GARDEN FARMING

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GINN AND COMPANY
BOSTON · NEW YORK · CHICAGO · LONDON

913.9

The Athenæum Press
GINN AND COMPANY · PROPRIETORS · BOSTON · U.S.A.

FOREWORD

From the earliest time the quick-growing garden crops have attracted much attention. At first, cultivation of these plants was confined to a restricted area near the habitation because it was convenient to have a fresh supply of appetizing plants and because a large return could be had from a small area. So long as the industries of the people allowed them to occupy the land, and the population was rural rather than urban, the garden formed the great source of the supply of vegetables; but as economic conditions changed and the population of the country became centered in great cities, the garden expanded into an intensive enterprise known as the market garden. But soon the supply of these gardens became inadequate, and through improved transportation facilities the products of distant fields became available; as a result an extensive rather than intensive method of gardening was developed, to which the name "truck farming" has been given.

Prior to the development of the truck farm there grew up, as a supplement to market gardening, a very important branch of gardening under glass, known technically as the forcing industry. The large investment, the great number of people occupied in this industry, and the great aggregate return from it have created a demand for definite information concerning the cultivation, transportation, and marketing of these crops, and the control of insect enemies and diseases. It is the purpose of this volume to present in considerable detail the results of observations and investigations which it has been the privilege of the author to make concerning this great industry, which in money value represents double the income of that derived from the fruit interests of the United States, including the pomaceous fruits, the stone fruits, the small fruits, and the subtropical fruits. In fact the potato crop alone equals in value the total value of the fruit crops above enumerated, while the miscellaneous vegetables return an aggregate annual value equal to that of the fruits, and yet this great industry has grown up unheralded and without representation, to any great extent, by our educational activities.

The writer appreciates the fact that this cannot be other than a very imperfect and inadequate attempt to cover so important and so great a field. He wishes to express his appreciation of the coöperation which has been afforded by his colleagues and begs that all who may recognize any of their handiwork in the following pages will be willing to consider the further dissemination of their ideas a public benefaction, although the author may have failed to give due credit where credit belongs. It has been the intent and purpose, however, to acknowledge all quotations and adaptations in the preparation of these pages. It has been the aim to bring together information which will be useful alike to the student and to the practical grower and to present it in a systematic yet readable form. The author wishes to acknowledge helpful suggestions from Dr. W. W. Tracy, Sr., Mr. W. R. Beattie, Professor William Stuart, Mr. W. A. Orton, Dr. F. H. Chittenden, and others, as well as extracts from their writings; and to make acknowledgments to the Moninger Greenhouse Construction Company for figures 22 and 23 and to the Minnesota Agricultural Experiment Station, the West Virginia Agricultural Experiment Station, and the United States Department of Agriculture for other illustrations.

L. C. CORBETT

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GARDEN FARMING

PART I

CHAPTER I

VEGETABLE GARDENING, OR OLERICULTURE

Olericulture defined. The idea of a garden is more intimately associated with the cultivation of vegetables than with that of fruits or flowers; the term "horticulture" is therefore more strictly applicable to vegetable gardening than to either fruit culture, floriculture, or landscape gardening. Nowadays, however, the term "horticulture" is expanded to include not only the cultivation of the garden under the heading of olericulture, but also fruit culture or pomology, floriculture, and landscape gardening.

Market gardening *versus* truck farming. The general subject of olericulture may be divided into two great divisions, namely, market gardening and truck farming. Ordinarily no distinction is made between these two lines of endeavor, but modern practice has brought about a sharp distinction between them. Encyclopedic and dictionary definitions recognize no difference in them, but market gardening may be defined as *that branch of olericulture which has for its object the production of large quantities of a great variety of the standard vegetables and small fruits, to supply the demands of a local market.* Truck farming is more restricted in its scope, is usually more extensive, and has chiefly to do with a few standard crops which yield large returns per acre and which can be shipped to distant markets. *Truck farming has for its object the production of a few crops in large quantities for more or less remote markets.* Among the truck crops may be mentioned kale, cabbage, spinach, potatoes, sweet potatoes, eggplants, cucumbers, lettuce, radishes, beets, and, to a limited extent, cauliflower. Truck farms frequently have a considerable area devoted to the cultivation of strawberries. Celery and onions may also be classed as truck crops, but as a rule these are made *special crops*. Celery or onion growers devote their energies exclusively to the one crop and give little or no attention to other truck crops.

It becomes evident, then, that truck farming, to be profitable, must have at its command the markets of large cities, while market gardening can frequently be made profitable in the vicinity of inland towns with a comparatively small population. In fact, truck farming is a development of olericulture which has resulted from the aggregation of people in great centers of population like New York, Philadelphia, Boston, and Chicago. As rapidly as states become manufacturing or commercial sections, just so rapidly does the business of the truck farmer and market gardener develop. The population changes from a producing to a consuming one. The statistics of population of the New England States, compared with those of the Southern States, show that the ratio between the food-producing and the food-consuming population is almost exactly the same, but in the New England States the consuming population forms about 80 per cent of the total, while in the Southern States the producing population forms about 80 per cent of the total. Yet many of our largest and most important truck farms are situated in the South Atlantic States. The reason for this is that the climatic and soil conditions of these regions, together with the labor supply which is available, render the industry profitable in two respects—cheapness in the cost of production, and the ability to produce crops in advance of the normal season farther north. For instance, in the latitude of Charleston, South Carolina, the potato harvest is frequently in progress by the middle of May, and farther south, in the latitude of central Florida, this truck crop is harvested in the latter part of April. By taking advantage of the progress of the season from southern Florida to the New England States the standard vegetable crops may be produced in the open from midwinter to midsummer. The result is that the large centers of consumption are now supplied with fresh vegetables throughout the whole twelve months. Formerly this was not possible except by the use of cold frames and forcing houses. Although this southern extension of vegetable growing has contributed very largely to the supply, and, to a considerable extent, has cheapened the standard garden vegetables, making them available for the masses, yet it has not discouraged the development of the forcing industry, which has for a number of years been an important branch of market gardening in the vicinity of the large Northern cities.

From the nature of the crops grown by the market gardener and the truck farmer, means for quick transportation and good markets are two of the chief requisites for success. The large quantity of truck produced, as well as its perishable nature, has induced the railroads and private car lines to inaugurate fast-freight schedules for handling vegetables, and to equip cars with refrigerating apparatus, so as to carry the product to the market in the best possible condition. Without these facilities the present truck development would be impossible except at seaport towns, where good steamship facilities are offered. Previous to the advent of fast freight and refrigeration the truck centers of the South were confined to a few seaboard towns which had steamer lines making regular trips to New York, Philadelphia, Baltimore, and Boston, but since the development of rapid railroad transportation the great bulk of the truck shipments go by rail. Inland towns and cities are now as near the fields of production as are seaport towns. Their distance is measured not in miles but in the hours required to transport their produce to the market.

Crops and cropping systems. Not only have these industrial developments aided the trucking business, but special varieties of vegetables suited to the purposes of truck growers have been developed, and this field yet offers one of the most attractive lines of work for the horticulturist. There is a demand for varieties which have good shipping qualities, which mature quickly, and which are especially adapted to the Southern climates. But behind and above all this the success of either the trucking or market-gardening business depends upon the man guiding it. Besides being a crop grower he must be a thorough business man, equipped to overcome obstacles in the cultivation of his crops as well as in the shipment and marketing of them. This means that he must have a carefully conceived and well-thought-out plan of procedure, involving the most complete and profitable use of his land — that from the beginning to the close of the growing season he must have a succession of crops so adjusted to one another that there shall be a continuous supply to meet the demands of the market at a time when there is no destructive competition from localities possessing an advantage over his own. His crops must not be so early as to come in competition with the growers south of him, nor yet so late as to come in competition with those north of him, who have the advantage of cheaper transportation. With the Southern grower there is less risk in early crops than in late ones, for as soon as the grower situated closest to the center of consumption has a product which meets the demands of the market, his more distant competitor is placed at a disadvantage.

Then, too, the acreage of the crops should be adjusted to the labor supply. For best results in market gardening and truck work it is necessary to keep a fixed corps of well-trained assistants or laborers who can carry out the details in cultivating, harvesting, and marketing a particular crop. If it becomes necessary to depend upon transient labor, there is always the danger that the required amount of labor cannot be obtained just at the time it is needed; but with a sufficient number of men of experience, and with an acreage properly proportioned among the various crops, the grower will be able to keep his labor force profitably employed and their number nearly constant, and thus be able to meet the demands of the market at the proper time. Such a plan carries with it a balance between the labor and the acreage of crops, together with a rotation or succession of crops.

Rotation of crops. In all farming operations it is necessary to practice as wide a rotation of crops as possible. Any crop, if grown on the same soil continuously, deprives it of certain elements of plant food which, sooner or later, render it incapable of producing that crop at a profit. Soil which has for many years grown a single crop, such, for instance, as clover, becomes unfit for the production of that crop, and the farmers say the soil is "clover sick." With market-garden crops like results follow, and there are in addition plant diseases and insect enemies which become more troublesome each year that a crop is grown upon the same area. A rotation therefore tends to adjust the crop to the soil best fitted for its production, to maintain fertility, and, to a limited extent, to overcome the bad results from insect pests and plant diseases. With such crops as cabbage, cauliflower, kale, and turnips, all of which are subject to the same class of diseases and the same insect enemies, it frequently becomes necessary to abandon for a number of years the land on which such crops have been grown, until the organisms which produce the diseases become starved out. The clubroot of cabbage forms one of the very best examples of this type of plant disease. The wilt of the muskmelon and cucumber and the wilt of cotton are also diseases of this nature. They are diseases which, because of their ability to perpetuate themselves from year to year in the soil, and because they develop in the interior of the plant tissues, cannot be successfully treated by external agencies. The only known remedy for them is to starve them out by not growing the host plants upon the infested soils for a series of years.

Succession of crops. A succession of crops is, as a rule, of more importance to the market gardener than to the truck grower. Because of the proximity of the market gardener to the markets which he supplies, he can afford to plant in succession so as to prolong the season for his crops, particularly if he is supplying a local market which depends largely upon home production. The market gardener at the North can afford to make three or even four plantings of peas, three or more plantings of string beans, the same of beets, and so on through the list, while for the Southern grower the only safe way is to plant a large quantity at one time, which will give him a sufficient product to enable him to ship large consignments — carload lots — to one or more of the great cities at a particular period. A succession of plantings of the same crop is therefore of little moment to the truck grower who is at a distance from his market. What he desires is a variety of crops which follow one another, and which will not meet severe competition in the market to which he is catering. In order to accomplish this and at the same time utilize the land to the best advantage, truck growers frequently have two different crops growing upon the soil at the same time. A common arrangement is to plant strawberries and potatoes upon the same land at the same time. The potato crop will be harvested early in the season, and the entire area then becomes available for the strawberry plants, which will produce a paying crop the succeeding year. By this practice the potatoes, beans, or whatever is grown between the strawberries, not only pays for the cultivation of the strawberries but returns a remunerative crop while the strawberry plants are becoming established and are making preparations for the next season's returns. For crops which require a long period to come to maturity it is a common practice to plant between them some short-season crop, such, for instance, as string beans between cucumbers. The beans can be planted somewhat earlier and thus have a start of the cucumbers and, in regions with high winds, act as a protection to them; by the time the cucumbers demand the whole area the beans will have been removed. Where land is very expensive this

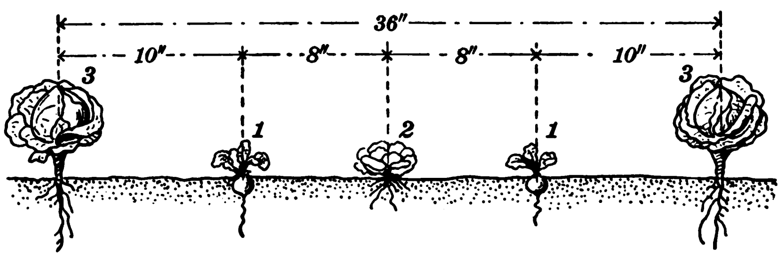


FIG. 1. Double cropping

1, 1, radish; 2, lettuce; 3, 3, cabbage

system of double cropping, or catch cropping, is common. Quick-growing crops, such as radishes and lettuce, are frequently produced between wide-planted rows of cabbage, cucumbers, tomatoes, potatoes, and the like, as suggested in figure 1. This enables one to harvest a series of crops from the same land throughout the whole season. Then, too, because of the short season which many of these crops require it is sometimes possible in regions where the growing period is long to produce as many as four crops upon the same land during a single year. In many of the Southern truck-growing regions this is possible. One instance which has come to the writer's attention is that of a truck grower who produces upon his land in the fall a crop of lettuce which is harvested in December. Upon the same land he produces another crop of lettuce which is harvested late in March or the first of April, and before this crop is harvested beans are planted, so that by the last of May or early in June a crop of beans is taken from the land, thus making three crops from the soil between the last of October and the first of June. The land is then cultivated and planted in cowpeas, which are plowed under, thus making four crops, three of which are very remunerative, upon the same land during a single growing season.

Special equipment. Besides taking advantage of the season and utilizing the land in the best possible way by a succession of crops as well as by a catch-crop system, the successful market gardener and truck grower provides against adverse conditions in nature by the use of every device which will overcome such conditions. In those localities where droughts are liable to occur and to interfere seriously with the quality and the yield of the product, irrigation facilities are provided which enable the grower to supply water at the critical time. This is frequently an advantage with some of the delicate crops, not only because of the necessity for providing water, but because the water can be applied in a particular way which prevents the occurrence of injurious plant diseases and discourages the increase of harmful insects. In addition to such irrigation facilities, gardens are equipped with cold frames, protected either by glazed sash or by "muslins." Muslin-protected frames are built somewhat after the fashion of the ordinary cold frame, but are covered with cloth — that is, unbleached muslin — which may or may not be treated with a preservative solution. In mild climates this arrangement enables the grower to carry successfully half-hardy plants over periods when the weather is too cold for them to remain in the open unprotected. At the North, where such simple devices do not provide sufficient protection, growers resort not only to cold frames but to hotbeds, which are heated either by fermenting stable manure or by pipes from a hot-water or steam-heating plant. Where the object is to carry the plant beyond the transplanting stage a more elaborate structure is required. Greenhouses are erected and provided with suitable heating apparatus to maintain congenial conditions throughout the winter months, in order that plants may be carried under glass throughout their whole period of growth. In the vicinity of no city in the United States is this industry more largely developed than in the vicinity of Boston, where many acres are covered by glass roofs and devoted to the cultivation of tomatoes, lettuce, and cucumbers during the winter months.

Besides possessing a knowledge of these devices and makeshifts for lengthening the season and for overcoming adverse conditions, the successful truck grower or market gardener must have knowledge of the insect enemies and diseases which are liable to attack his crops and of the methods for controlling them. He should also have special knowledge of the effect which plant foods or fertilizers have upon the growth of plants and be able to use these to the best advantage for increasing the yield and perfecting the quality of the crops which he wishes to produce.

Soil and exposure. While in truck growing soil and exposure are of less importance than is the accessibility of the market, yet the character of the soil, to a great extent, determines the time of maturity of the crop, no matter what the climatic conditions. In other words, a cold retentive soil is always "late," while a warm, light, sandy soil is always "early." The cold soil, the one which is heavy and retentive of moisture, cannot be cultivated as early in the season as can the lighter, sandy soil, which dries out more quickly. Seeds planted in the cold soil will not germinate as quickly, neither will the plants grow as rapidly as those planted in the warmer soil. Hence for trucking or market gardening it is desirable to have a light warm soil rather than one which is heavy and cold, particularly for supplying the demands of the early market. For certain crops, however, the cold retentive soils are absolutely necessary, and, as before noted, the persons who make a specialty of growing crops which demand such an environment usually grow no other crop except the one requiring these conditions, such as onions and celery. The natural fertility of the soil for truck work is a matter of small consequence. If the mechanical conditions are good, the fertility can be supplied by manure, the plowing under of green crops, and quickly available fertilizers, such as nitrate of soda, muriate and sulphate of potash, and phosphoric acid. The successful market gardeners and truck growers who are located upon light sandy soils endeavor to combine the use of stable manure with that of quickly available fertilizers. In addition to the use of from 10 to 40 loads of stable manure they frequently use from 500 to 2000 pounds of high-grade fertilizer to the acre, in order to produce in a single season the three or four remunerative crops above referred to. There are no soils which are naturally sufficiently fertile to produce paying crops under such an intensive system as holds in market gardening or truck farming. In fact, not even the richest soils in the United States are capable of producing crops sufficiently large to warrant a grower's carrying on such a system without the use of stable manure, green manures, and fertilizers combined. In many localities it is impossible to secure an adequate quantity of stable manure, but when it can be secured, even if it has to be shipped from a distance by car or boat, it will be advantageous and profitable. By the use of large quantities of stable manure and by plowing under heavy crops of cowpeas or other legumes, the mechanical character of the soil, as well as its fertility, can be changed to a marked degree. Heavy retentive soils can be lightened and made "earlier." The drainage can be improved by tilling and by subsoiling, and the seed bed constantly made deeper until a depth of 10 or 12 inches has been reached, which is sufficient for most market-garden crops.

