielding	Nitrogen	2.5
Tankage	550		Potash	11.1
Muriate of potash	450		Available phosphoric acid	7.2
Nitrate of soda	110			

The grower who used the above formula became convinced that it contained too little nitrogen for his soil, and he used, then, the following:

	Pounds.			Per cent.
Nitrate of soda	150	yielding	Nitrogen	4.6
Sulphate of ammonia	100		Potash	10.0
Dried blood	450		Available phosphoric acid	5.8
Muriate of potash	400			
Acid phosphate	900			

Another Rhode Island grower uses the following:

	Pounds.			Per cent.
H. G. sulphate of potash	360	yielding	Nitrogen	3.9
Acid phosphate	550		Potash	8.6
Tankage	730		Available phosphoric acid	6.0
Fine ground bone	120			
Nitrate of soda	120			
Dried blood	120			

Another grower made various changes in the formulas he used from year to year, and the following represents the ideal which he finally reached. He uses only the highest grades of materials:

	Pounds.			Per cent.
Fine ground bone	400	yielding	Nitrogen	4.0
Dissolved bone black	400		Potash	10.0
Dry ground fish	300		Available phosphoric acid	6.4
Cotton seed meal	300			
Nitrate of soda	200			
Sulphate of potash	200			
Muriate of potash	200			

Very excellent results are claimed for this formula for potatoes and vegetables in rotation with cereals and grasses. He mixes but 500 pounds at each mixing, and instead of weighing out each time the amount of the materials to be mixed, he uses boxes gauged to hold approximately the right weights.

Another grower has used the following with good results:

	Pounds.			Per cent.
Dissolved bone black	750	yielding	Nitrogen	4.5
Tankage	760		Potash	10.3
H. G. sulphate of potash	430		Available phosphoric acid	6.7
Sulphate of ammonia	140			
Nitrate of soda	100			

Proposed formula for onions:

	Pounds.			Per cent.
Muriate of potash	400	yielding	Nitrogen	4.4
Acid phosphate	550		Potash	10.0
Tankage	500		Available phosphoric acid	5.9
Fine ground bone	200			
Nitrate of soda	350			

Rhode Island formula for general purposes:

	Pounds.			Per cent.
Nitrate of soda	125	yielding	Nitrogen	3.2
Tankage	750		Potash	10.0
Dissolved bone black	725		Available phosphoric acid	8.0
Muriate of potash	400			

A compost with hen manure:

	Pounds.			Per cent.
Air dry hen manure	1330	yielding	Nitrogen	2.0
Acid phosphate	530		Potash	4.5
Muriate of potash	140		Phosphoric acid	5.1

As we have said heretofore, we have never found any fertilizer in which there is purchased nitrogen, which paid its cost on the Indian corn crop. The Rhode Island Station gives the following formula for corn, which is certainly well compounded to suit the manurial requirements of the plant for most soils. But for a soil notably deficient in potash, as much of the New England soil is, we would reverse the percentages of phosphoric acid and potash.

	Pounds.			Per cent.
Acid phosphate	920	yielding	Nitrogen	5.1
Nitrate of soda	330		Potash	5.0
Tankage	550		Phosphoric acid	8.3
Muriate of potash	200			

The acid phosphate in the above is stated in the bulletin as dissolved bone, and the following remarks are appended.

"Dissolved bone is frequently sold at so high a price that it would be better economy to omit its use and substitute a little extra nitrate of soda to supply the nitrogen; and dissolved bone black, dissolved phosphate rock or double superphosphate to furnish the phosphoric acid." This advice is good, except that it would add more expense to the nitrogen, and it would have been better to have stated plainly that soluble phosphoric acid is one and the same thing, no matter whether it is derived from bone or rock, and if the "dissolved bones" are not really dissolved rock phosphate it would be an exception to the general practice of the fertilizer trade, for the idea is so common among farmers that the phosphoric acid from animal bones is better than that from rock, that manufacturers have gotten into the habit of calling dissolved rock, bone.

Another Rhode Island formula for use on sandy soil for corn is as follows:

	Pounds.			Per cent.
Muriate of potash	360	yielding	Nitrogen	4.2
Dissolved bone black	1000		Potash	9.0
Nitrate of soda	550		Phosphoric acid	9.2

The main fault in this is that all the nitrogen is furnished by the immediately available nitrate of soda, and if the corn is planted where there is no plowed under sod, there would be need for some organic nitrogen to keep up the nitrification during the long season in which corn grows. Then, too, the phosphoric acid could be more cheaply gotten in South Carolina dissolved rock than in bone black, though the percentage might not have been so high, but as the percentage of phosphoric acid is too high anyway, this would be no disadvantage, unless the soil is known to be very deficient in phosphoric acid.

The Rhode Island Station gives the following formula, which was devised for the soil of an old pasture of sandy land, known to be very deficient in phosphoric acid:

	Pounds.			Per cent.
Nitrate of soda	200	yielding	Nitrogen	3.7
Tankage	700		Potash	10.0
Double superphosphate	700		Phosphoric acid	15 8
Muriate of potash	400			

The bulletin states that half a ton per acre of this formula was used for Indian corn, and the yield to have been much above the average. We are of the opinion that the yield must have been much above the average and the price of the crop still further above the average for the farmer to have gotten the cost out of the crop. The same grower stated that this formula, applied at the rate of a ton per acre, produced a yield of 280 bushels of potatoes per acre on an old sandy-loam pasture. This would not have been considered an extraordinary yield for such fertilization by the growers of the early potato crop in the South Atlantic coast, and it would have been more satisfactory to know how many potatoes could have been grown on the old sod without such a heavy application, for it is not the largest crop that is always the most profitable.

Another Rhode Island fomula for corn on sandy soil is as follows:

	Pounds.			Per cent.
Nitrate of soda	250	yielding	Nitrogen	2.8
Muriate of potash	300		Potash	7.7
Acid phosphate	1200		Phosphoric acid	8.0
Cotton seed meal	250			

COMPOST FOR CORN WITH HEN MANURE AS A BASIS. RHODE ISLAND STATION.

	Pounds.			Per cent.
Air dry hen manure	1190	yielding	Nitrogen	1.8
Acid phosphate	710		Potash	3.4
Muriate of potash	100		Phosphoric acid	6.0

FORMULA FOR MILLET AND HUNGARIAN. RHODE ISLAND STATION.

	Pounds.			Per cent.
Acid phosphate	900	yielding	Nitrogen	3.5
Nitrate of soda	200		Potash	8.0
Muriate of potash	300		Phosphoric acid	6.3
Cotton seed meal	600			

The bulletin suggests that on old land in poor condition probably better returns would be obtained by substituting a little nitrate of soda and a considerable amount of dissolved phosphate rock for a portion of the cotton seed meal.

FORMULA FOR BARLEY. RHODE ISLAND STATION.

	Pounds.			Per cent.
Dissolved bone	930	yielding	Nitrogen	5.2
Muriate of potash	220		Potash	5.5
Tankage	380		Phosphoric acid	7.9
Nitrate of soda	470			

FORMULA FOR SPINACH, LETTUCE, CABBAGE AND CUCUMBERS. R. I. STATION.

	Pounds.			Per cent.
Muriate of potash	370	yielding	Nitrogen	5.6
Nitrate of soda	500		Potash	9.7
Acid phosphate	590		Phosphoric acid	4.2
Cotton seed meal	540			

FORMULA FOR ASPARAGUS. RHODE ISLAND STATION.

	Pounds.			Per cent.
Nitrate of soda	370	yielding	Nitrogen	3.9
Muriate of potash	630		Potash	15.8
Fine ground bone	1000		Available phosphoric acid	5.5
			Total phosphoric acid	11.0

FOR SEEDING DOWN AND TOPDRESSING GRASS. RHODE ISLAND STATION.

	Pounds.		Per cent.
Muriate of potash	200	yielding	
Nitrate of soda	200	Nitrogen	4.0
Cotton seed meal	600	Potash	5.5
Acid phosphate	500	Phosphoric acid	6.4
Fine ground bone	500		

FORMULA FOR FALL GRAIN. RHODE ISLAND STATION.

	Pounds.		Per cent.
Nitrate of soda	50	yielding	
Muriate of potash	200	Nitrogen	3.0
Acid phosphate	400	Potash	5.0
Fine ground bone	700	Phosphoric acid	8.0
Tankage	650		

FOR SPRING TOP DRESSING GRASS LANDS. RHODE ISLAND STATION.

	Pounds.		Per cent.
Nitrate of soda	300	yielding Nitrogen	2.3
Acid phosphate	1480	Potash	5.5
Muriate of potash	220	Phosphoric acid	9.6

We quote the following from the bulletin of the Rhode Island Station on the effect of wood ashes as a fertilizer, and the supplementary constituents which should be used in connection with them:

"We find that farmers in most sections of Rhode Island highly esteem wood ashes as a manure, and in many localities they seem to hold a rank next to barnyard manure. From repeated inquiries made in many sections of the State it appears that the beneficial effect of wood ashes is, almost without exception, attributed to the direct manurial action of the potash which they contain, yet it is usual to hear that the effects from a single application are often visible for from ten to fifteen years. When we consider, however, that 100 bushels of ashes weighing about 4,500 pounds would, upon the average basis of 5 per cent. of potash, contain but 225 pounds of actual potash, which is equivalent to but 450 pounds of muriate of potash, it would seem at least astonishing that an after-effect from such an application should be visible for from ten to fifteen years unless it were due in a considerable measure to something other than the small amount of potash it contains. An application of a ton of potato or vegetable fertilizer containing 10 per cent. of potash would supply 200 pounds of potash, equivalent to 400 pounds of muriate of potash, or an amount nearly equal to that supplied by 4,500 pounds of wood ashes; and yet we practically never hear of any long continued after effect from the use of muriate or sulphate of potash, or of chemical fertilizers which contain them. Wood ashes contain on an average about 1.5 per cent.

of phosphoric acid, which would amount to an application of 67.5 pounds of phosphoric acid for each 4,500 pounds of wood ashes, an amount equivalent to what would be furnished by about 300 pounds of fine ground bone. Now if the action of the ashes is based upon the combined manurial effect of the potash and phosphoric acid, then 450 pounds of muriate of potash and 300 pounds of ground bone would be expected to exert an effect analagous to that obtained from the wood ashes. As a matter of fact we believe that the farmers of Rhode Island and many other parts of New England have obtained results with wood ashes which are not due to, and which doubtless would not be attainable, by the use of the quantities of muriate of potash and bone above mentioned. It would appear to be equally unsatisfactory to attribute the beneficial action of wood ashes solely to small quantities of magnesia, soda, or whatever else they may contain, regardless of the lime. The experiments thus far conducted at this Station, as well as others at Hope Valley and Westerly, together with experiments by farmers in West Kingston, Usquepaugh, and several other localities without the State, point strongly to the value of lime on many soils; not only as direct plant food, but also in putting the soil into a condition suitable for the growth of certain plants, and into such a condition that the nitrogenous plant food stored up in the soil, as well as that in organic nitrogen and ammonium sulphate employed, may exert its maximum effect. In this connection, also the well known value of lime in improving the physical condition of sandy as well as clayey soils should not go unmentioned. In other words, our experience and observation in this State leads us to believe that the chief cause of the long continued after effect of wood ashes is the *lime* which they contain and not the potash, as has been heretofore generally supposed. Certainly if such is the case it behooves the farmers of the State to try the lime experiment for the purpose of testing this question, for the same amount of lime and other fertilizing elements which wood ashes contain can be purchased in other, probably equally effective, forms at a lower price. It will be evident from what has just been said, that wood ashes contain but little phosphoric acid, and it is also true that they contain no nitrogen. Therefore if they are to be used on a rational and economical basis they must be supplemented by phosphatic and nitrogenous fertilizers. The following materials used upon one acre would be about equivalent, so far as concerns potash, phosphoric acid and nitrogen, to one ton of fertilizer containing 10 per cent. of potash, 6.5 per cent. of available phosphoric acid, and 4 per cent. of nitrogen:

Wood ashes......................	4000 pounds
Dissolved phosphate rock	1000 pounds
Nitrate of soda..................	510 pounds

Practically the same amount of lime and other ingredients would be contained in the following:

Air slaked lime	**2000 pounds**
Dissolved phosphate rock	**1460 pounds**
Muriate of potash.................	**400 pounds**
Nitrate of soda......................	**510 pounds."**

All of which we assume is probably theoretically true, and yet in the effort to make an artificial substitute for the wood ashes, would there not be a danger of a great loss of nitrogen? We are of the opinion that these matters may well be applied to some soils, but that the fertilizing chemicals should be mixed and applied, and the lime applied separately and not in mixture with the fertilizers. So far as the long-continued after effect of the wood ashes is concerned, we are of the opinion that the Rhode Island Station is to a great extent correct in attributing at least part of it to the lime they contain, and especially we would add to the extremely fine condition in which the lime exists in the wood ashes. But we consider it an error to advise the use of air slaked lime as an application to the soil. Freshly water slaked lime is far better. Then, too, while ashes have a long after effect, we cannot agree to the statement that similar after effects are not found from applications of potash salts and phosphoric acid. In a considerable section with which we are familiar the long continued use of phosphoric acid to the soil has resulted in an accumulation, so that farmers there no longer find any effect from new applications of superphosphate, and it is a well known fact that potash accumulates in a similar manner.

To the following remarks from the Rhode Island Station we heartily agree: "Barnyard manure contains relatively more nitrogen than potash, and is notably deficient in phosphoric acid, so that if the manure is to be used on the most economical basis a small amount of potash and a much larger quantity of phosphoric acid should be used in connection with it. Owing to the great variation in the composition of such manure, depending upon the cattle food used, the care of the manure, and the amount of foreign matter mixed with it, no attempt to give the exact amounts for use will be made. A motto in relation to manures which should find its place on every farm would read somewhat as follows: Save what you have, supplement it wisely and buy economically."

We would add that this saving and supplementing can well be done by mixing the manure daily, when taken from the stable, with a mixture of acid phosphate and kainit in equal parts. It has long been the practice with some to use plaster for this purpose, but while plaster, if properly used, is effectual in preventing the loss of nitrogen, it fails to add the potash and phosphoric acid needed, and the above mixture will be as effective in preventing loss of nitrogen, and will at the same time add what the manure is deficient in. The Rhode Island Station has done perhaps more in the investigation of the value and effects of lime than any other of our Stations, and we add here, as an addition to what we have already said upon the effects of lime, the following quotation from Bulletin 46 of that Station:

CHEMICAL ACTION OF LIME.

"Lime unites with acid substances in the soil, by which the soil is sweetened, or its natural acidity (sourness) overcome or reduced. In case certain injurious iron compounds are present in soils, these are so transformed by lime as to be rendered harmless. It also acts upon the potash compounds in the soil in such a way that the lime takes the place of the potash, setting the latter free for the use of plants. If lime is present in a soil to which ordinary commercial fertilizers, dissolved boneblack, dissolved bone, dissolved phosphate rock, or double superphosphate, have been added, it is probable that some of the soluble phosphoric acid will further combine with lime, in which condition it would be expected to be more readily available to plants than would have been the case had lime been absent, and a more favorable opportunity been given for all the phosphoric acid not quickly utilized by the plants to combine with iron and aluminum oxids.

BIO-CHEMICAL EFFECTS OF LIME.

"The presence of lime in soils favors the decomposition of the organic matter which they contain, and in this process carbonic acid is produced, which in turn acts upon the ingredients of the soils in such a way as to render the natural plant food much more readily assimilable. It plays, likewise, an important part in facilitating the change of ammonia into nitric acid, or, in other words, in placing at the disposal of plants the stored up nitrogen of the soil, as well as that applied to or left in it, in the form of animal manures, meat, blood, fish, plant roots, etc.

"Clover, alfalfa, and certain other of the plants which have the power of drawing their nitrogen supply chiefly from the air within the soil, are unable to make a satisfactory growth and to thus utilize the vast amount of nitrogen about them, provided the soil exceeds a certain degree of acidity, but by the application of lime they are made to thrive and to gather for the farmer stores of nitrogen, for which he must pay a fertilizer dealer, at present prices, at the rate of about thirteen cents per pound."

But it is unfortunate, perhaps, that the same effect the lime has in sweetening the soil for the bacteria that promotes the nitrogen collection of the legumes, will also sweeten it for the growth of other and injurious fungi, and hence it has been found that an application of lime to a soil well filled with decaying organic matter and planted in potatoes, will have the effect of promoting the growth of the fungus that causes potato scab. Hence it is well to avoid the direct application of lime to the potato crop. But if the lime is used to promote a previous growth of clover it will not injuriously affect the potatoes when planted on the clover sod. While most of the legumes are benefited in their growth by an application of lime, the Southern cow pea is an exception, and it seems to be injured rather than helped by the direct application of lime. But after a crop of peas has been grown on the land, the application of lime on the stubble will greatly aid in the work the peas do for the succeeding crop. Therefore, in a rotation of corn, winter grain, peas and cotton in the South the lime should always be applied on the small grain, especially if a large amount of organic matter has been applied to the preceding corn crop, either by the turning under of a winter crop or the application of the barnyard manures, or both.

Quoting further from the same bulletin of the Rhode Island Station: "Lime applied to stiff clays causes them to become more friable, more permeable to the air, easier of tillage and better capable of supplying water to plants as needed. Sandy soils, on the other hand, are rendered by it more compact and more retentive of water and fertilizers. On very dry, sandy soils smaller applications of lime must be made than upon moist ones, and the use of large quantities of lime upon such soils, in single applications is inadvisable.

WHEN TO APPLY LIME.

"For the reason that lime, while in its caustic state, is injurious to certain crops, and by lying in the soil its causticity is soon lost or materially decreased, it is evident that the ideal time to apply it would be in the autumn. When autumn seeding is practiced, either with grass alone or in connection with winter grain, the lime should be sown upon the furrows after plowing, and then most thoroughly harrowed in, for the degree of benefit from liming will depend to a great extent upon its even distribution and complete incorporation into the surface soil. Where seeding Indian corn fields to grass at the last hoeing is practiced, as is common in the Connecticut Valley in Massachusetts, it would be advisable to apply the lime in the manner outlined above after plowing the land in the spring for the Indian corn crop. Under other circumstances it is probably better not to lime just before Indian corn or rye, for these crops are liable to be slightly injured by fresh applications of lime, some of which is in a caustic state. [We would remark that we have never found this the case, and have used lime freely just before planting corn with the best effects.—W. F. M.]

"These statements, in relation to care in liming just prior to growing rye, Indian corn and millet, apply to cases where the nitrogen supply is chiefly in the form of nitrates, such, for example, as nitrate of soda, and where the soil conditions naturally induce rapid nitrification of the soil-nitrogen, or of the nitrogen applied in natural and artificial manures, such as ammonium salts or organic matter. If the soil is very sour and nitrates are not employed, then the use of lime immediately before these crops may prove of great service, for the reason that the benefit derived from the lime by virtue of its facilitating the transformation of the nitrogen into a form immediately assimilable by the plant, may far outweigh any direct injury that the lime might otherwise have exerted." And we would add that no good farmer will be so ignorant as to buy nitrates for his corn in a properly devised rotation, and no harm can come from applying lime to a soil where manure has been plowed under for the corn.

IMPROVEMENT OF WORN LANDS.

We find the following in Bulletin 62 of the Louisiana Station. How can the worn lands of Louisiana be most speedily and economically restored to their primitive fertility? The answer would be, by proper rotation of crops, with or without fertilizers. What crops shall be taken for this rotation? Any combination which omits our cow pea would be injudicious. Several years ago this rotation was decided upon as the best one attainable in this section: Corn, oats, followed by cow peas and cotton. This rotation is faulty in principle but correct in practice, and was adopted last season after two years' trial. The corn should precede the cotton, but experience has demonstrated that Rust Proof oats, the only variety successfully grown here, must be planted in October if maximum results are desired. [In North Carolina they should be sown in September.] Cotton cannot be removed in time for this crop, while corn can; hence this metathesis of crops. This rotation was adopted with and without fertilizers. It was begun in 1889. Three parallel strips, one-half acre wide and two acres long, were selected for the experiments. The eastern half of each was manured regularly with a fertilizer adapted to the crop, while the western half remains without fertilizer. The oats in the foregoing fertilized plat were fertilized with the Station's grain fertilizer at rate of 200 pounds of cotton seed meal and 100 pounds of acid phosphate, mixed and scattered and harrowed in with the oats. The peas, fertilized with 50 pounds of acid phosphate and 50 pounds of kainit. The pea, being a nitrogen gatherer, no nitrogen was applied additionally. The cotton was fertilized with the Station's compost for cotton, consisting of: One ton of acid phosphate; 100 bushels of stable manure; 100 bushels of green cotton seed; built in the following proportions: First layer, 5 bushels of stable manure; second layer, 5 bushels of cotton seed; third layer, 100 pounds of acid phosphate, etc. The cotton seed is made perfectly wet before spreading. The corn received the compost for corn, the ingredients the same as above, the proportion only being different, being one ton acid phosphate; 200 bushels of stable manure; 200 bushels of cotton seed, built as above, except proportion of 50 pounds of acid phosphate, 5 bushels of manure, and 5 bushels of seed. The cultivation of the above plats, for this year, was as follows: For corn, plat A, land was broken with three-mule disc plow, 8 inches deep in February. Rows marked off four feet apart and compost applied in the furrows at rate of 30 bushels per acre. A flat list was made on this and corn planted March 31st. At last cultivation peas at rate of two bushels per acre were sown broadcast. For oats followed by peas, the land was deeply plowed in October and the fertilizer named was scattered, and two and a half bushels of oats per acre harrowed in with it. After the oats were harvested peas were planted in rows, one bushel per acre, with the fertilizer named. For cotton the pea stubble was plowed in February and manured with compost. A careful study of the results of this rotation experiment will convince the most skeptical farmer of the wisdom of the system. The fertilized half has been built up 400 to 500 per cent. in eleven years, while that without fertilizer has gained twelve to twenty-five per cent. It should be the aim of every farmer to so handle his land as to make it grow richer instead of poorer. By this system it can be done, and at the same time getting better crops and profits. It is of special interest to note that the plat on which no fertilizers were used, in 1889 made seven and a half bushels of oats per acre, and 4.22 tons of green pea vines; the second year after, when it came again in oats, made 25.5 bushels oats, 816 pounds of straw, 24 tons of pea vines, the increase being simply due to the rotation and the peas.

An examination of the results will show the immense advantages to be derived from the moderate use of the proper fertilizers in the rotation. Incidentally it may be observed that each bushel of corn will give about 70 pounds of stover, which, when cured, is a most excellent forage for cattle, sheep and horses. The report would have been far more valuable and exact if the result from the use of fertilizers on each plat had been given as compared with the corresponding unfertilized plat and the cost of the gain compared. The only statement given is that in one very dry season when the fertilized plat made over ten bushels per acre the unfertilized plat did not make even a nubbin. But we are not informed whether the ten bushels on the fertilized plat paid the expenses. If it accorded with the experience of the writer it did not. While there is certainly shown a gratifying increase in the crops on the land, and the rotation is the same that this writer has been advocating for the cotton growers of the South for many years, it would be interesting to have such a course of fertilization for every crop grown compared with the same rotation in which no fertilizer is used except a liberal application of mineral fertilizers to the pea crop following the oats, and all the home-made manures and cotton seed are applied broadcast to the corn field. From our own experience and that of some others whom we have induced to try the plan we feel sure that in the financial profit, if not in the aggregate results, this last plan would make a far better showing than the fertilization of every crop in the rotation. The bulletin does not give any information in regard to the use made of the pea vines. If simply used as manure direct, there was a serious loss as compared with the feeding and returning to the soil of the resulting manure. What the Southern farmer needs to learn more than the mere use of commercial fertilizers is that there is a profit to him and a larger profit to his farm, through the feeding of all forage grown on it. There will be a greater and more valuable accumulation of humus in the soil through the feeding of the peas and corn stover than in any other way in which they can be used, as the resulting manure from the straw, peas and corn stover of two fields would be added to one of them to go into corn. Another fault in the rotation is that there is nothing to come in between the cotton and the corn, and our Southern soil especially needs a green winter cover as a nitrogen trap; even rye will do better than nothing, and will at least add more to the humus accumulation on the corn field. With this modification and the use of a larger application of phosphoric acid and potash to the pea crop, and no further fertilization with purchased plant food, this three year rotation will do more for the building up of the Southern soil and the prosperity of the Southern farmer than any course we can devise.

CHAPTER XLI.

FRAUDS IN FERTILIZERS.

There are in the manufacture of fertilizers today, men who are as honorable and correct in all their dealings as those in any other line of business, but in States where the fertilizer laws are not as strict, or are not as strictly enforced, as they should be, there are those in the fertilizer business (as in every other line of human effort), whose object is to live by their wits, and to give as little as possible for the money they receive. If the law and the inspectors do not watch for him, the farmer is perfectly helpless to discover these frauds. If the stuff has a rank smell he is apt to conclude that it is a good article, when it may not be worth hauling home. Owing to the increasing stringency of the fertilizer laws, there is less of fraud in fertilizers than formerly, but the rogues are still about, and the farmer should take care in the purchase of fertilizers to deal with men of established reputation in business affairs. It is far better to pay what may seem a high price for an article of proved merit than to get a mixture at an apparently low price in which you will pay a high price for all that is valuable in it and then have to freight a lot of utterly worthless stuff put in to make weight and to make the price look low. There is hardly a manufacturer who will not make for customers any particular description of fertilizer mixture, and in many cases it may be better to get the mixture made according to your formula than to make it yourself. But it is not of the honorable fertilizer manufacturer we would speak now. It is of the rogues and their dodges.

THE MAN WITH A SECRET.

One of the most common frauds is the man who has a fertilizer formula for sale. We struck one of these fellows recently, in North Carolina. A correspondent wrote to us that there was a man in his section selling a formula and farm rights for $3.00, and he sent me the secret, asking my opinion in regard to it. The whole thing was a mixture of a few well known chemicals used in mixing fertilizers. These were to be mixed with a certain quantity of stable manure, and lime and woods earth, and the resulting mixture was claimed to be equal to any fertilizer sold and the cost was to be but $4 per ton. I explained to my correspondent the result of mixing sulphate of ammonia, and stable manure with lime, and published the fraud in one of the State papers. The editor soon got a letter from the "professor" enclosing one of his circulars and saying that I had attacked him and he wanted space for an answer. Since I had simply shown up the article he was selling and knew nothing of the man, the editor did not notice his request, but sent me the circular. In this he states that a certain noted chemist (himself) had made a wonderful discovery, which had astonished the scientific world, and that the process would put millions in the farmers' pockets, when, in fact, the self styled professor had never been heard of as a chemist, and the scientific world had never been astonished at his mixture. But this fellow doubtless sold hundreds of dollars' worth of his recipes to men who could not afford to take a paper, and who did not get the Station bulletins, and did not know that the Stations are always ready to furnish practicable formulas for fertilizers without charge. These compost peddlers seem to have found a rich field in the South, for the same thing was tried here several years ago, and the North Carolina Experiment Station at that time issued a bulletin of warning to the farmers. But the men who bought "farm rights" from the last man had not, of course, read that bulletin.

"NATURAL PLANT FOOD."

Some years ago we received a circular from another correspondent, giving an account of another wonderful discovery, which was the natural food of plants. The circular gave the following analysis of this wonderful article. It was evidently gotten up for the purpose of bewildering the farmer, and I wrote to my correspondent that the article was simply pulverized phosphate rock and green sand marl, as was evident from the analysis.

It read as follows:

	Per cent.
Phosphoric acid. Total (P2O5)	21.60 to 29.49
Equivalent to bone phosphate of lime	27.20 to 64.38
Potash, (K2O) from glauconite	1.00 to 2.00
Equivalent to common sulfate of potash	2.00 to 4.00
Silicic acid (S1O2)	5.26 to 8.10
Carbonic acid (CO2)	2.07 to 3.00
Lime (CaO)	29.16 to 32.00
Magnesia (MgO) and soda (Na2O)	3.21 to 8.05
Aluminic (Al2O3) and ferric (Fe2O3) oxids	5.14 to 10.26

All this looked exceedingly learned and chemical, and the farmer, knowing nothing under the sun about the meaning of all this array of symbols and figures is totally uninformed as to the nature of the stuff. The circular stated all these things were available to plants in the soil. The mixture was sold all the way from $20 to $28 per ton, according to locality. The New York Station took up the examination of the article in a bulletin, and showed that it contained in a ton but 28 pounds of available phosphoric acid and 2.6 to 4.5 pounds of potash, and at trade values for these, a ton of the great natural plant food was worth $1.52.

This fraud, which was simply, as was evident from the analysis, a pulverized phosphate rock and green sand marl (glauconite) has been so fully exposed that nothing has of late been heard of it.

All that a farmer needs to know in regard to any fertilizer mixture is how much nitrogen, phosphoric acid (in an available form) and potash it contains. That a certain percentage of phosphoric acid is equivalent to what would be contained in another combination, such as bone phosphate of lime, has nothing to do with the matter, and is only put there to make the farmer think there are bones in it; as these fellows know that most farmers have a high opinion of the value of bones, though they know that the article has no bone in it whatever. They also know that farmers consider sulphate of potash the best form, and hence they say that the percentage of potash in their stuff is the same amount that would be found in a certain amount of sulphate of potash, while there is not a particle of sulphate in the stuff.

So far has this habit of putting "equivalent to," on the sacks obtained, that firms that should know and do better sometimes add these meaningless figures. I have before me a sample of "Pure Raw Bone." The analysis printed on it says: "Ammonia, 3.65 to 4.15 per cent.; phosphoric acid, 22.00 to 24 per cent., equivalent to bone phosphate of lime, 48.00 to 52.00 per cent."

This simply means that the article contains about 3 per cent. of nitrogen and 22 per cent. of insoluble phosphoric acid. Fertilizer manufacturers have always put the nitrogen content on their sacks in the form of ammonia, because as they say, "the farmers understand ammonia but not nitrogen." How it is easier for a farmer to understand a combination than a simple element we cannot understand. The figures are put there simply because they look larger in the form of ammonia, a compound of nitrogen and hydrogen, than they would if only the actual nitrogen was printed. The 3.65 per cent. of ammonia is simply 3 per cent. nitrogen but it looks larger to put on the combination figures, and so the practice has grown. The above analysis does not show a very high grade of raw bone meal, and the sliding scale is deceptive also, as it gives the dealer a loophole to crawl out of. The law in North Carolina does not allow a manufacturer to say 3.65 to 4.15 per cent. He must give the lowest percentage he claims and no more, and this law also requires that nothing be printed on the sacks except the percentages of nitrogen, available phosphoric acid and potash. Only this and nothing more, unless, as is proposed, the source from which the constituents are derived be added.

In some of the States no value is allowed for insoluble phosphoric acid, while in others it is valued at 2 cents per pound. In regard to this we quote from Dr. Roberts's book on the "Fertility of Land." He gives a table showing that "the average of forty-nine soil analyses shows that more than 4,000 pounds per acre of phosphoric acid are contained in the first eight inches of surface soil, the larger part of which, presumably, is insoluble under present methods of tillage. Would it be wise or profitable to purchase, at 2 cents per pound, additional insoluble phosphoric acid, when the soil contains such vast stores of this low grade plant food? True, a part of the so-called insoluble phosphoric acid may become available and produce beneficial results, but since the soil is usually abundantly supplied with the same kind of material, would it not be wiser to make it available by tillage than to purchase more of this lazy plant food?"

We quote the above largely because there has been special effort to put insoluble phosphoric acid on the market in the form of "floats," or pulverized phosphatic rock, and the soft phosphates of Florida, which are not adapted to the making of acid phosphate. There is abundant evidence, however, that on some soils these insoluble forms of phosphoric acid do produce good results, though seldom on the immediate crop. If offered at a reasonably low price there is nothing fraudulent in the selling of these articles to the farmer, provided a fair price is charged for the same. It would be noted that the value to the farmer of insoluble phosphoric acid depends largely in the material that carries it. In ground raw bones, the phosphoric acid is in an insoluble form, but the material decays rapidly in the soil, when finely ground, and the acid becomes available more quickly than that in the rock phosphate. but the chances are the farmer will have to pay more for it than if he could buy soluble phosphoric acid in a superphosphate.

As we have before remarked, the frauds in fertilizers are becoming fewer annually, as the laws of the different States become more stringent and are more strictly enforced. In the Cotton States, where fertilizers have long been sold in immense quantities, the laws are better than in those States where the use of these has but recently begun, and there should be some united effort on the part of those in control of the fertilizer inspection in the various States to get uniformly good laws and to enforce them. These laws are as much for the benefit of the honest manufacturer as the farmer, for he has to contend with an unfair competition.

Recently the peddlers of secret formulas for fertilizer mixtures have been very active in the South, where the farmers buy fertilizers largely, and, by extravagant tales of what their fertilizers will do and the cheapness of the mixtures, they have been able to sell a good many of their recipes to those who think they cannot afford to take a paper, and who never think of calling on their Experiment Station for the proper formula, which they could get free of charge. One of the most recent circulars issued by these humbugs and sold to farmers reads as follows:

HOME FERTILIZERS.

Recipe price, $5.00.

The greatest fertilizer known for the farmer.

Results much better from using the home fertilizer than any other made.

Cost, $3.00 per ton.

Box to hold one ton four feet square.

INGREDIENTS.

No. 1. Stable manure one inch thick.
No. 2. Chemicals one gallon on layer.
No. 3. Lime one-eighth of an inch thick.
No. 4. New dirt one inch thick.
No. 5 Ashes one-half inch thick.
No. 6. Salt 60 pounds per ton.

CHEMICALS FOR ONE TON.

Potash, 8 pounds; nitrate of soda, 4 pounds. coperas, 4 pounds, muriate of ammonia, 12 pounds; phosphate acid, 5 pounds. Mix with 12 gallons of warm water.

....Agent

The name of the concocter of this mixture is not given, but at the bottom is written "John Green, Agent, from Sullivan Co. Tenn." Now as to the ingredients of the mixture. Muriate of ammonia is never used for fertilizing purposes, for the nitrogen in it can be had far more cheaply in other forms. The chemicals are to be mixed with warm water. This would make the ammonia be set free by the potash, and be lost. Copperas (which the ignoramus spells "coperas") is the sulphate of iron and of no use as a fertilizer. Nitrate of soda is, of course, valuable, but it, too, would be lost in the mixture, and if not, the amount of it in the ton would, as one chemist has said, be about equal to three dead cats per acre. Commercial potash is not used as a fertilizer ingredient, since its caustic properties would set ammonia free, and the lime would not only have this effect but would revert the little phosphoric acid in the mixture. The salt is of no value whatever as a fertilizer, and the ashes would have the effect of releasing the ammonia in the stable manure, with only the "new dirt" to catch it. One ton of this mixture would contain about 7 pounds of phosphoric acid. 6 pounds of nitrogen (if it did not get away) and 22 pounds of potash. As an average commercial fertilizer contains about 170 pounds of available phosphoric acid, 50 pounds of nitrogen and 45 pounds of potash, the bulletin of the North Carolina Station, from which we get these facts, well remarks that it would take over two tons of the home fertilizer to furnish the potash in one ton of the average commercial fertilzer, over eight tons to furnish the nitrogen and over twenty-four tons to furnish the phosphoric acid. Those who read this, or the bulletin of the North Carolina Station, will hardly be swindled out of their $5 bills.

The same bulletin, No. 173, of the North Carolina Experiment Station, of the College of Agriculture and Mechanic Arts, gives the following wonderful circular, the original of which is embellished with a portrait of "Col. I. J. Britain, Inventor, Winston, N. C.," and is as follows:

"THE PROCESS

OF COMPOUNDING THE FARMERS'

COMPOUND FERTILIZER.

"First dig a stable pit size of stall or stable three feet deep. After digging the pit take a rich loamy soil, or swamp muck. After being good and dry place in the pit to the depth of six inches, then place a thin layer of tobacco stalks, rotten straw or cotton seed. Then apply liberally by hand over the entire surface of the pit, the following compound or mixture:

"Twenty-five pounds saltpetre, one bushel of common salt and one quart of carbolic acid, one gallon on each layer of the rich soil. Then dilute the carbolic acid in ten times the amount of water, and sprinkle each layer. Then fill in another layer of rich soil and straw, and apply another sprinkle of the compound, and continue as above stated six inches of loam and another sprinkle of compound until the pit is filled to the surface of the ground. Then floor the stall or stable by laying small poles on the compound and floor the stable. The stock should be kept in the stall six months. The drainage of the stock and stall adds a great deal to the compound. This is the single process of compounding the Farmers Compound Fertilizer.

"Then construct alongside of stables a pen or pens with water tight floor, slanting downward. Place a V trough by the side of pens to catch the contents of said pen and run off in a barrel. Fill the pens with barnyard, chip manure, tobacco stalks or any rubbish, leave the pens uncovered. Construct by trough, the water from eaves of barn or stables into the pens. Care should be taken not to let too much water go into the pens. Thus you have a complete leaching system. When the barrels are filled with lye from the pens it should be poured in stall or stable and sink into the pit with the compound. This is the double process of manufacturing the Farmers Compound Fertilizer.

STOCK IN THE STALL IS A GOOD CONDUCTOR OF

amonia from the air. Established by which the amonia phosphoric acid and Potash from the solid manure, is conducted into the pit under the stall or stables and is there joined by the same ingredients in a safer and more abundant form, from the liquid manure deposited by the stock: making a powerful and available plant food in a much more concentrated and availible form than is found in high priced commercial fertilizers. At the end of six months your pits are ready to throw out, the contents of which has by this time become out as black as ink and as strong as lye. If you now want to use this through a drill it will be necessary to dry by spreading thinly on barn lot or floor and run through a sieve, or what is better, if you have one, an old fanning mill. If you wish to use in the drill on any crop when a drill is not necessary the drying sieving may be dispensed with. An ordinary stable, say 10x14 feet will furnish 200 bushels of the compound sufficient to fertilize 20,000 hills of tobacco or twenty acres of wheat with the highest grade fertilizer known to science. The public is warned not to infringe upon my invention unless they are authorized by myself or lawful agents, for my rights must be respected.

Copyright secured.

I. J. BRITAIN, WINSTON, N. C."

We have copied this singular circular in full, spelling, punctuation and all, to show with what sort of stuff some men try to fool farmers The bulletin well says that the prominent statement that "stock in the stall is a good conductor of amonia from the air" is not true. Neither is the statement that the result of all this waste of time and labor is a powerful and available plant food in a much more concentrated form than is found in high priced fertilizers, true. Still further from the truth is the statement that the mixture is "the highest grade fertilizer known to science," for it is nothing of the sort. Inquiry of the Librarian of Congress reveals the fact that their indexes do not show any entry of a copyright for the process of compounding the Farmers' Compound Fertilizer by I. J. Britain. The directions are a jumble which no one can follow. He uses 25 pounds of saltpetre, or nitrate of potash The nitrogen and potash can be had in far cheaper forms. The bushel of common salt is of no use whatever. Carbolic acid is used, and this is of no value as plant food, and, in fact, would be a preservative from decay and a hindrance to germination. But the whole process is so absurd and wasteful of time and labor that it would seem it is only needed to state it to see this. But many simple minded folks are annually caught by just such pretenders, and our lists of humbugs would hardly be complete without this one, which flourishes close to the home of the author.

The way to deal with all these secret process fellows is to report them at once to your Experiment Station, and their secret will be gotten, and published and shown up in its true colors. There is not a Station in any of the States that will not furnish, free of charge, correct formulas for the mixing of concentrated fertilizers to the farmers of the State on application. As we have said, it is the men who do not read and do not take the agricultural papers who get caught with these baits, and pay far more than the correct information to be gained by reading would cost them.

CHAPTER XLII.

THE STRAWBERRY AS A FIELD CROP.

The great extension southward of the culture of the strawberry as a market crop has made its proper fertilization a matter of great importance to the growers. There is now a regular succession of the strawberry, from the earliest that come from Florida to the latest that reach the great cities of the North from points north of their latitude. At the distant points the growers are, of course, entirely dependent upon commercial fertilizers for the production of the crop, and they have found that the strawberry needs liberal feeding. Fortunately the soils on which the strawberry thrives best are also the soils on which commercial fertilizers have their best effect. Low, flat lands, where the permanent moisture is not far below the surface, and where the soil is well filled with humus, are always the best soils for the strawberry, and even where they seem less fertile than the dry uplands they will produce better crops of strawberries simply by reason of the presence of moisture always in reach. Not that strawberry lands should not be well drained, but that the soil should have the water table not too far down, so that capillary moisture can always be depended upon.

MANURIAL REQUIREMENTS OF THE STRAWBERRY.

As in most fruits and vegetables potash plays an important part in the production of the fruit of the strawberry, while phosphoric acid is the controlling factor in the growth of the plants and the maturity and firmness of the fruit. While a due percentage of nitrogen is needed for a luxuriant growth, an excess of this element will be apt to cause the fruit to be soft, and to carry badly. We can see, therefore, that the crop demands a well proportioned complete fertilizer in which, with a due percentage of nitrogen there will be an abundant supply of phosphoric acid and potash. As the plant analysis shows the need of the plant for potash, and the soils in which the market culture of the strawberry, in the South especially, are deficient in this constituent, the percentage and form of the potash becomes an important matter to the strawberry grower. While nitrogen is an important element, we are of the opinion that the growing of a crop of cow peas the summer before planting the strawberries will usually supply a sufficient amount of nitrogen for the first growth of the plants, and that subsequent growth can be maintained by top dressings of nitrate of soda. The growing of the peas will not only supply nitrogen forming organic matter, but will make a profitable forage crop to precede the strawberries, and a large part of the phosphoric acid and potash needed by the strawberries, can be advantageously applied to the pea crop to encourage its growth, and to enable the plant to do the greatest possible amount of nitrogen catching for the strawberries. The common practice of the strawberry growers in the South is to set the plants in August or September, and to heavily fertilize the ground so as to get a fair crop of fruit the following spring. In the spring, as growth begins, a top dressing of nitrate of soda is added. The plants are allowed to mat along the rows, and to bear a crop the following year, after which they are plowed under. In this system a field is planted every year, so as to have always one to turn under after the crop is off. But owing to the fact that there is apt to be long continued dry weather at the time usually selected for planting, many growers are making a practice of setting later in the fall, even in November and December whenever the ground is not actually frozen. In the North, there is no doubt we believe that spring is the best time to set the plants, but here our finest success has been from November setting. We once set a patch of strawberries in November and cold weather set in at once, but no harm was done, and much to my surprise the plants set a very good crop of fruit in the spring, and were so well grown that we allowed it to ripen. If we were at all certain of seasonable weather in September, we would prefer that month for the setting to any other, but we are usually compelled by reason of the drought to be later in setting.

Fertilizer formula for the strawberry: Acid phosphate, 900 pounds; cotton seed meal, 700 pounds; nitrate of soda, 200 pounds; sulphate of potash, 200 pounds. Of this the best growers would use not less than 1,000 pounds per acre, on land where no previous crop of peas has been grown. Where a growth of dead pea vines has been plowed under, the amount of organic nitrogen in the shape of cotton seed meal can be dispensed with; and the nitrate of soda should be reserved for the spring dressing where the plants are set late in the fall.

FORCING THE STRAWBERRY.

There is no fruit so easily and profitably forced under glass in winter as the strawberry. But let no inexperienced person suppose that a strawberry plant can be taken up in the fall, placed under glass and given a forcing temperature and succeed. For the purpose of forcing, the plants need to be grown for months previous, and properly handled so as to make strong crowns that will bloom and fruit well. We always force strawberries in six-inch flower pots. We begin with the first rooted runners in early summer. As soon as these have started to form white roots an inch long we take them up and set them in three-inch pots, in the ordinary compost of rotted sods and manure which we use for general greenhouse potting. The plants are set in a frame on a bed of coal ashes to prevent the earth worms from getting in, and are shaded with lath screens in place of sashes, thus giving them a varying shade and sunlight; and special attention is given to the supplying of the plants with water. As soon as the roots have matted around the balls of earth in these pots, they are transferred to the 4-inch size, replaced in the frame and treated as before. Then, as soon as the 4-inch pots are well filled with roots, they are again repotted into six-inch pots in which they will be fruited. These pots are now plunged to the rim in the coal ashes and attended to carefully. As the pots get well filled with roots some liquid mamanure is applied, once a week, to encourage a luxuriant growth and to aid in the formation of strong crowns, for no weak plant can be successfully forced. As cold weather approaches less water is given, the plants are allowed to become semi-dormant, and are allowed to be exposed to the frost for a while, since the forcing must be preceded by a short period of rest. The first plants are put in the houses in December. All the old leaves are trimmed off, the plants well watered and started in growth with a night temperature of about 45 degrees, and kept moderately cool in day time. As they begin a new growth we give, once a week, a watering with a solution of an ounce of nitrate of soda to four gallons of water, taking care to apply it only when the plants are moist at the root and not when needing water, and to pour it on the soil and not over the foliage. See that the drainage of the pots is right so that the abundant watering that is needed will not sour the soil. The side bench of the house near the glass is the best position for the plants. As the blossoms appear it is well to brush them over daily at noon with a camel's hair brush, to insure fertilization; and no variety should be forced unless it has perfect flowers, and it is naturally an early bloomer in the open ground. Flowers of sulphur dusted on the hot water pipes is valuable for keeping down fungus troubles. Do not pack the pots so closely as to touch each other, but have a space of two inches around every pot. Carefully avoid watering overhead, on the whole plant, when blooming, but always apply water by pouring it under the leaves. When well grown, and the variety is a good one, the crop should be a profitable one. They are sold in paper boxes holding half a pint. We have found, as with the tomato, that bone dust added to the soil is better than stable manure, though the ordinary potting compost, if old and well rotted, answers very well. If earth worms get into the pots they will paste the soil together and cause it to sour. If there is evidence of their presence pour a little lime water on the pot to draw them out, and at the same time sweeten the soil. The plants that have been forced in winter can be planted in the open ground in the spring and will make a late crop there as they get into growth. During their growth in preparation during summer, and in the house in winter, it is needless to add that no runners should be allowed to grow; and the keeping of them off will be one of the chief attentions needed in the preparation of the plants, aside from keeping the pots watered and free from weeds.

CHAPTER XLIII.

BLACKBERRIES AND RASPBERRIES.

The requirements of these are so similar that we treat them together. Both are fond of a comparatively heavy loam, but are not very particular as to soil, provided it is in a fertile condition and well supplied with humus. Plants of the red raspberry and the blackberry should always be grown from root cuttings, as such plants are far better than those from the suckers around the old plants. The black caps are grown from tips of the canes, which should be buried along the rows after the growth of the season is about mature. The running blackberry (or dewberry) can be grown in the same manner. We set the plants in rows six feet apart and three feet in the rows, and train to stakes, or to a single wire stretched from the stakes about four feet from the ground. Dewberries should be allowed to trail along on the ground along the rows the first season, and should not be tied up until the spring they are to fruit. The best way to train them is to set forked stakes about two feet from the ground, and lay slender poles like hoop poles from stake to stake to which to tie the vines. These poles are better than wires, as the wire is apt to chafe and cut the canes. After the fruit is gathered, cut away the old canes and train out as many new ones from each stool as are sufficient, and train them along the rows out of the way of cultivation and injury.

MANURIAL NEEDS OF BLACK AND RASPBERRIES.

If the growing of peas or clover previous to the strawberry crop is desirable, it is far more so with the blackberry and the raspberry, and success will not be certain with these unless the soil is kept well supplied with organic matter. As they will keep the ground longer than the strawberry this is one of the points to look after during their growth. We have found it a great advantage to plant a single row of cow peas between the rows of blackberries, after the fruiting season is over, and to cultivate them as long as it is practicable, letting the whole growth die on the land to be plowed under in the spring. Treated in this way there will be no need for the application of nitrogenous fertilizers, but a fair supply of the mineral elements should be given annually, making the mixture about 4 parts of acid phosphate to one of sulphate of potash. Allow no more canes to grow in the hill than can have room for full development, and shorten them back annually, or, what is better, pinch in summer to induce the growth of side shoots and to make bushy canes.

PROPAGATING THE PLANTS.

Many growers depend on the suckers from the base of the blackberry and red raspberry plants for planting. But it will be found that far better plants can be grown from cuttings of the roots made in the fall. We make these cuttings about three inches long, mix them in moist sand in boxes and bury the boxes outdoors during the winter, with a mound of earth over them to prevent access of water. They remain there till early spring and are then planted in the open ground in rows wide enough for horse cultivation, and dropped about four inches in the rows. These root cuttings make a strong growth during the summer, and are far better plants than those cut from the old plants as suckers. With new and rare varieties that are high priced we have adopted another and more rapid way. Years ago when there was a furor over the Herstine raspberry a friend bought two large plants for which he paid $5. He received them late in the fall and asked me how he had better treat them. I told him that if he would give me the plants I would propagate them and give him one-half the plants I made, as I thought I could put him just as far ahead in the spring as with the plants he had. He brought me the plants, which were very fine ones, with long roots. These were cut into pieces about an inch long, placed thickly in shallow boxes of light soil, and covered half an inch. The boxes were then placed on the propagating bench in the greenhouse, where there was a good bottom heat. There they started rapidly and as soon as leaves developed were set in two and a half inch pots, with the ordinary potting compost, and placed in a cool greenhouse, and a little later were shifted into three-inch pots. By the time frost was over in the spring I had 250 strong plants with tops a foot or more high, and these, planted in the open ground, each, during the summer, made a plant as strong as we would have had from the original plant had it been set, and we had 250 plants instead of two for the $5. Of course, with raspberry plants at the usual price per thousand it would hardly pay to adopt this method, but with plants selling at fancy prices it will enable the grower to get a stock in advance of the lower rates. Blackberries are propagated from root cuttings in the same way as red raspberries.