One of the secrets to success in market-garden and truck work is to be able to anticipate the demands of the market, and to have a large and sufficiently early supply of vegetables to meet these demands. This depends more upon the ability of the man to manage his business than upon the fertility of the soil or the method of cultivation practiced.

Plant diseases and insect enemies. In order to appreciate fully the action of insect enemies and plant diseases, as well as to determine the influence of fertilizers and the moisture supply upon growing plants, a brief sketch of the structure and function of various parts of the plants becomes necessary. Plants are made up of three distinct parts, two above ground and one usually beneath the soil. These parts we recognize under the names "root," "stem," and "leaf." Each one bears a definite relation to the others, both as regards its arrangement and its functions.

Root. The function of the root is first mechanical, then physiological. The mechanical function is to give anchorage to the plant and to support the stem which carries the leaves. The physiological function is, of course, the most important one and consists in gathering from the soil the crude mineral foods which are used by the plant. These foods are usually about twelve in number, the most important of which are nitrogen, potash, phosphoric acid, lime, magnesia, silica, iron, and sulphur. These materials are gathered from the soil in solution — that is, carried in water — by the growing tissue of the roots. This growing tissue is usually situated in a comparatively restricted region near and at the tip of the root. This actively growing tissue is called by botanists *meristem tissue*, and so long as the cells in the neighborhood of the tip of the root remain in an actively dividing condition they belong to the class of meristem tissue; but as soon as they lose this function and become fixed in form their outer surface changes in character and becomes thicker and less able to take up mineral matters from the soil. Young actively growing roots are therefore essential to the rapid development of crops; and since the rapid development of vegetables is a very desirable feature, the soil conditions should be such as to induce rapid growth. After the crude materials which form the foods of plants are taken up from the soil they are carried through the older tissue, which is provided with ducts and channels through the stem to the leaves.

Stem. The stem acts as a framework to support the leaves, flowers, and ultimately the fruit, and as a means of conducting to the leaves the food which is gathered by the root. In fact, the stem has one system of pipes or ducts through which the crude material is carried to the leaves and another system through which the finished products ready for use in plant growth are carried back to the various parts of the stem and to the root, where they are either stored up or used in building additional tissue in stem or root. The function of the stem, therefore, is largely mechanical rather than physiological.

Leaf. The leaves are the most exposed of the delicate organs of the plant, and their functions are more complex than those of any other plant organ. Leaves are usually broad, thin, and so arranged as to have a very large area exposed to the air and sun. Under normal conditions they are usually green in color. There are a few exceptions to this, as in the case of beets and some other plants with colored leaves. Both the broad expanse of leaf surface and the green color are important factors connected with the function of the leaf. The broad surface gives an extensive area over which the green tissue is spread, and provides for a large number of small openings, particularly on the underside of the leaves, through which air is taken in and through which moisture is thrown off. These small openings, which are provided with more or less active motor cells along their edges, are called *stomates*, or *stomata*. It is through these openings that the excess of moisture pumped up by the root with the dilute mineral food is thrown out of the plant system. If it were not for these, the plant would become overstocked with moisture, affected with œdema, and sickly in appearance. It is by this rapid movement of water from the roots through the leaves to the air by means of the stomata that the tissue of the plant is kept in a tense condition. As soon as there is insufficient moisture at the root of the plant to provide for this rapid movement the plant wilts or flags, and as soon as moisture is again supplied the tense or turgid condition of the tissue is restored. These stomata are, therefore, very important organs, intimately associated with the process of plant nutrition. They are also important in connection with plant diseases, as will be noted later.

The green color of the leaves, above referred to, is caused by small (microscopic) bodies contained in the cells which build up the outer layers of the leaf (all plant tissue is made up of small independent parts called cells, which might be likened to the individual bricks used to build the walls of a building). These little green bodies, which are called *chloroplasts* by botanists, are present in sufficient numbers when the plant is in a healthy condition to give it its characteristic green color. Their function is, perhaps, the most important of any connected with plant growth, for under the influence of sunlight they are able to take the crude materials gathered by the root and supplied by the air, and from them to develop the materials necessary to build the various plant tissues. Some of these products will be recognized under the names "starch," "sugar," and "oil." The starches are changed into sugars and are used by the plant in building up certain portions of its structure. The oils are frequently stored up either for use by the young plant in the seed or in various parts of the plant tissue, as in the flowers, where they give the pleasant odor which is characteristic of many plants. The oils which give the perfumes are called essential oils. These oils are volatile at ordinary temperatures; they make an impression upon the sense of smell and give us the odor which is either pleasant or offensive.

Other things being equal, the greater the food supply, including moisture, with congenial atmospheric conditions, the more rapid will be the development of plant tissue, and consequently the more rapid the growth of the plant. In commercial market gardening or truck farming quick growth is as a rule the result desired.

Plant diseases. It is a misfortune that there are such things as diseases of plants, but every commercial grower of plants is familiar with a greater or less number of discouraging factors, either in the form of plant diseases or insect enemies. Plant diseases, as we recognize them at the present time, are the results of low forms of plant life, that is, parasitic plants which live upon the growing tissue of other plants instead of deriving their nourishment directly from the soil or from dead and decaying plant tissue. These low-form parasitic plants are known under different generic names, but, collectively, they may be spoken of as fungous diseases and bacterial diseases.

It is not necessary for us to go into the distinction between these types of plant diseases; it is sufficient to note the manner in which they act upon their host plant and interfere with its growth and profitable development. In general they act in two ways. They either break down the tissue of the leaves and thus interfere with the nutrition of the plant by dwarfing and stunting its growth and curtailing its ability to elaborate the crude materials provided by the roots; or they gain an entrance to the ducts and passages of the interior of the plant, and by their growth and development clog these passages so as to cut off the flow of crude material gathered by the roots for the use of the leaves.

As a general thing, the fungous diseases attack the plant from the outside, while the bacterial diseases work upon the inside. What has already been stated is sufficient to indicate the importance of a knowledge of the behavior of plant diseases in determining the method of their control. It is evident that diseases which attack the plant from the outside can be resisted by placing upon the surface of the plant materials which will discourage or prevent the growth of these parasites, but when it comes to diseases which act upon the interior organs of the plant, the control is a much more difficult problem. As stated above, the club root of cabbage is a disease which acts in this obscure way and is, therefore, very difficult to control. The only means at our command, as yet, is to practice a rotation so that neither cabbage nor any of its near relatives shall be grown upon the soil for several years after it shows an infection from this disease.

Fungicides. The means at our command for controlling plant diseases are called fungicides, because they are used for the purpose of combating or controlling the growth of fungi.

In general, applications of fungicides are made to the seed, stems, or trunks of trees while in a dormant condition, and to the leaves and stems of plants while in a growing condition. They are usually in the form of a liquid, a dust, or a gas. For practical purposes the liquid or dust form is most convenient and satisfactory. For use in greenhouses, however, where the plants are in a confined atmosphere, the gases are effective and satisfactory. They have also been extended to field uses by means of tents or covers which are temporarily placed over the plants for the purpose of providing a confined atmosphere in which to expose them to the action of the poisonous gas.

The treatment for plant diseases should not be looked upon as a remedy for the disease but simply as a preventive measure. There are very few plant diseases for which we have absolute remedies, but there are comparatively few of the more important plant diseases for which we do not have a satisfactory preventive. In other words, the control of plant diseases depends upon the ability of the grower to detect symptoms which indicate the presence of these diseases, and a knowledge of the means for holding them in check before they have become sufficiently rampant to destroy any considerable portion of his crop. This knowledge should nowadays be looked upon as one of the most important factors in the equipment of a person for success in the growing of either fruits or vegetables. The special diseases to which the several crops are subject and the means of controlling them will be discussed under each subject considered.

In this connection we deem it wise and pertinent to discuss briefly the means of applying various fungicides and insecticides. Fungicides which are in the form of a liquid spray are most satisfactorily applied by a force pump through a nozzle which makes a very fine mist. The nozzle which is most satisfactory for this purpose is either the Vermorell or one of the types of the Seneca. The Vermorell nozzle is constructed upon a correct scientific principle for making a spray or mist; that is, upon the "eddy-chamber" principle, in which a liquid is forced, under high pressure, into a small chamber from an opening at a tangent to the side of the chamber. The liquid is shot into the chamber at a high velocity, is forced to assume a rotary motion inside the chamber, and can escape only by a small orifice at the center. It is this rotary motion which breaks up the liquid, upon its exit from the small orifice, into a very fine cone-shaped spray or mist. One difficulty with this type of nozzle is that the liquid to be used must be free from all obstructions, such as small particles of lime or dirt of any kind. There are many devices for carrying the spraying material, such as barrels mounted upon wagons, carts, or sleds, and smaller receptacles which can be carried in the hand or upon the back. A few of the more serviceable forms of spraying apparatus are shown in figure 2. Each person will have to judge for himself which of the devices will best suit his conditions, this depending largely upon the area of the crop grown. For extensive field operations power sprayers which are manipulated by horse power, steam, or gas engine are most satisfactory, while for smaller operations the hand pumps are very convenient.

Dust sprays, so called, are very fine powders which contain the necessary ingredients for destroying or preventing the growth of parasitic plants upon crops, and are applied by dust guns which act upon the principle of a rotary fan or bellows, blowing the dust at a high velocity from a long tube upon the foliage of the plants, preferably while they are moist.

Preparation of fungicides. The following fungicides are to be diluted with water and used as a spray:

Bordeaux mixture is the best general fungicide for surface fungi, including blights, mildews, etc.; it is prepared as follows: In a wooden or earthen vessel dissolve 4 pounds of powdered or

KEY

1. One-horse power sprayer for vegetables.
2. One-horse cart and hand-power sprayer for vegetables.
3. Gasoline-power orchard sprayer.
4. Knapsack type of compressed air sprayer —pump inside tank.
5. Barrel and pump for hand power
6. Bucket pump.
7. Compressed-air sprayer.
8. Double Vermorell nozzle.
9. Single Vermorell nozzle.
10. Eddy-chamber nozzle.
11. Hose clamp.
12. Cut-off valve.
13. Extension rod and cut-off.

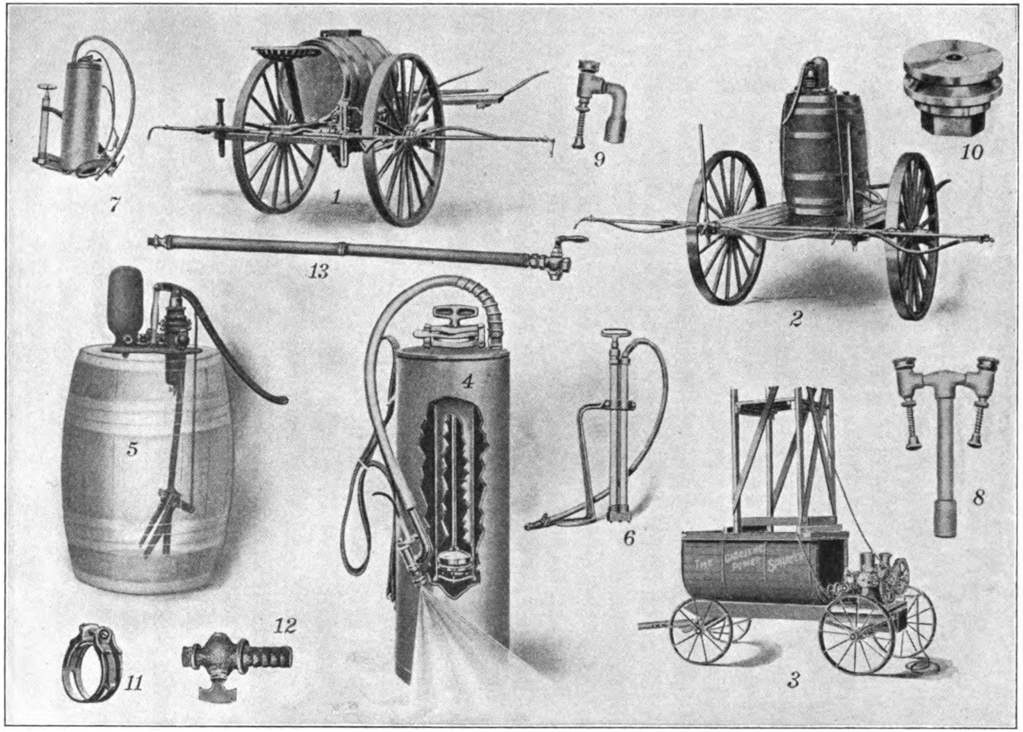


FIG. 2. Useful types of spray rigs and devices

crystal blue stone (copper sulphate) in 10 gallons of water. In another vessel, preferably wood, dissolve or slake 4 pounds of freshly burned stone lime, using the same quantity of water as in the former case. Dilute these solutions to 25 gallons each and draw equal quantities of them into a third tank, keeping them agitated as they flow into the third tank. The third tank may be the barrel or receptacle to which the spray pump is attached, but in the passage of the liquid from the two receptacles first mentioned to the third one, they should pass through a fine brass wire screen or gauze which has a mesh about the same size as the orifice in the nozzle to be used. These two solutions should not be mixed until immediately before using them upon the plants. Stock solutions of copper sulphate and lime, however, may be made and kept indefinitely, so long as they are not mixed. This solution, as will be noted from the above statement, consists of 4 pounds of copper sulphate and 4 pounds of lime diluted with 50 gallons of water. This is the standard Bordeaux mixture, which is used for the treatment of cucumber blight and mildew, the potato blight, and other similar diseases of fruit and forest trees.

Ammoniacal carbonate of copper. This is another standard fungicide, but is less used than Bordeaux mixture because of its great cost and the increased danger of injury from its application. It is made as follows: Place 3 ounces of carbonate of copper in a large glass receptacle, preferably a bottle, and to it add 1 quart of ammonia (strength 22 degrees Baumé). After the ammonia has been added, stir until the copper carbonate is dissolved. This makes a stock solution which, when needed, should be diluted to 25 or 30 gallons in order to make it the proper strength for use upon tender plants.

Corrosive sublimate. A solution made by adding 2 ounces of corrosive sublimate to 16 gallons of water was formerly used extensively for treating potatoes for potato scab. This is exceedingly poisonous and dangerous to use and should never be left where human beings or domestic animals can gain access to it. Seed potatoes treated in this solution for an hour and a half before planting will be very effectively guarded against the potato scab.

Formalin. Another preventive of potato scab is prepared by adding 1 pound (1 pint) of formalin to 30 gallons of water. Soak the seed potatoes in the liquid for about 2 hours.

This treatment is less dangerous, more easily prepared, and not more expensive than the corrosive-sublimate treatment, and of late has largely replaced it.

Insects and insecticides. It is not possible, in this connection, to enter into the specific differences which distinguish different families and groups of insects from one another. For our purpose, however, it is sufficient to know that those insects which as a rule are most injurious to crops are of two classes: insects which gain their sustenance by biting or devouring the tissue of the plant, and those which gain their sustenance by sucking the juices of the plant. The first class of insects have jaws fitted for biting and for masticating the plant tissue, and their work is followed by defoliation or by the destruction of areas of leaf or stem tissue. The mouth parts of sucking insects are not made for biting, so do not admit of the destruction of plant tissue in that way. Such insects have tubelike mouth parts which they insert in the tissue of the plant to suck its juices. It is evident, therefore, that insects of the two classes must be fought from different standpoints and with different insecticides.