Blackcap raspberries are grown from the tips of the canes, which are covered with soil in summer and by fall have formed a strong plant, which can be then separated from the cane. Some of the blackberry family, such as the dewberry, are also grown from the tips. Raspberries are far more difficult to grow in the South than they are in the North, and require for their best success a moist soil and partial shade during the heat of the day. The blackcaps are far more certain croppers in the South than the red raspberries, but the red varieties can be grown if attention is paid to the summer pinching of the canes to induce a bushy growth, for if long canes are exposed to the sun they will certainly be killed.

The Michigan Experiment Station has published a descriptive catalogue of over 400 varieties of raspberries, which those interested can get for consultation.

CHAPTER XLIV.

FERTILIZERS IN THE VINEYARD AND ORCHARD.

After years of patient experiment in the growing of grapes with commercial fertilizers on a soil nearly pure sand, we think that we have learned something in regard to the food necessities of the vine. The soil of the sand hills of Southern North Carolina was selected for the series of experiments carried on to determine the food requirements of various fruits and tobacco for the very reason that the soil was nearly a barren sand and had never been in cultivation, and hence was not altered by manuring. These experiments were conducted by the North Carolina Agricultural Experiment Station through a series of years, and were managed with the most minute care to avoid any source of error. The land was cleared from the original pine forest, and every stump was dug up and hauled off the land, since the burning would have made changes in the food content of portions of the land, and this we aimed to avoid. The little humus that would naturally have collected in a forest had been regularly destroyed by the forest fires which annually ravaged that section. The forest growth was long leaf pine and scrub oak, and between these the land was covered with the tall growth of wire grass *(Aristida Stricta)*, the great feeder of the fires. This sand hill region has been found peculiarly favorable as a winter home for people suffering from throat and lung diseases, and considerable settlements have grown up with hotels for the transient guests, and many homes of those who have found health there and have remained to make permanent homes. These residents made some experiments in fruit culture, at first only with grapes, and they found that with the aid of fertilizers the apparently barren sand grew grapes in wonderful profusion and of remarkably fine quality. Later on other fruits were attempted, and now the peach is the leading market fruit. The experiments were inaugurated for the purpose of studying the needs of the various fruits as to food, and to show the growers how most economically to grow the fruit. Of course the amounts applied on such a soil are no indication of what should be applied on a different soil and in a different climate.

Still, the evidence is that trees and vines, like other plants, need a proper proportion of all the leading forms of plant food usually deficient in many soils. The same question arises in the fertilzation of fruit trees and grape vines as with the annual crops. How shall we accomplish their feeding in the best and most economical manner, and what forms of plant food are most generally needed by orchard and vineyard products? We think that our experience has taught us something in this regard.

FEEDING THE APPLE ORCHARD.

A study of the tables in the appendix to this book will show that in the leaves of the apple and the whole structure of the tree, the chief needs are nitrogen and potash, while in the fruit potash takes the lead, and phosphoric acid cuts a small figure. The complaint is general in most parts of the country, that apples do not grow as they formerly did. Men keep an apple orchard and make a hay field or a pasture of it, and expect the soil to continue to give them fruit while in every crop they are taking away from the soil the plant food the trees need. It is easy to convince farmers of the need for using fertilizers on their wheat, oats and corn crops, but most of them seem to imagine that an apple tree does not need feeding, but can take care of itself like the trees of the forest. The great reason for the failure of apples where they once did well is the depletion of the soil of the mineral matters which the trees need.

A crop of apples of fair proportions will remove more potash from the soil than three good crops of wheat. No farmer would be surprised that wheat finally fails to grow on land receiving no fertilizer, but the idea of applying fertilizers to apple trees never seems to occur to them. There are endless theories in regard to the proper method of planting, pruning and feeding apple trees. Some prominent authorities insist that deep plowing during the whole of the tree's existence is essential to succcess, and point to the old apple orchards in sod as examples of bad treatment. To some extent they are right, for the common method of keeping orchards in sod for the purpose of pasturage or mowing hay from them is certainly an evil practice. But there is a right way and a wrong way of keeping trees in sod, as we will endeavor to show.

PLANTING AN APPLE ORCHARD.

The most common mistake made at the start is in planting trees too old. Nurserymen commonly root-graft apples in winter, and set them in nursery rows in the spring. The first season's growth in the nursery is a tall, straight stem with few or no branches. The man who wishes to do the best with his orchard will select these "maiden," or one-year-old trees for setting. There are several advantages in this. The trees can be had for less money than the two or three year trees commonly planted. The planter can start the head of his trees uniformly, just where he wants to start it, and the young tree, not being crowded in a nursery row, can develop a head of proper proportions, and by the time it has reached the age at which most people want to plant from the nursery it is a far larger and better proportioned tree than the one left in the nursery row. The nurseryman heads back the trees in his rows the second year, but he does not head them down so low as they should be in the orchard; and when we plant a two or three year old tree we generally have an ill shaped head started, and started where we do not want it. The result is that if we are to get the uniformity of head we want there must be a great deal harder pruning done at planting time, and the trees are never as symmetrical as they would have been had they been planted as yearlings and properly started.

Writers on fruit culture have various notions as to what should be the method used in starting a tree in the orchard. Many insist that the central stem should never be shortened, while others would head back as the nurserymen do, and form an open headed tree. We certainly prefer this plan.

Five years ago we planted two apple trees of the same variety within 30 feet of each other. The trees were planted in a close sod and have never had any cultivation. They are in a soil of fair fertility and on a lawn near a dwelling. One tree at planting was headed back to the point where we wished the head to start; the other had the leading shoot left, and the side branches merely shortened. Both have been properly pruned to keep the head clear of becoming a tangle of shoots, and both have grown fairly well. But the tree headed back and formed into a round, open head has far outstripped the other, is now about twice the size and bearing apples. while the other has not reached this stage. The headed back tree has a trunk of not over 20 inches from the ground. The other has a trunk of four feet. The growth of the tree headed back has been rather phenomenal, and is fully as great as that of trees set at same time in the orchard and kept cultivated annually. But the lawn where it stands has merely been mown. and nothing has been removed from the soil. All the grass decays where it falls, and no manure of any kind has been given to either tree, but there will be some applied now that they are getting into bearing. It seems evident, however, that the decaying organic matter from the grass has furnished the trees all the nitrogen they needed, since all the organic matter produced has been returned to the soil, and they will need only light dressings of acid phosphate and plenty of potash. I said they had had no manure, but they have been twice limed, and this has, of course, helped in the nitrification of the organic matter, and in the release of potash from the clay soil in which they stand.

Still, while it is evident that apple trees can be planted in sod and do well, we do not think that this one instance warrants us in recommending the general planting of apple trees in sod. What we want in the young tree for the first years of its life is vigorous growth, and as a rule this is promoted by good cultivation and manuring. But we do object to the advice given by a prominent writer on orcharding, to plow and cultivate the orchard deeply so as to force the roots down in the soil. We prefer to work all plants shallowly, so as to keep the roots in the best soil and in reach of the influences of the air and fertilizers, and not to force the roots of trees down into the unimproved and unaerated subsoil. If the roots are forced down by deep cultivation there must inevitably be a great loss of the fertilizing matters applied before the deep set roots can get the benefit of them. Prepare the soil deeply and well before planting and then cultivate shallowly, every summer till July, until the trees get into a bearing state, and then put the orchard in grass and treat it as you would a lawn, by frequent mowing and letting the cut grass lie to help the trees. In short, plant and grow an apple orchard for apples alone, and you will get them.

STARTING THE TREES.

Having selected one-year-old trees with a single stem, we prune all the roots that have become in any way bruised or broken in digging, and cut off all the fibrous roots, as they are commonly dried up. Make the holes no deeper than the plowing was done, for a deep hole in the hard subsoil will simply be a reservoir for the water to settle in and damage the roots. Put no manure of any kind around the roots of a young tree, but simply put the surface soil in the bottom and work it in among the roots, and then ram the earth as though you were setting a post. Never pour water in the holes to settle the earth, for the wet earth will crack and admit air in drying. A good ramming of moderately dry soil is all that is needed. In the North it is probable that spring planting will be best, but anywhere south of Pennsylvania we would, as a rule, set trees in the fall. Nurserymen advise planters to get the trees in the fall, even if they set them in the spring, and heel them in ready for planting; the recommendation is mainly for the convenience of the nurserymen, for we had rather plant than heel in.

Having set the trees, the next thing is to head them back to the point where you wish the head to start. Low headed orchard trees are best in any locality, and south of the Potomac no orchard tree should have a stem of over two feet, and we make ours about 20 inches. Farmers say they want the trees tall enough to get under in cultivating. The fact is that there is no need for getting under them, for if the cultivation reaches the outer branches it is sufficient; for the feeding roots of a tree are all, as a rule, out where the drip falls and beyond, and there is the place where cultivation and manuring are needed. Therefore we head back the young tree to the height we want the stem. The low head protects the stem of the tree from the hot sun and the trees do not get blown over as tall stemmed ones are sure to be. When growth begins in the spring we select the three or four best situated buds that start near the top as the limbs of the future tree, and rub off all others; and allow no others to start during the summer but those we have selected for the main limbs. These, at the next pruning in winter, are shortened back to make them branch and gradually form a round and open headed tree, and care is afterwards taken that no sappy sprouts are allowed to grow in the centre of the tree. These are rubbed out as soon as they start, so as to throw the whole strength of the tree into the desirable form. An orchard started in this way will seldom need any pruning at all after it gets to a bearing size, except keeping out the water sprouts in the centre and around the base of the tree.

We have given these methods of practice as a necessary preliminary for the feeding of the orchard. We have said that the feeding roots are out where the limbs reach. There is, then, little use for putting manure or fertilizers up against the stem of the tree after it has developed much top. In our experiments at Southern Pines, N. C., we proportioned the amount of fertilizer applied to the size of the tree, and did not apply it all over the ground until the roots of the trees had occupied the land between the rows. We began by applying the fertilizer to a small circle around the tree, making the amount applied proportionate to the space occupied by the roots, and enlarged the circle every year as the roots extended. In ordinary orchard culture this minute care, is, of course, not needed, and as some crops are commonly grown between the rows the whole soil should be fertilized at once.

CULTIVATING AND CROPPING THE ORCHARD

There can be no possible objection to the growing of vegetable crops in a young orchard to help in paying the expense of cultivation; but the common practice of planting the orchard in corn is objectionable. Tall growing plants like Indian corn and the like, which occupy the land during the whole summer, are objectionable for more than one reason. The crowding prevents the proper development of the head of the tree, and the wide reaching roots rob the soil of too much moisture. Low growing crops that occupy the land during the earlier part of the summer, like early Irish potatoes and other early garden crops, are far better, for all cultivation in the orchard should cease by the first of July; and then some soil cover crop like crimson clover should be sown, to keep a green cover on the land during the winter and to plow under for the furnishing of the organic matter that is to supply the trees with the needed nitrogen. It is a good plan to set a stout stake on each side of the tree a foot or more high in the line of cultivation, to prevent a careless plowman from striking the trees with the singletree. What we want in the trees is a good but not too rank and sappy a growth. Therefore, as a rule, we would avoid the use of stable manure and depend on the promotion of the growth of the legumes by liberal applications of phosphoric acid and potash, to furnish all the nitrogen needed. In fact this will, in a few years, be found a superabundance, and after the orchard is put in grass there will be no need for any nitrogenous application, but liberal applications of potash and phosphoric acid will be needed to replace the mineral matter carried away in the fruit. An orchard in a mown sod on which no animal is allowed to graze and from which no grass is taken away, will be longer lived, more healthy and fruitful than a cultivated orchard, if the mineral matters are kept supplied to the soil. The outcry against orchards in grass on the part of some writers has been caused by the old method (or lack of method) with orchards in grass. We wish to especially impress upon our readers that it is not this kind of grass-orcharding we advise, but the keeping of the orchard in grass purely for the benefit of the trees. The grass, mowed frequently during the growing season, will be constantly adding humus to the soil, and tending to promote rather than impair the moisture content. The fertility of the soil must be kept up by regular applications of phosphoric acid and potash, and if this is done the soil loses nothing but what is carried off in the fruit, and the fertilizers applied will more than make good this loss. Another advantage in this method of keeping an orchard in grass is the fact that a soft cushion is formed under the trees, and the windfalls are not bruised. In fact, if the trees are headed as low as we advise there will be little trouble in gathering the greater part of the fruit without ladders. An annual dressing of the following mixture will keep the grass in fine condition, and the dead grass itself will furnish organic matter, forming nitrogen sufficient for the trees.

Acid phosphate, 1,600 pounds; muriate of potash, 400 pounds to make a ton. Of this use 400 pounds per acre annually in bearing years at least. If at any time there should be evidence of lack of vigor in the trees, replace the acid phosphate with raw bone meal, which will furnish about 4 per cent. nitrogen. One caution about the distances for planting. Most of our apple trees will do better planted not less than 35 feet apart each way. Crowding is a general fault with inexperienced planters. On very fertile soil even a wider distance will be better.

ANALYSIS OF THE APPLE TREE AND ITS PRODUCTS.

Apple leaves collected in May contain water, 72.36 per cent.; ash, 2.33 per cent.; nitrogen, 0.74 per cent.; phosphoric acid, 0.25 per cent., and potash, 0.25 per cent. Collected in September they contain water, 60.71 per cent.; ash, 3.46 per cent.; nitrogen, 0.89 per cent.; phosphoric acid, 0.19 per cent., and potash, 0.39 per cent. The fruit of the apple contains 85.30 per cent. of water, 0.39 per cent. of ash, 0.13 per cent. of nitrogen, 0.01 per cent. of phosphoric acid and 0.19 per cent. of potash. The wood of the whole tree, roots and branches, averages 60.83 per cent water, 1.50 per cent. ash, 0.35 per cent. nitrogen, 0.05 per cent. phosphoric acid, and 0.17 per cent, potash.

Estimating 40 such trees per acre, there would be removed from the soil in a crop of ten bushels per tree, in the fruit alone, 32 pounds of nitrogen, 8 pounds of phosphoric acid, and 45.6 pounds of potash.

A crop of wheat of twenty bushels per acre removes from the soil in grain and straw about 29 pounds of nitrogen, 9 pounds of phosphoric acid and 5 pounds of potash. It will be seen then that the draft on the soil, especially in potash, is far heavier from a crop of apples than a crop of wheat. It has taken a large amount of plant food to build up a big tree, and to supply its annual crop of leaves and fruit; and in most cases the owner of the orchard expects to get a crop of hay or pastureage from the orchard, too. And then we hear people wonder why they do not get fruit as their fathers did on the same farm. They manure their wheat, but starve the orchard which is drawing on the mineral resources of the soil more than three times as much as the wheat is.

To supply the manurial needs of the fruit alone on a bearing orchard as above, would require per acre 200 pounds of nitrate of soda, 60 pounds of acid phosphate and 100 pounds of muriate of potash. If, however, the orchard is in sod and the grass is kept mown for the benefit of the trees, there will not be the need for that amount of nitrogen, as there will be a large amount of organic matter returned to the soil, and for the benefit of the trees themselves we would increase the amount of phosphoric acid, and make the dressing of nitrogen in the form of tankage or cotton seed meal, and use 300 pounds of acid phosphate, 200 pounds of cotton seed meal and 100 pounds of muriate of potash per acre. Or it might be as well to put the phosphoric acid in the form of floats or pulverized rock, which would be more slowly available it is true, but would, nevertheless probably be better for trees than the more readily available acid phosphates.

CHAPTER XLV.

THE PEAR.

The climate and soils of the Atlantic coast of the United States, from Boston to Cape Hatteras, are peculiarly adapted to the successful culture of the pear, and the section of this range best adapted to pears is that known as the Delaware and Maryland Peninsula. In this favored region the pear attains a size and quality unknown in most other sections. We once showed pears from the eastern side of the Chesapeake Bay, at an exhibition in Baltimore, in competition with the best Boston growers, and our pears of the same varieties were so far superior to the Boston pears that the Boston men did not recognize the varieties.

But the pear has a wide range over the country where it will succeed very well. It likes a deep and fertile clayey loam, and during its early growth should have about the same treatment as to feeding that we would give the apple. Much attention was formerly given to the cultivation of the pear on the Angers quince stock, in order to produce a dwarf and early fruiting habit, as the small range of the quince roots would for a while, check the naturally rapid growth of the pear, and thus throwing it into the making of fruit spurs would still further check the rapid growth of the tree and continue it in a fruitful condition. Some varieties on the quince did not fruit excessively and finally developed into standard trees, and then unobservant men said that the trees had formed roots from the pear stem. The fact is that when we put a pear on a quince root, and allow no further shoots of quince to grow, all the subsequent growth of roots is pear and not quince, for the leaves of a tree form all the material for growth, and pear leaves form food for pear growth for limbs and roots alike. Hence all subsequent growth of the tree is pear overlaying and extending from the old quince roots, and if the growth of the tree is not retarded by excessive fruit bearing, it will finally develop into a standard tree, and not a root can be found directly proceeding from the pear stem.

This fact in vegetable physiology has been strangely overlooked by all writers on fruit culture. Any nurseryman of experience knows that while he may graft a large block of various kinds of apples on the same lot of seedling crabs, each variety will form from the piece of crab root its own peculiar root system. Some of the trees will be easy to dig while others will form a root system which makes them harder to lift. What has made this difference? Not the stock, for the stocks are all the same, but the top which was grafted on it has made the root system peculiar to the variety. No matter what the stock used in working a tree, the subsequent growth will be that of the top, whatever that may be; for all elaboration of material for growth is done by the leaves, and partakes of the nature of the plant from which the leaves come. The quince stock, with roots feeding in a more limited space than the pear roots, will for a time check the rapid growth of the pear and throw it into fruiting earlier.

But of late years so many varieties of pears have been introduced which bear at a comparatively early age on the pear stock, that less attention is now paid to dwarf trees on the quince. The introduction of hybrids with the Chinese sand pear has given an impetus to pear culture in the South, where the old varieties are seldom a success; and while the Kieffer and Leconte are not of the highest excellence, they flourish and give large crops in sections of the country where no other pears can be grown, and form the starting point for improved varieties adapted to Southern conditions. Only a few days ago we, as Judge, examined a seedling pear from the Kieffer which marks a real advance. It is supposed that the Kieffer is a seedling from the Bartlett crossed with the Chinese sand pear, and this seedling seems to give further evidence that this is true, for while it has the general shape and appearance of the Kieffer, it has a brilliant red cheek, and one with his eyes shut would pronounce it a Bartlett. When seedlings of such excellence can be produced from Kieffer there is a wide field for the workers in the South, in improving the pear that will succeed there.

While this book is not intended to treat of the fungus diseases of fruits and other plants, but rather on their growth and feeding, we cannot refrain from saying here a few words in regard to the disease which, so far, has baffled fruit growers in preventing it. This is the fire blight of the pear, which also at times attacks apples and quinces, but hardly to the same extent that it does the pear. All sorts of odd notions have prevailed among intelligent growers as to the cause of pear blight, and some still have a notion that it is caused by frozen sap in winter. But the investigations of scientists have fully demonstrated that the blight is caused by one of those microscopic forms of plant life known as bacteria, which gets into the shoot in the early spring, probably by means of the bees which visit the blossoms. As these grow downwards, destroying the young growing tissues between the bark and wood, there is no way to get any fungicde material to them. Though the blight begins its growth early in the season, its presence is only known to the ordinary observer by the sudden wilting and blackening of the foliage on the affected limb. The only way to check it is to cut the affected limb off well into the sound wood, and to keep the knife used constantly sterilized by dipping it into a solution of carbolic acid, to prevent transferring live bacteria to sound wood. Then burn all the cut-off wood at once, and keep on planting more pear trees. Some varieties are less liable to the blight than others, but all are to some extent, subject to it, and if anyone tells you that a certain variety is blight proof you can be sure he does not know what he is talking about.

Since writing the foregoing I have visited one of the famous Pippin orchards in the mountains of Albemarle County, Virginia. The owner wished me to give him some advice in regard to the twig blight, which was very troublesome. I spent some hours in the study of a large number of trees, and what struck me most was the fact that there was no signs of blight on the trees which were destitute of fruit, but on those carrying a crop there was uniformly blighted twigs. This fact seems to confirm the experiments made at one of our Stations, showing that the point of infection with the blight bacteria is the blossoms, and when these fill without setting fruit there was no infection. The important point in preventing fire blight in pears and apples is to watch its first start in spring and cut it out before the whole limb is affected, for there is no infection later in the season.

One thing that we have learned by experience, and that is that pear trees growing in sod are far less affected by blight than those cultivated and heavily manured. The rank growth induced by heavy manuring is peculiarly the prey of the blight. We once had two plantations of pears in a similar soil, and only separated by an evergreen hedge. One lot were in a piece of land which was used as a vegetable garden and annually manured and well cultivated. These blighted continually, with the sole exception of a tree of the Buerre D'Anjou, which had such a luxuriant growth and spreading habit that nothing would grow near it, and the land there was only cultivated to the extent of the wide spreading limbs. Over the other side of the hedge was another plantation of pears which were set on a lawn and had never been cultivated from the start. The lawn was constantly mown and kept in perfect order, and all the cut grass allowed to remain where it fell. It was also annually top dressed with bone and potash. We never saw a blighted limb on these trees in the six years we had them in charge, and while they did not make as heavy growth as the trees in the cultivated land, they bore annual crops of fine fruit.

Hence, with the pear as with the apple, we would cultivate the trees in grass as soon as they have attained to a bearing size. No one ever has trees to blight, so far as we have observed, till they get to blooming, and this is additional evidence that the bacteria gain entrance through the blossoms.

The pruning of the pear tree from the start must be done in accordance with the particular habit of the tree, for pear trees vary greatly in their habit of growth. Seckel needs hardly any pruning to keep it in perfectly round and symmetrical growth, except to prevent too dense a head. Sheldon tends to grow up into a Lombardy poplar form and needs shortening back to buds on the outside of the shoots, to induce a more spreading habit. Some of the books are fond of showing pears trained in a pyramidal form, but we have always found that for our climate the round and open headed form is the best for all our fruit trees. Branched low to the ground and trained into this form they are better for our purposes than pyramids which need the constant care of an expert. With trees like Kieffer and Leconte, which are inclined to make long shoots, it is important to practice summer pinching to induce the formation of a compact head. We have seen many Kieffer trees which have been allowed to take their natural habit, and which soon load the long shoots with fruit and break with the weight. If these long shoots had been checked by pinching the terminal buds when a foot or two long, they would have branched and become more compact. Summer pinching is often of greater value than winter pruning with such rapid growers as the Kieffer and Vicar. With feeble and crooked growers like the Bartlett, hard and close pruning should be the rule while young, and no summer pinching should be done, for the Bartlett needs encouragement to grow rather than checking. Winter cutting increases growth and summer pinching checks it. Bear this in mind in all your pruning.

FEEDING THE PEAR.

What we have said in regard to the feeding of the apple orchard will apply with equal force to the manuring of the pear. Avoid too much nitrogenous manure, and too rank a growth if you want to avoid the blight; but after the trees have come to bearing age put them in grass and keep the grass as you would a fairly good lawn. An annual topdressing of raw bone meal and muriate of potash, in proportion of five of the first to one of the latter, will keep pears in sod in a sufficiently thrifty condition, and they will be far less liable to blight than if cultivated. Even in the young and formative stage of the trees of apples and pears, the cultivation should not be kept up later than July, so as to give the trees time to ripen the wood growth of the season, and to be in a better condition to pass through the winter. Remember too, what we have said in regard to cultivation, that if the land is cultivated to the outer edge of the limbs it is sufficient, since the feeding roots are out beyond the limbs and not at the base of the stem.

The New Jersey Station suggests the following in regard to feeding the pear: "Two good mixtures of fertilizers to apply are, first, equal parts of ground bone, muriate of potash and acid phosphate; second, one and on-half parts of ground bone and one part of muriate of potash; 500 pounds per acre is usually applied. Where nitrogen is needed, nitrate of soda is one of the best forms, but it may be omitted when crimson clover is grown."

CHAPTER XLVI.

PEACHES, PLUMS AND CHERRIES.

The so-called "stone" fruits all require nearly the same treatment. The peach, being a short lived tree, needs constant and regular cultivation annually during the whole term of its existence. But, as in the case with young apple trees this cultivation should not be continued too late in the season, and some cover crop should be sown to protect the soil during the winter and to be turned under in the spring for the benefit of the trees. In the peach growing region of Delaware and Eastern Maryland it has become a common practice to sow the orchard in crimson clover in July, at the close of cultivation, and to plow it all under in the spring.

PLANTING A PEACH ORCHARD.