The first class of insects, which gain their nourishment by eating the tissue of the plants, can, of course, be poisoned, and this is usually successfully accomplished by the use of Paris green or arsenate of lead in suspension in water. Paris green is used at the rate of 5 ounces of the green to 50 gallons of water, while the arsenate of lead is used in somewhat greater strength — 1 to 2 pounds to 50 gallons of water.

Those insects which obtain their nourishment by sucking the juices of plants can be destroyed only by the use of insecticides which come in contact with the body of the insect. For this purpose volatile oils or oil and soap mixtures are usually employed. Kerosene emulsion and whale-oil soap are two of the standard remedies for this class of insects.

Kerosene emulsion. Kerosene emulsion is made as follows:

Hard soap or whale-oil soap	½ lb.
Boiling water, preferably soft water	1 gal.
Kerosene	2 gal.

Dissolve the soap in the water, add the kerosene, and churn with a pump for 5 to 10 minutes. Dilute 4 to 10 times before applying. Use strong emulsion for all scale insects. For such insects as plant lice, mealy bugs, red spider, and thrips the weaker preparations will prove effective. Cabbage worms, currant worms, and all insects which have soft bodies can also be successfully treated by the use of contact insecticides. It is advisable to make the emulsion shortly before it is used. The emulsion is especially effective in summer to kill the young and tender lice.

Whale-oil soap. Whale-oil soap spray is prepared as follows: Dissolve in hot water if wanted quickly. As a spray on dormant trees for San José scale use 2 pounds of whale-oil soap to 1 gallon of water; for summer use on scale or aphis use 1 pound of soap to 5 to 7 gallons of water.

CHAPTER II

THE SOIL AS A FACTOR IN THE WORK OF THE MARKET GARDENER

A controllable water supply, good tillage, and suitable soil are three of the important factors with which gardeners are concerned in the production of crops. Arranging these factors in the order of their importance, most gardeners will agree that they stand: (1) water, (2) culture, and (3) soil.

Water supply. The water supply influences the mechanical condition of the soil, and this in turn has an influence upon the character of the crops that can be grown. The water supply determines to a large extent the availability of the supply of plant food. The food upon which plants thrive is intimately connected with the particles of which the soil is composed, and it is through the action of moisture, frost, tillage, and low forms of life that the material suitable for nourishing the plant is made available.

Water supply also influences the rate of plant growth. Farmers know only too well the effect which a prolonged drought has upon the yield of crops, the growth of trees, and the labor necessary to prepare soils properly; without a sufficient supply of water, growth is slow and dwarfed, and the resultant crop usually very meager. Arid countries may frequently, and in fact often do, possess exceedingly fertile soils, but which for lack of water are sterile. As soon as water is carried to these regions a most productive territory may be developed. The most intensive agriculture in the world is oftentimes carried on upon lands which, under normal conditions, are sterile but which, through the influence of irrigation, are rendered extremely productive. Too much water, however, is as detrimental as too little. Plants require a certain balance between the water in the soil and the air in the soil.

Air of the soil. All normal soils upon which plants thrive carry a large volume of air in the spaces between the soil particles, and every soil particle is enveloped in a minute film of moisture. The tiny growing roots of the living plant are capable of drinking up this minute supply of moisture and are also benefited by the air which is contained between the soil particles. Too much water in the soil drives out the air, fills the spaces with moisture, and acts, to a certain extent, as a smother to the roots. Roots, like the leaves, must have a certain amount of free oxygen in order to perform their normal functions. The withdrawal of an excessive amount of moisture from the soil, however, leaves it dry, hard, barren, and incapable of supporting productive plant growth. Slight variation or fluctuation in the amount of moisture in the soil is not detrimental and to a certain extent is desirable, but these fluctuations should not be extreme. It is always desirable to maintain sufficient moisture to prevent the plants from flagging, but it is not desirable to have the soil at all times highly charged with moisture. From studies of seed germination it has been determined that considerable fluctuation between day and night temperature is needed for the highest germination of certain seeds. The same is true, to a certain extent, with the fluctuation of moisture, although this factor is probably of less importance than temperature. The soil, however, should at all times be maintained as nearly as possible in that condition which gardeners recognize as ideal for the growth of plants — a condition which is easily determined by experienced gardeners from the way the soil behaves when handled but which is not easily described.

Water temperature. The temperature of the water used for irrigation or syringing is of little importance so long as it is below 80° F. and above 50° F. The influence of water at a high or low temperature is only temporary, and no decided influence on the plants can be discovered from the use of hot or cold water. A slight change in temperature of the soil is noted where extremely warm or extremely cold water is used; but this change is only temporary, and careful observations have not been able to detect any decided influence upon either the growth or the yield of potted plants in greenhouses which are watered with water within the above temperatures.[1] The time and manner of applying water is more important than its temperature.

[1] *Wisconsin Agricultural Experiment Station Report, 1897*, pp. 317–320.

Cultivation. In the open, cultivation has for its object the preparation of the seed bed, liberation of plant food, and the destruction of weeds. These results are secured chiefly through spading, plowing, harrowing, hoeing, and cultivation. Under greenhouse conditions, however, these mechanical operations cannot be carried on as they are in the open field, and the wise gardener, whether working under outdoor or greenhouse conditions, cultivates his crop well before he plants it. In fact, many persons believe that a very large part of the cultivation of a crop can be done before the crop is planted. This is emphatically true with greenhouse crops. The important part of the cultivation of greenhouse crops takes place in the compost heap. The work of fining the soil and of liberating plant food is almost entirely accomplished while the soil is in the compost heap, as is also to a less extent the destruction of weeds. In a properly constructed compost heap the successive workings to which the soil is subjected fine the particles by grinding them together and thoroughly mix the several component parts of the heap. This mixing and grinding process also has a tendency to render the plant food which is contained in the soil more available, so that two of the important objects of cultivation are readily accomplished in the compost heap. If the handling of the soil is at sufficiently frequent intervals and the heap is not too deep, a considerable percentage of the weed seeds which are contained in it may be induced to germinate and the young weeds killed by the handling of the soil.

The compost heap. The construction of the compost heap and its care are, therefore, most vital matters to gardeners cultivating under glass. Composts are necessary in gardening under glass because maximum production is required of special plants. Natural soils are not developed for this purpose but rather for an average production from a large variety of plants. It is necessary, therefore, in order to secure maximum production with any plant to prepare a soil for this special purpose. Two types of compost must be considered: first, special composts for a particular purpose in order to obtain plant food of the desired kind and in necessary proportions; and second, a general compost for use as a basis for special crops or composts. The general compost heap should consist of foundation or base material; that is, it should be made from the heaviest soil to be used in any greenhouse operation, which should carry a maximum amount of fiber, and it should also have a liberal supply of humus, preferably of a rather heavy nature, such as that from peat, muck, or cow manure, or for special purposes, from cow manure alone. It is much easier to lighten soil than to render it heavy after it has been thoroughly composted. Lightening can be accomplished by the admixture of sand, leaf mold, or peat; sometimes coconut fiber and materials of this sort are also used for the purpose, but for making a soil heavy, clay alone must be used. Since clay cannot be handled in the same way as the lighter materials, it is best to construct the compost heap of the heaviest loams that will be required for any crop to be grown and depend upon the use of sand, leaf mold, etc. for making those special types of soil required by particular crops.

Time of preparation. The compost heap should be prepared several months before it is needed, in order to allow sufficient time for the accomplishment of important changes which take place in the soil. The reason for this is that all plant foods are more or less inert, and in order to make them available for use by plants certain low forms of life must have opportunity to act upon them, and certain mechanical as well as chemical changes must take place through decomposition and fermentation; in other words, the soil must have time to digest these raw materials before the plant can feed upon them. Certain factors, such as heat, moisture, the presence of lime, and an abundance of decaying organic matter, are desirable in order that a compost of the best character may be produced. As a guide to the preparation of plant foods the chemist determines the kinds and sources of foods required by various plants. This we supply as best we can from manures, fertilizers, etc., but these materials are raw and crude, and in order to prepare the most important of them for use by the plants we must have the beneficial effect of the soil bacteria. These organisms are too minute to be observed except with the aid of the highest-power compound microscope, yet they are of the greatest economic importance to farmers and gardeners alike. Their function is to transform this inactive plant food of the rock particles, decaying vegetation, and animal remains into active plant food; and in order that these helpmates may do their best work for us, we must observe certain conditions essential to their well-being. The compost heap must contain an abundant supply of decomposing organic matter. The decomposition in this material must not be allowed to take the form of acid fermentation; in other words, sufficient lime must be incorporated into the compost heap to keep the process of fermentation and decomposition from becoming acid. Heat is also necessary in order to stimulate action of these little organisms. Under normal growing conditions, however, the heat generated from decomposition and fermentation is sufficient for the high development of the organisms, provided there is moisture in the soil at all times. Heat and lack of moisture are not congenial; heat and excessive moisture are not congenial; and the right amount of moisture without sufficient heat is not productive of good results. Under normal conditions the heat, as has already been suggested, will come from natural sources and will be generated in the process of decomposition and fermentation. The moisture and lime must be applied as occasion requires. The gardener should at all times keep a close watch upon the compost heap to see that it does not become excessively dry, as bacteria cannot work to good advantage in dry heaps. Decomposition is arrested by either excessive drought or excessive moisture. All these factors accomplish their greatest good during the normal growing period of the year. Cold weather checks all activity, so that it is necessary to have the compost heap constructed at a time when it will be possible to take advantage of the benefits of the season in accomplishing the desired results. The compost heap should, therefore, be constructed during the fall, early winter, or very early spring so as to be in condition to allow the greatest activity of these beneficial organisms during the summer months. If the compost can be made a year in advance of the time it is to be used, it will be all the better. As none of these natural operations progress rapidly, time is important.

Soil sterilization. In garden operations it is quite as important to treat the soil so as to resist certain injurious forms of life as it is to supply food for others. Soil sterilization has for its direct object the treatment of soil in such a way as to render it free from injurious enemies, chief among which are eelworms, or nematodes. As a consequence of sterilization the soil is freed of spores of injurious fungi, such as mildews, molds, and damping-off fungi, which cause heavy loss under certain conditions. Besides these advantages sterilization also produces a decided benefit by liberating plant food and improving the mechanical condition of the soil. For best results, in spite of what has already been said in regard to the advantages of a long compost period, sterilization should be performed immediately before the compost goes into the benches; or in some cases where proper equipment is available it has been found most economical to sterilize the soil after it has been placed upon the benches. Early sterilization gives opportunity for reinfestation and interferes with the action of the ferments and bacteria of a highly beneficial order. It is, therefore, best to defer all sterilization until after the period of composting has been completed, and to take the soil directly from the sterilizing boxes to the greenhouse bench.

How to sterilize the soil. There are two means at our command for sterilizing soil to rid it of eelworms. These two means consist of the two extremes of heat and cold. Repeated freezings are as satisfactory for sterilizing greenhouse soils to rid them of the eelworms, injurious to most greenhouse crops, as is heat; but unfortunately not all garden or greenhouse operations are conducted under conditions which will permit of subjecting the soil to repeated freezings and thawings in order to sterilize it. To be independent of any emergency that may arise, the grower must therefore rely upon the use of heat to sterilize soil. For this purpose it has been found that plank boxes about 2 feet deep, 4 to 6 feet in width, and of any desired length sufficient to hold from one to five cartloads of soil, serve the purpose well. These boxes are usually placed so that the tops are flush with the surface of the ground, in order that the soil when shoveled from the compost heap can be dumped directly into the sterilizing boxes. The pipes through which the steam is conducted may be either agricultural tile laid in the bottom of the boxes, or perforated pipes such as are used for steam or water, so arranged that the distance between the pipes is sufficient to permit the use of a spade or shovel. In all cases the line of perforations should be on only one side of the pipe. In the construction of the boxes these perforations should look downward instead of upward. The reason for this is that the soil is liable to be packed into the perforations if they are upon the top or sides of the pipes, and thus interfere with the emission of the steam. If, however, they are on the underside of the pipe, they are not likely to become clogged or packed with soil from the outside, and their efficiency is as great as if they were on the upper side. The length of time that the soil should be left in the boxes will depend upon the character of the soil, the steam pressure, and the tightness of the

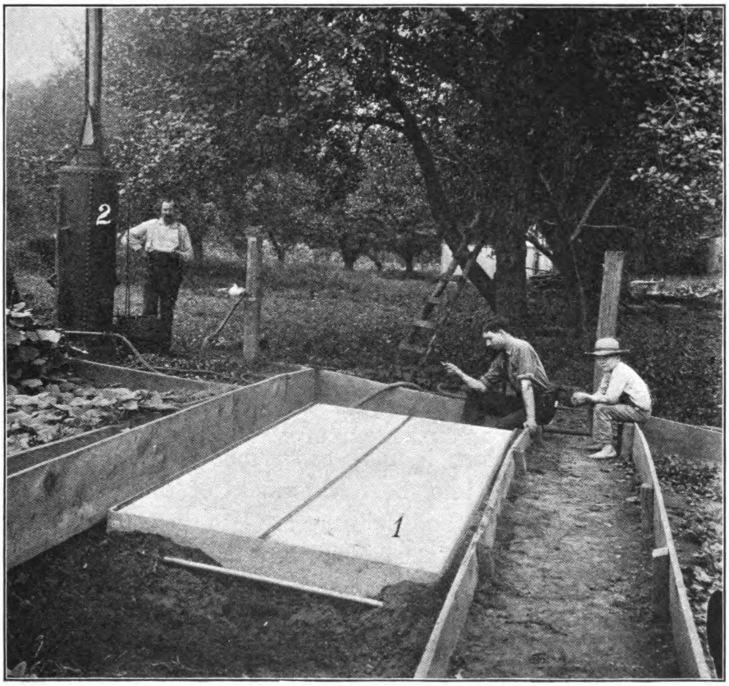


FIG. 3. Shamel soil sterilizer
1, inverted metal pan ; 2, steam boiler

box. The sterilizing box should be fitted with a tight lid so as to hold the steam in the box. A common test used for determining the length of time required for sterilization is to place a potato about three inches below the surface of the soil in the sterilizing box. When the soil has been heated long enough to cook the potato thoroughly, it is considered safe to place it in the greenhouse bench. For use in seed beds, and greenhouses with solid beds, another type of sterilizer, known as the Shamel sterilizer, shown in figure 3, is extensively employed with great success. This contrivance consists of a large metal pan 4 to 6 feet in width, 8 to 10 feet in length, and about 6 inches deep, fitted at one end with connection for a steam hose. This pan is inverted over the surface of the soil area to be sterilized, the sides are well banked, and the steam is admitted under pressure. The hot steam fills the space under the inverted pan and penetrates the soil, effectively sterilizing it for seed-bed or greenhouse use.

The advantages of sterilization, as have already been noted, are the destruction of nematodes, more or less complete destruction of spores of fungi of various kinds, and the liberation of plant food. From observations which have been made it is believed that if sterilization gave no protection from enemies or diseases, the operation would still be justified and prove economical because of the increased growth of plants in such soils over that in ordinary compost.

From what has been stated it will be noted that the soil must be considered, from its mechanical relation to the plant, as a mechanical support for the plant, as a carrier of moisture and air, and as a conveyer of plant food. Fortunately for the gardener the soil under outdoor conditions is more easily modified than any other single factor entering into the environment of the plant. Heat, sunshine, wind currents, and moisture are less easily modified than are the soil conditions. In fact, moisture conditions are the only other factor over which man has any direct control. Through irrigation we can influence the moisture supply of plants; by the use of fertilizers, the turning under of green crops, the use of lime and proper cultivation, we can greatly modify soil conditions. The soil is one of the most complicated factors with which we have to deal, yet it is one which, from a market gardener's standpoint, can be most satisfactorily changed.

Transportation facilities, water supply, congenial climate, and sufficient labor are of more importance to the market gardener than the soil; for he can, through the use of artificial means already mentioned, modify the soil to meet the requirements of any special crop with which he may be dealing, provided, of course, it is true soil. In general agriculture the composition and fertility of the soil is of greater importance than in market gardening or floriculture.

CHAPTER III

PRINCIPLES OF PLANTING AND CULTIVATION

Preparation of the soil. The thoroughness with which the soil is prepared for planting determines, to a large extent, the cost of the after cultivation of the crop. It not only determines the cost of the cultivation of the crop but it also predetermines, to a very considerable extent, the stand of plants which will result from the use of good seed. Good seed upon poorly prepared soil will give an unsatisfactory and uneven stand of plants, while good seed upon thoroughly prepared land should give a perfect stand of plants. The time of germination is also governed by the thoroughness with which the seed bed is prepared. If the soil is only partially fined and compacted, the seeds will be much longer in absorbing the necessary amount of water to cause them to germinate; but with thoroughly fined and compacted soil, the process of conducting the water to the seed begins immediately. These remarks tend to show the importance of properly preparing the soil in connection with the stand of the plants. The after cultivation of a thoroughly fitted area is much easier than that of one which has been only partially prepared. Soils which have been carefully handled previous to planting have a smaller percentage of noxious weeds than those carelessly prepared, for the reason that the operations of plowing, harrowing, compacting, and preparing the seed bed follow one another in succession, giving an opportunity for weed seeds to germinate between the successive steps, those which have germinated being killed, naturally, by the later operations. This of course destroys a considerable percentage of the weed seeds in the layer of soil which comes under the influence of implements of cultivation.

Plowing. The first and one of the most important operations in the preparation of soil is deep stirring, accomplished by either plowing or spading. In most farm operations the deep stirring of the soil is practiced but once each year. In truck-crop work, however, it becomes necessary to stir the soil deeply several times. With light sandy soils this deep stirring can be done very early in the season, and little heed need be given to its moisture content; but with heavy, retentive soils it is of the utmost importance that deep cultivation be done only when the soil is in good mechanical condition. A soil is in good mechanical condition if, after being gently compacted between the fingers and the palm of the hand, it gradually falls apart when the pressure is released. If it is moist enough so that it retains its form and the soil particles seem to be broken down, it is too wet to work; and if worked in this condition, it will require several years of the most careful management to restore it to its proper physical texture. Upon clay soils or heavy clay loams it is, therefore, of the utmost importance that the work of plowing and harrowing be done when the soil is in proper mechanical condition. Not only is the physical structure of the soil destroyed, but bad treatment tends to lock up the available plant food and render the soil unproductive.

For truck farming and market gardening, deep plowing should be practiced. If new land is to be brought under cultivation for market-garden purposes, it should be broken up to the depth of about 8 inches and a heavy coating of manure incorporated with the surface layer of the soil. After the soil has been in cultivation for one or two years, the process of deepening the seed bed should then begin. This operation should not be a radical one, but the seed bed should be deepened slightly each year; that is, by plowing 9 inches deep the second year, 10 inches deep the third year, and so on, until 12 or 14 inches of the surface soil have been brought under cultivation and reduced to the proper state of a seed bed. This will necessitate the use not only of the turning plow but of a subsoil plow as well. It does not necessarily follow that the whole 12 or 14 inches of soil which is used as a seed bed should be brought to the surface. It is sufficient if the first 8 or 10 inches of the soil be turned over. This depth will insure covering all organic matter sufficiently and will admit the air to the lower layers, if they are broken up by the use of the subsoil plow. In general, plowing should be done with a plow which has a quick turn to the moldboard, and which cuts a deep, rather narrow furrow, so that the soil as it is turned over is thrown with considerable velocity and in such a manner that the particles grind forcibly upon one another. This is a very important part of the mechanical preparation of the soil.

Harrowing. After plowing, the ground should never be allowed to lie exposed to the sun and wind more than a few hours. The harrow should follow the plow as quickly as possible. It is a good

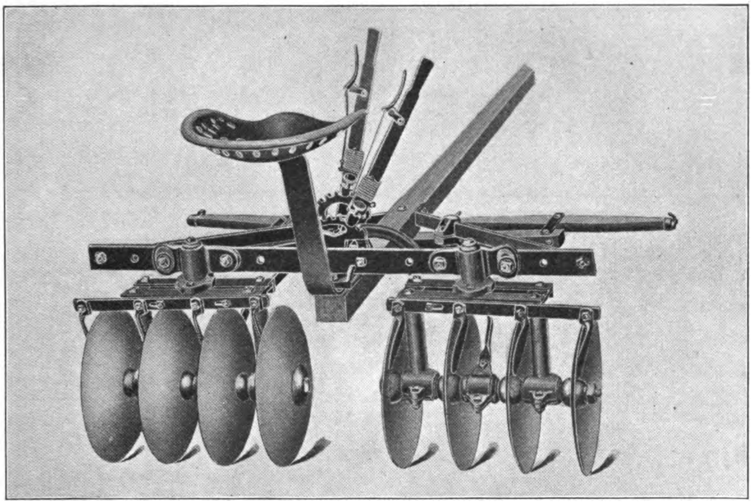


FIG. 4. Disk harrow

rule in cultivating the soil never to plow more during any one day than can be harrowed before night. Formerly, harrowing and compacting the soil were practically one and the same operation, but in recent years harrows have been constructed on quite different principles. The advent of the disk harrow, as shown in figure 4, which not only loosens and lifts the soil but pulverizes it, marks one of the great advance steps in soil cultivation. This implement, however, does not compact the soil. The acme harrow, shown in figure 5, which is another important pulverizing implement, compacts the soil to a slight extent, but its action is more that of the mold board of a plow than of a compacting implement. The cutting portions of the acme harrow are so constructed that they first cut the clods, then turn them either to the right or to the left, according

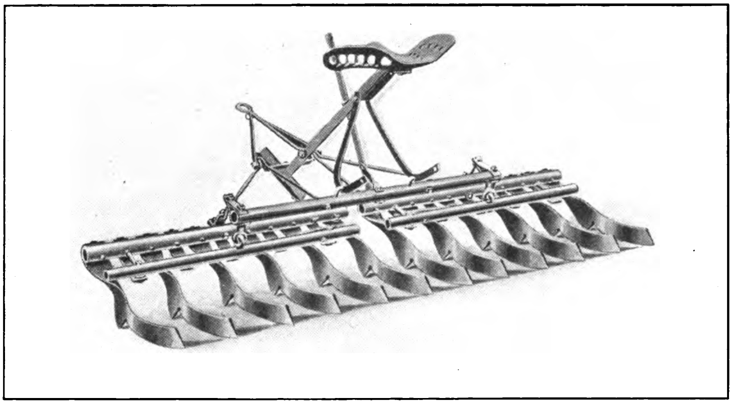


FIG. 5. Acme harrow

to the portion of the blade with which they come in contact. In the action of both these harrows the soil is pushed against itself so as to give it a grinding motion, which produces the same result in the same manner as the mold board of the turning plow.

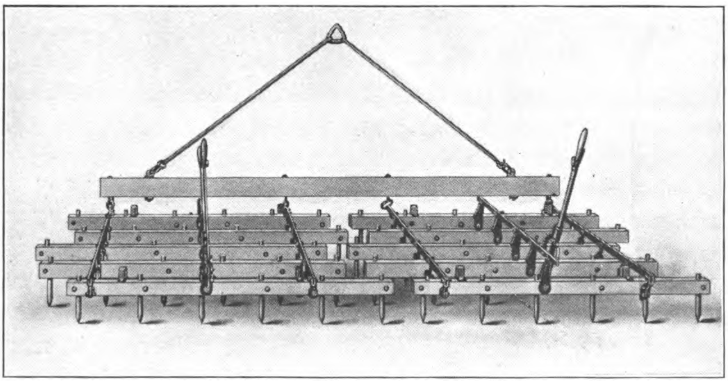


FIG. 6. Spike-tooth harrow

The old type of harrow, shown in figure 6, was constructed with a heavy wooden frame and provided with teeth varying in size from one-half to seven-eighths inches square, sometimes even larger.

The heavy frame was supposed to act as a clod crusher, and the teeth were not only to loosen but to stir the soil. This heavy implement, together with the tramping of the animals, had a tendency to leave the soil somewhat compact. It is only within recent years, however, that the importance of thoroughly compacting the lower strata of the seed bed has been appreciated; but since extensive investigations in soil physics have been carried on, and the movement of water in the soil is more fully understood, the importance of this feature in cultivation has been emphasized and is pretty generally understood by cultivators at the present time. The compacting of the soil in the seed bed may be effected by an ordinary land roller or, better still, by a subsurface packing implement, one of the best of which is shown in figure 7 and is constructed as follows: A series of ten or twelve independent cast-iron wheels about 2½ feet in diameter are provided with a rim about 1½ inches wide, and along this rim are placed offsets about 1½ inches wide and 3 inches long. These are not placed opposite one another but are arranged alternately at intervals of about 2 inches along the rim of the wheel. This gives the casting a surface nearly 6 inches wide, of which only about one half is actually occupied by iron. When these wheels, which are upon a common axle, are made to pass over the soil, the implement, having sufficient weight to crush the clods, leaves the surface of the soil comparatively loose and slightly rough, but the underlying portions of the seed bed are forced compactly together. By following this implement with a spike-tooth harrow which will cut 2½ to 3 inches deep, an almost perfect seed bed can be obtained. The subsurface packing closes up the capillary tubes in the soil; that is, it forces the particles of the soil close enough together so that a comparatively small amount of water is sufficient to cause an upward movement in the soil beneath. This compacting brings that portion of the soil which has been displaced by plowing and harrowing into intimate relation with the very compact substrata which have not been disturbed by cultivation, and sets up a movement of water from a considerable depth; this is carried toward the surface until it comes in contact with the loose blanket of soil which has been produced by the spike-tooth or acme harrow, leaving a loose mulch 2 or 3 inches deep over the surface. This is the ideal way of preparing a seed bed for general farm crops. For truck crops, which are planted very shallow, it is necessary to have the harrow which produces the soil mulch work to a depth of not more than 2 inches, so as to leave the soil compact except for the last 2 inches on the surface. This will be found sufficient to bring the moisture up to within 2 inches of the surface of the ground and will provide a suitable seed bed for the more delicate seeds which are to be planted in it. The chief end to be attained in the preparation of the soil is a very fine seed bed, underlain by a thoroughly cultivated yet compact stratum at least 8 or 10 inches deep.

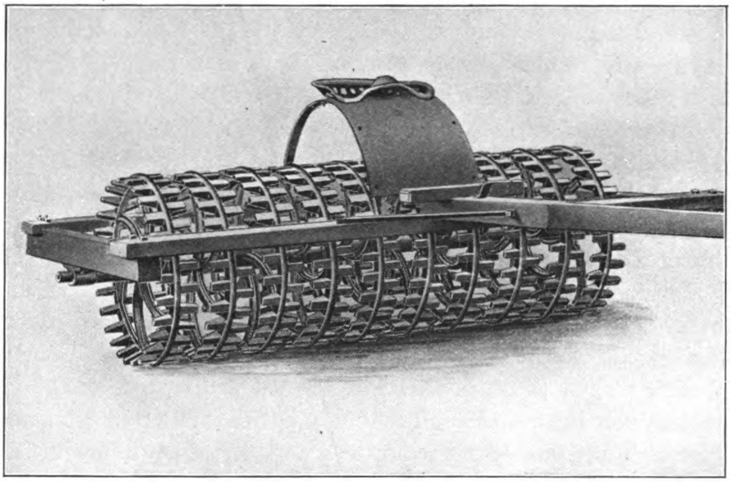


FIG. 7. McColm pulverizer and clod crusher

Water-holding capacity of the soil. The water-holding capacity of the soil is increased by this method of tillage. It enables the soil not only to take up more moisture during a rain but also to retain the moisture longer after a rain. The important point is that the loose mulch of soil over the surface of the cultivated area acts as a cover to prevent direct and rapid evaporation. The opening and loosening of the soil by deep cultivation increases its power to absorb moisture quickly.

The water-holding capacity of the soil is also increased by the fineness of the soil. While it seems a rather contradictory statement to say that the finer the soil the more water it can hold, yet this is true, because each particle of soil is enveloped by a very thin film of moisture when it is in proper condition for the growth of plants. The smaller the particles the greater the number in a given volume of soil; the greater the number of particles occupying a given space, the more surface there is exposed for this film of moisture; and the finer the soil the more tenaciously is this moisture held. This is the reason why clay soils or soils containing a considerable percentage of clay lose their moisture much more slowly than do light sandy soils. The large particles of the sandy soil allow the water to leach through as well as to evaporate more rapidly than is possible with the compact clay soils.

Implements which will be found of advantage. As before stated, a turning plow, a good subsoil plow which only breaks up the subsoil without bringing it to the surface, a disk harrow, an Acme harrow, a spike-tooth harrow, and a Meeker disk-smoothing harrow will all be found of great service in the preparation of land for trucking and market gardening. There are probably no implements better suited for surface cultivation of crops in the field than one-horse and two-horse cultivators built after the Planet Jr. and Iron Age models. Those implements which do best work stir the surface only and have numerous narrow teeth rather than a few broad ones. The efficiency of surface cultivation lies in breaking up the crust as soon after each rain as the ground can be cultivated, or as soon as there is the slightest tendency to form a crust. The formation of crust indicates that direct evaporation from the soil, which is undesirable, is going on. Cultivation, then, should follow immediately upon noting these conditions. The end to be attained in cultivation is not only the destruction of weeds but the conservation of the soil moisture by the maintenance of a soil mulch. Cultivation should at all times be conducted so as to expose a minimum of soil surface to the action of sun and air; this can be secured only by level culture. Cultivators which leave the land in ridges, or methods of cultivation which tend to ridge or "bed up" the land, expose a much greater portion of it to the action of the sun and air than do the level methods. One square rod of soil, if it lies perfectly flat, has only one square rod of surface exposed to the action of the wind and sun. But suppose that the same area is raised into ridges six inches apart and six inches high; by computation it will be an easy matter to determine the exact increase of area over this plot, and it will surprise one to find how much more surface of the land is actually exposed under these conditions than when it lies perfectly flat. In fact, it is possible almost to double the surface exposure of land by throwing it into such narrow ridges. Since the object of surface cultivation is the preservation of moisture, the more nearly the area can be made to approach a perfect plane the better.

Artificial means of modifying the soil. Beside the mechanical benefits derived from culture and drainage, quite as important physical modifications can be produced by the addition of organic matter to the soil through turning under heavy crops for green manure. In those districts where cowpeas, crimson clover, vetch, and clover can be used for this purpose the fertility of the soil can be decidedly increased at the same time that its physical character is modified by plowing under these crops. Under conditions which permit the use of soil-improving crops only during the winter, crimson clover or rye will serve a useful purpose; while the rye adds no fertility, it will prove of great value as a means of increasing the humus content of the soil.

The effect of turning under large quantities of green manure or coarse stable manure is to modify the physical character of the soil. Heavy soils become more friable, more easily worked, and somewhat darker in color. Light sandy soils are equally benefited by such treatment. The addition of organic matter makes them more retentive of moisture, less liable to erosion, and better able to hold and withstand injurious effects of heavy applications of chemical manures. In fact, decaying vegetable matter or humus seems to be Nature's great restorative for all soil ills. In cases where continuous heavy applications of high-grade chemical fertilizers have produced injurious effects on crops, the plowing under of green crops and the use of lime quickly restore the soil to its normal cropping capacity.

Requirements for germination. There are three necessary factors for the germination of seed: heat, moisture, and air (or oxygen). Given any two of these without the third, seeds will not germinate. In any humid region these three factors are usually present during the growing period. The one which is most apt to be lacking is a proper amount of moisture, and this leads to the statement that while these three factors are essential, they must be present in definite relations to one another. For certain seeds it is necessary that the soil be only slightly warm, while for other seeds it is necessary that it be comparatively hot. It is also necessary that the moisture be present within certain limits; that is, the soil must be neither too wet nor too dry. There is, then, a certain definite relation existing between these three essentials. If the soil is too moist it contains, as a rule, a deficient amount of air, so that the removal of moisture and the application of heat tend to increase the amount of air in the soil. The changes which occur during a single season in the relation between these different factors — heat, moisture, and air — give us a clew to the reason why certain crops do best when planted early in the season and why others do best when planted late in the season, when the moisture content of the soil is comparatively low and heat is high. In general, we know that such plants as lettuce, radishes, cabbage, cauliflower, spinach, etc. grow best during the cool, moist parts of the year. Hence spring and autumn, during which these conditions are most prevalent, are the normal seasons for the growth of these plants. Such plants as tomatoes, eggplants, corn, and beans, however, require a higher degree of heat and do best if planted later in the season, after the soil has warmed up. Under artificial conditions in the greenhouse and in the hotbed, the gardener has these factors almost entirely under his control. If he has a greenhouse, the heating plant can be operated so as to maintain the degree of heat desired. Water can be applied or withheld to give the proper humidity to the soil, and as the amount of water in the soil determines very largely the amount of air, the water displacing the air, the proper balance between these two factors can easily be maintained. Under field conditions, however, water is practically the only factor which can be controlled. Irrigation provides a way of supplying a lack of moisture, and tile draining serves as a means for carrying off any excess of moisture. Indirectly irrigation and drainage influence soil temperature as well as its air and water content. Drainage by removing excess moisture renders cold, late soils earlier and otherwise more congenial for plant growth.