Peach trees should always be but one year old from the bud when set. In the South the planting can be best done in the fall, at any time after the leaves fall up to Christmas, but in cold latitudes the planting should be deferred till spring. We always prune the roots of a peach tree rather closely, leaving only the stout roots five or six inches long, as the small fibres will all be dry and worthless in any event and the young roots put out more rapidly from a clean cut surface. We are not yet ready to adopt the plan recommended by Mr. Stringfellow, of Texas, to cut off the roots to a mere stub and set the trees in holes made with a crowbar, in sod land, though trees thus treated will live and grow. We prefer to dig a moderate sized hole, no deeper than the plowing has been, and then to ram the soil tightly to the pruned roots. After planting, we trim off all side shoots closely, and then head back the main stem to about twenty inches from the ground. In the Spring, when growth begins, we select the best situated buds, three or four, near the top, to form the head, and rub off all others. During the summer we watch the young shoots and if one limb is inclined to grow too fast for its fellows, and thus form a one-sided head, we pinch its tip and check it.

The second spring the pruning needed will be to shorten back the young growth of the previous year nearly one-half, and to thin out the shoots that may interfere with each other in the centre of the tree. The peach bears its fruit on the wood of the previous year, and the tendency of growth is toward the extremity of the branches, and finally to leave the centre of the tree destitute of young wood. The annual pruning, then, should be directed towards the maintenance of fruit wood well distributed throughout the head of the tree, so that the load of fruit will be carried without overloading the extremities and causing the limbs to break.

FEEDING THE PEACH.

Heavy applications of nitrogenous fertilizers are to be avoided in peach culture, as encouraging too rank and sappy a growth and conducing rather to wood than fruitfulness. If the orchard is sown annually in crimson clover or some other legume growing during the winter, it will get all the nitrogen needed without artificial application of phosphoric acid and potash, and especially potash. Frequently an unhealthy and yellowish condition of the tree has been cured by the application of potash, and this fact has caused some to believe that the disease known as "yellows" can be cured by potassic applications, which is hardly possible. The yellows is caused by a fungus, some think, on the roots of the tree; a species of the mushroom family. If this is true, it would seem that the best way to fight the yellows is with fungicides applied to the soil. The application of phosphoric acid and potassic fertilizers in liberal amount will greatly aid the growth of the clover, and the increased growth will enable the plant to do more nitrogen catching, so that in a few years it may be found best to cut the clover for hay rather than to continue the accumulation of humus material in the soil. Of this, however, every grower must judge for himself. After plowing under the clover, the clean and shallow cultivation of the soil is important, for no weed growth should be allowed on the land to withdraw moisture from the trees during their early summer growth. Some of the best work with the peach has been done by the Connecticut Agricultural Experiment Station.

The report of the Connecticut Station for 1895 has the following statement in regard to the composition of the peach:

"When peach trees are set 18 feet apart each way, as is the common practice in this State, there are 130 trees to an acre. Experienced growers reckon three baskets to a tree, an average yield for orchards five years planted. Four baskets per tree is a maximum crop. From the above data are calculated the quantities of nitrogen and mineral matter removed from an acre of 130 trees by the average crop of three baskets of peaches per tree, viz.:

NITROGEN AND ASH INGREDIENTS IN A PEACH CROP OF 390 BASKETS PER ACRE.

"Nitrogen, 19.7 pounds; potash, 21.9 pounds; soda, 1.2 pounds; lime, 1.0 pounds; magnesia, 1.0 pounds; oxide of iron, 0.4 pound; phosphoric acid 4.2 pounds; sulph. acid, 1.0 pounds; chlorine, 0.4 pound.

"Contrary to the commonly received idea, the pulp of the fruit contains the greater part of both the nitrogen and mineral matters. Only about one-fourth of the nitrogen and one-tenth of the ash elements are contained in the stones. While these quantities of nitrogen and mineral matters are smaller than those removed by many other garden or field crops, it does not follow that peach trees need less care for their proper manuring. The quantities of plant food required for the yearly growth of wood and leaves must be considerable. Young twigs contain a larger proportion of nitrogen, phosphoric acid and potash than old wood. But we have no exact data at hand from which to compute the yearly demand of the growing peach tree on the plant food in the soil. Field experiments demonstrate that liberal fertilization is necessary to secure the most profitable returns from peach orchards."

The figures given simply show what is carried off from the acre of land by the crop of peaches, and indicate that an annual return of 20 pounds of nitrogen, 22 of potash and 5 of phosphoric acid will restore to the land what the average peach crop requires, and that 27 pounds of nitrogen, 30 of potash and 7 of phosphoric acid will make good the deficit caused by a maximum crop, provided there are no other sources of loss besides the export of fruit. But it is one thing to return to the soil what the crop has removed and, to some extent, another thing to maintain the fertility of the soil so far as relates to the suitable supply of plant food.

The active feeders of the tree in the soil are the young rootlets and root hairs that are put forth the current year. The roots of five or two years ago are probably themselves totally incapable of feeding the plant. Even last year's roots are of little use except as they are necessary bases of the new rootlets that develop this year. The young roots of each successive year of growth thus occupy different positions in the soil, and since most of the plant food in the soil is incapable of movement, much of it, at any time, is out of the reach of the rootlets, and to be fertile the acre of soil must contain many pounds of plant food in order to insure to the crop the few pounds which it requires.

"If the soil is very rich to begin with, the trees may produce well for years without fertilizers, but the New England hills that furnish the best orchard sites, are, as a rule, not fertile, and must be well enriched to make them profitable. It is now no doubt well known to orchardists that soils have the power of changing the solubility and availability of the plant food which may be put upon them in fertilizers. It is well proved that phosphoric acid applied in water-soluble form, becomes, in many soils within a few days or weeks, quite insoluble in water, and for a considerable time gradually diminishes in availability. Certain soils contain enough phosphoric acid to serve many large crops if it were freely accessible to their roots, but that this phosphoric acid is not immediately available is demonstrated by the fact that moderate dressings of plain superphosphate strikingly increase the yield. What has just been stated of phosphoric acid is equally true of potash. As to nitrogen, we know much but not nearly enough of its incomings and outgoings. We know that the soils of forests, meadows and moist pastures gain in nitrogen, while dry, naked or tilled ground loses nitrogen from year to year. We know that clovers and legumes generally rapidly enrich or may enrich the soil they grow upon, as respects nitrogen, while the culture of cereals, root and fibre crops, and garden truck, diminishes and exhausts the soil nitrogen. As a rule in case of soils that have a fair proportion of fine clayey matters, all the phosphoric acid and potash that may be needed to aid any crop, if once applied cannot escape from the soil and will be retained near the surface, will not in any event descend much below or spread from where it has been placed. With nitrogen it is very different and loss of this element may occur in three ways: First, by leaching out in the drainage water as nitrates; second, by escaping into the air as nitrogen gas, and, third, by conversion into comparatively inert forms, such as exist in leaf mold, swamp muck and peat, or in the cell tissues of fungi and shells of insects. For this reason, soluble and active and therefore costly, fertilizers are best applied in small doses, at or near the surface of the ground and at short intervals; while cheap, insoluble and slowly-acting manures may be used in large applications and deeply mixed in order to establish a more permanent state of fertility. The amount of any needed fertilizer element to be supplied annually, must be learned by experience and experiment, since soils vary greatly in their composition and qualities; and the supply must commonly be several or many times larger than the amount annually taken off in the crop. One fertilizer element that is scarcely noticeable in the export of the peach crop, is nevertheless important to its production. The chief ingredient of the ash of the wood, bark and leaves of all trees is generally lime. The wood of healthy peach twigs of one year's growth contained 1.87 per cent. of ash, of which 54.2 per cent. was lime, 9.5 per cent. magnesia, 16.3 per cent potash, 4.3 per cent. phosphoric acid and 6.9 per cent. sulphuric acid. The mature leaves of oak and chestnut trees contain about 30 per cent. of water, 3 to 4 per cent. of ash, and of the latter 30 to 40 per cent. is lime. Where the water of wells or springs coming from the soil, is soft or but slightly hard, the orchard needs lime to be supplied. This substance dissolves rather freely in the drainage water and is, therefore, subject to constant waste. Wood ashes and lime should be broadcasted at the rate of 500 pounds per acre annually, and this dressing will be of the greatest benefit to the crimson clover now so commonly used in the orchards." Our own opinion is that no peach or other orchard would need so frequent an application of lime, and that the above amount in connection with grass in the apple orchards and the annual clover in the peach orchard during the latter part of the season, would be ample for all needs if applied once in three years. These remarks in regard to the fertilization of the peach are equally applicable to the fertilzation of orchard trees of any kind, and the lime is even more important in the apple and pear orchard than in the peach orchard.

THE PLUM.

While the statement that plums require a heavier soil than peaches is true, especially of the European (or Domestica) sorts, the Japanese and American varieties will thrive on a great variety of soils, and we have seen them bearing heavy crops on a deep sand. Many nurserymen bud their plums entirely on peach seedlings, but this has one difficulty. While the peach stock makes a vigorous tree it is just as liable to the peach tree borer at the crown of the root as the peach; hence many have begun to use the Marianna plum as a stock and find that it is better than the peach, as it thrives on a greater variety of soils and resists the borer better, while it has root development enough to promote a vigorous growth. The budding is done in August, at the same time the general budding of the peach is done, and the buds remain dormant till the following spring. Some nurserymen insert buds of the plum and peach in June and get a small growth the same season, but the practice is not to be recommended as a general rule, though careful growers can make just as good trees from the little June-budded stocks as any, and for our own planting we rather prefer them; but the average planter had better take the yearling trees. In planting, we prune the roots to four to eight inches long. The finer rootlets will have all dried and become useless and new roots are produced on the ends of the clean cut roots sooner than from the dried up fibres. The peach and all other fruit trees we treat in the same way. Of late years there has been a great deal of controversy over a method of planting advocated by a grower in Texas. He prunes off all the roots of the tree and leaves only a stub 3 or 4 inches long. He then makes a hole with a crowbar in the sod, sticks the tree in and rams the earth to it. He claims that trees treated in this way will make better trees and better roots than if planted in a big hole with all the roots. Climate has a good deal to do with these things, and experiments in a more northern latitude have not been as favorable as those made in the South, where trees planted in this way certainly do grow and thrive remarkably. The planting should be done in the South as soon as the leaves are off in the fall and up to Christmas, and in the North probably April would be the better time. For most of the Japan plums a distance of 16x20 feet will be about the proper space for the planting. As with the peach, the plums should, during the early stages of their growth at least, receive careful culture during the early part of the summer, and after July should have a crop of crimson clover sown among them. After the trees have gotten well to fruiting, they can safely be put into grass and used as a chicken yard. The pruning is about the same we give the peach, and the manuring we have already mentioned. If the clover or other nitrogen collecting legume is grown among the trees, with a good application of phosphoric acid and potash, there will be no need for any nitrogenous manures, but the application of the phosphoric and potassic fertilizers should be faithfully kept up annually if the production of maximum crops is desired. All the Japan plums are inclined to overbear, and there is no fruit grown that can be so improved by systematic thinning of the young fruit. Thinning not only improves the size and quality of the fruit and takes off the strain from the vitality of the tree, but it also lessens the tendency to rot where the fruit grows touching each other. But pick the fruit by hand and do not merely shake the trees or thresh off the fruit with a pole and thereby bruise many that are left. With the domestica (or European) sorts it is essential that daily jarring of the trees be practiced so as to catch the curculio which lays eggs in the fruit and makes them wormy. If the chickens, as I have said, are allowed access to the trees and the jarring is done daily, they will gather up the bitten fruit and insects, and keep the trees comparatively free. A large machine like an inverted umbrella is used in large orchards for the collecting of the insects. It is made on a stout frame with cotton cloth and a slit on one side so that it can be slipped around the body of the tree. If the machine has an opening at the bottom under which a pan of kerosene is attached, the insects and bitten fruit roll into this and are at once destroyed.

Plums prefer rather a heavier soil than the peach, and thrive well in sod. We have here an old plum tree, growing in a hollow in the woods, where it has never received any cultivation whatever. It stands in the shade of large oaks and other trees of the original forest, and yet, year after year it bears crops of the finest plums. How old it is we do not know for it was there many years before we came into possession. It would hardly be classed as a remarkably thrifty tree, and yet it is healthy, free from black knot, and does not seem to be troubled by the curculio. Our chickens have the free range of the woods where it grows, and this fact may, to some extent, account for its freedom from insects. In fact, from our experience in the past, we believe that a chicken yard is about the best place for plum trees. All the old European varieties are peculiarly liable to the attacks of the curculio, and a regular jarring of the trees in a poultry yard will keep them down as effectually as any plan we have ever tried. Then, too, the droppings of the poultry will give much plant food to the trees. Plums of the more recently introduced Japanese varieties are inclined to grow long, rank shoots and to get overloaded. The pruning should be similar to that of the peach to preserve the trees in a round headed shape, and to keep the fruit spurs well distributed over the tree. One fact in regard to plums, and especially the native and Japanese sorts is the repugnance they have in many varieties to self impregnation. Hence it is important that the varieties should be well mixed together in the orchard. A farmer who had an orchard of the Wild Goose plum asked me one day why it was that only one corner of the orchard bore heavy crops. I asked him if there were any other plum trees near that corner. He said that there was a hedge row of the native Chicasa plums there. The reason was then quite apparent, for the wild plums were helping to set the fruit. While plums do well in a sod after they have attained a bearing size, we would, as in the case of apples and pears, grow the sod solely for the benefit of the trees and would not cut hay from it, but simply keep it mown and let the grass decay where it falls. In addition to this an annual application of 300 to 400 pounds per acre of a mixture of acid phosphate and muriate of potash, in proportion of five parts of the phosphate to one of the potash, will keep up the fertility of the soil and the health and productiveness of the trees.

CHERRIES.

Cherries, like plums, will thrive well in uncultivated soil, as is well attested by the immense trees along the fence rows in the Middle Atlantic States. But the Morello class of pie cherries thrives best under the same treatment as the peach, and should be well cultivated if fine crops are expected. The sour cherries are the only ones that can be grown with success in the South Atlantic coast region, though the finer sorts thrive in all the mountain country of the Southern Alleghanies. The same treatment as to manuring that has been advised for the peach will suit the cherry as well. In the South, the trees of the larger cherries should always be upon the Mahaleb stock, and headed very low to shield the trunks from the sun. In fact, this low heading of fruit trees, while the best anywhere, is absolutely essential in the South, if we are to prevent sun scalding on the southwest sides of the trees.

Cherry trees in more northern sections are budded for the sweet varieties on the Mazzard stock, as this makes a larger tree than the Mahaleb; there only the sour cherries are worked on the Mahaleb stock. The trees are usually set at two years old, but we prefer to set one year trees, as we can then better start the formation of the low head the cherry should always have. With the sour cherries it is essential that the orchard should have good cultivation throughout its entire life, and the same is true for the best success in orchard culture of any of the varieties, though there are thousands of the most magnificent cherry trees along the fence rows on the Delaware and Maryland Peninsula which have never received any cultivation at all further than that given the fields on which they border; and yet the trees are vigorous and healthy and produce enormous crops. The sweet cherry tree is a gross feeder and will find food by means of its wide-spreading roots in a soil where the dwarfer, sour cherries would not thrive, and if the soil for these is made too rich they may run merely into an annual wood growth and bear little fruit. The sowing of a crimson clover crop in the cherry orchard is just as important and useful as in the peach orchard, and all the nitrogenous matter the trees need can be supplied in this way. But, as has been well said in the bulletin of the Delaware Station, the plowing under of this clover in the spring should be done as soon as the land is in order to plow, for early plowing and subsequent shallow cultivation, is an important matter for the retention in the soil of the moisture the cherry needs for its best development. The Delaware Station advises the application of 300 to 500 pounds of acid phosphate and 150 to 250 pounds of muriate of potash per acre to the cherry orchard. One of the most extensive cherry growers in Western New York applies three pounds of muriate of potash and two pounds of acid phosphate per tree, either in the spring or when seeding to crimson clover. The regular application of phosphoric acid is an important thing for the proper maturity of the wood in the fall. As with all the stone fruits that bloom early, the cherry will be safer in a northern exposure in most parts of the country, so that the blossoming period may be retarded. The most profitable sour cherries for market are the Montmorenci and the Early Richmond. The same jarring that is practiced with the plum and peach is useful in catching the curculio on the cherry, and should not be neglected. The best remedy against sun scald and bursting of the bark is to head the trees close to the ground and get the protection of the top as soon as possible.

CHAPTER XLVII.

THE GRAPE.

The wide range of soils and climates in the United States in which grape culture succeeds is an evidence of the great adaptability of the vine for varied conditions. The grape thrives well on soils of very different character, and is at home anywhere in a soil abounding in the plant foods it needs; provided it has a well drained location, for it will not thrive with wet feet; a compact clay is about the poorest soil for the grape. The Delaware, which is inclined to be a feeble grower in such a soil, grows with the utmost luxuriance on a shaly hillside and finds its most congenial home in the sandy uplands of the South. On these sandy lands we found that there is no plant grown which is so readily affected by the commercial fertilizers as the grape. And we have also found that a complete fertilizer, in which there is a fair percentage of nitrogen and a large percentage of phosphoric acid and potash, is the best for the grape. With such a fertilizer we grew the Niagara grape to such a size that we were compelled to pack them in the carrier baskets used for peaches, as the smaller grape baskets were entirely too small for the clusters. Our vines were planted in rows ten feet apart and eight feet from each other in the row. We used a modification of the Munson trellis. Posts were set in the rows, and cross pieces two feet long nailed across their tops four feet from the ground. Wires were stretched along the line of posts and two others along the ends of the cross pieces. The arms were taken along the central wire and the fruit shoots hung over the outer wires so as to completely shelter the grapes beneath. This style of trellis is convenient for the cultivation, pruning and harvesting of the grapes, and there is far less rot than on an unsheltered, vertical trellis. For a fertilizer we would advise the following, to make a ton. Acid phosphate, 1,000 pounds; cotton seed meal, 600 pounds; and muriate of potash, 400 pounds. Of this we would use 400 to 500 pounds per acre, annually on a sandy soil.

A ton of fresh grapes will remove from the soil 3.2 pounds of nitrogen, 0.2 of a pound of phosphoric acid and 5.2 pounds of potash. In the wood-growth the amount of phosphoric acid is greatly larger than in the fruit, and the amount of potash nearly three times as great. The main requirements, then, evidently are phosphoric acid and potash. As in the case of the orchard of peaches, the vineyard will be greatly better off if the cultivation ceases at midsummer, and the spaces between the rows are sown with a leguminous crop that will remain during the winter. With such a growth there will soon be no need for any applications of nitrogen in the fertilizer, which can then be reduced to the two constituents, acid phosphate and potash.

The Southern species of the Vulpina (*Rotundifolia*) genus, the "Scuppernong," are commonly grown from Southeastern Virginia southward along the coast on horizontal arbors, and there is a belief that they should never be pruned; and there are, in the South, immense vines that cover acres with the growth from a single trunk, and bear profusely. But proper pruning is just as good for the Scuppernong and other grapes of this class as for others, with the difference that these grapes produce fruit from two-year-old wood, while the Labrusca varieties grown in the North bear on one-year wood. A proper amount of strong canes must be preserved in the Scuppernong class and the old gnarled wood cut out. This must be done in the fall, to avoid the heavy bleeding these vines are apt to make when cut in the spring. These grapes prefer a sandy soil and a warm climate, and will not ripen north of Southern Virginia. In a soil suited to them they are not at all exacting in their requirements as to food, and all over the South Atlantic slope can be seen immense vines which have never been manured or pruned. But they will, nevertheless, well repay the application advised for other grapes. Grown on the wide extended arbors it is not practicable to grow the leguminous cover crops, and some nitrogen should always be a part of the fertilizer, and no mixture is better than the above.

PROPAGATION OF THE GRAPE.

Most of the varieties of our native grapes are easily increased from cuttings of the one-year-old wood, made in the fall and buried out of reach of frost (in the colder latitudes) till spring, and then set in nursery rows. In the South they can be set at once where they are to grow, and slightly protected by a thin cover of pine leaves or straw to prevent the soil from freezing. The cuttings should be made with about three eyes unless the wood is of a very short jointed variety, when four or more eyes may be used. They should be set with the top bud just above the ground, and the cuttings should be cut right under the bud at the lower end and an inch above the bud at the top. They will be fit to set in the vineyard at the end of one summer's growth. Some varieties, like the Delaware and Norton's Virginia, which are slow to root in the ordinary way, will root well if tied in bunches and buried in the fall upside down, and then in the spring set in the proper position. Why this is so I do not attempt to explain, but the fact is that refractory cuttings will root when so treated that would not root if set at once in the proper position. It is frequently desirable to change the variety of grape in a vineyard and then the grafting method should be used. Having strong, old stocks we cut them down to the crown of the roots, and late in the fall, here, insert cleft grafts and then mound the earth over the whole deep enough to exclude the usual amount of frost. In the North the grafting should be deferred till March, but should be done before there is any swelling of the buds, and the earlier it is done the better. Mr. A. S. Fuller grafted grapes in the fall in the North, by covering the graft with an inverted flower pot and burying the whole in the soil, just leaving the bottom of the pot uncovered, and then covered the whole with straw to protect from freezing, and put on top the straw eight inches of soil. If the grafting is done in the spring the scions should be cut in the fall and buried as the cuttings are, so as to keep them dormant, for the grafting can be done with success after the vines start if the scions are dormant. Strong growing sorts, like the Champion and the Concord, are fine stocks for grafting, and we have seen canes of the Delaware from a graft on the Champion which, by fall, were 20 feet long, and in good condition to begin fruiting the following season. The scion is cut in the ordinary wedge shape, with a bud on the outside just above the point to which it is inserted in the stock. There are other methods used in the grafting of the grape, but the ordinary cleft-graft on the crown of the root, is more uniformly successful and is as good as any. We do not use any wax in grafting grapes, but always bury the graft well in the ground at the point of union. A modification in the grafting of grapes was invented by Mr. Allen Warren, of this State, who is a large grower of the Scuppernong. While the Scuppernong is easily grown from layers it is rather refractory from long cuttings. Mr. Warren goes into the woods and gets roots of the Wild Bullace grapes belonging to the same family as the Scuppernong. These he cuts into three-inch pieces and makes a split across the root about midway. He then makes his scion wedge-shape, as for ordinary cleft grafting, sticks it through this slit and then sets the graft as an ordinary cutting. In the fall following it will be seen that rootlets have started from the root and also from the projecting end of the graft, a much stronger vine is the result and there is a perfect union with the scion where it crosses the root. The same practice can be followed with the Labrusca varieties by taking roots of the same species. Grapes are seldom as fine in a rich garden as in the vineyard. This is because of the excess of nitrogen in the soil, and they should have only phosphoric acid and potash to balance this. It is the result simply of an unbalanced food ration.

CHAPTER XLVIII.

GARDENING UNDER GLASS.

WHAT CAN BE DONE WITH A HOTBED SASH, AND THE USE OF FERTILIZERS IN FRAMES.

This book would not be the valuable *Vade Mecum* we would like to make it if we gave no attention to the needs of that large class of cultivators who work under artificial conditions, and whose operations are upon a more intensive scale than those of any other class of growers. Winter forcing of vegetable crops under glass is a business of rather recent development in this country. Not that it has not long been done in the hothouses of the wealthy, where the products cost their weight in silver, but it is only of recent years that the increase of wealth and population in our large cities has made it possible and profitable to grow vegetables and fruits under artificial conditions in winter. The great development of the trucking industry in the South and nearby tropical sections, with modern facilities for transportation, incited the gardeners of the North to greater efforts to meet this competition. Knowing that with skill and capital garden products of all sorts could be produced in finer quality under glass than in the open ground, it only remained to secure a clientage which would pay a price for these products that would warrant the extra expense of producing them. And, as in all business where men set themselves earnestly to work and there is a fair amount of competition, methods are gradually developed for cheapening the production to meet the increase in competition. In the earlier days of winter forcing under glass the small amount of products grown commanded very fancy prices, and these fancy prices stimulated others to engage in the business, with the inevitable result that increased production of articles bought by a limited class of people, led to a decrease in price on the market. But the American gardener is ever on the alert to meet the difficulties of his profession, and the cheapening of the product simply set him to work at the task of cheapening the production by increasing the area of his work and doing things on a larger scale, using facilities with which smaller cultivators find it difficult to compete. Naturally the cultivation of vegetables, fruits and flowers in the cold months first developed in the colder sections of the country, near the large

Northern cities where wealth has accumulated and the customers for these things live. The competition around the market gardener in the crops grown in the open ground, and the competition of those in a more sunny climate made it necessary for the wide awake gardener to adopt some means for getting the advantage of his immediate neighbors and competing on somewhat equal terms with those south of him, who were handicapped by long transportation charges. So today the gardener who simply meets the local competition, is less successful than the man who by extra skill and the use of glass meets the competition of those further away in a more sunny climate, and puts on his local market, products of superior excellence and in better condition than those from a distance grown under natural conditions and with less application of skill. For instance, the writer, even in a Southern home-market, every winter sells tomatoes from the forcing house in direct competition with the open ground product from Florida, and gets five times the price that the Florida product brings, simply because of the greater excellence and superior condition of his product. For a long time this business of growing products under glass was confined to the immediate vicinity of the great markets of the North. Only a few years ago we noted the fact that in the market reports one morning the first cucumbers from the open ground in the lower Gulf States were sold on the Northern market, and the same morning cucumbers from a hothouse in Vermont were sold there, and the product of the hothouse in that semi-arctic climate brought several times the price of the Southern article. Since these products in such a climate must have been produced at a great cost, and being at a considerable distance from the New York market where they were sold, the thought occurred to me that there was the opportunity of the grower in the Upper South no further from the market, and with a milder and more sunny climate, which would allow of cheaper houses, less coal and with the abounding sunshine, even in the coldest weather, to compete again on better terms with his Northern competitor.