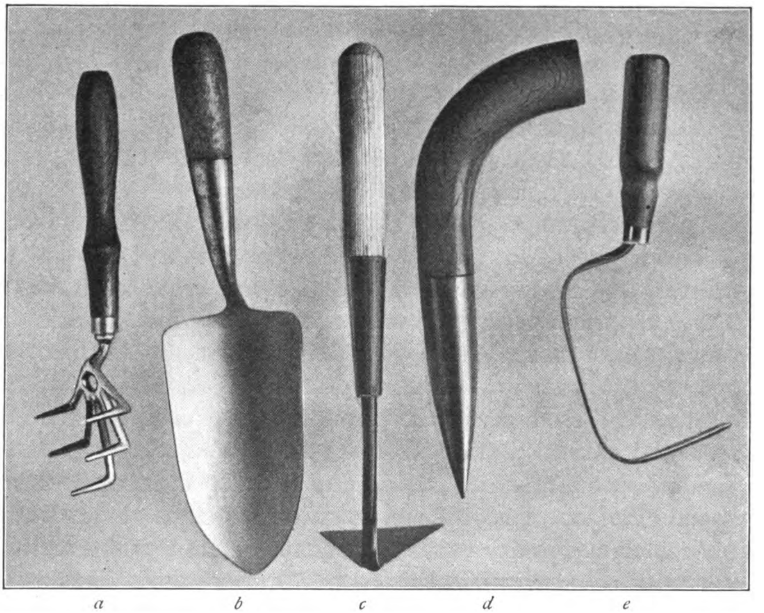
Seed sowing. Seeds are sown by machinery whenever practicable. In planting certain crops, such as squashes, it is not possible to use machinery, but with such crops as spinach, beets, radishes, turnips, and all of the small seed crops, which are planted in drills, it is much cheaper and more satisfactory to plant them by machinery than by hand. If very accurate results are desired, however, it is never safe to depend on machinery. Where careful experimental records are to be taken into consideration, it is necessary to plant the seeds by hand.

In seed sowing one must be thoroughly familiar with the requirements of the crop in hand. Some seeds must be sown deep while others should scarcely be covered. The depth to plant is governed by the nature of the crop and by the size and vitality of the seed. Whatever the depth of planting, the object in covering the seed should be to bring the soil into close contact with the seed as soon as it has been planted. This is of special importance in localities where precipitation is scanty. The tendency of the seed drill is to open the furrow and allow the earth to fall loosely over the seeds after they have been dropped. The soil then becomes compacted and closely surrounds the seed only after a considerable length of time, unless some mechanical means is resorted to for compacting the soil over the seed. Appreciating the importance of compacting the soil by artificial means, Peter Henderson first demonstrated such an operation by the illustration of a man walking from end to end of a row, after the seeds had been scattered and covered by hand, placing one foot directly in front of the other. This tramping of the soil immediately over the seeds accomplished what has been insisted upon under the discussion of subsurface packing of the soil; that is, it restored the capillary relations between the surface layers of the soil and those immediately beneath it, so that a direct current of water was established between the lower layers and the surface of the soil, thus bringing the earth close to the seeds, and the water where the seeds could immediately absorb it. Under these conditions, even in the driest places and during protracted droughts, seeds can be made to germinate readily and a good stand of plants can be obtained. This compacting of the soil, which was illustrated by Henderson, has been taken advantage of in the manufacture of seed drills for garden as well as for farm operations. Such drills are provided with a wheel or roller following the drill point. The roller or wheel is flat or concave, so that the soil over which it passes is compacted over the seed. Sometimes the press wheels are made very narrow, while in other cases they are as much as 3 inches wide. The width is determined by the diameter of the wheel, the load carried by the drill, and the crop planted. Grain drills used in agricultural practices are provided with narrow wheels placed immediately behind each drill tooth. These have considerable weight and compact only a very narrow strip of the soil over the seeds. Such drills are called press drills. The seed drills used by market gardeners are provided with a following wheel, usually having a concave surface. This wheel is about 6 or 7 inches in diameter with a surface 2½ to 3 inches wide and has considerable weight. These operations are of much more importance than is generally supposed, and it is worth one's while to carry on some demonstration tests to prove the value of the different methods of covering and treating the seed at planting time.

Thinning. Crops which are grown in the open from seed sown in place are usually planted much too thick, in order to secure a proper stand of plants. It is necessary, therefore, to thin them in order to give room for full development. This thinning is done not only to give the plants an opportunity to expand their leaves properly but also to provide them with a sufficient area from which to gather food. Thinning should therefore be done as soon as possible after the plants are up, in order that those which are to remain shall not, in any way, be hampered in their growth by the competition of plants which are later to be eliminated. This early elimination prevents the wasting of the available food of the soil, because the food which has been taken up and used by the plants which are afterwards destroyed is lost so far as that season's growth is concerned.

Thinning is accomplished in various ways according to the crop. There are several implements designed as weeders which serve the purpose of thinning or chopping out. The thinning of cotton is generally done with a broad hoe and is called "chopping out." With beets, which are to stand much closer than cotton plants, chopping out is also practiced, but it is generally done with a narrow hoe. Sugar beets, garden beets, and onions are usually thinned by hand or with a small hand implement similar to that shown in figure 8, *c* or *e*. The thinning of spinach, called "spooning out," is almost always done with an iron spoon (see Spinach).

Transplanting. For various reasons, such as the long season required for growing, the great cost of seed or of thinning, several of the important vegetable crops are managed most advantageously by sowing the seed in specially prepared beds, either in the open or under glass, and transferring the young plants, at the proper



a *b* *c* *d* *e*

FIG. 8. Hand tools

a, weeder (rake type); *b*, trowel; *c*, weeder (hoe type); *d*, dibble (steel tipped); *e*, weeder (double edged)

season, to their permanent location. This is accomplished in a number of ways. Hardy plants like cabbage are sown in drills a few inches apart in specially prepared beds in the open. At transplanting time they are carefully loosened and lifted with a spade or other implement. They are then assorted, placed in baskets, and carried to the field, where they are puddled and set either by hand with a dibble like that shown in figure 8, *d*, or by means of a transplanting machine.

Plants of cucumbers and muskmelons are often started in hotbeds or cold frames several weeks in advance of the normal time for planting in the open. The seeds may be planted either in squares of sod placed grass side down in the hotbed or cold frame, or in wooden boxes such as are used for marketing berries. Paper pots, earthen pots, and old tomato cans with tops and bottoms melted off may be used as receptacles for growing plants to be transplanted to the field.

Often cucumber, melon, tomato, and other plants are grown in place in the soil of the hotbed or cold frame, and at transplanting time are removed to the field in balls of earth containing the roots of the plant, cut out with a ring of galvanized iron or tin of suitable size. By slipping a spade or thin paddle under the ring after it has been pressed into the earth to the desired depth, the whole can be easily lifted and transferred to a suitable carrying board. In the field the plants are slipped out of the metal rings into holes prepared in the soil at proper intervals; the rings are then returned to the seed bed for a new supply of plants.

Setting plants in the field. It frequently happens that the plants in a seed bed, particularly tomatoes, cabbage, eggplants, and others of a like nature, grow taller than is desired. In transplanting these to the field it is usually advisable to trim off the lower leaves and bury the stems for a considerable part of their length, rather than attempt to head them back. In the case of tomatoes all except the topmost leaves can be removed, and the stem buried to the same depth that the general root system is buried, say 4 inches. This treatment is of real advantage to the plant because the stem throws out additional roots along the whole section buried, so that the root system of the plant is increased by the length of stem placed under the surface of the soil. With properly grown plants, however, these makeshifts are not necessary; and with cabbage, cauliflower, kale, etc. of proper size the plants can be set very rapidly by the use of a dibble if the roots have been puddled.

The dibble, as understood by gardeners, is simply a pointed implement made of either wood or steel. It may be straight or curved, or it may be provided with a D-handle similar to that of a spade. The character of the implement will depend largely upon the nature of the soil in which it is to be used. If the soil is sticky, as are many alluvial soils containing large amounts of organic matter, and does not compact readily but adheres to implements, it is necessary to use a steel or metal-pointed dibble. If the soil contains a large percentage of clay or sand, the dibble may be simply a sharp stick.

In setting plants with a dibble one precaution should be observed. After an opening in the soil has been made by inserting and withdrawing the dibble, the plant should be established, not by compressing the soil around the base of the plant with the thumb and fingers, but by inserting the dibble at a distance of two or three inches to one side of the plant and to the same depth as the opening, and then giving the dibble a side thrust toward the plant. This operation closes up entirely the opening made to receive the plant, and places the soil in contact with the plant root throughout its whole length, while the common practice of firming the plant with the thumb and fingers leaves an unoccupied space below the point where the soil is moved by the fingers; that is, the plant is suspended in a hole. In such a position it is impossible for the active roots of the plant to come in contact with the soil and to establish themselves so that they can provide the necessary food and water; as a result the plant withers and dies. Figure 9 shows the proper use of the dibble in setting plants and also a plant set and fixed with the fingers.

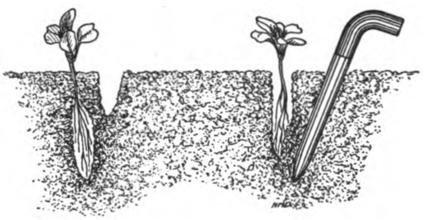


FIG. 9. Improper and proper use of dibble in setting plants

Reducing the leaf area. Another important point to be considered in transplanting, particularly in connection with plants grown in a seed bed and dibbled out, is the reduction of the leaf area. With strawberries, cauliflower, cabbage, kale, etc., which have broad, succulent leaves and which evaporate a large amount of moisture, it is desirable to make the leaf area as small as possible in order that the greatly reduced ability of the root to supply moisture may not be overtaxed. After a plant has been removed from the soil and before its roots are established, it cannot provide its leaves with the accustomed supply of moisture. The result is that the plant flags and dies; but if the leaf area is reduced so that the demands for moisture are greatly diminished, the roots will be able to establish themselves and within a few days provide the necessary amount of moisture. When it is necessary to set plants during a very dry season, it is desirable to take advantage of every precaution that will tend to lessen the demand upon the roots for water. In dry spells gardeners usually endeavor to do their transplanting from four o'clock in the afternoon to as late an hour as the workmen can see.

It is also sometimes necessary to supply water in order to insure a stand of plants. If watering is necessary, it should be done an hour or more before the plants are dibbled, so that the soil will have an opportunity to dry a little. It will then assume a better mechanical condition than would be possible if the watering were done after the planting. Watering tends to puddle the soil and to start up direct evaporation, which frequently results in more harm than good. But if the watering is done in advance of the transplanting, the roots are at once placed in contact with moist earth, and direct evaporation may be checked by sprinkling dry earth over the moistened area as the plants are set.

Transplanting devices. In order to enable persons engaged in the production of large areas of crops which must be transplanted to do the work quickly, cheaply, and efficiently, several styles of plant-setting machines have been designed. The results aimed at in the construction of all such implements are speed and economy of labor, which are secured by the use of horse power and quick-motioned boys, the efficiency depending upon the skill of the boys. The stand of plants is safeguarded by the use of water in connection with the transplanting.

The most successful plant-setting machines consist of a frame, usually mounted on three wheels, the third wheel, which has a broad, concave tire and is located under the end of the tongue, serving as a guide and roller. The other wheels are of greater diameter than the third and carry the major part of the load, which consists of a cask of water, a driver, and two boys to place the plants. A furrow is opened by a narrow two-winged plow. The operators place the plants between the two blades of the plow and hold them in proper position until the machine has moved ahead far enough to allow the earth to fall about the roots of the plants and be compacted by the firming shoes or rollers. As each plant is placed, the machine automatically discharges a small quantity of water about its roots. A machine of this type is shown in figure 11, page 46.

Depth of planting. The depth at which to plant varies with the requirements of the plants. Such vegetables as tomatoes, egg-plants, and those which readily send out roots from their stems can be set deep, but those which have a definite crown, or division, between root and stem should be set so that the crown is not forced below the surface of the earth. In this respect strawberries are perhaps the most exacting of any plants with which the gardener will have to deal. The distances at which to plant will be discussed later under each of the crops.

Growing plants for transplanting purposes. From a cultural standpoint, agricultural and truck crops raised for profit may be divided into two groups: (1) those which are grown from seed planted where the crop is to mature; and (2) those grown from seed placed under special conditions and transplanted to the field when the soil and atmospheric conditions will allow such exposure. Among the crops which are extensively handled in artificially prepared seed beds are the following: cabbage, onions, beets, sweet potatoes, celery, tobacco, tomatoes, peppers, and, less extensively, sugar cane and cassava — the last two being crops which are grown by transplanting, but for which no special seed beds are prepared. With all of these crops the time and method of transplanting to the open, as well as the resistance of the crop to cold, determine to a large extent the type of seed bed in which the young plants are grown. For instance, cabbage, for the early crop at the South, is sown in September for transplanting to the field in December; while at the North seeds are sown either in cold frames in September and wintered under cover, to be transplanted to the open early in the spring, or in the greenhouse or hotbed in March. In the case of onions of the Bermuda type, it is the common practice in Texas to sow the seed in September or October in specially prepared seed beds, which can be irrigated, and to allow the young onions to grow until sometime in December, when they are transplanted to the field. At the North all the onions which are transplanted for field purposes are grown in cold frames or hotbeds, the seed being sown early in February or March and the young plants placed in the open after the soil has become thoroughly warmed and in a high state of cultivation.

Beets are less extensively transplanted than the two crops just mentioned, but in some localities they are sown in cold frames in the fall, to be planted in the field early in February or March.

The sweet-potato plant is less resistant to cold than the cabbage, onion, or beet and is grown, not from ordinary seed, as these plants are, but from the roots which have been held through the winter in suitable storage buildings. In the Northern states these roots are started in manure or fire-heated hotbeds in order to force them into growth for planting in May of the succeeding year. At the South this crop is handled in a different manner. It is sufficient in certain localities to leave a part of the last year's field undisturbed, so that the roots will throw up plants for the succeeding year. After these plants have developed to some extent, the young shoots are detached and used as cuttings to add to the plantation. With the long season at the South this method is perfectly feasible and makes the production of this staple crop cheap and satisfactory.

This illustrates the influence which locality has upon the methods followed in propagating plants which of necessity must be multiplied artificially.

Making a fire-heated hotbed. A fire-heated hotbed, such as is used at the North for the propagation of sweet-potato plants, may be made somewhat as follows: Select a sloping piece of land which is well protected from the cold winds of February, March, and April, with a southern exposure if possible. The general slope of the land should be such as to allow building a furnace sufficiently large to receive 4-foot wood without sawing or cutting. From this furnace carry a brick or sewer-pipe flue through a portion of the area which will form the chamber beneath the floor of the hotbed. Arrange supports for the floor high enough above the furnace to prevent the floor from catching fire, and brick or board up the sides so as to make a tight compartment. Carry the flue to such a distance that no sparks from the fire will be thrown out into the space beneath the floor and so that the smoke will be dissipated throughout the whole compartment. At the end of the frame, opposite the furnace, erect a board flue which will act as a smokestack to remove the excess combustion. This should be provided with a damper. The floor of the hotbed is then constructed so as to be about 1 foot from the ground at the flue end and about 3½ feet from the ground at the furnace end. The frame may be made from 12 to 18 feet wide and from 60 to 100 feet in length. In some instances such beds have been made 200 feet long, but it is usually better to limit the length to 100 feet or less, as there is a better distribution of heat at this distance. About 4 inches of clean sand should be placed on the floor, and in this the seed potatoes should be bedded so that they will not touch each other. All that is necessary is to have the roots actually separated from one another.