Some time since I received a letter from a grower in the Berkshire Hills of Massachusetts, saying that he was there engaged in the business of forcing cucumbers in winter. He said that there he was obliged to use double-glazed sashes on his house, a very expensive heating apparatus and a great deal of coal, and still the business was a remunerative one. He had formed the idea that in the Upper South he could find a climate better adapted to winter forcing by reason of a milder winter and more sunshine, which would necessitate less expense in construction and maintenance, while not much further to ship the products than from Massachusetts to New York. I told him that there was no doubt about the feasibility of the plan. The indications, therefore, are that the example set by the energetic growers of New England and the North will gradually extend this winter forcing southward. One of the leading winter crops under glass in the North has for many years been that of lettuce, and the demand for winter lettuce is such that the business has extended greatly, and the Arlington growers in the vicinity of Boston, have become famous for their product. A number of years ago the writer conceived the idea that lettuce could be grown with success southward by the aid of cold frames, at far less expense than in the heated structures used in New England. At that time we were located in Northern Maryland, and the markets of Baltimore and Washington were then largely supplied with Boston lettuce. With perfect faith in the feasibility of growing good winter lettuce in frames I began the culture with 600 sashes 3x6 feet, and with the aid of straw mats found no difficulty in producing there first-class lettuce, and in selling it readily in the markets of Baltimore and Philadelphia

Coming South in later years I urged upon our growers the great profit that could be derived from frame culture in a mild climate, and to show my faith I put down 1,000 sashes at Old Point Comfort, Va., for the growing of lettuce and cauliflower for the New York market and the supply of the great Hygeia Hotel, and the culture was even more successful than in Maryland. Still later, in North Carolina, I urged the culture of winter crops in simple frames on the attention of our growers. But as soon as a Southern market gardener begins to contemplate anything like cold weather work he thinks of some cheap substitute for glass, and has a notion that cotton cloth will answer all purposes in his climate. Our growers took hold of the lettuce idea, but could not get the nerve to invest in glass, hence the business in the South has largely been developed under cloth in lieu of glass, and though the cloth is a poor substitute for glass the great adaptability of the climate to the purpose has enabled them to make large profits from the crop grown under these crude conditions, and it will not be long before the more far sighted will perceive the necessity and the profit of using glass. Then, with the beginning of frame culture the transition will be easy to regular greenhouse structures and artificial heat for regular winter forcing.

The production of vegetables, fruits and flowers under glass in winter even in the sections of the country where it has most developed, and where acres are covered with houses for the business, is still in its evolutionary stage, and with the rapid increase in population and wealth in the great cities, and the perfection of the means for the rapid transport of the products, the business will extend to sections where the growers have heretofore simply been relying upon the advantage their climate gives them, and have been inclined to be extensive rather than intensive cultivators. Our people, especially in the South, have always been anxious to be large farmers, large truckers and small- fruit growers, and to get a reputation for the extent of their operations rather than the perfection of their product. With the inception of winter gardening, even with the crude aid of plant-cloth, there is already a disposition to concentrate capital and labor on smaller areas, as it becomes evident that the man who pays more attention to quality than quantity will win in the competition with his neighbors. The effort that the Northern growers have made by the erection of expensive greenhouse plants, to compete with this in more favored climates, is leading to the same effort on the part of the growers in the upper South, who are beginning to realize the advantage their rapid transportation facilities give them in sending products of a very perishable nature, which those still further South cannot handle on equal terms.

But it is not merely of the Southern development we would treat in this book, but of winter culture under glass generally, and the part that commercial fertilizers are everywhere taking in this culture. The older winter forcers in the immediate vicinity of the Northern cities, like the market gardeners there in the open ground, have long enjoyed the advantage which comes to the gardener from the ability to command large supplies of stable manure, but the progress of market gardening southward has been made possible solely through the agency of commercial fertilizers and railroads. Even in those parts of the country where there was the ability to command supplies of stable manure, the growers under glass and in the open ground have long since found out the great advantage of having manures which are more completely adapted to the making of a balanced ration for their plants than was possible where stable manure alone was used. Hence there are no men who are studying the use of commercial fertilizers more closely than the gardeners under glass, whether florists or vegetable forcers, and it is in the interest of this class that we have determined to prepare this part of our book. We propose to treat the subject from the simple frame and its use North and South to the more elaborate forcing house in use in the North and gradually coming southward; hence we will begin with the crops that have attained the greatest commercial importance.

WINTER LETTUCE.

Few of our friends on the farm who have never had an opportunity to observe the culture, have any notion of the great extent to which the growing of so simple a crop as lettuce has developed. The consumption of lettuce in all of our larger cities and towns has wonderfully increased of late years. Thirty years ago, when the writer began to cultivate frame lettuce in Maryland, the demand was limited to the wealthy and better hotels and restaurants, and few people of moderate means ever saw a head of lettuce in winter.

Even now the crop in the dead of winter does not bring as large a price as in the early spring months, when every one begins to crave salads, and while the winter crop, if well grown, is a very profitable one and one that has never known a glut, the experience of all growers is, we believe, that the crop of March and April always brings the largest price by reason of the increased demand.

LETTUCE IN COLD FRAMES.

The cultivation of the crop in cold frames must, of course, be confined, in winter, to those sections of the country where either a simple sash suffices for its protection and growth, or where the aid of a straw mat is sufficient; in colder sections the frame is simply used to carry plants over the winter for spring setting, to make an early crop in open ground. There, the winter culture must be in greenhouses, constructed for the purpose and properly fitted with apparatus for heating. The manurial requirements of the lettuce crop are mainly for nitrogen and potash, and the soils in which the crop is most successful are usually deficient in just these elements; for the sandy lands of the Atlantic coast are the best soils for the lettuce crop. In fact, in a clay soil, no matter how fertile, the crop, especially of the heading sort, can never compete with that grown in a sandy loam; so that growers in a different soil are obliged to prepare an artificial soil to meet the needs of the crop.

There are two general classes of lettuce grown, and innumerable varieties. The commercial grower, however, rarely experiments with strange sorts, but sticks to the one that has proved best for his purpose. The growers who are supplying the markets of the eastern cities invariably grow a heading lettuce, while those whose market is in the western cities invariably find that the curled sorts are most called for. A large grower of plants, whose sales extend to all parts of the country, recently said to me that he had not for years sold any lettuce plants west except the curled variety, known as the Grand Rapids, and that he never had a call for the Grand Rapids lettuce from any eastern grower, for they always want either the Boston Market or the Big Boston. People of critical taste, who have an opportunity to test the difference between the curled lettuces and the heading (or cabbage) sorts, invariably come to the conclusion that the loose, curled lettuces are of far superior quality to the cabbage sorts. But the market gardener cannot afford to do missionary work or to try to educate the public taste for what they do not call for; he must take his market as he finds it, and cater to what the people call for. Therefore, if the grower is sending his crop to a western market he should grow the lettuce that the western market demands, and so also with the grower for the eastern cities. The lettuce crop is one the culture of which cannot extend so far south as that of many other crops of the market garden. It is of such a perishable nature that the grower, to make a regular profit, must be within twenty hours at furthest from his market, and the grower in the farther South can never compete in this crop on equal terms with his more Northern brother of the upper South; hence, the culture has not progressed much further south than the vicinity of Wilmington, N. C. There, and along the line of the railroad known as the "CoastLine" in N. C., there has been the greatest development of the culture, and generally entirely under cloth. The growers build frames twelve feet wide, with a ridge pole running through nearer the north than the south side, so as to make a short span to the north and a long one to the south. The ridge pole is about four feet high, and twilled cotton cloth is attached to rollers, like an awing rolling up to the ridge pole to give air, and running down and fastening to the sides of the frame with harness snaps. It costs about $500 per acre to construct and prepare these frames for the growing of the lettuce. A site is generally selected where the soil is of a sandy nature, and large quantities of woods earth, which has been piled and sweetened over one season, are dug into the soil. Commercial fertilizers containing 5 per cent. of nitrogen, 7 per cent. of phosphoric acid and QPD of potash are used at the rate of one ton per acre. The large percentage of potash needed on these soils makes it necessary that this part at least of the fertilizer shall be applied some time before planting the crop, since it is always used in the caustic form of a muriate, and if freshly applied to the crop at planting time it will cause serious trouble and perhaps destroy the plants. Some time since a grower in the eastern part of North Carolina sent me specimens of his young lettuce plants and wanted to know what disease had attacked them. The edges of leaves were turning red, and examination showed that the tips of the roots were destroyed. I wrote him that in my opinion they were burnt by the fertilizer, and to test the matter I planted them in my own frames and they grew finely and made good lettuce. He answered that he had just applied a large dressing of fertilizer containing 10 per cent. of potash, and set the plants at once. The result was that he had to replant his entire crop after exposing the frames to the rains for some time, and was thrown out of the early winter crop entirely. Growers of frame lettuce in the South generally endeavor to get two crops during the season, the first during the early part of December and up to Christmas, and then replant for the spring crop in March. Some growers make no effort to produce the December crop, since they claim that the replanting of the frames renders the lettuce liable to disease and damages the March crop which is of more value than the December crop.

Southern Head lettuce, when well grown, usually brings $5 per barrel in December, while the same quality of lettuce will usually, in March, bring $10 per barrel. Some of the more thoughtful growers are finding out that lettuce of fine quality, shipped in neat boxes, will bring a better price than that shipped in barrels, as it gets to market in better shape. Those who grow only the March crop claim that this one crop brings them about $3,000 per acre of frames, and they all admit that with glass sashes they can produce a finer quality of lettuce and have less danger of loss from unusual cold or snow than under the cloth, but they hesitate to expend the $4,000 it requires to cover an acre with glass frames. I have endeavored to show our growers that in the long run their cloth covered frames are the more costly of the two, for sashes made of cypress timber and kept well painted will be good for twenty years, while the cloth must be renewed at least once in two years, and sometimes lasts but a season; so that the extra price gotten for lettuce grown under glass, will in a few years make good the difference in first cost, and, in fact, will pay at once. To test the matter I built and planted a considerable area in glass frames the past fall, and planted them in Big Boston lettuce. By the middle of February I had sold lettuce for double the cost of the frames, and had the sashes ready to produce spring crops of radishes and beets, and to harden off my early tomato plants. In other words, counting the area covered with glass by the acre, I had in these few months sold lettuce at the rate of $7,260 per acre. Since an acre can be covered solid with glass sashes for $4,000 it would seem to be a good business proposition to use the glass in place of the cloth, especially as a second crop from same sashes will be ready in March. The disadvantages of the cloth covered frames are several. When the weather is cold, even when the sun shines, the cloth must be kept on, and the partial shade draws the plants and makes them less sturdy. If snow happens to fall it must be hurriedly gotten off or serious damage will result, and as a cold wave usually follows a snow storm, the frames are then protected only by the thin cloth. With glass ashes, when the sun shines, no matter how low the mercury may be, a little air will be given and the bright sunshine makes the plants grow stout and sturdy, and prevents attacks of rot that the close air under cloth may favor. Then, when snow falls, we let it lie on the glass as an efficient protection from the following cold. My lettuce grown under sashes was sold without expense, to grocerymen who sent their wagons to my place for it daily, and paid $1 per dozen heads for it. Grown on a larger scale, of course, I would have to take the chances of the larger Northern markets, as the other growers do; but still, with the superior product packed in neat crates or carriers, it would be sold by the dozen in direct competition with the hothouse lettuce of the Boston growers, and not as Southern lettuce, by the barrel. For home use we greatly prefer the Grand Rapids lettuce to the heading lettuce of any kind, but as we have said, the grower must cater to his market, and until the people of the East find out the superiority of the curled lettuce the growers cannot afford to produce it. For the Christmas crop of lettuce we sow the Big Boston seed in late August in the open ground, and make another sowing or two in September. The plants are set in the frames, prepared as we have described to be covered with cloth, or in frames six feet wide and fourteen inches deep to be covered with glass sashes three feet wide and six feet long, laid crosswise the frames. The plants are set as soon as large enough, and are shaded for a while till they get started. No cover is placed over them until there is danger that the mercury will fall below freezing at night, and then the cover must be removed daily to prevent too rapid and flabby a growth, for lettuce grown with a high temperature will not only not head so well, but will be too flabby to ship in good order. An acre of frames will require the constant attention of two or three men all winter, if the two crops are grown. One grower of our acquaintance keeps eight men to manage three and a half acres in lettuce frames during the winter; these same men of course attend to the shipping. While in the South the sashes are usually sufficient to protect and grow lettuce, the wise grower will always have at hand some mats to cover the glass in exceptionally cold spells. We make these mats from the common broom-sedge of the South, which is the cheapest and most lasting material we can get. They are made four feet wide and seven feet long so as to break joints and cover all cracks between sashes; in our coldest weather we can completely exclude frost with these mats. Lettuce, until it heads, does not mind considerable frost, but when the head is formed it is essential to keep the frost out, as it is then easily damaged. We always let the later sowings remain in the open ground, so as to have them ready for replanting at any time, as the plants will come through the winter in the open ground here easily, in a place slightly sheltered from the cold winds. The culture of lettuce in frames in the South is so easy and simple that no farmer's family should be without a full supply during the winter, hence a few sashes should always be found in every farm garden.

MAKING THE FRAMES.

We construct cold frames of any convenient length, running east and west. The back (or north) side we make of inch and a half plank 18 inches high, and the front(or south) side 12 inches high. These sides are nailed to posts on the outside, firmly set in the ground for if not attached in this way, the sides soon get tilted out of the perpendicular. Some growers make no cross bars to the frames, but simply set the sashes across. This is cheaper, of course, but it involves two men always at hand on each side of the frames to handle the sashes, hence we prefer to go to the extra expense of dovetailing into each side, every 3 feet, a 2x4 inch piece. This is not nailed fast to the sides, but simply dovetailed so that it can be knocked out of the way when preparing the bed. On the middle of this piece we nail an inch strip to serve as a parting strip between the sashes and so make a slide on which one man easily slides the sashes up or down for ventilation. The sashes are the regular three by six foot size, and cost now, complete, about $1.50 each, made of clear white pine or cypress. Our Southern yellow pine makes a very heavy sash and one that does not hold paint well, and is more apt to warp than those made of white pine or cypress. We never use a puttied sash on the frames. They are simply grooved so that the glass slips in easily and rests butted against the pane above. A tack at the bottom holds the whole row in place and when a pane gets broken, all we have to do is to slip the row up and run in another pane at the bottom. This makes the sash much lighter than if it is puttied and the glass lapped.

SOIL AND PLANTING

Soil is a very important matter in the growing of frame lettuce, for the character of the soil affects the crop more than in the case of many other plants. Lettuce prefers a sandy soil, and as the frames in which winter lettuce is grown are fixed affairs we must, in order to make a rotation, change the soil instead of the plants. We clean out the frames every fall and use the contents as manure elsewhere. Beginning in early spring, we prepare a compost for the frames the coming fall, for it must be turned and rotted and fined during the whole summer. To make this compost we gather oak leaves, grass sods and manure and pile them in layers. As our natural soil is stiff clay we add to this compost during the summer, all the washed sand about the place, and chop the heap down and turn and mix it several times during the summer, so that by planting time it is a mellow, black mass of loam. After the frames are filled with this prepared soil we apply to each sash (or eighteen spuare feet) five-sixths of a pound of concentrated fertilizer containing 8 per cent. phosphoric acid, 5 per cent. nitrogen and 3 per cent. potash; this is about the rate of a ton per acre. This application must be made at least a week before planting and well mixed with the soil, and if there is no heavy rain in the meantime the bed should be well soaked before any planting is done, so that the fertilizer may get well assimilated with the soil and not injure the roots of the plants. I have thus described our practice because the preparation and manuring of the soil is the vital point in the growing of frame lettuce; for an inferior article will hardly find a market, while extra fine heads always sell at a good price.

We set the plants of Big Boston lettuce 10x12 inches apart in the frames The first crop is set as soon as the plants are large enough. Each sash is watered as fast as planted, and the sash put on and covered with straw or sand to shade the plants till they get hold of the soil; then the sash is taken off and not returned till the nights get frosty. In fact, there is here very little use for the sashes till the first crop is about heading, which it should do about the first of December, and be all cut out by Christmas. The second crop plants, that were sown in September, are left in the open ground and slightly protected by leaves scattered between them (but not over them). As fast as the first crop is cut out the outdoor plants are set in their places, and this second crop should all be ready to cut out during March. In the meantime, in the greenhouse, we have cucumber plants in pots of four-inch size; these are set in the centre of each sash as fast as the lettuce is removed, and are protected at night so long as the nights are cool, and finally the frames are left to the cucumbers and the sashes stored under cover for another season, after being well painted. In some frames we sow beets and radishes instead of a second crop of lettuce, and by careful attention can usually get beets ready for the table when the seed sown in open ground is getting above the soil.

The growing of frame lettuce on a large scale requires ready capital, for, while the crop, well grown, pays remarkably well, it also requires a very expensive outfit and expensive preparation and fertilization. But when the frames are properly attended to the quality of the lettuce produced cannot be excelled by that grown in the hothouses of Boston at a still greater expense. To put an acre of soil under glass will cost $4,000 here, and in some localities more; the preparation of the soil and the fitting it and planting the crop will cost at least $200 more. Of course the outlay for the frames and sashes is in the shape of a permanent investment for a number of years, but the preparation of the soil is an annual job and cannot be neglected, for if you allow the old soil to remain, no matter how well you fertilize it, the crop will be less and the ravages of rot will soon make the saving an expense rather than a gain, for with the best precautions there will always be a little root rot among the head lettuce, though generally very little among the curled leaf sorts.

We formerly used and advised a fertilizer for lettuce containing 10 per cent. potash, but we have found that this amount is not needed, and makes the risk of damage too great in such heavy fertilization, and we now use but 3 per cent. of potash.

CAULIFLOWER AND LETTUCE COMBINED.

Well grown cauliflowers will always bring a good price in April, and this is about the only crop of cauliflowers that can be well grown in the South, as it is difficult to get summer plants through our long, hot seasons; hence it is necessary to call in the help of the frames to forward the crop for the early spring market. The seed for this purpose is sown early in September, and in a rich and moist bed, and the plants are grown on rapidly by abundant watering in dry weather. The frames are prepared in the same careful manner as are those in which the lettuce crop is grown alone. Six plants of the cauliflower are set at uniform distances in each sash, and the spaces are then filled in with Tennis Ball or Boston Market lettuce; the Big Boston not being suitable for this purpose on account of its size. This lettuce is from seed sown at the same time with the cauliflower, and is intended to be ready for market during the month of January and in early February. By the time the lettuce is cut out, the cauliflower plants are beginning to crowd to the glass, and to carry the crop on with success it is necessary to have an extra set of frames. The cauliflowers are gradually hardened off till the second week in March the sashes are entirely removed; these are then placed on the extra frames and are used either for the forwarding of the tomato plants and other things from the greenhouse or hotbed, or for growing a later crop of lettuce, and in this case the later crop should be of the Tennisball, too, as it will get into head before the weather is too warm. The cauliflowers will generally head well in April, and at that time well grown cauliflower sells very well. The important thing so far as the success of the cauliflower is concerned is to never let the plants have the least check in their growth, but to keep them steadily growing without keeping them so close as to make them tender. Any serious check will cause them to form heads prematurely and make "buttons," as the gardeners call them, instead of large and fully developed heads.

RADISHES AND BEETS IN FRAMES.

The Southern gardener, who realizes the great advantage his sunny climate gives him for frame culture, will not be satisfied with the growing of a single crop. There will always be a great advantage in having fully double the space in frames that he has glass to cover, so that when a half hardy crop can be exposed to outer air towards spring he can transfer the glass to other frames, and for the growing of other crops and the hardening off of the plants that are to go into the open ground later. But there are two crops which he can well afford to give the entire winter frames to. These are early beets and radishes. On warm and sheltered borders the seed of the Chinese Rose Colored radish can be sown here in late September, and with a slight cover of strawy manure as the weather gets cold, the crop can be marketed all through January, as we did the present season. In fact, our last radishes of this kind were sold from the open ground in February, and were still in good condition for use. But for the best trade the more tender, forcing radishes are far better, and these must have the protection of the sashs and mats; we use the turnip rooted varieties entirely for the frames. Having a frame from which a crop of lettuce has been cut for the Christmas market, we give a light application of nitrogenous fertilizer, generally of nitrate of soda, and sow the radishes and beets in rows ten inches apart, and as soon as up, thin them to an inch or two apart for the radishes and three for the beets; we use the Crosby Egyptian beet for frame sowing. Air is given in all sunny weather and the bed kept clean of weeds with hand weeders. Frost must be rigidly excluded by banking the outside of the frames and by covering with mats during cold nights, and in this climate there is no great difficulty in entirely excluding frost from a cold frame. If the seeds are sown the first of January, the radish crop should be ready to pull by the time the beets badly need thinning, and the thinned out beets are transplanted to take their place, so that the entire frame is then beets; and this beet crop should be ready to bunch the latter part of March. All of these practices and dates are for the central part of North Carolina, and further south the practice would be somewhat modified; but there is no section north of Florida where the sashes of glass will not be more profitable than the poor substitute of plant cloth, which rarely excludes frost in cold weather and is a makeshift at best.

The later uses for the sashes, so long as the nights are cool, have been suggested in the setting of cucumber plants under the sashes; a further late and summer use for the frames can be made with the egg plant and tomato. When the tomatoes are transplanted to the open ground, which here is usually in early April, the nights are still cool and it is too early to trust the tender egg plants outside. We have these grown in pots in the greenhouse, so as to have by this time very large plants in four-inch pots. Some tomato plants are potted in the same way and kept near the glass to keep them short and stout. Two egg plants are then set under each sash and under others one tomato plant is set to each sash. Of course the sun is now warm and the plants will need little protection in daylight, but the sashes are run over them at night, to keep up the rapid growth, till finally the plants crowd against the glass, the nights get warm and they are turned loose. In the fat soil of the lettuce frames the plants attain a luxuriance far greater than in the general plantation, and the tomato plants are trained to stakes with a single stem, a practice we have abandoned in the general crop, but which is desirable here for an extra early crop. Under this treatment we can get ripe fruit from Maule's Earliest tomato the first of June, and have had stray specimens ripe in May.

Of course we use the sashes for the hardening off of the general early crop of tomatoes to go into the open ground, but we never attempt the hardening off of the egg plant. All that we have not room for in the spare frames are kept under glass in the pots till the nights are warm, for a check to an egg plant is ruin for the season.

COLD FRAME CULTURE IN MORE NORTHERN SECTIONS.

What we have written has been more especially in reference to the practice best adapted to the section from Virginia southward, but the use of frames for the culture of the lettuce crop can easily be extended to the latitude of Philadelphia on the eastern coast of the United States, and Kentucky in the central section. North of Virginia it will be necessary to carry the plants for the second crop in winter in extra frames, where they will simply have the protection of the sashes and be kept in a hardy condition till needed. We have grown frame lettuce on a large scale and with profit in the northern part of the Eastern Shore of Maryland, and also in a very cold locality in the elevated country north of Baltimore city, where we had a winter climate colder than that of Philadelphia. In this instance our frames were built of brick and sunk below the general level, and we used tongued and grooved shutters for covering the frames in cold weather. In this way we grew the winter crop of lettuce and headed it with perfect success in winters when the mercury fell to eighteen degrees below zero, and yet no frost got into the frames to do any damage. Under such conditions, however, the question may arise whether it would not be better to use heated greenhouses at once, for under these climatic conditions, and the constant presence of heavy snowfall, the attention to the frames was a serious matter, and the labor of constant cleaning of snow and the taking off and on of the heavy shutters, which required two men to handle, made the culture nearly as expensive as it would have been in houses heated by hot water, where the work could at least have been more comfortably done. Therefore, in sections where the winter temperature is apt to go below zero and there is a heavy snowfall, it will be found better to use greenhouses for all winter forcing of vegetable crops.

FRAME CULTURE OF FLOWERS.

From Virginia southward the simple cold frame, constructed and operated as for the lettuce crop, can be made a very profitable means for the procuring of a supply of many kinds of flowers during the winter. While from North Carolina southward the single Luxonne violet grows and blooms with hardly any care all winter, in the open air, yet at times the prevalence of frost will seriously damage the flowers. Then, too, the double flowered sorts, such as Marie Louise and Lady Hume Campbell, are more tender and apt to be damaged in the open ground in severe spells, while they bloom freely and continuously in the frames treated just as we do lettuce. With the rapid improvement in the means for transportation, the florist of the Upper South should be able to put his cut flowers on the New York market in the best condition. The florists in all the Southern cities now get large quantities of cut flowers from the commission men in New York, and they are sent here in fine condition. These flowers are cut in New Jersey and other districts around New York and sent to the commission men, and if they can then send them South safely, there is no reason why the more cheaply grown product of the Upper South at least, should not find a market in the North. Violets can be grown as well and as plentifully here in cold frames as they are grown in the greenhouses North, and if as well grown they will command as good a price. Then, too, the various members of the Narcissus family and the Roman hyacinth, which here bloom in the open ground from December for the Romans, to February and March for the Narcissus, and are then subject to be damaged by the sudden freezes, can be protected in the frames and the flowers cut in as good condition as from the forcing houses North, while the bulbs can then be left to fully mature and are as good as ever, or even better. Frame-grown Narcissus and Roman and White Italian Hyacinths will, ere long, be a regular article for winter shipment from the Upper South, wherever there is a chance for their arrival in twelve to fifteen hours.

Cold-frame culture of flowers can even be carried further than the violets, Narcissus and hyacinths in the Upper South, for with well constructed frames giving more head room than for lettuce and other low crops, the carnation can be grown and bloomed here, with certainty and more healthily, than in the heated houses of the Northern florist. Of course the sides of the frame must be well banked and the mats must be used to exclude frost. This is no mere theory, for we have grown carnations successfully in this way at Old Point Comfort, Va. In that case we had our frames banked thickly with seaweed, which was an abundant material, and which packs closely and is not blown off by the wind. A foot thickness of the seaweed was packed all around the frames, and the glass was protected by straw mats, made of broomsedge, which makes a thicker and warmer mat than rye straw. Of course it is more troublesome to attend to carnations in such a frame than in a greenhouse, but the crop is as good, the plants more healthy and the profit greater than where a lot of coal is burned in expensive boilers for heat.

Our frames here, prepared in the same way we prepared them for lettuce, and planted in Marie Louise and Lady Campbell violets, have given a wonderful bloom during the winter. But there is so much difficulty in carrying the double-flowered violets through the summer here that it is advisable to get the clumps from the North annually. The single-flowered Luxonne violet has become, here, almost a weed, and it stands the long summer heat and is such a wonderful winter bloomer that we are inclined to believe that the Southern grower had better be content with the single-flowered violets. The single variety of violet, known as the California, will also stand our summers, and in late winter and spring makes a splendid bloom; but does not bloom in midwinter like the Luxonne. The Luxonne seeds so freely here in summer that it has become, as I have said, almost a weed, and while it grows with the utmost luxuriance and makes an immense bloom in the rich soil of the frames, it will grow and bloom in the poorest sandy soil of the South; bloom, though, with stems too short to be used. We have seen an old sand yard in this State, where not a sprig of grass would grow, perfectly blue with the violets all winter long. In preparing a frame for the violet we make the soil rather heavier than is best for lettuce, and incorporate a larger amount of woods earth and rotten leaves, for the violet delights in leaf mold. Neither do we make so heavy an application of the commercial fertilizer as for the lettuce crop, but put in a little to give the clumps an early start in the fall. The frames for the hyacinths and the Narcissus we treat exactly as we would for the lettuce crop. Roman hyacinths naturally begin to bloom in the open ground here in late December, if the bulbs are left in the ground or are planted early in the fall. As the flowers sell best about Christmas it will be best not to put the sashes on too early, as they might get the flowers too soon. The first of December is early enough to use the glass and this will bring the best spikes at Christmas, and there will be a continuation of blooms till late in January. In fact, with bulbs that were allowed to grow in masses in the frame and not lifted in summer, we have cut flowers of fine size from Christmas to March, and have sold $5 worth of Roman hyacinth flowers from a sash. The variety of hyacinth known as the White Italian is later and makes longer and larger spikes than the Roman, and when grown in frames makes a fine cut flower for the Easter trade. The bulbs are planted in the frames in the fall, but the sashes are not used on them till about six weeks before

Easter. We have never used mats on Narcissus and hyacinths, as the simple cover of the sash is all sufficient here. Roman hyacinths are very unsatisfactory in the South in the open ground, from the fact that they inveterately endeavor to bloom during the coldest weather we have. But in frames they are very fine, superior in bloom to any forced greenhouse spikes. The White Italian blooms in the open air in late March, and in the frames can be protected and kept till Easter. But let no one suppose that frames can be managed for any crop in a careless manner; or that anything less than a careful manipulation of the soil and the heavy application of fertilizers will give good crops. An acre in glass-covered frames will give four good men all the work they can attend to. Intensive gardening means rich soil, high manuring, a large investment of capital on a small area, and the closest attention to details. Then it will pay in a way that the ordinary trucker has hardly dreamed of; but if any of these things are neglected, the gardener had better let intensive winter work alone.

FRAMES FOR THE COMMERCIAL FLORIST IN THE SOUTH.

With all that has been said on the subject of the use of frames in the South we have hardly touched the value of the simple sash in a mild climate. The work of propagating and selling plants at wholesale is being rapidly divided into specialties. Few of the larger firms engaged in the culture of the flowering plants now grow all the plants they catalogue. Certain sections have been found to be particularly well adapted to certain cultures, and there growers have entered into the culture of certain plants to the exclusion of all others, and are thus able to produce a superior class of plants at rates that make it more profitable for others to buy from them than to grow them themselves. The specialization of culture is more general among the largest firms in the trade than among the retail florists in small towns, who must keep up a variety. The large wholesale florist finds that he can devote his glass to a certain specialty, such as palms, and he grows palm trees by the million, and looks to other specialists for his carnations, roses and other things which he can buy more cheaply than he can grow them in competition with his palms; thus there has gradually developed a division of labor. A certain locality on the Hudson River has been found to be particularly well adapted to the growing of violets in great perfection, and growers there are devoting wide fields to the violet in summer and the other men in the trade buy from them rather than raise them in smaller lots for their own trade. The soil and climate of California have been found to be admirably adapted to the perfection of seed, both of vegetables and flowers, and the trade is centering there.

Then it has been found that there is a great advantage to the Northern dealer to have his roses grown in the longer season of the South, where the plants are not damaged by mildew as they are in the North. The demand for good roses is practically unlimited. Other plants may have a popularity for a time, but the rose lives through every fashion and is more and more popular every year. Then the immense numbers that are now used by the growers of flowers for winter cutting creates a new demand for plants, and forms a great specialty into which skillful men in the South can enter successfully. The ease and cheapness with which roses can be propagated in the South will inevitably cause the culture to centre there, since the Northern growers cannot compete with the Southern product when it is put on the market in large numbers. Here, too, the simple sash on a frame comes in for profitable use. It is found in the North that the tender sorts of roses like the Teas and Noisettes, do not root readily from cuttings grown in the open ground, and the plants, too, are not hardy enough to be left in the open ground in winter. In the South the plants are not only hardy, but the cuttings can be rooted just as easily as those from the housed plants in the North. Then in the case of that gorgeous family of roses known to the trade as hybrid perpetuals, which unlike the teas and other everblooming sorts, ripen their wood and drop their leaves in the fall, this ripe wood can be made into cuttings eight or ten inches long and inserted full length in the open ground in the South in the fall, slightly covered with pine leaves to prevent hard freezing, and they root with ease and make fine large bushes for shipping North in the fall so that the florists can have them to pot for spring sales of large plants.

PROPAGATING TENDER ROSES IN THE SOUTH.

This is probably the most profitable use that can be made of cold frames in the South, by men who have acquired the rquisite skill in the work, and the method is easily learned if the learner is content to go slowly at first, until he has acquired the requisite skill in handling such plants; for, no matter how much one may read on such a subject, skill only comes from practice. When done on a large commercial scale, the propagation of roses can be better done in a regular propagating house, where the operator can work with more ease and in any weather; still, the propagation can be carried on with the simple frame with about as much certainty as in a well appointed propagating house; of the use of which we will speak after we have completed the consideration of frames and their use.

The propagation of tea and other evergreen roses should begin about the last of August, and can here be continued from cuttings from the open field until nearly December. The cuttings used are the young shoots that have just made a flower bud. The upper part of such shoots will usually be found too soft for propagation, and some experience is needed to detect the exact condition of the wood which is best suited for rooting. It must not be too ripe, but just ripe enough to present some woody fibre to the knife in making the cutting. We make the cuttings with three buds. The base of the cutting is cut right below the bottom bud and the top is made half an inch above the top bud. The leaf is left entire on the upper bud but removed from the two lower ones, If this leaf decays in the cutting bed then reject that cutting even though it roots. The loss of the leaf is an indication of weakness in the cutting and it will not make a first class plant. We place the cuttings in water as fast as made, for it is important that the cut may not be allowed to dry before setting. Now the bed in which the cuttings are to be set should be ready. This is simply an ordinary cold frame in which a bed of three inches of clean sand replaces the usual rich soil. Standing in front (or on the south side) of the frame, the propagator marks a deep cut in the sand with a straight edge across the frame. Beginning at the extreme left end of the frame as he fronts it, he sets the cuttings up to the top leaf in the sand, and turns all the leaves to the left so that they will be out of the way of the next row. The cuttings are set about an inch apart and the rows are marked three inches apart, and the sand packed closely to each row as set. Turning the leaves all to the left, they will, as the setting proceeds, nearly entirely cover the surface of the sand. As fast as a sash is filled it is well watered with a fine rose to settle the sand about the cuttings. The glass is heavily white-washed or painted for shade, and is propped up an inch or more at the back to allow a circulation of air. Wooden labels are used to indicate the names of the varieties in the rows and parts of rows to prevent mixing. After the cuttings are set, the bed will need watering daily to keep the sand wet, and if all goes right they should be forming roots in about four weeks. As soon as they have made roots the fourth of an inch long they must be potted into pots two and a half inches in diameter, using a compost made during the summer of rotted grass sods and old manure. This should be composed of sods from a clay loam and not a sandy soil, for the rose prefers a firm soil. Potting must be done firmly and the plants are then packed into another frame, preferably on a bed of sifted coal ashes to prevent the earth worms from getting into the bottom of the pots. They are well watered, and the shaded sashes placed over them; they must never be allowd to suffer for water. By the time cold weather comes these plants will have made some growth and have become well established in their pots. They are now salable as two and a half inch pot plants, or they can be carried over winter in the frames and planted in the field in the spring to grow during the summer for shipment to customers in the fall, who want them to pot for the spring retail trade. Of course the shading must be removed from the glass as the plants get established and the weather gets colder, and regular attention must be given during the winter to watering and airing the frames. As the weather gets cold, the pots should be packed all over with cotton seed hulls, to prevent the freezing of the pots and soil, but they should be kept as cool as possible for frost to be excluded, as it is not desirable that they should get into active growth during the winter. One sash three by six feet will winter three hundred plants, which will be worth, dug from the field the following fall, from forty to one hundred dollars per thousand at wholesale, according to the rarity of the varieties. Fifteen thousand plants can be set on an acre, and it will be seen that this is another profitable use for the sashes and frames. Of course anyone going into the propagation of roses for the trade will have his connections North who will handle his stock, and when the whole work can be done on contract for the large houses who distribute the stock, it can be seen that an important industry can easily grow up in this way. But, as we have said, when one goes into business on a large scale he should be provided with an outfit of propagating houses, which, during the winter, can be used for other purposes, as we will suggest.

The only artificial fertilizer the rose grower needs to use in his potting compost is raw bone dust, and in the field the plants will take as much manure as a corn field, and will need as much more cultivation if the best plants are desired.

For the propagation of the hardy hybrid roses the Southern grower needs no glass. The cuttings should not be made till the wood is perfectly ripe and the leaves have fallen or will rub off easily. We then make, in November, cuttings of the summer's growth of about four or five eyes or buds, cutting the lower end off right under a bud and the upper end half an inch above one. Select a piece of well sheltered, fertile loam soil, and insert the cuttings up to the upper bud, six inches apart in rows two and a half feet apart, and mulch the rows with pine straw or cotton seed hulls to prevent the soil from freezing. If the wood is well ripened most of the varieties will root and be ready to grow in the spring, though some varieties root more certainly than others. The time for setting the cuttings is in November, but we have frequently set them later; and on one occasion cuttings of the new rose, Margaret Dixon, set in February, made plants over six feet high the same summer. These roses are, of course, allowed to grow during the summer where the cuttings are set, and are salable in the fall just as the tea roses are. Some dealers in the North have gotten prejudiced against the cutttings rooted in the open ground in the South because the plants sent them are long-shanked and look like roses that were budded too high. This is caused by making the cuttings too long and leaving a part above the ground. If the cuttings are of moderate length and are inserted their whole length in the earth, the plants will branch from the ground in a symmetrical way. Others have objected that the plants that have been sent North from the coast country of South Georgia have long, ropy roots and fail on being potted. This arises from growing the plants in a sandy soil and too far South, where the wood does not get so well ripened by the coming of frost. Roses need a clay loam in which to make the most compact root growth suitable for potting when sent North. It will be but a short time when all the larger dealers North will have their roses grown in the South, on contract, just as they now have tuberoses and other bulbs grown there. Propagation of roses on a large scale necessarily involves a considerable investment in glass and pots and land, for nothing but the best soil is fit for the purpose. A propagating house 100 feet long and twenty feet wide will require 1,000 sashes on the frames. The house will cost $2,000 and the frames $1,500, three acres of stock plants will be needed for cuttings, and twenty acres of land for the summer planting. Pots and freight will cost about $1,000, and such an outfit in the hands of a skilled man with plenty of labor at hand, should turn out 250,000 plants annually. The tea roses will go into the field in March, and during the winter the propagating house can be used for growing other plants, and in spring for starting tomato and egg plants, which, in March can be transferred to the frames after the roses have gone out, and, and an immense number of plants be had for sale to planters, or planted in one's own land for the growth of the fruit. Or if the business grows as it should the house can be partly planted with stock plants of roses and the propagation kept up during the winter from wood grown inside. This will involve the use of more greenhouses for the establishing of the winter plants.

PROPAGATING HARDY ROSES IN FRAMES NORTH.

The hybrid roses that are so easily propagated from cuttings in the open air in the South, are equally easy to propagate in colder latitudes by the use of the simple cold frame. In this case the cuttings should be made of about four eyes and set in three-inch pots, in a good compost of sods and manure suitable for the potting of roses. These pots are then plunged over their rims, in a bed of sifted coal ashes in the frames, and careful attention paid to watering, airing and protection during the winter. They will have formed roots by the time planting time comes in the spring, and can then be transferred to the open ground in nursery rows for the summer.

Wherever the frames are built closely and protected by banking, and are covered in cold weather by mats or shutters, violets can be grown and bloomed as freely as in greenhouses. In fact, from Virginia southward the violets are better off in the frames than in any greenhouse.

Our lady amateurs often go to a great deal of trouble in rooting slips of their favorite geraniums. If they would take a simple frame and a sash in the early fall and place in it a bed of clean sand, and insert all the cuttings they want in this, give one good soaking and then put on a shaded sash slightly tilted at the back, they need not give the geraniums any further attention till rooted, as they will be in three or four weeks, when they can be transferred to small pots.

We have thus, in detail, tried to show the capabilities of a simple frame and hotbed sash, so that the Southern reader especially can realize the possibilities of intensive horticulture with very simple appliances. The conditions are constant care and attention, and a liberal expenditure for manures and fertilizers, for intensive gardening means a soil of exuberant fertility, such as we seldom see in the open garden; but we have by no means exhausted the resources of the cold frame and sash.

ASPARAGUS IN COLD FRAMES.

There is, as we have seen before, no crop grown by the market gardener which has been so steadily and uniformly profitable, North and South, as the asparagus crop when properly grown and handled, in soil made as fertile as possible. Some gardeners have made the forcing of asparagus in hotbeds and houses a profitable matter, but this involves the loss of the forced roots, while in cold frame culture the bed maintains its productiveness for years. It will not, however, be advisable to plant a bed for immediate use of the sashes. In preparation for frames the beds should be planted so that they will be included in a six-foot frame. The soil should be trenched to a depth of twenty inches and filled with old, rotted manure, and a good addition should be made as a top dressing after the roots are set. Set the roots 12x12 inches apart and more shallowly than in the general open ground culture. Keep the beds perfectly clean and in the fall add a dressing of kainit at rate of one-fourth of a pound to each 18 square feet, the size of a sash. In the spring give an equally heavy dressing of cotton seed meal (or tankage), and again keep the beds well worked. The following fall build the frames. Then, during the winter, when an early crop of lettuce has been sold from other frames, run the sashes on the asparagus frames and keep the glass close till the soil is well warmed. Then, as the shoots begin to appear, give air as needed, and protect carefully with mats in cold nights, cutting the asparagus as fast as the shoots attain the proper size until shoots appear on the outdoor crop, when the cutting should be stopped to give the frame-roots a chance to fully develop. The following season they can be cut longer, and if the manuring and fertilization is kept up the beds will continue productive for many years. In the colder sections North the same practice can be pursued with heated houses or frames. At Cornell University Prof. Bailey describes a house used for the forcing of asparagus, which is simply made of canvas stretched over an iron frame which forms the heating pipes. With the simple frame and sash the Southern gardener can get the crop from the frames during February, when the price is always fine, and as a second use of the sash for the winter it may prove more profitable than a second crop of lettuce.

STRAWBERRIES IN FRAMES.

It is a comparatively easy matter, from Central North Carolina to Southern Georgia, to forward the strawberry crop with the use of sashes so that the fruit will compete with that from Florida in February and early March. In preparation for the crop we must begin in the early summer of the previous year. Using an early variety of strawberry, we take the runners as soon as they show white roots an inch long and put them in three-inch pots, using the same rich compost of rotted sods and manure we would use for the roses or other plants in pots. They are then set, close together, in a frame on a bed of coal ashes, are shaded by lath screens and kept carefully watered till the roots have gotten complete possession of the pots. They are then set in the frames in August, ten inches apart each way. The soil in the frame is made as deep and rich as we make it for the lettuce crop, and the plants are kept clean and not allowed to make any runners. By the time cold weather arrives they will be big and strong and will have made fine fruiting crowns. They must now be allowed to take their winter rest, for it will not do to excite them into continued growth and bloom. About Christmas the sashes are placed over them, the old leaves cleaned away, and a light dressing of nitrate of soda is added around them; about four ounces to a sash. Close attention must now be paid to watering so that the plants shall never suffer from drought, and to airing on all occasions when the sun shines brightly, and covering to exclude frost on cold nights. As the plants develop fresh leaves and begin to bloom, but not before, it is well to add a mulch of chopped straw around them for the fruit to rest upon and be kept clean. The crop should come on in late February and early March. For frame culture, as for regular forcing in greenhouses, we would grow fresh plants annually. If well grown thus, in the Upper South, the crop should be a very profitable one, since the fruit can be put into the market of better quality and in better condition than that from the far South. In fact, there are times in winter when even the Florida grower may wish that his plants were in frames.

IMPORTANCE OF WATER IN INTENSIVE GARDENING.

When we come to artificial culture with the aid of glass, water becomes a matter of great importance, for we cannot at all times, even in winter in the sunny South, depend on the rainfall; and the rainfall, if plentiful, may come in such cold weather that we cannot afford to use it in our frames. Hence when we begin winter gardening under glass a full supply of water under pressure is of the first importance. Perhaps the cheapest mode of supplying this need is by the use of a windmill and elevated tank, connected with piping through the framing ground, so that a hose can be attached at intervals and the watering speedily and effectively done. The success of the crop may depend on our ability to irrigate the frames thoroughly, and with an extensive series of frames the loss by reason of lack of water might be enough to have fully provided the needed supply. Windmills are more effective in the flat country near the sea coast, among the hills they are at times unsatisfactory; in such case a hot air pumping engine is the best thing we have tried for pumping purposes. In any large truck garden, whether there is much or little glass, the ability to give a full irrigation in the open ground will often make all the difference between great profit and a dead failure, so that the first essential in a profitable market garden is a water supply under pressure. The large amounts of commercial fertilizers used in market gardening require a regular supply of moisture, in order that the plant food may be dissolved and the crops get the benefit of it, and any long interval of drought will cause damage through the caustic nature of some of the materials used.

Having a water supply under pressure does not mean that the gardener shall continually drag long hose around everywhere, for any man who is at all handy with a pipe-wrench can arrange a pipe system for temporary use in summer that will furnish points of attachment for short pieces of hose, which can be taken up and stored in cold weather. One of the most successful celery growers we ever knew, grew his crop on high land of a strong clayey nature; but he had a water tank and laid temporary pipe lines all through his celery plantation, so that a few feet of hose would enable him to soak every part of it with the minimum amount of water. Every large frame-yard should have a series of hydrants along between the frames, to which hose and sprinkler can be attached and the watering rapidly and easily done. No one, particularly in the sunny South, should ever attempt frame culture of any plants on a large scale without contriving for the water supply under a good pressure; and if this is necessary in frame culture it is still more needed when we come to forcing crops in the heated greenhouse, and the manure heated hot-bed.

HOTBEDS.

The only difference in structure between the cold frame and the hotbed in that the latter has an excavation made under it, for packing fresh heating manure in, to get up and maintain an artificial heat. In the vicinity of the larger cities hotbeds are still largely used for the Winter growing of lettuce and other crops that are grown in frames in the South. There the growers can depend on regular and abundant supplies of fresh horse manure, and where labor is abundant the hotbed may be made a profitable method for the production of these crops and the forwarding of plants for the open ground. But there are few gardeners so situated, and even where the manure can be had, the hotbed is not the cheapest structure in the long run for the production of crops that require heat for any length of time, for it is always a diminishing heat, and the labor of attending to the beds is far greater than in properly arranged and heated greenhouses.

In some places the gardeners have adopted fire-heated beds, to save the expense and labor of manure handling and to maintain a more uniform heat. These beds are constructed with an excavation below as for the manure, but in place of the manure a brick flue is built through the length of the pit, and above it a floor is made on which the soil is placed. A furnace at one end furnishes the heat, and the hot air chamber below makes it uniform over the bed. This is a poor and inconvenient imitation of a greenhouse, and the same sashes that are used on the frame could be put into the shape of a double-span house that would admit of head room for getting through the centre, and beds or benches on each side over the flue; and while there would be less bed-space by reason of the walk, the ease of management and the fact that one can work there in all weathers gives the narrow greenhouse a great advantage over the heated frame. It is not the intention of this work to enter into the general construction of greenhouses for all purposes, but to show that in the beginning of forcing, a cheap structure can be made that will answer many purposes; and which, as skill in the management of plants under artificial conditions increases, more elaborate structures will take their place. We have treated at large on the possibilities, especially in the South, of a simple sash on a frame, and we will now treat of real winter forcing.

THE FORCING HOUSE.

The character of the house needed will depend largely on the crop to be forced. Such dwarf growing crops as radishes, snap beans and asparagus need low and compact houses, while crops like tomatoes and cucumbers require more head room in the house. Long, narrow structures, such as can be made with the ordinary hotbed sashes, with side walls of plank nailed to posts four feet high and wooden gutters, to which each alternate pair of sashes are fastened to form rafters to the ridge pole, and the others hinged at the bottom to the gutter and fastened by iron straps punched with holes so that they can be elevated for ventilation, and one walk through the centre just giving room under the ridge for head room and two side benches, can be made cheaply, and will make admirable houses for radishes or beans on the side benches. The heating, if funds are not plentiful, can be done with brick furnaces set in a pit at the end of the house, and a brick flue taken around under the side benches to a chimney at the furnace end. If the house is much over fifty feet long there had better be a furnace at each end running directly to a chimney at the other, for a flue over 100 feet long is of little value. The best, and, in the long run most economical, mode for heating, is by hot water boiler and pipes, so as to give a uniform heat through all the house. The tyro at forcing will generally make the mistake of running too much heat, and the heat is harder even for an experienced man to regulate in a house that depends on a furnace and flue than in a house heated by hot water. Where means will afford it will always be better to have houses properly constructed by an experienced greenhouse builder and designed for the crop for which they are to be used.

For the winter forcing of tomatoes, which is one of the chief crops grown under artificial conditions, a very different house should be made. For this purpose we prefer a full-span roofed house twenty feet wide, and ten feet high to the ridge in the centre. This will give a bench on each side near the glass, two walks and a bed in the centre or rather a floor space on which the pots or boxes in which the plants forced are grown. The side benches can be used for the forcing of snap beans, which require about the same heat as tomatoes. In the South a house for winter radishes will be better merely with a flue, since it will only be during cold snaps that any fire heat will be needed. In fact, if much is given there will be more leaves than radishes, and the low house will be better for them than the higher one, as they need to be kept close to the glass. The span-roof house should run north and south in length, so that both the morning and afternoon sun can be had. A small sash-house, with a flue, is essential to any market garden whether winter forcing is practiced or not, for it is greatly better than a hotbed for the starting of the plants, that are to be transferred later to the cold frames and the open ground. Merely for the purpose of starting plants a very small house will be sufficient for a large number of sashes or cold frames, since the young seedlings can be thickly grown at first, if given plenty of room in the frames. A house fifty feet long by ten feet wide will not only give room for the sowing of seed, but for the first transplanting of a large crop of tomato and egg plants and peppers, and such a cheap structure can be afforded in any garden of any pretensions to size. If one goes into regular winter forcing it involves capital and experience, and if the gardener has not had experience in the work he had better employ someone who has, until he gains the needed experience, for no greenhorn will at first make a success of winter forcing.