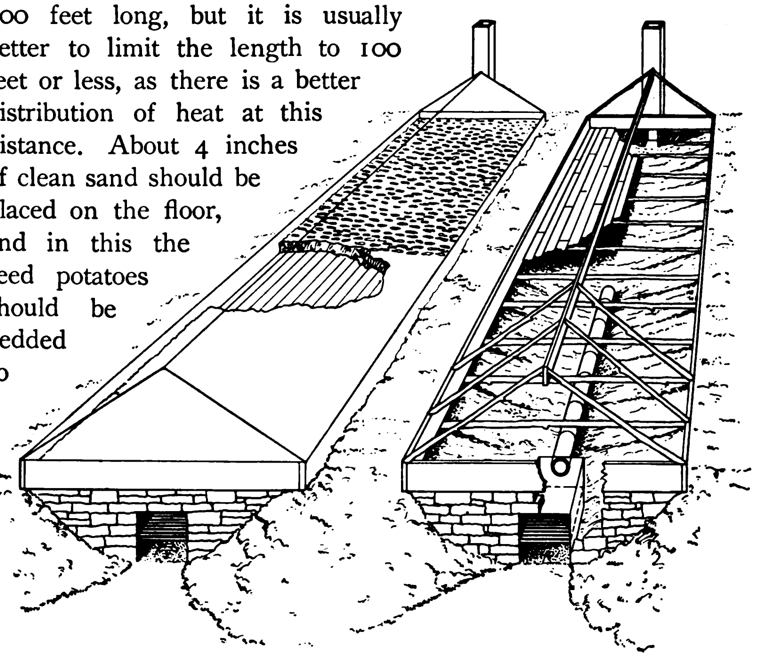


FIG. 10. Fire-heated sweet-potato bed
Showing general plan and detail of construction

Rafters with a ridgepole, or a ridgepole with thin sawed strips sprung over to form a support for muslins, will be sufficient to protect the sweet-potato bed. Manure hotbeds for sweet potatoes are covered with sash the same as hotbeds intended for the germination of ordinary garden seeds. It is necessary to provide slightly more head room in the case of beds built for starting sweet-potato plants than in those intended for garden vegetables.

The provisions necessary for the growing of sweet potatoes at the North are the most elaborate required for any extensively grown truck crop except tomatoes. Figure 10 illustrates very well the general appearance of a sweet-potato bed constructed according to the plan outlined above.

Celery. While celery is extensively grown in certain parts of California, Ohio, Michigan, New York, and Florida, the plants are usually started in beds in the open. For some of the extremely early crops at the North it is necessary to start plants in greenhouses or hotbeds, but for the main crop it is sufficient to sow seed in the open, in rows or broadcasted in specially prepared beds. In some cases the plants must be transplanted before being finally set in the field. Ordinarily, however, when celery is grown on an extensive scale, the plant bed is simply sheared or gone over with a light mowing machine in order to reduce the top surface, and then with a special digging machine the plants are lifted and immediately set in the field, usually by hand.

Tobacco. As a rule tobacco is grown in much the same way as celery. The common practice in some of the extensive tobacco-growing regions is to place brush or other combustible material over the area which is to be used as a seed bed, and to fire this early in the season so as to destroy the weed seeds and warm up the soil. This provides suitable conditions for the germination and growth of the tiny seeds of this plant. In some cases it is only necessary to provide a sheltered place for the seed bed. Sometimes sash are used, but generally the seed bed is made in the open in a place convenient for watering and weeding, and the plants grown without special attention to transplanting until they are large enough to be lifted and placed in their permanent location in the field. In regions where tobacco is the staple crop, particularly at the North, transplanting is carried on by machinery, which greatly facilitates the work and materially reduces the cost. There are several types of transplanting machines, among which the one shown in figure 11 is a fair representative.

Machinery for transplanting. Sweet potatoes, tomatoes, and tobacco are the three crops which are most extensively planted by machinery at the present time. The feasibility of handling cabbage in this way is receiving attention by the extensive growers because of the difficulty, in the trucking region along the Atlantic coast, of securing sufficient hand labor to deal with the extensive crops which are now being grown. Up to the present time, however, the immense quantities of cabbage produced have all been transplanted by hand, as have the onions and beets which have been subjected to this type of cultivation. It is probable that machine transplanting will never be used for onions and beets because of the limited space between the individual plants and the proximity of the rows in which they are set. But when the space between

FIG. 11. Transplanting machine in operation

the individual plants is eighteen inches and the distance between the rows is great enough, as in the case of cabbage, sweet potatoes, tobacco, tomatoes, and peppers, it is perfectly feasible to use machinery for transplanting.

Truck farming has reached a stage where it is necessary to take advantage of every means to reduce the cost of production, and a mechanical transplanter is one of the factors which is bound to play an important part in the reduction of the cost of producing cabbage. It is as well suited for handling cabbage as sweet potatoes and tobacco. Celery, while grown with sufficient space between the rows to admit of using the transplanter, is set so closely in the rows that it may never be feasible to transplant this crop by machinery. In fact, many delicate plants require special attention and are more or less exacting in regard to handling; they will always have to be transplanted by hand. It should be perfectly feasible to transplant sugar cane and cassava with the machine, although up to the present time these crops have never been handled in this way.

Commercial production of plants for transplanting purposes. Truck farmers and market gardeners, as a rule, plan to grow their own plants for transplanting to the field. It frequently happens, however, that through bad seed or adverse conditions the stock of plants is insufficient or is entirely lost. If no other plants were obtainable the farmer or gardener would be obliged to devote the whole or a part of the area intended for that particular crop to something else. The demand for crop plants by growers who have suffered such misfortunes has, during recent years, led a few individuals to make a business of growing such plants on an extensive scale.

Large enterprises of this character now exist near Baltimore, Maryland, and Charleston, South Carolina. The managers of these industries maintain extensive seed beds, both in the open and under glass, in order to be prepared to meet the demand for plants for the garden or truck farm at all seasons and in any quantity. One firm operating a business of this character annually grows from 4 to 5 acres of cabbage plants, from 4 to 6 acres of celery, and large areas of tomato, beet, pepper, and asparagus plants; besides these some 2 acres under glass are used for the propagation of ornamental bedding plants. Such firms do a wholesale business exclusively, and while well known in the trade are little known to the public outside of truck-farming districts. One of the plant producers located in an especially favored section on the South Atlantic coast conducts a business which enables him to supply cabbage plants in carload lots. Six years ago this grower met the demand for cabbage plants from 60 pounds of seed sown on 2 acres. At the present time he uses over 1 ton of seed on about 70 acres of land. Extensive growers are able to produce plants under favorable conditions at very low cost, and in many localities it has come to be the practice of the growers to depend upon the "plant man" for their annual supply. In fact, it is frequently not a question of preference but one of economy. Growers conducting intensive cultivation on expensive land with high-priced labor can better afford to purchase plants than to grow them. The special rates and quick transportation facilities now available to plant growers will tend to build up this important accessory to truck farming. It cannot be denied that to be able to purchase plants to make up a shortage or to replace those lost through misfortune or poor seed is a great advantage to the market grower.

Fertilizers. In market-garden work and in agriculture the terms "fertilizers" and "manures" are usually synonymous. A fertilizer or manure may be defined as any substance applied to the soil which increases the soil's supply of available plant food. There are two classes of such manures: (1) those which add to the sum total of the plant food in the soil, such as stable manure, green crops plowed under chemical fertilizers which contain nitrogen, phosphoric acid, and potash; (2) manures which by their chemical action upon the soil make available an increased amount of the plant food already contained in it. The latter act in the way of a stimulant rather than as a true manure, yet, according to the definition, they are just as much manure or fertilizer as is any substance which increases the actual quantity of available plant food in the soil. Such fertilizers as land plaster, lime, salt, etc. belong to this class, since they add nothing to the sum total of the plant food in the soil, but by their chemical action render available an increased amount of the existing plant food.

The action of fertilizers on the growth of plants is determined by the predominance of one or another of the three important elements which usually make up a fertilizer, namely, nitrogen, phosphoric acid, and potash.

Nitrogen. Nitrogen, which, in stable manure, is in the form of ammonia, and in commercial fertilizers may be in the form of dried blood or other animal products or nitrate of soda, is the most active principle in all our so-called manures or fertilizers. This particular ingredient stimulates leaf growth, intensifies the green color of most plants, and has a tendency to promote an abnormal growth of herbage and to delay maturity. For lettuce, spinach, cabbage, and leafy plants in general, where it is desirable to get a large quantity of herbage, nitrogen is a most important manure.

Phosphoric acid. Phosphoric acid is one of the most essential ingredients of the soil and, at the same time, one that is most often lacking. Phosphoric acid is intimately associated with the growth of the stems and roots and with the development of the seed of nearly all plants. In most of the commercial fertilizers prepared for the use of truckers or market gardeners, phosphoric acid is the leading or important constituent. It is generally used in larger proportions than either nitrogen or potash. Since it is intimately associated with the process of seed production, it is an important fertilizer to be used in connection with beans, peas, and all crops in which seed production is the end sought.

Potash. Potash, the third element of plant food, is less apt to be lacking in soils than either of the other two. It ranks next in importance to phosphoric acid and is intimately associated with it in the work of producing stems and seeds. Potash, as a rule, has a tendency to counteract the work of nitrogen in that it tends to hasten maturity rather than to continue growth. This is particularly true of the muriate of potash which is prepared by treating crude rock with hydrochloric acid, making it potassium chloride instead of potassium sulphate, which results when the crude salts are treated with sulphuric acid. Both forms of potash are available and are used by truckers to a considerable extent. Potash can be obtained as high-grade sulphate or muriate of potash, each of which carries about 50 per cent of available potash; or it may be obtained as kainite, a low-grade salt carrying about 14 per cent potash. The high grades cost much more per ton, but, on account of the greater amount of potash which they carry, they are in reality cheaper. Where large quantities of potash must be applied, it will be found safer to use the sulphate.

Stable manure. While stable manure must be looked upon as the most complete and desirable form of plant food, yet, unless very carefully handled, it is frequently deficient in nitrogen and phosphoric acid. In truck work the aim should be to supply any deficiency which may exist in the stable manure used; that is, the stable manure should be supplemented by the addition of a small percentage of nitrogen and of phosphoric acid.

How to apply manure. When coarse, only partially decomposed manure is to be used, it is best to apply it either in the fall or early in the spring and plow it under; but when well-decomposed stable manure is available, it should not be applied until after the rough ground has been plowed and harrowed. Stable manure has the decided advantage over chemical manures, not only of being an almost complete fertilizer in itself, but also of having a most beneficial mechanical effect on the soils to which it is applied. This mechanical effect cannot be obtained by chemical manures, for they add nothing in the way of organic matter to the soil. Stable manure, however, adds to the soil a considerable amount of organic matter, which tends not only to change the color of the soil somewhat, but to lighten it, making it warmer, more retentive of moisture, and capable of better drainage. For many soils these mechanical and physical effects are of quite as much importance as are the fertilizing ingredients themselves. It is never a good policy in truck farming to rely upon artificial or chemical manures alone. They should be supplemented to the fullest possible extent by stable manure and by plowing under green crops, such as cowpeas, rye, buckwheat, etc. The rule should be to keep the soil always covered by a crop, no matter if it is necessary to plow it under within a few weeks after sowing.

Irrigation. The importance of a controllable water supply has already been pointed out. It is absolutely necessary in greenhouse and frame work and is of much more importance in outdoor operations than is generally realized. Irrigation is essential to crop production in arid regions, but in humid sections it has not been considered necessary for most crops. Irrigation or a controlled water supply is one of the greatest crop insurances that can be provided even where humid conditions prevail. It often happens that a single irrigation at just the right time will save a crop, prolong its harvest period, or safeguard it against frost. In humid regions irrigation is a form of insurance to be used in case of accident.

Two methods of applying water are open to the vegetable grower: the *sprinkler system*, which has many modifications and adaptations, and the *furrow system*. Flooding is seldom employed in truck farming, the one notable exception being in Texas in connection with the seed beds for Bermuda onions.

The sprinkler system. This system of irrigation requires the water to be carried in a closed receptacle under considerable pressure. This pressure can be secured by the use of a standpipe or elevated tank, or by pumping directly into the mains. The distribution of water by means of a "rose sprinkler" attached to a hose is the simplest form of a sprinkler system and is extensively employed in the frame culture of cucumbers, beets, radishes, and plants not injured by overhead watering.

A sprinkler system that can be used in field practice was developed about 1900; this was based on the use of large eddy-chamber nozzles, each capable of sprinkling one square rod. The nozzles are so distributed that the area to be wet is entirely covered. Since the capacity of the nozzles, under forty pounds pressure, is one inch per hour, the system is highly efficient and well suited for crops that may be so watered. This plan is one of the best for irrigating lawns. The pipes can be laid at the time the lawn is made and the nozzles placed on a level with the surface so that the lawn mower will pass over them. The system is efficient and not an obstruction or an eyesore.

One of the earliest sprinkler plants with which the writer is familiar consisted of long lines of perforated gas pipe attached so as to be rotated, and supplied with water under pressure. This device was designed by a private gardener for watering a strawberry bed. The pipes were set near the surface of the ground and so arranged that by changing the angle from time to time the bed could be watered on either side of the line of pipe as far as the jet of water would carry. This idea has been modified at various times and is now made the basis of one of the systems in common use. Instead of having a simple perforated pipe, small nozzles of various designs are fitted to tapped perforations, and the supply pipes, instead of being placed on the surface of the ground, where they interfere with cultivation, are placed on posts high enough to be out of the way. This system is used in greenhouses as well as in extensive field operations. It is a favorite plan of watering with cultivators who use muslin-covered frames. It is economical of water and is satisfactory for many crops.

The muslin hose. A simple but useful method of wetting seed beds and certain plants, where the water supply is not under high pressure and where the furrow method cannot be employed, consists in using a muslin hose. This is merely a tube of the desired length made by sewing the two edges of a strip of muslin about nine inches wide together. Such a tube should be thrown down along the line of the plants to be watered, and a flow of water under sufficient head to fill the tube should be supplied. If a seed bed is being moistened, the tense tube can be rolled over the bed from side to side, and the water which oozes through the meshes of the cloth will moisten the bed sufficiently. This plan can be adopted for small plants in rows as well as for seed beds; in fact, it is sometimes used to irrigate celery.

The furrow system. Crops, such as head lettuce and celery, which will not permit the use of water on the foliage can best be irrigated by the furrow system. This does not require water under pressure, but the land must be carefully graded and leveled and the rows run so as to lead the water at a uniform rate of flow from one end to the other. To irrigate by this system it is necessary to have head ditches on the highest ground, from which water can be drawn by diversion dams or by pipes or lath boxes inserted in the bank of the head ditch to supply the furrow between the row of plants to be watered. As a rule, a small stream of water flowing slowly through the furrows is more effective than a large volume of water flowing quickly. The furrow plan is adapted only to field operations and is essential for only those crops which will not tolerate overhead watering or for those which suffer severely from blights and rots developed by the presence of moisture on the leaves. The most annoying pests of this character are celery blight and cucumber mildew.

In intensive industries where valuable crops are being grown, irrigation is a most important factor and should be considered as a regular part of the equipment in the culture of certain crops.

Subirrigation. Subirrigation, as the name implies, is the method of applying water beneath the surface of the soil. This system of watering is used to a limited extent. It is employed in a few greenhouses devoted to the culture of lettuce, and in a few gardens where intensive cultivation is practiced. It is economical of water, places the moisture where it will serve the plant best, and is of special advantage for plants susceptible to leaf diseases. A variety of devices are used to carry the moisture into the soil. The most common is drain tile placed in a carefully graded ditch or furrow under the row of plants to be watered. The openings at the joints, as well as the porous nature of the tile, allow the water to escape into the soil. The precaution to be taken in the installation of this system is careful grading of the lines of pipe so as to insure an equal distribution of the moisture. A plan for subirrigating greenhouse beds is described and illustrated in figure 26, page 80.