CHAPTER XLIX.

SOME GENERAL CONCLUSIONS.

1. Commercial fertilizers are simply plant food, in a concentrated form and more or less immediately soluble condition, and are not stimulants any more than stable manure is a stimulant.

2. Lime and land plaster may be regarded as stimulants from the fact that, although plant food to some extent, they have a further office as reagents in bringing about changes in matter already in the soil, and bringing into use matters otherwise unavailable to plants. Hence if used with the idea that they are manures and will make the soil rich, the result will finally be to exhaust the soil of some matters essential to plant life, while if their office is properly understood they are the most efficient agents in the maintenance of the fertility and productiveness of the soil.

3. While they are not to be regarded as mere stimulants, commercial fertilizers, used as a constant reliance for the getting of the same crop from the same soil year after year, will finally result in a condition of the soil in which it will no longer respond to the application of the fertilizers as it once did, largely because of the mechanical condition of the soil and the using up of the humus; one of the most efficient agents in making the fertilizers available to plants.

4. While the application of a fertilizer mixture to every crop planted or sown may show an increase in the crop, such a course is seldom profitable, and the indirect accumulation of fertility through the agency of the legumes, aided by commercial fertilizers, will generally give more profitable results than the application of fertilizers direct to the sale crop. In other words, the place to use the fertilzer for our ordinary farm crops is in the promotion of the growth of the legumes that make food for animals and food for the soil at the same time.

5. One crop farming, or, rather, planting the same soil year after year with the same crop, and applying commercial fertilizer for the purpose of getting a crop, is merely gambling on the chances, and like every other kind of gambling results in final disaster to the gambler.

6. The soils of the South have lost fertility faster through the leaving

of the land bare of vegetation in winter than through the cropping of cotton in the summer. While a green cover crop is important in any part of the country, as a trap for the nitrates in winter, it is of far greater importance in the South where there is little or no snow and where there is more rain in winter than hard freezing. But the same practice of one cropping will lead to soil exhaustion and "old fields" as surely in the wheat fields of the Northwest, though the fertility of the soil may stand it longer; but when once the soil in that climate is depleted it will be harder to restore it than in the climate of the South.

7. The Southern uplands are naturally more deficient in humus than those of the North. In the Northern forests the leaves fall early and the snow packs them down where they fall, so that the hills gather humus. In the Southern uplands, the leaves fall more gradually in the autumn, and the winds blow the dry leaves off into the low grounds and hollows, accumulating fertile hollows and bottoms, while little humus accumulates on the hills from the lack of snow to hold the leaves there. Hence in the improvement of the Southern hills, the stocking of the soil with vegetable decay to remedy this defect is the most important thing.

8. The blood red clay of the Southern Piedmont plateau only needs proper plowing and cultivation, and the accumulation of humus in it, to make it a productive soil, for, being the result of the decay of feldspathic rocks, it is well supplied with all the mineral elements of plant food, and only needs the proper tillage and the accumulation of nitrogenous organic matter to make it a productive soil. On these soils deep and thorough plowing and subsoiling, and rapid, clean and shallow culture, with a good rotation of crops in which the legumes are frequently brought on the land and the manure made from their feeding is used as an additional source of humus and plant food, will give better results without an ounce of commercial fertilizer than they will with the annual scratching and application of costly fertilizers.

9. While some of our flat and low lying soils abounding in humus may give profitable crops through the heavy application of fertilizers year after year, the same course on the upland soils will not result in profit either to the land or the owner.

10. Hence to make the liberal use of commercial fertilizers profitable a well adjusted system of crop rotation is essential. The experiments at the Ohio Station through a series of years gave the following results, as stated in their bulletin: "At the prices at which mixed fertilizers are sold in Ohio the attempt to furnish all the nitrogen, as well as all the phosphoric acid and potash required to produce increase in cereal crops grown in continuous culture, has invariably resulted in pecuniary loss, although very large increase of crop

has been thus produced. The rotation of cereals with nitrogen-gathering crops, therefore, has been shown to be absolutely essential to the profitable use of commercial fertilizers in any form." This is in perfect accord with all of our experience, for we have found that with the exception of certain high priced crops, like those of the market garden and tobacco, it has never been as profitable to use a complete fertilizer for the direct production of the crop as through the accumulation of nitrogen by means of legumes.

11. In the use of the legumes as nitrogen collectors, a short rotation is essential, since nitrogen, when it has come into the readily available form of a nitrate, is rapidly lost to the soil. The same Ohio experiments confirm this, for they say: "Thus far in these experiments the surplus nitrogen accumulated by a crop of clover, the roots only being left in the ground, has not been more than sufficient to satisfy the demands of the one crop immediately following the clover.

12. Hence in wheat growing in the northern section of the winter wheat belt a rotation of three or four years will be found the most profitable. We would suggest the following: Wheat, clover cut for hay and fallowed for wheat again. Clover cut for hay, then pastured and manured for the corn crop the following year and repeat, a four year rotation in which one field of wheat following corn has the benefit of the manure applied to the corn and another the clover lay and the corn also has the clover and manure. In the southern part of the Middle States either adopt a three year rotation of corn, wheat and clover, or, if the oat crop is an important one, make a rotation of corn on clover sod manured, vetch among the corn for a winter cover, oats on the plowed down vetch, cow peas on the oat stubble at once after harvest and cut for hay and land disced for wheat and sown to clover. In the Upper South where the land is adapted to wheat make the following. Corn well manured with home-made manure, winter oats or wheat after the corn, cow peas after harvest cut for hay and land sown at once in crimson clover or vetch, cotton on the plowed down legumes aided by the meal from the previous crop. In all these rotations we would use commercial fertilizers only on the legumes, and on these in a very liberal manner only phosphoric acid and potash. This liberal use of the mineral elements of plant food will result in a larger growth of forage for cattle feeding, and a larger amount of nitrogen accumulation. The increase in forage will mean an increase of manurial accumulations in the stables and barnyard, and a growing independence of the fertilizer mixer, the building up of the fertility and productiveness of the land and increased profit to the farmer.

13. Barnyard and stable manure made by feeding animals on which a profit has been secured, is a far cheaper source of fertility than commercial

fertilizers. Quoting again from the Ohio bulletin we find, "The increase of crop per pound of fertilizing constituents applied has generally been smaller when barnyard manure was used as the carrier of fertility, than where chemical carriers were used; but the lower cost of the barnyard manure has made it possible to use this material with profit when the use of commercial fertilizers resulted in loss. A marked superiority is indicated from manure which has been kept under cover until required for use, over that which has been exposed, even but for a short time, in an open barnyard, and it seems possible to materially increase the effectiveness of manure by treating it with nitrogen-fixing materials."

14. It is always more profitable for the farmer who uses the commercial fertilizers to buy the materials and mix them at home than to buy the ready mixed articles. He is thus able to vary the proportions of the different constituents to suit the particular soil or particular crop he is growing. The Ohio Station has also investigated this matter in a thorough manner and gives the following conclusions: "In the field experiments of this Station, herein reported, factory mixed fertilizers, made by firms of high standing, produced no greater crops than home-mixed fertilizers of equivalent composition. The cost of the factory-mixed fertilizers was greater by 50 to 90 per cent. than that of the equivalent home mixtures. The verdict of these field experiments is confirmed by the investigations of all other agricultural Experiment Stations which have reported upon the comparative value of factory-mixed and home-mixed fertilizers. Physical and chemical examination of the two forms of mixtures shows that the factory-mixed fertilizer is not more homogeneous in its character than that mixed by the farmer. Fertilizing materials may be as perfectly mixed with a shovel on a barn floor or in a large box as by the most elaborate mixing machinery. The most thoroughly mixed fertilizer is apt to separate in transportation, the finer particles settling to the bottom, the coarser rising to the top; hence the fertilizer mixed at home will usually reach the field in better condition than that mixed at some distant factory. Those who purchase the crude materials and mix for themselves are less likely to have materials of inferior quality imposed upon them than those who buy ready made fertilizers. The possible annual saving in the fertilizer bills of Ohio farmers by cash purchase of materials and home mixing or control mixing, reaches $300,000 to $400,000."

If such is the case in Ohio, where it is but a recent thing to use the commercial fertilizers, what would be the result in the Cotton States where the sales of fertilizers run up into several millions of dollars annually while in Ohio they little exceed half a million, and a possible saving of 50 to 90 per cent. may be made?

15. While experiments with fertilizers will show that the best results are obtained from a complete fertilizer in which there is a due proportion of nitrogen, phosphoric acid and potash, it by no means follows that it is to the farmer's interest to use the complete fertilizers when by a proper rotation of crops and the use of legumes he can get without cost and often at an actual profit, the nitrogen which makes the greater part of the cost of the complete fertilizer. A long experience in the cultivation of the soil enables us to say, without fear of successful contradiction, that for our ordinary farm crops such as cotton, wheat, corn, etc., there is never any need for the purchase of a complete fertilizer, if the proper rotation of crops is followed, legumes grown and used as forage and manure saved with care and applied in the best place.

16. On crops of extra value, such as those of the market gardener, it pays to use the complete fertilizers in a lavish and apparently wasteful manner where the early crops thus grown are followed by legumes for feeding and the accumulation of humus. The tobacco grower, too, finds that it usually pays to use a complete fertilizer, though we are not sure that even here the use of the legumes may not give as good results, though further experiments are needed to determine this.

17. Where it is necessary to use artificial nitrogen the most readily available form is nitrate of soda. But this should never be used on plants in a dormant state, since it is very readily leached from the soil if not at once used by plants. The nitrate is valuable to start off plants in the early season, but should always be accompanied by some form of organic nitrogen to keep up the effect after the nitrate has been used, and to gradually produce nitrates in the soil, since it has been ascertained that crops take nitrogen only after it has been reduced to a nitrate in the soil. The best forms of organic nitrogen are found in cotton seed meal, pulverized fish scrap, dried blood and tankage, and the poorest of all is pulverized leather scraps.

18. Pay no attention to the man who would persuade you that phosphoric acid in a soluble form is better from one source than another. Phosphoric acid in animal bone, in phosphatic rock and in furnace slag is one and the same thing, and the only thing you need bother about is its solubility. Phosphate rock dissolved in sulphuric acid is largely soluble. Phosphoric acid in raw bones is all insoluble, though from the nature of the material it may become soluble more quickly than that in untreated rock. A superphosphate made from animal bones by dissolving them in sulphuric acid is better than that from the rock only because it has a larger per centage of phosphoric acid, but it, of course, costs more for this reason. One per cent. of the one is fully as good as one per cent. of the other. Phosphoric acid in Thomas slag is

largely insoluble, but finally gives good results, as will any other form of insoluble phosphoric acid finally in the soil. For ready and quick results the dissolved superphosphate, or, as it is called, acid phosphate, should be used. Some farmers have an exaggerated idea of the value of raw bone as a source of phosphoric acid. A good and pure article of bone meal will have about 4 per cent. of nitrogen which will at once show for itself, while the phosphoric acid in the bone is really very slow in becoming available. It is usually the most costly form in which to buy phosphoric acid.

19. Potash is found in wood ashes in a very available form, and the ashes also usually contain a small percentage of phosphoric acid and a large percentage of lime, and where they can be had cheap enough are valuable. But where potash is the thing sought, it can usually be had cheaper in the form of the concentrated muriate. Near the seaboard it may, at times, pay to buy the crude potash salts in the form of kainit, and kainit seems to have a special value to the cotton grower as a preventive of blight in the leaves. But where there is a distance to freight from the port of entry it is always cheaper to buy the muriate or high grade sulphate, since they have 50 per cent. or more of potash, while the kainit has but 12 per cent. For tobacco, and for crops generally in which sugar content is desirable, the sulphate is the best form.

20. While in the hands of a judicious farmer the commercial fertilizers are of immense value, the fact still remains that the growing of forage and the breeding of live stock, and the saving, in the best manner, of all manurial accumulations on the farm, lie at the very foundation of all rational farm improvement and the maintenance of the fertility of our lands North or South. So long as states like North and South Carolina raise three bales of cotton for every cow raised the farmers will continue to be the agents of the fertilizer trusts, and no real advancement will be made. Texas grows more cotton than any other State, and yet Texas raises three cows to every bale of cotton grown, and Texas is thriving more than most of her sister States of the cotton growing section.

21. The true office, then, of the chemical fertilizers is to aid in the increase of the productiveness of the land in those crops that tend to the improvement of the soil and furnish food for cattle at the same time. Used in this way, the chemical fertilizers will gradually increase the amount of home-made manure and render their own use less necessary. until finally none of them need be used except an occasional replenishing of the phosphoric acid and potash in the soil, and in many soils but one of these may ever become deficient.

22. No chemist can tell you what your soil lacks in the way of plant food.

Chemical analysis may show an abundance of plant food in it and yet it may be in a very unproductive condition through lack of availability of what it contains. The only way to find out what you need to buy and what you need not buy is to question the soil itself by a series of experiments, as we have tried to describe. The observant farmer, who wishes to avoid wasting his capital in the purchase of what he does not need to buy, will make these experiments. Those who are willing still to buy at haphazard will continue their present spendthrift plan.

23. It is evident, then, that the farmer who is to be successful in the future, must be the thinking and reading farmer, and a legume farmer, for in legume-growing and the feeding of live stock will be found the key to prosperity, no matter whether you are growing spring wheat in the Northwest or winter wheat inthe Central States, or cotton in the South. The basal principles of soil improvement are the same in any climate and with any money crop.

24. While the market gardener finds his best profit in a very lavish use of commercial fertilizers for his early crops, he will find, no less than the general farmer, that success with them depends largely on his keeping up the humus content of his soil, by the same means the farmer must adopt, the growing of legumes. The Southern market gardener has here a great advantage over those in the North, from the fact that his crops are gotten off early in the summer and his longer season enables him to grow the annual legumes as a succession crop on his heavily enriched acres, and to thus produce an immense amount of stock feeding material. Every Southern market gardener then, should be also a stock feeder, either of dairy animals, if his location will make them profitable, or of beef animals. In this way he can not only largely increase his profits, and be ready in times of a serious glut in the market to use certain crops as stock food, but he will also be enabled to raise a large quantity of manure, and we have noticed that the truck farmers who use the most animal manures in connection with commercial fertilizers are, as a rule, the most successful in the production of superior crops, and their soil gets more independent of drought conditions through the humus-making capacity of the home-made manures. While with most crops of the market garden the commercial fertilizers and legumes will bring fine crops, such crops as cabbage and lettuce, and cucumbers and melons are very much superior when they have some stable manure also.

25. Unless aided by the humus-making legumes and the humus-making manures, the heavy applications of complete fertilizers in market gardening will seldom have their best effect. The man in the South who simply grows a sale crop of corn after his early truck crops in order to get the full returns

from his investment in fertilizers, will soon find that he does not get as good results from the same application of fertilizers which his neighbor does who follows his truck with legumes, and feeds stock and makes manure at home. He uses up the moisture-retaining humus in his soil, and the chemical fertilizers are not dissolved as readily should drought intervene, as they are in the soil on which legumes have been grown and stable manure applied.

26. Not only will it be found important in the market garden to follow the early crops with some recuperative one, but it will also be found fully as important to follow a well settled rotation of the garden crops themselves. The diseases, especially those of a bacterial origin, that attack certain crops, infect the soil at times so that the same crop coming on the land, or a crop of near relationship, will be more seriously affected than in the first place. Tomatoes, egg plants and Irish potatoes should not follow on the same land, but should be kept as wide apart as possible, since they are all affected by the same diseases. No matter how heavily you manure it seldom pays to cultivate the same land year after year in the same, or a nearly related crop.

27. The market gardener, far more than the general farmer, needs to practice the home mixing of fertilizers, because the factory mixed articles are seldom mixed in the proper proportion for his use, and the manurial requirements of his crops vary to a greater extent than those of the general farmer. He will find, too, that a rotation in fertilizers will often produce as good results as a rotation in crops. In the lavish use of fertilizers in the market garden certain forms of plant food, like the phosphoric acid and potash, may accumulate in the soil, and there may be no need for awhile of such heavy applications of these. Then a rotation with stable manure and barn yard manures, in which the nitrogenous constituents are far in excess of the mineral constituents, will be found a valuable change.

28. In the home garden, where almost every one relies upon stable manure and where little attention is generally given to a proper rotation of crops, the soil often gets soured through the accumulation of humic acids, and a good application of lime during the winter, followed in the spring by a generous application of superphosphate and potash, will renew the life of the garden and give far better crops than a continued application of stable manure. We often hear people say that their gardens are so rich that they cannot grow potatoes, as they run to vines. It is not excessive fertility which causes this, but an unbalanced fertility, an excess of nitrogen and a deficiency of phosphoric acid and potash. Add these, and the garden which was too rich for potatoes will astonish you with its product. A garden which has for many years been manured annually from the stables is the place of all others where the commercial fertilizers will produce their best effect, and a

year or two of substitution of the chemicals for the stable manure will have the happiest effect. Still, since in the home garden we depend upon the stable manure to keep up our humus supply, we must soon return to the manure pile, though we may still supplement its deficiencies with phosphatic and potassic additions.

29. In the orchard, during the formative period of the trees, we want a good and well balanced growth, but not too rank a one to induce weakness and disease. Orchards planted on old and worn soils will need, during their early years, a complete fertilizer. There is no objection to the use of stable manure on the young orchard, provided it is supplemented by a liberal application of phosphoric acid and potash to complete and finish the growth induced by the nitrogenous material. After the first few years there will be plenty of nitrogenous matter added to the soil, in the legumes which should be annually plowed under during the period in which the orchard is kept in cultivation.

30. Of late there has been so much written in regard to the necessity for continuous cultivation of apple and pear orchards, that one who does not agree with these writers is apt to be considered heterodox on the subject of fruit growing. Those who insist on the cultivation of orchards during their whole life, have usually gotten their ideas from seeing the ill success of orchards in sod, from which a crop of hay is annually taken and no fertilizing matter returned to the soil. Such orchards fail as a matter of course. Meeting recently at a fruit growers meeting in Virginia with Mr. Van Alsteyne, of the New York Farmers Institutes, we were happy to know that as a practical fruit grower he had found by experience that it is best to keep a bearing apple orchard in grass, if the grass is kept for the benefit of the trees only. His orchard in grass has given better crops than cultivated orchards in the same section. Cultivation and the turning under of humus-making crops is all right during the forming of the tree. Growth is then what we want, but rapid growth is not favorable to early bearing, and we check this by putting the trees in grass and then either mow the grass two or three times during the season and allow it to rot on the land, or allow pigs with jewelled noses to ramble in the orchard and destroy the wormy fruit. At the same time we must remember that the mineral elements must be maintained in the soil through annual applications of phosphoric acid and potash, for a fair crop of apples will carry off three times or more of potash than a crop of wheat of 20 bushels per acre, while the maturing of the wood requires a large additional amount.

31. In the North, where snows come heavily, the apple trees may be better trained with a central leading shoot in the head, but in the South, a

head formed 20 inches from the ground and open and spreading is far better form. The low headed tree in grass is more easily pruned and the fruit more easily gathered, while the windfalls are hardly hurt by the fall on the soft sod. Young trees in the South are apt to suffer in their first years from sun scald, and if headed but 20 inches from the ground a simple shingle stuck on the southwest side will protect the stem, and the spreading top will soon form a sufficient screen, while the tall stemmed trees are for years exposed to the effects of sun scald, and are many of them killed thereby.

32. An occasional dressing of lime will be of great benefit to orchard trees and will promote the growth of the sod, and thus increase the amount of organic matter returned to the soil from the cutting and rotting of the grass, for if we expect the best results from the apple orchard we must be content to devote that land to apples exclusively, and not expect anything but apples from it. We will then not be disappointed, and will have no reason to say that we cannot grow fruit as our fathers did. While it has not been practicable in the limits of this book to take up the subject of plant diseases and remedies, we take it for granted that every fruit grower is awake to the necessity for spraying his trees to prevent disease and to destroy insects. At some future time we hope to take up this branch of the subject in a separate treatise.

33. In the culture of the grape on the pine barrens of the South Atlantic States it has been found that on these soils which contain little plant food of any kind, a complete fertilizer is annually needed to keep up the growth of the vines. On soils northward and where there is more of natural fertility, the annual growth of peas (or other legumes) as a winter cover will furnish all the nitrogen needed, and any artificial application may be rather an injury than a help, from causing a long-jointed and less fruitful cane. Hence, as in the orchard, the annual application of phosphoric acid and potash will generally suffice, and a coat of lime once in five years will be of great help. Shallow cultivation till July should be the rule in the vineyard. Then a sowing of crimson clover through the centres of the spaces between the rows of vines, where the roots are feeding, to be plowed under in the early spring.

34. There is no class of cultivators to whom the humus content of the soil is of more importance than to the grower of small fruits. On a soil deficient in vegetable matter, the strawberry rarely succeeds well. A clover sod or a heavy growth of cow peas turned under forms the best preparation for the crop. While a complete fertilizer is needed it should not be too largely of a nitrogenous character, since any excess of nitrogen is apt to produce soft fruits that will not ship well. Where quality is valued to an extent that will warrant the additional cost, the best form of potash for the straw-

berry is the sulphate free from chlorides, but as market growers usually grow for size and appearance rather than quality, the muriate is more commonly used; on the home strawberry bed use the sulphate. Rotation is important to the strawberry grower, too. Two crops is all that should be taken. The plants are then plowed under and cow peas sown for hay, followed by vetches in winter and corn in the spring. Then oats, followed by cow peas heavily fertilized with acid phosphate and potash, and the whole plowed under for strawberries again. A sole dependence on the commercial fertilizers is as bad for the strawberry grower as for any one else, and he should grow crops of forage and feed cattle to make manure that will aid in the humus accumulation in his soil. A soil well filled with organic matter will make a better crop of berries without fertilizer than a soil deficient in this will with a heavy application of fertilizer.

35. Finally, no matter what crop you are using the fertilizers on, always keep a small piece without any application as a check plat to show what the treatment is doing for you. Without something of this sort you will be simply guessing as to whether the application is paying you or not. In brief, study your soils and crops, and do nothing simply because your neighbors or your fathers did it, but always be ready to give a reason of an intelligent character for the hope that is in you. If this book has no other effect than to set its readers to thinking, it will have accomplished its mission.

APPENDIX.

USEFUL TABLES.

The following tables have been compiled from every source that is considered reliable. They are largely the result of Station investigations in this country and in Europe, and are given here as a means for reference, so that the reader can find for himself facts that otherwise he would have to correspond with his Station to find out.

AVERAGE FERTILIZER CONSTITUENTS OF SEA WEED.

One hundred pounds of dried sea weed of various kinds has been found to contain of: Nitrogen, 2.65 pounds; phosphoric acid, 0.75 pounds; potash, 3.35 pounds; lime, 9.00 pounds; magnesia, 1.68 pounds. It is evident therefore, that the estimate which the farmers near the sea have placed on this material as a manure is warranted by its composition. Those situated accessible to the great deposits that are washed upon our beaches will be wise to save all they economically can. We were once in our life a seaside farmer, and know full well the value of the material. We found that the best use for the sea weed was to put it in the cemented basement we had under the cow stables, and as the droppings were sent down through shutes they were mixed and piled with the sea weed. The great abundance of moisture and salt contained in the material prevented injurious heating, and a regular daily dressing of the piles with phosphate, added not only to its manurial value the phosphoric acid in which it was deficient, but also acted as a further preventive of the escape of ammonia, and the resulting manure gave remarkable results on our truck crops. As a manure for sweet potatoes we found that raw weed, spread thickly on the land during the winter and plowed under in the spring, was all that was needed to give the most abundant crops.

CONSTITUENTS OF FORAGE PLANTS PER ACRE.

The Pennsylvania Station made experiments to determine the total dry matter and plant food in certain forage crops, and gives the following results:

POUNDS PER ACRE, TOPS AND ROOTS.