The grower can ill afford to overlook or neglect any factor of crop production which increases his risk. The relative importance of factors of safety, such as cold frames, muslin-covered frames, fertilizers, irrigation, insecticides, and fungicides, will vary with the crop and locality. In one section frost protection will be the controlling factor, in another water, and in still another protection from disease may be the measure of success. The wise grower will soon determine the limiting factor for each crop in his locality.

CHAPTER IV

FORCING AND FORCING STRUCTURES

Definition of forcing. The term "forcing," as used in horticulture, means growing plants out of season. Artificial conditions produced during the winter for the purpose of imitating the conditions under which tropical plants normally grow cannot be considered forcing; but when such crops as lettuce, cucumbers, radishes, and tomatoes are grown out of their normal season and environment, the crop is then being forced. The forcing industry is seldom made a special line of work by market gardeners; as a rule it is an adjunct to floriculture, truck farming, or market gardening, usually the last. The industry is confined to comparatively few crops and to those sections where severe winter conditions prevail and where extensive markets which will take a high-priced product are accessible. One of the most important forcing centers of the United States is in the immediate vicinity of Boston.

Crops which are forced. The vegetables most often forced are: (1) lettuce; (2) tomatoes; (3) cucumbers; (4) radishes; (5) cauliflower; and (6) beans. Slight attention is given to muskmelons and eggplants, and still less to asparagus and rhubarb. The forcing of mushrooms is of considerable importance in America, where climatic conditions do not admit of growing them successfully in the open. To meet the needs of the forcing industry special varieties have been developed which thrive well when grown in a forcing house, but which are not adapted to out-door conditions even in this country.

Since the operations carried on in a forcing house are necessarily limited in extent, they must be made as intensive as possible; that is, the greatest quantity of product as well as the maximum number of crops must be secured from a given area in the shortest possible time. It is not feasible at this point to give specific cultural directions for the handling of the various crops which are grown in forcing structures, but this subject will be considered under the general management of the different crops. However, some attention can profitably be given here to forcing structures and their management.

Forcing structures. Forcing structures are of two types — temporary and permanent. The hotbed is the simplest forcing structure, but is usually a temporary affair and cannot be looked upon as more than a side issue in market gardening or trucking. It may, however, be advantageously used for lengthening the season, for

FIG. 12. Commercial cold frames properly arranged for cucumbers

bringing on a crop in advance of its normal season, or for growing a very short-season crop like lettuce or radishes.

Cold frames. As the name implies, cold frames are sash-covered frames without heat. The application of heat transforms them at once into hotbeds. While cold frames can hardly be accorded the dignity of forcing structures, yet they play an important part in the protection of plants in autumn and spring, as well as during the winter. In some important Southern crop-producing areas cold frames are the chief reliance of the growers.

Commercial cold frames are constructed, as shown in figure 12, by placing parallel boards with space enough between to carry standard hotbed sash; that is, six feet apart and any multiple of three feet in length. The crop to be protected should be planted in the open in such a way that when cold weather approaches, the boards may be put in place and the area covered with sash. If the crop is to be grown in the spring instead of in the autumn, seed is not planted until the side boards are arranged and the sash is ready to be put in place. If cucumbers or beets are planted, both the sash and the boards are removed as soon as all danger from frost has passed, so as to give the crop the entire use of the area, as shown in figure 13.

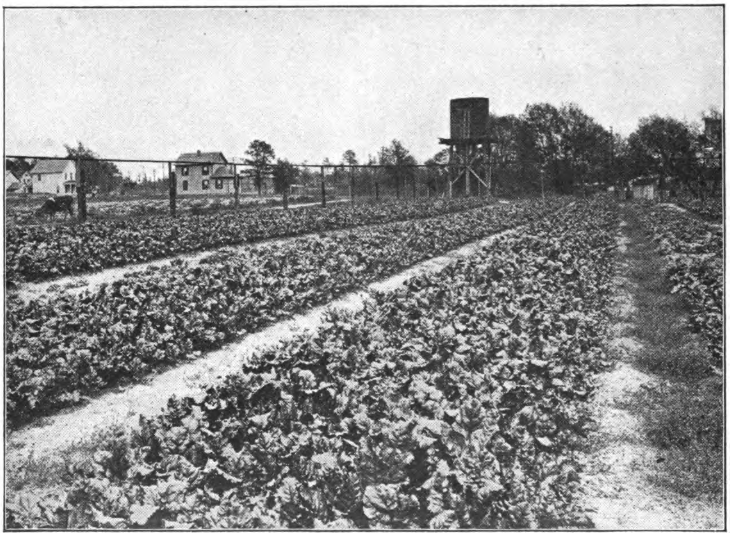


FIG. 13. Early beets after the frames have been removed

Muslin frames. Muslin frames have the same general style of construction as that described above, except that the side boards are arranged from fourteen to fifteen feet apart, and the inclosed area is protected by the use of muslin instead of glazed sash. Such frames can be used only where the frosts are light and where the main object is to protect the crop from injury by storms, wind, and frost. In certain sections this method of protection is extensively employed. Muslin frames combined with adequate means for irrigation form a most satisfactory crop insurance in several of the vegetable-growing areas of the South.

Permanent cold frames. Cold frames are often more elaborate and more permanent structures than those just described. Permanent cold frames are sometimes spoken of as "pits." They usually consist of a structure, similar in design to the one shown in figure 17, placed over an excavation varying in depth from fifteen inches to four feet. Such excavations are walled up with brick, stone, or concrete, and the superstructure is often made of the same material. These permanent cold frames or pits are used for the winter storage of semihardy plants or for carrying over winter lettuce, cabbage, and pansy plants, to be used for early spring planting. All such structures are covered with standard hotbed sash, which is often supplemented by straw mats or shutters the same size as the sash.

Cold frames are built according to a variety of designs to suit the climate and the purpose for which they are intended. The convenience of permanent frames is greatly increased by the use of supports and guide strips for the sash, but these are not absolutely necessary.

Hotbeds. Hotbeds are true forcing structures. They may be used to anticipate the planting season in the spring from one to three months and to prolong the season in the autumn for the same length of time. Some short-season crops, such as lettuce and radishes, are brought to perfection in the hotbed. These structures are also used, like cold frames, for starting, in advance of the planting season in the open, some of the long-season crops which require a high temperature early in their growth. Such plants as muskmelons are often started in hotbeds, and when they require more space the frames are either raised and propped up so as to allow the plants to escape or are removed altogether.

Hotbeds, as the name implies, require some form of heat, which, in most cases, is supplied by fermenting manure.

Manure for hotbeds. The best manure for a hotbed is produced by grain-fed work animals — horses or mules. A sufficient quantity to meet the needs of the work must first be accumulated and then piled in a broad, flat heap. When it begins to heat, it should be repiled into the form required by the hotbed, care being taken to scatter the hottest portions of the mass evenly through the heap, to insure even heating. The duration of the heat will depend on the freshness of the manure, the quantity of litter, straw, leaves, or peat it contains, and the compactness and depth of the heap. Fresh manure, well composted and thoroughly packed in a deep heap, will give maximum heat.

The location of the hotbed. The hotbed should be located on a main line of travel between the house and some important outbuilding. It should be on well-drained soil and in a place not exposed to north or west winds. Other important requisites are exposure to full sunlight and nearness to an adequate water supply.

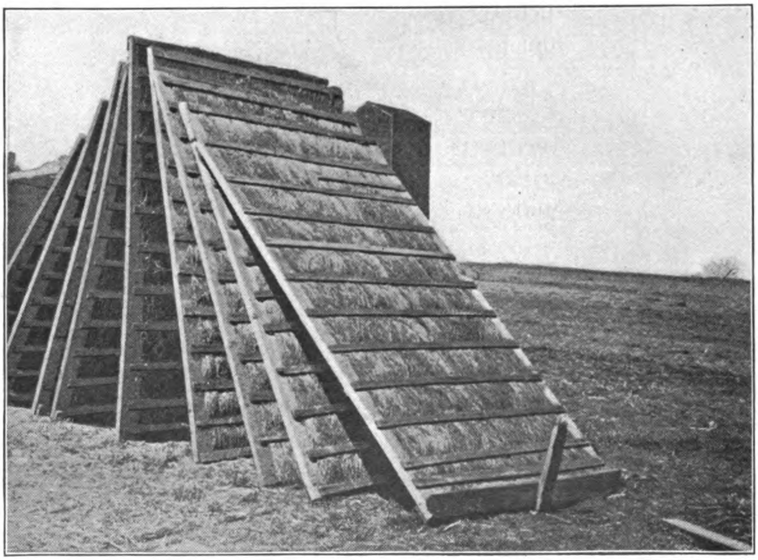


FIG. 14. Hotbed protectors made of salt hay, a substitute for straw mats

Care of the hotbed. Provision should be made for the protection of the hotbed during severe weather. This can be done by means of straw mats or board shutters or both. Straw mats are usually made from rye straw cut before any grain has formed in the heads. Strong cord is used for warp, and the straw, arranged in small wisps with the heads overlapping in the middle, is for the filler. Well-made mats are a most effective protection and if properly cared for when not in use, will last several years. A substitute for straw mats, made by packing a slatted frame about 2½ inches thick with salt hay, as shown in figure 14, is extensively used in some localities. Board shutters are usually made of $\frac{7}{8}$-inch tongue-and-grooved lumber, cleated together to form a shutter the size of the sash used.

Watering the hotbed. No single operation connected with the maintenance of a hotbed is of more importance than watering. The time and method of watering determine the growth of the plants, their freedom from disease, and the effectiveness of the hotbed. Watering should be done in the *morning* and on *bright days only*. The use of water in the evening lowers the temperature at the most

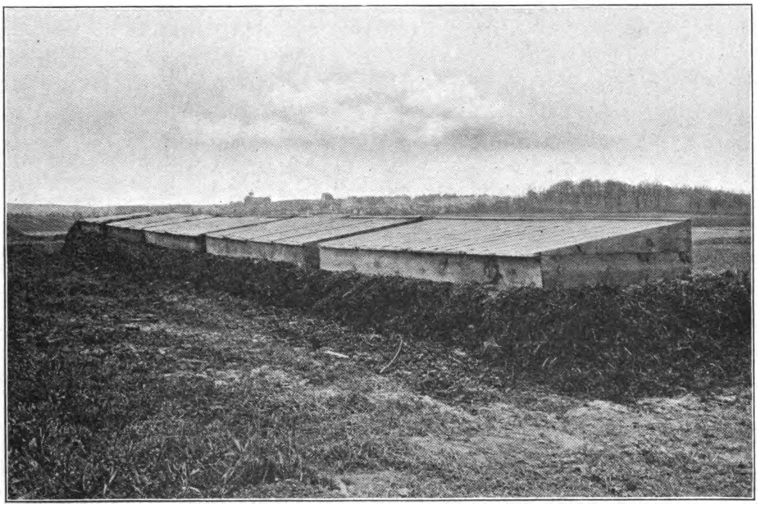


FIG. 15. A temporary hotbed

critical time of day. A moist atmosphere at night is often harmful, as it stimulates the development of disease and has a tendency to weaken the plants.

Temporary hotbeds. Hotbeds may be temporary so far as their use and location are concerned. Temporary hotbeds usually consist of a flat compact heap of fermenting manure on which a frame (see figure 15) is placed and well banked with additional manure. As soon as the frame has been placed, a layer of good compost or rich garden soil, three inches deep, is scattered evenly over the inclosed area of the frame. Then the sash are put on and the temperature is allowed to pass the maximum and begin to decline before planting is begun. As soon as the temperature has fallen to 90° F. it is safe to begin seeding.

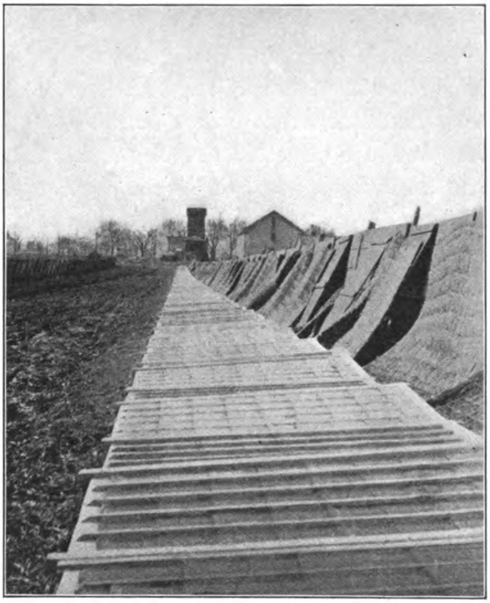


FIG. 16. Temporary hotbed protected by sash, mats, and fence

Vegetable growers as a class employ a temporary type of hotbed, which is constructed by making an excavation from 15 to 18 inches deep, 6 feet wide, and any multiple of 3 feet in length. The excavation is lined with boards, packed with fermenting material, and covered with sash and mats (see figure 16), as are the temporary cold frames so extensively employed at the South. Hotbeds of this type are used with good success by gardeners about Boston, Cincinnati, and other cities. They are simple, cheap, effective, and well suited for forcing lettuce, radishes, carrots, etc.

Permanent hotbeds. Permanent hotbeds are so called not because they are permanently or constantly heated but because a pit walled with boards, brick, stone, or concrete (as shown in figure 17) has been provided for the reception of the fermenting material. The frame for the sash may be smaller than the manure pit, or it may be a part

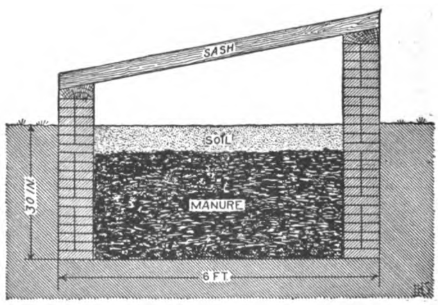


FIG. 17. Cross section of a permanent hotbed pit

of the pit wall itself. Such hotbeds may be 6 feet wide to carry one line of sash, or 12 feet wide to carry a double line, the design in all cases being such as to conform to the standard 3 x 6 foot sash. Another type of permanent hotbed is constructed to take advantage of steam or hot-water heat from a greenhouse heating plant. Such hotbeds use no fermenting material, are permanent in character, but are brought into requisition only as needed to start plants in the spring. They are used by amateur and professional gardeners handling greenhouse and bedding plants to a much greater extent than by growers of vegetables.

Greenhouse construction and management. The modern forcing structure is an immense glass shed provided with steam or hot water pipes to maintain the desired temperature, and with as light a framework as will carry the amount of glass necessary. The objects to be attained in such structures are: (1) light; (2) a proper degree of heat; (3) sufficient ventilation; (4) a certain degree of permanency; and (5) sufficient water facilities for maintaining the proper humidity.

To secure the maximum amount of light in a forcing structure, it is necessary to dispense with as much timber as possible in the framework of the building. To this end, modern greenhouse construction has reduced itself to the use of small rabbeted strips of wood, usually $1\frac{1}{2}$ or 2 inches deep by $1\frac{1}{4}$ or $1\frac{1}{2}$ inches thick, and if possible cut the length of the slope of the roof. These strips, which are technically known to greenhouse builders as sash bars, are rabbeted, as shown in cross section in figure 18, *A*, so as to carry the glass, and are placed the proper distance apart to receive glass of the desired width. The weight of the structure is lessened and the light-obscuring features are decreased by the use of gas pipes for supporting posts, as well as for purlins and trusses (see figure 18, *B*, *B*). The amount of light may also be increased by the use of wide or large-sized glass, which, of course, requires fewer sash bars and consequently results in less shading from the framework of the building. A popular size of glass is 16 x 24 inches, while many growers use an even larger size. Some put the glass in the 24-inch way, thus placing the sash bars 24 inches apart. The writer's personal preference, however, is for sash bars spaced to carry 16-inch glass, which makes a somewhat stronger roof than the wider spacing. By placing the sash bars 16 inches apart and using a 12 × 16 inch glass, the construction is made cheaper than when a 16 × 24 inch glass is used, and the same amount of framework is necessary in either case. The only feature which adds to the obstruction of light in the use of 12 × 16 inch glass is the extra lap which is necessary in the middle of each section. The 16 × 24 inch glass brings the laps 24 inches apart, while the 12 × 16 inch glass brings them only 12 inches apart.