	Total yield.	Dry matter.	Ash.	Organic matter.	Nitrogen	Phos. Acid.	Potash.	Lime.
Flat pea	41.412	9.037	906	8.167	239.3	49.8	161.3	122.2
Canada pea..	21.582	4.218	615	3.603	114.6	30.3	54.0	73.1
Spring vetch.	10.740	6.327	609	5.718	127.3	53.2	138.0	143.7
Sand vetch ..	8.316	2.713	252	2.461	78.7	22.7	52.8	42.7
Red clover...	29.760	7.438	626	6.812	143.7	39.6	156.6	98.3
White clover.	31.440	6.349	723	5.626	173.8	51.0	179.4	95.6
Alsike clover.	24.786	5.910	603	5.307	119.8	36.1	155.9	86.1
Crim. clover .	25.665	4.604	501	4.102	108.3	24.6	97.9	84.9
Timothy.....	21.750	6.281	555	5.726	47.0	27.5	78.0	35.5

To furnish the same amount of nitrogen per acre there would be required of nitrate of soda:

	Pounds.
In case of flat pea..............................	1495.7
In case of Canada pea	716.3
In case of spring vetch........................	795.7
In case of sand vetch..........................	495.9
In case of red clover	898.2
In case of white clover	1086.3
In case of alsike clover	749.0
In case of crimson clover.......................	676.8

It must be remembered, however, that when these crops are cut for hay a considerable proportion of the nitrogen is removed in the tops, but there will still remain, in the organic matter of the roots and stubble, far more than is usually applied in a ton of high grade fertilizer. The following table from the Virginia Station gives the results from the application of different forms of fertilizers on the wheat crop. The amounts applied were sufficient to supply all the phosphoric acid and one-half the potash and nitrogen removed by a crop of wheat of 25 bushels per acre:

Average of 3 years.	Grain per acre. Bushels.	Straw per acre. Pounds.
No fertilizer..	6.28	769
Potash and nitrogen	11.37	1037
Potash and phosphoric acid........................	16.29	1512
Phosphoric acid and nitrogen	18.02	1769
Potash, phosphoic acid and nitrogen.................	21.49	1991

Phosphoric acid was evidently the controlling factor.

ASHES.

The Connecticut Station examined 55 samples of cotton hull ashes, and found that the highest percentage of potash was 36.45, and the lowest, 10.26. The average percentage of potash in all the samples was 22.4 The Ontario College and Experimental Farm Report for 1897 gives the composition of the ashes from different kinds of wood as follows:

	Per cent. Potash	Per cent. Soda.	Per cent. P. acid.	Per cent. Lime.	Per cent. Magne.	Per cent. Iron ox.	Per cent. Sul. acid.
Hickory	9.17	4.35	2.12	44.43	6.49	0.24	0.56
Rock elm	6.66	2.69	.71	49.52	2.64	.25	.59
Red oak	5.75	1.00	.92	48.97	2.45	.37	Trace
Butternut	3.99	2.27	1.76	44.95	5.22	.45	.42
Walnut	4.62	....	.70	35.93	5.35	3.42	1.51
Cherry	5.28	.92	1.90	46.93	3.00	1.29	.79
Pear	9.73	Trace	.81	42.07	3.10	.39	.93
Plum	4.81	Trace	2.49	48.39	1.89	.22	.63
Peach	6.98	.27	3.43	41.49	3.18	.30	.73
Quince	6.32	1.76	2.29	48.22	3.17	.33	1.07
Grape trimmings	12.21	7.67	6.31	21.39	9.96	.44	2.64

"The fact that these ashes were pure and prepared from the wood only, explains why the percentages of mineral constituents are so much higher than in those found in the average ashes of the market."

PERCENTAGE OF THE AVAILABILITY OF THE DIFFERENT FORMS OF NITROGEN.

The Connecticut Station, in a series of experiments with oats and Hungarian grass, found the availability of the nitrogen in different combinations as follows: Putting nitrate of soda as the standard of comparison

	Per cent. available.
Nitrate of soda	100.00
Dried blood	73.30
Dry ground fish	63.90
Ground bone	16.70
Tankage	49.40
Horn and hoof	68.30
Linseed meal	68.90
Cotton seed meal	64.80
Castor pomace	64.60

The constituents of fertilizers are printed on the sacks in percentages. Nitrogen is usually put there in the form of ammonia. To find the actual nitrogen in the article multiply the percentage of

Ammonia by 0.8235 and the result will be the percentage of nitrogen.
Nitrogen by 1.214 and it will give the ammonia for that percentage.
Nitrate of soda by 0.1647 and the result will be the actual nitrogen.
Muriate of potash by 0.632 and the result will be the actual potash.
Sulphate of potash by 0.54 and the result will be the actual potash.

WHAT CROPS REMOVE FROM THE SOIL.

Green fodders.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. Acid.	Per cent. Potash.
Corn fodder	78.61	4.84	0.41	0.15	0.33
Sorghum fodder	82.19	....	0.23	0.09	0.23
Rye straw green	62.11	....	0.33	0.15	0.73
Oat fodder	83.36	1.31	0.49	0.13	0.38
Millet	62.58	....	0.61	0.19	0.41
Hungarian grass	74.31	....	0.39	0.16	0.55
Orchard grass	73.14	2.09	0.43	0.16	0.76
Timothy grass	66.90	2.15	0.48	0.26	0.76
Perennial rye grass	75.20	2.60	0.47	0.28	1.10
Italian rye grass	74.85	2.84	0.54	0.29	1.14
Mixed pasture grasses	63.12	3.27	0.91	0.23	0.75
Red clover	80.00	....	0.53	0.13	0.46
White clover	81.00	....	0.56	0.20	0.24
Alsike clover	81.80	1.47	0.44	0.11	0.20
Crimson clover	82.50	....	0.43	0.13	0.40
Alfalfa	75.30	2.25	0.72	0.13	0.56
Cow pea	78.81	1.47	0.27	0.10	0.31
Serradella	82.59	1.82	0.41	0.14	0.42
Soja bean	73.29	....	0.29	0.15	0.53
Horse bean	74.71	....	0.68	0.33	1.37
White lupine	85.35	....	0.44	0.35	1.73
Yellow lupine	83.15	0.96	0.51	0.11	0.15
Flat pea	71.60	1.93	1.13	0.18	0.58
Winter vetch	84.50	1.94	0.59	1.19	0.70
Prickley comfrey	84.36	2.45	0.42	0.11	0.75
Corn silage	77.95	....	0.28	0.11	0.75
Corn and soja silage	71.03	....	0.79	0.42	0.44
Apple pomace silage	75.00	1.05	0.32	0.15	0.40

Dry hay and fodder.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Corn fodder and ears	7.85	4.91	1.76	0.54	0.89
Corn fodder, no ears	9.12	3.74	1.04	0.29	1.40
Teosinte	6.06	6.53	1.46	0.55	3.70
Millet, common	9.75	....	1.28	0.49	1.69
Japanese millet	10.45	5.80	1.11	0.40	1.22
Hungarian millet	7.69	6.18	1.20	0.35	1.30
Mixed grass hay	11.99	6.34	1.41	0.27	1.55
Mixed rowen	18.52	9.57	1.61	0.43	1.49
Red top hay	7.71	4.59	1.15	0.36	1.02
Timothy hay	7.52	4.93	1.26	0.53	0.90
Orchard grass hay	8.84	6.42	1.31	0.41	1.88
Kentucky blue grass hay	10.35	4.16	1.19	0.40	1.57
Meadow fescue hay	8.89	8.08	0.99	0.40	2.10
Tall meadow oats grass	15.35	4.92	1.16	0.32	1.72
Meadow foxtail hay	15.35	5.24	1.54	0.44	1.99
Perennial rye grass hay	9.13	6.79	1.23	0.56	1.55
Italian rye grass hay	8.71	....	1.19	0.56	1.27
Salt marsh hay	5.36	....	1.18	0.25	0.72
Japanese buckwheat	5.72	....	1.63	0.85	3.32
Red clover hay	11.33	6.93	2.07	0.38	2.20
Mammoth clover hay	11.44	8.72	2.23	0.55	1.22
White clover hay	....	....	2.75	0.52	1.81
Crimson clover hay	18.30	7.70	2.05	0.40	1.31
Alsike clover hay	9.94	11.11	2.34	0.67	2.23
Blue melilot	8.22	13.65	1.92	0.54	2.80
White melilot	7.43	7.70	1.98	0.56	1.83
Sainfoin	12.17	7.55	2.63	0.76	2.02
Sulla	9.39	....	2.46	0.45	2.09
Lotus Villosus	11.52	8.23	2.10	0.59	1.81
Soja bean, whole plant	6.30	6.47	2.32	0.67	1.08
Soja bean, straw	13.00	....	1.75	0.40	1.32
Cow pea, whole plant	10.95	8.40	1.95	0.52	1.47
Serradella	7.39	10.60	2.70	0.78	0.65
Scotch Tares	15.80	....	2.96	0.82	3.00
Ox eye daisy	9.65	6.37	0.28	0.44	1.25
Dry carrot tops	9.76	12.52	3.13	0.61	4.88
Barley straw	11.44	5.30	1.31	0.30	2.09
Barley chaff	13.08	....	1.01	0.27	0.99
Wheat straw	12.56	3.81	0.59	0.12	0.51
Wheat chaff	8.05	7.18	0.79	0.70	0.42
Rye straw	7.61	3.25	0.46	0.28	0.79
Oat straw	9.00	4.76	0.62	0.20	1.24
Buckwheat hulls	11.90	....	0.49	0.07	0.52
Couch grass hay	14.30	6.00	1.41		
White mustard, dry	15.00	7.45	1.77	0.81	1.36
Cow pea, another author	10.70	7.50	2.66		
Kidney vetch	16.70	5.32	2.21	0.47	1.45
Vetch, hairy	16.00	8.41	3.68	0.97	2.44

Vegetable leaves, etc.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Cabbage	88.40	1.96	0.34	0.20	0.28
Beet, garden	90.50	1.46	0.30	0.10	0.45
Beet, sugar	89.70	1.53	0.30	0.07	0.40
Carrot	82.20	2.39	0.51	0.10	0.29
Chicory	85.00	1.65	0.35	0.10	0.43
Corn cobs	80.10	0.59	0.21	0.05	0.22
Corn shucks	86.19	0.56	0.18	0.07	0.22
Corn stalks	80.86	1.25	0.28	0.14	0.41
Mangel wurzel	90.50	1.41	0.30	0.08	0.41
Potato tops	77.00	3.13	0.40	0.18	0.46
Sweet potato vines	80.06	2.45	0.42	0.07	0.73
Tomato vines	73.31	11.72	0.24	0.06	0.29
Tomato vines, another	83.61	3.00	0.32	0.07	0.50
Turnip tops	89.80	1.19	0.30	0.09	0.28

Vegetables.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Artichokes	80.00	0.98	0.32	0.14	0.48
Beans, garden	15.00	2.74	3.90	0.97	1.21
Beans, soja	10.00	4.80	5.51	1.04	1.26
Beets, garden	88.00	1.07	0.20	0.08	0.48
Beets, sugar	86.95	1.04	0.22	0.10	0.48
Carrots	89.79	0.92	0.15	0.09	0.51
Parsnip	83.20	1.00	0.18	0.20	0.44
Potato	79.75	0.99	0.21	0.07	0.29
Turnips	89.49	1.01	0.18	0.10	0.39
Cabbages	90.52	1.40	0.38	0.11	0.43
Celery	84.10	1.76	0.24	0.22	0.76
Cucumber	95.99	0.46	0.16	0.12	0.24
Horse radish	76.68	1.87	0.36	0.07	1.16
Lettuce	94.00	0.81	....	0.07	0.37
Mushroom	88.80	1.00	0.47	0.34	0.51
Onion	87.55	0.57	0.14	0.04	0.10
Peas, garden	12.62	3.11	3.58	0.84	1.01
Pumpkin	92.27	0.63	0.11	0.16	0.09
Radish	93.30	0.49	0.19	0.05	0.16
Rhubarb tops	91.67	1.72	0.13	0.02	0.36
Spinach	92.42	1.94	0.49	0.16	0.27
Sweet potatoes	71.26	1.00	0.24	0.08	0.37
Tomato	93.64	0.47	0.16	0.05	0.27

Seeds.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Acorns, dry	15.00	2.55	1.04	0.37	1.28
Barley	14.90	....	1.76	0.82	0.54
Corn grains	10.88	1.53	1.82	0.70	0.40
Buckwheat	14.10	....	1.44	0.44	0.21
Millet, common	12.68	....	2.04	0.85	0.36
Millet, Japan	13.68	....	1.73	0.69	0.38
Soja beans	18.33	4.99	5.30	1.87	1.99
Cotton seed	8.42	3.78	3.13	1.27	1.17
Sorghum seed	14.00	....	1.48	0.81	0.42
Oats	18.17	2.98	2.06	0.82	0.62
Wheat, spring	14.35	1.57	2.36	0.70	0.39
Wheat, winter	14.75	....	2.36	0.89	0.61
Rye	14.90	....	1.76	0.82	0.54
Rice	12.60	0.82	1.08	0.18	0.09

Mill products.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Corn meal	12.95	1.41	1.58	0.63	0.40
Corn and cob meal	8.96	....	1.41	0.57	0.47
Ground oats	11.17	3.37	1.86	0.77	0.59
Ground barley	13.43	2.06	1.55	0.66	0.34
Rye flour	14.20	....	1.68	0.85	0.65
Wheat flour	9.83	1.22	2.21	0.57	0.54
Pea meal	8.85	2.68	3.08	0.82	0.99

By products.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Corn cobs	12.00	0.82	0.50	0.06	0.60
Hominy feed	8.93	2.21	1.63	0.98	0.49
Gluten meal	8.59	0.73	5.03	0.33	0.05
Glucose refuse	8.10	....	2.62	0.29	0.15
Malt sprouts	18.38	12.48	3.55	1.43	1.63
Brewers' grains, dry	9.14	3.92	3.62	1.03	0.09
Brewers' grains, wet	75.01	....	0.89	0.31	0.05
Rye bran	12.50	4.60.	2.32	2.28	1.40
Rye middlings	12.54	3.52	1.84	1.26	0.81
Wheat bran	11.74	6.25	2.67	2.89	1.61
Wheat middlings	9.18	2.30	2.63	0.95	0.63
Rice bran	10.20	12.94	0.71	0.29	0.24
Rice polish	10.30	9.00	1.97	2.67	0.71
Cotton seed meal	7.81	6.95	6.79	2.88	0.87
Cotton seed hulls	10.17	2.40	0.69	0.25	1.02
Linseed meal, O. P.	8.88	6.08	5.43	1.66	1.37
Linseed meal, N. P.	7.77	5.37	5.78	1.83	1.39
Peanut cake meal	10.40	3.97	7.56	1.31	1.50
Apple pomace	80.50	0.27	0.23	0.02	0.13

Fruits and nuts.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Apple leaves in May	72.36	2.33	0.74	0.25	0.25
Apple leaves in September	60.71	3.46	0.89	0.19	0.39
Apple, fruit	85.30	0.39	0.13	0.01	0.19
Apple tree, whole	60.83	1.25	0.35	0.05	0.17
Apricots, fresh	85.16	0.49	0.19	0.06	0.29
Blackberries	88.91	0.58	0.15	0.09	0.20
Blueberries	82.69	0.16	0.14	0.05	0.05
Cherries, fruit	86.10	0.58	0.18	0.06	0.20
Cherries, tree, young					
Cherries, branches	79.50	0.78	....	0.05	0.06
Cherries, roots	67.20	1.22	....	0.08	0.07
Cherries, trunks	53.20	0.81	....	0.04	0.06
China berries	16.52	4.13	1.19	0.43	2.33
Cranberries, fruit	89.59	0.18	....	0.03	0.09
Cranberries, vines	....	2.45	....	0.27	0.32
Currants	86.02	0.53	....	0.11	0.27
Grapes, fresh	83.00	0.50	0.16	0.09	0.27
Grapes, wood	....	2.97	....	0.42	0.67
Lemons	83.83	0.56	0.15	0.06	0.27
Nectarines	79.00	0.50	0.12		
Oranges, California	85.21	0.43	0.19	0.05	0.21
Oranges, Florida	87.71	....	0.12	0.08	0.48
Olives, fruit	58.00	1.42	0.18	0.12	0.86
Peaches, fruit	87.85	0.32	....	0.05	0.24
Peaches, branches	58.26	1.93	0.90	0.22	0.50
Pears, fruit	83.92	0.54	0.09	0.03	0.08
Pears, branches	84.00	0.76	....	0.04	0.08
Pears, roots	66.70	1.40	....	0.07	0.11
Pears, trunks	49.30	1.71	....	0.07	0.13
Plums	47.43	0.54	0.18	0.02	0.24
Prunes	77.38	0.49	0.16	0.07	0.31
Raspberries	81.82	0.55	0.15	0.48	0.35
Strawberries, fruit	90.84	0.60	0.15	0.11	0.30
Strawberries, vines	....	3.34	....	0.48	0.35
Chestnuts, native	40.00	1.62	1.18	0.39	0.63
Peanuts, hulls	10.60	3.00	1.14	0.17	0.95
Peanuts, kernels	6.30	3.20	4.51	1.24	1.27
Peanut vines, cured	7.83	15.40	1.76	0.29	0.98
Banana	66.25	1.15	0.08		
Pineapples	89.28	0.35	0.02		

Dairy products.	Per cent. Moisture.	Per cent. Ash.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.
Whole milk, average	87.00	0.75	0.53	0.19	0.18
Skimmilk	90.25	0.80	0.56	0.20	0.19
Cream	74.05	0.50	0.40	0.15	0.13
Buttermilk	90.50	0.70	0.48	0.17	0.16
Whey	92.97	0.60	0.15	0.14	0.18
Butter	79.10	0.15	0.12	0.04	0.04
Cheese	33.25	2.10	3.93	0.60	0.12

Woods.	Per cent. Moisture.	Per cent. Ash.	Per cent. Phos. acid.	Per cent. Potash.
Ash	10.00	0.32	0.01	0.14
Chestnut, bark	10.00	3.51	0.11	0.28
Chestnut, wood	10.00	0.16	0.01	0.03
Dogwood, bark	10.00	9.87	0.14	0.34
Dogwood, wood	10.00	0.68	0.06	0.19
Hickory, bark	10.00	3.97	0.06	0.14
Hickory, wood	10.00	0.68	0.06	0.19
Magnolia, bark	10.00	2.98	0.09	0.19
Magnolia, wood	10.00	0.48	0.06	0.14
Maple, bark	10.00	9.49	0.42	1.18
Oak, post, bark	10.00	12.10	0.12	0.25
Oak, post, wood	10.00	0.77	0.07	0.17
Oak, red, bark	10.00	6.29	0.10	0.18
Oak, red, wood	10.00	0.57	0.06	0.14
Oak, white, bark	10.00	0.26	0.02	0.11
Oak, white, wood	10.00	0.26	0.02	0.11
Pine, Ga., bark	10.00	0.37	0.02	0.02
Pine, Ga., wood	10.00	0.03	0.01	0.05
Pine, old field, bark	10.00	1.94	0.09	0.08
Pine, old field, wood	10.00	0.18	0.007	0.008
Pine, yellow, wood	10.00	0.23	0.01	0.02
Sycamore, wood	10.00	0.99	0.12	0.23

POUNDS PER ACRE IN A CROP OF COTTON YIELDING 100 POUNDS OF LINT PER ACRE.

Material.	Per cent. Nitrogen.	Per cent. Phos. acid.	Per cent. Potash.	Per cent. Lime.	Per cent. Magnesia.
Roots (83 lbs.)	0.76	0.43	1.06	0.53	0.34
Stems (219 lbs.)	3.20	1.29	3.09	2.12	0.92
Leaves (192 lbs.)	6.16	2.28	3.46	8.52	1.67
Bolls (135 lbs.)	3.43	1.30	2.44	0.69	0.54
Seed (218 lbs.)	6.82	2.77	2.55	0.55	1.20
Lint (100 lbs.)	0.34	0.10	0.46	0.19	0.08
Total pounds per acre	20.71	8.17	13.06	12.60	4.75

ANALYSES OF FERTILIZERS AND FERTILIZER MATERIALS.

Materials.	Per cent. Nitrogen.	Per cent. Available phos. acid.	Per cent. Insoluble phos. acid.	Per cent. Total phos. acid.	Per cent. Potash.
1. Supplying nitrogen					
Nitrate of soda	15.5 to 16				
Sulphate of ammonia ..	19 to 20.5				
Dried blood, high grade	12 to 14				
Dried blood, low grade .	10 to 11	....	....	3 to 5	
Concentrated tankage ..	11 to 12.5	....	....	1 to 2	
Bone tankage	5 to 6	....	....	11 to 14	
Dry fish scrap..........	7 to 9	....	....	6 to 8	
Cotton seed meal	6.5 to 7.5	....	....	1.5 to 2	2 to 3
Castor pomace..........	5 to 6	....	....	1 to 1.5	1 to 1.5
2. Supplying phos. acid					
S. C. rock phosphate ...	....	....	26 to 28	26 to 28	
S. C. acid phosphate....	....	12 to 15	1 to 3	13 to 16	
Fla. land phosphate....	....	....	33 to 35	33 to 35	
Fla. superphosphate....	....	14 to 16	1 to 4	16 to 20	
Fla. pebble rock........	....	....	26 to 32	26 to 32	
Bone black.............	....	....	32 to 36	32 to 36	
Bone black superphos. .	....	15 to 17	1 to 2	17 to 18	
Ground bone	2.5 to 4.5	5 to 8	15 to 17	20 to 25	
Steamed bone	1.5 to 2.5	6 to 9	16 to 20	22 to 29	
Dissolved bone	2 to 3	13 to 15	2 to 3	15 to 17	
Thomas slag	....	....	....	11.4 to 23	
3. Supplying potash					
Muriate of potash	....	....	....	....	50
Sulphate of potash, h. g.	....	....	....	....	48 to 52
Sulph. of pot. and mag.	....	....	....	....	26 to 30
Kainit.................	....	....	....	....	12
Sylvinite	....	....	....	....	16 to 20
Cotton hull ashes.......	....	....	....	7 to 9	20 to 30
Wood ashes, unleached.	....	....	....	1 to 2	2 to 8
Wood ashes, leached ...	....	....	....	1 to 1.5	1 to 2
Tobacco stems..........	2 to 3	....	....	3 to 5	5 to 8
4. Farm manures					
Cattle excrement, solid, fresh	0.29	....	....	0.17	0.10
Cattle urine, fresh	0.58	....	....	....	0.49
Hen manure, fresh	1.10	....	....	0.85	0.56
Horse dung, solid.......	0.44	....	....	0.17	0.35
Horse urine, fresh	1.55	....	....	....	1.50
Human manure........	1.00	....	....	1.09	0.25
Human urine	0.60	....	....	0.17	0.20
Pigeon, dry	3.20	....	....	1.90	1.00
Sheep dung, solid	0.55	....	....	0.31	0.15
Sheep urine, fresh......	1.95	....	....	0.01	2.26
Swine dung, fresh......	0.60	....	....	0.41	0.13
Barn yard manure aver.	0.49	....	....	0.32	0.43

AMOUNT AND VALUE OF MANURE PRODUCED BY DIFFERENT FARM ANIMALS.

Animal.	Per 1,000 pounds, live weight.			Value of manure per ton.
	Amount per day.	Value per day.	Value per year.	
Sheep	34.1 pounds	7.2 cents	$26.00	$3.30
Calves	67.8 pounds	6.2 cents	24.45	2.18
Pigs	83.6 pounds	16.7 cents	60.88	3.29
Cows	74.1 pounds	8.0 cents	20.27	2.02
Horses	48.8 pounds	7.6 cents	29.27	2.21

This is from the bulletin of the Cornell University Agricultural Experiment Station, and is based on a valuation of nitrogen at 15 cents, phosphoric acid at 6 cents and potash at 4½ cents per pound.

To prevent loss from the manure while it is necessary to keep it stored it is advised to use the following preservatives:

Preservative.	Per horse of 1,000 lbs.	Per cow of 880 lbs.	Per pig of 220 lbs.	Per sheep of 110 lbs.
Acid phosphate	1 lb., 0 oz.	1 lb., 2 oz.	3 ozs.	2 1-2 ozs.
Plaster	1 lb., 9 oz.	1 lb., 12 oz.	4 3-5 ozs.	3 3-5 ozs.
Kainit	1 lb., 2 oz.	1 lb., 5 oz.	4 ozs.	3 1-5 ozs.

If kainit is used, it should be applied to the fresh manure and covered with litter, so that it does not come in contact with the feet of the animals. All preservatives are more effectual if applied to the manure while it is perfectly fresh.

FOOD CONSTITUENTS IN DIFFERENT PARTS, OF THE PEANUT PLANT.

IN WATER FREE SUBSTANCE.

	Water. Per cent.	Ash. Per cent.	Protein. Per cent.	Fibre. Per cent.	Nitrogen-free extract. Per cent.	Fat. Per cent.	Nitrogen. Per cent.
Alabama peanuts	10.88	4.26	35.37	2.66	19.33	55.37	5.50
Tennessee peanuts	4.86	2.51	27.07	2.52	19.30	48.60	4.33
Georgia peanuts	12.85	2.18	30.49	2.34	21.86	43.13	4.88
Spanish peanuts (Georgia)	13.15	2.72	32.18	3.50	20.43	41.17	5.15
Peanut vines and leaves	31.20	10.64	12.63	22.32	48.34	6.07	2.02
Peanut hay (average)	12.94	3.39	7.22	67.29	19.42	2.68	1.17
Peanuts, inner coat of kernels	10.80	5.72	25.11	20.96	26.89	21.52	4.00
Peanut meal (av. of 2,785 analyses)	10.74	5.48	52.49	5.93	27.26	8.84	8.40