For the roof of a greenhouse or forcing house the glass should be laid on the same plan as are shingles; but instead of a long lap, as in the case of shingles, a very short one should be made. *A proper width for a lap is from 1/8 to 3/16 inch.* Wider laps collect dirt, obstruct the light, and are much more apt to cause breakage by the freezing of moisture between the laps.

Laying the glass. Greenhouse glass should always be bedded in putty; that is, the putty should be placed in the groove of the sash bar and the glass pressed into it instead of on top of the glass, as is customary in ordinary glazing.

The old and reliable lapped-glass roof for greenhouses will probably never go out of fashion, but the cost of laying it and the tedious method usually employed have induced many to seek a substitute in other styles, such as the "butted" and zinc strip. The following method of laying lapped glass is so simple and so easily mastered, by even an unskilled laborer, that it cannot fail to meet a much-felt want: If the work is to be done during cool weather, which is not desirable, choose a warm room, and upon a table about 2 feet high arrange a board much like the kneading board used by a pastry cook. This should be wide, smooth, and perfectly flat. Warm a quantity of putty, say 5 or 8 pounds, sufficiently to make it soft and pliable, but not sticky. With the hand spread the putty over the board in a layer of uniform width and of a length as great as that of the glass to be used, and with a section of 3- or 4-inch vitrified sewer pipe, as a rolling pin, roll the putty into a thin layer about 3/16 inch thick. Then with the glass held as shown in figure 19, that is, with the ends firmly grasped in the hands, the convex side turned away from you and the edge about 1/4 inch back from and parallel with the edge of the putty, press the glass through the putty so as to cut off a narrow

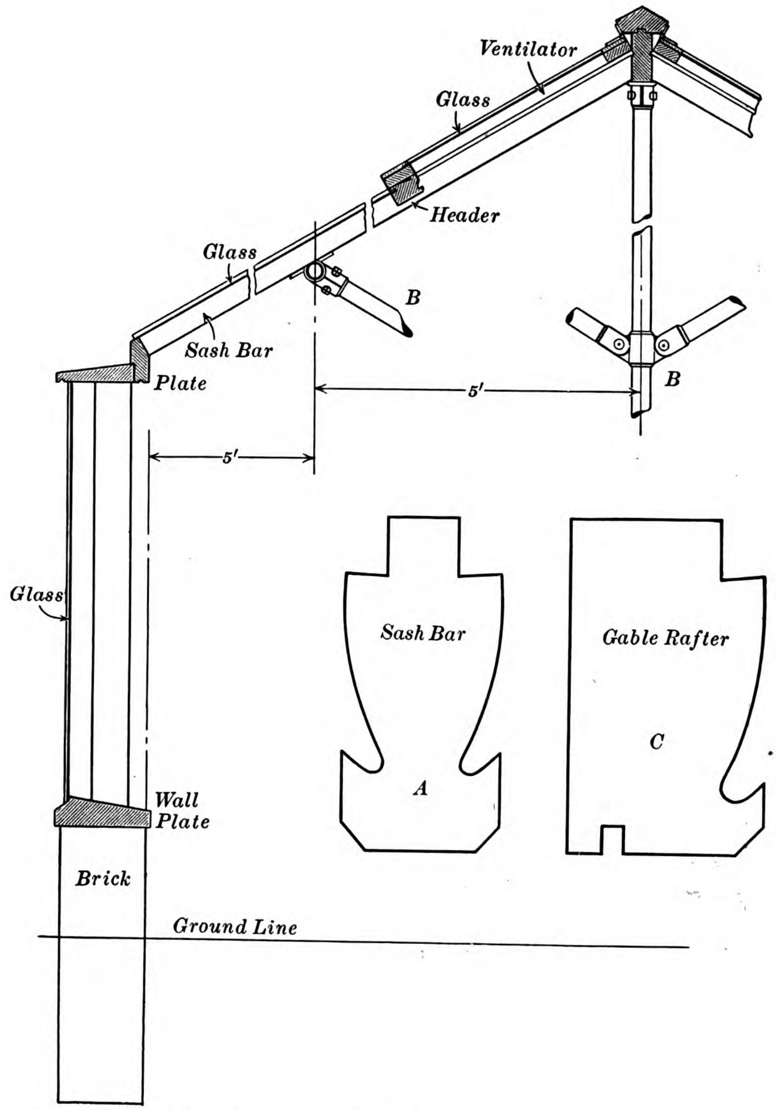


FIG. 18. Details of greenhouse construction

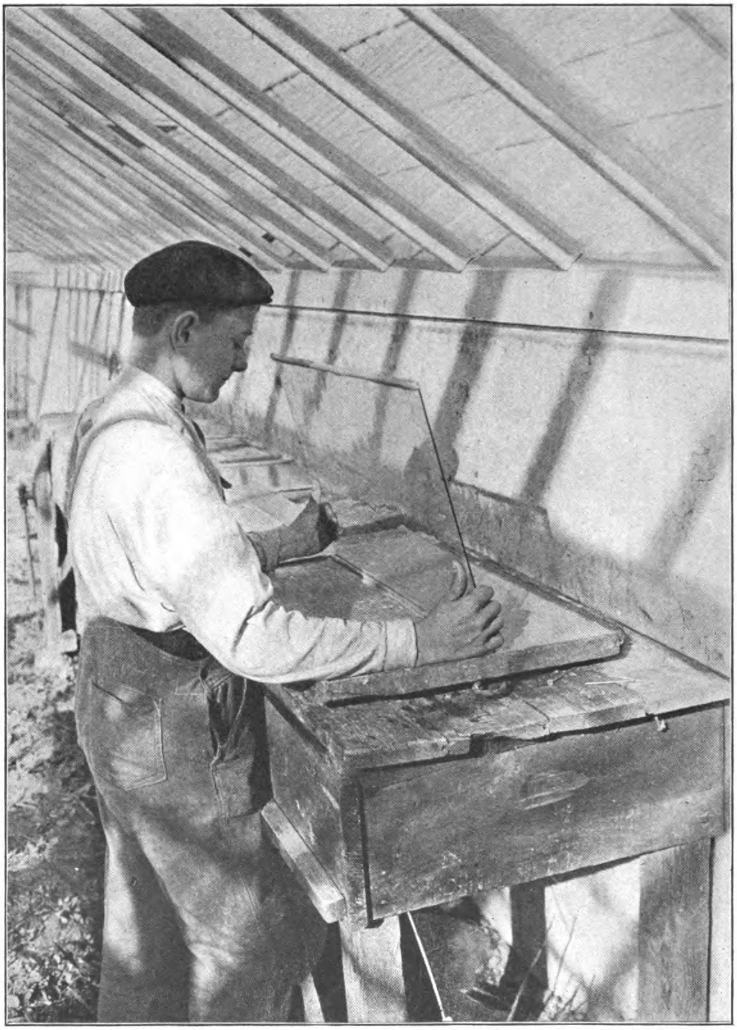


Fig. 19. Putting putty on the glass

strip. Tip the pane toward you, then backward, and draw it forward with a scraping motion. This operation will loosen a strip of putty which will adhere to the edge of the glass, as seen on the upper edge of the glass in figure 19. Turn the glass and repeat the operation; then with a putty knife cut off the ends of the two lines of putty sufficiently to allow for the desired width of lap. Pass the glass to a man on the roof, holding it putty side up. The man on the roof should turn the pane over and press it firmly in place, as shown in figure 20, thus squeezing out any superfluous putty, which will pass in both directions out of the rabbet of the sash bar. As soon as the glass is fastened in place the operation is complete, save for cleaning off superfluous putty.

One man can putty glass for two men to lay; that is, he can spread putty, open boxes, and putty and hand up sufficient glass

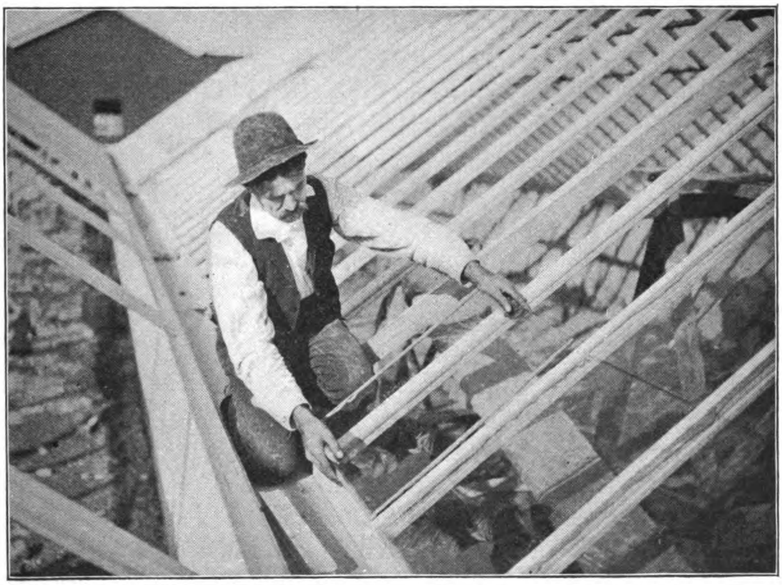


FIG. 20. Laying the glass

to keep two men on the roof busy adjusting and fastening it in place. In building a new house a record was kept of the time required to cover one side of a 20 × 30 foot house with sash bars 12 feet long and 16 inches apart. Three men, using 16 × 24 inch double-strength glass, laid one side of the roof in $2\frac{1}{2}$ hours, which is quicker than the same area of butted glass could have been laid and the caps screwed down. After two winters and one summer this roof does not leak a drop. Laying a lapped-glass greenhouse roof was a great undertaking until this method was discovered.

Proper degree of heat. The proper degree of heat for a forcing house depends upon the crop to be grown. For instance, lettuce requires a temperature of from 40° to 50° F. at night and from 60° to 65° F. during the day, while tomato plants require from 55° to 60° F. at night and from 65° to 75° F. during the day. It is obvious that houses of the same area which are to be devoted to crops with different heat requirements will need different amounts of radiation. A given number of feet of pipe is capable, under given steam pressures or temperatures of water, of giving off a definite quantity of heat. Therefore, if the house be provided with sufficient piping to maintain a night temperature of 65° F., it will be difficult, unless proper valves are supplied, to reduce the temperature to 40° F. It is, however, much easier to change from a high temperature to a low one than from a low to a high. That is, the piping can be arranged for the maximum degree of heat, and by supplying valves to cut out a certain number of runs of pipe the lower temperature can easily be secured; whereas, if the house is piped for the minimum temperature, the higher temperature can be secured only by supplying additional piping or by increasing the temperature of the circulating medium. Table I gives the relative heating values of hot water at 160°, 180°, and 200° F., and of steam at 5 and at 10 pounds pressure.

There are certain definite rules governing the amount of piping necessary to provide a given degree of heat in a house of given dimensions. These have been carefully worked out by mechanical engineers and experimenters under actual conditions in the greenhouse and are concisely stated in the following paragraphs, rearranged from Bailey's "Horticulturist's Rule Book."

Radiating surface for heating greenhouses. *Radiating surface*, that is, the length of pipe of any given size whether of steam or hot-water pipes, is estimated in square feet of exterior surface. All projections, ornaments, etc. on the exterior of pipes or radiators are counted as efficient surface. Formerly cast-iron pipe of about 4 inches in diameter was almost always used for greenhouse work; it is still used to some extent for hot-water heating, but most houses are now piped with wrought iron, which is made of standard size and thickness and is a regular article of trade.

The heating surface of a boiler or hot-water heater is that part which is exposed to the direct heat of the fire and of the heated gases.

The grate surface is the number of square feet of grate in the boiler or heater.

In estimating the radiating surface required for greenhouses, the area expressed, that is, the number of square feet of glass in the roof, gables, and side walls, is taken as the basis of computation. Certain rules of practice have been found to give fairly good results in proportioning radiating surface, grate surface, and heating surface. The ratio of heating surface to grate surface will depend upon the kind of coal to be burned and the economy desired. The more heating surface, that is, the greater the area of boiler exposed to fire and heated gases, provided per unit of grate surface, the higher the efficiency and economy, but the greater the first cost of the heater. *The usual practice is to employ 40 square feet of heating surface to 1 of grate surface for hard coal, and 80 feet of heating surface to 1 of grate surface for soft coal.*[1]

One foot of heating surface in a steam boiler or a hot-water heater will supply heat for about 8 square feet of *radiating surface*, under mean conditions. This will usually give a heater ample in size for the work required; but if more radiating surface is added, the heater may in some instances prove to be too small. The table on the following page gives more exact proportions.

To maintain the temperature of the greenhouse at 70° F. above that of the surrounding air, for hot-water heating in which the maximum temperature of the water is maintained at 180° F. there should be 1 square foot of radiating surface for every 4 square feet of glass; for low-pressure (under 5 pounds) steam heating there should be 1 square foot of radiating surface for every 5 square feet of glass. Some authorities would give somewhat higher figures, and there is no doubt that if the house is not much exposed, the higher proportions will give satisfactory results.

Table I gives more exact values for these quantities and will be found to accord with the best practice in heating of greenhouses, either by steam or hot water. The temperature for steam at 5 pounds pressure is about 220° F, and for steam at 10 pounds pressure, about 240° F.

[1] For small upright heaters, 25 per cent less.

TABLE I. RELATION OF GLASS SURFACE, RADIATING SURFACE, AND HEATING SURFACE[1]

	Hot-Water Heating			Steam Heating	
When temperature of radiating surface is . .	160°	180°	200°	220° (5 lb. pres.)	240° (10 lb. pres.)
Temp. 100° F. above surrounding air	2.3	2.7	3.2	3.5	4.2
" 90° " " "	2.55	3.0	3.55	3.9	4.66
" 80° " " "	2.75	3.38	4.0	4.37	5.25
" 70° " " "	3.2	4.0	4.5	5.0	6.0
" 60° " " "	3.8	4.5	5.25	5.85	7.0
" 50° " " "	4.5	5.4	6.4	7.0	8.4
" 40° " " "	5.7	6.7	8.0	8.7	10.5
" 30° " " "	7.7	9.0	10.6	11.6	14.0
Heat units given off by 1 sq. ft. radiating surface	230	270	320	350	420
Radiating surface supplied by 1 sq. ft. heating surface in boiler or heater	12.2	10.5	8.8	8.0	6.8

The figures in the columns headed Hot-water Heating and Steam Heating in Table I indicate the number of square feet of surface exposure that can be supplied by 1 foot of radiation when the hot water or steam in the radiating pipes is at the temperature indicated at the top of the column, and when the temperature desired in the house is indicated in the left-hand column of Table I.

Size of pipes connecting radiating surface and boiler or heater. Various writers have given empirical rules for proportioning main-supply and return pipes, which have proved quite satisfactory in practice. The following by George Babcock will be found satisfactory for greenhouse heating, whether with low-pressure steam or with water:

The diameter of the main pipe leading to the radiating surface should be equal in inches to 0.1 of the square root of radiating surface in square feet. No main pipe should be less than 1¼ inches in diameter. For water heating return pipes should be the same size as main pipes, and for steam heating merely large enough to return the water which was converted into steam. In practice

[1] Rearranged from Carpenter's work "Warming by Hot Water and Steam."

¾ inch is considered the minimum size. Table II, below, shows the radiating surface the various sizes of main supply pipes, or risers, will furnish with steam or hot water.

TABLE II. CAPACITY OF MAIN SUPPLY PIPES, OR RISERS

Size of Pipes (in inches)	Radiating Surfaces supplied (in square feet)
1¼	155
1½	225
2	400
2½	620
3	900
3½	1220
4	1600

TABLE III. DIMENSIONS OF STANDARD WROUGHT-IRON PIPE

Inside Diameter Nominal	Length of Pipe per sq. ft. of Radiating Surface	Number sq. ft. in 1 linear foot of Pipe
½	4.502	.221
¾	3.637	.274
1	2.903	.344
1¼	2.301	.434
1½	2.010	.497
2	1.611	.621
2½	1.328	.752
3	1.091	.916
3½	.955	1.044
4	.849	1.178
4½	.765	1.309
5	.629	1.656

Wrought-iron welded pipe (*for steam and water*). Pipes 1 inch and below are butt-welded and proved to 300 pounds per square inch, hydraulic pressure.

Pipes 1¼ inch and above are lap-welded and proved to 500 pounds per square inch, hydraulic pressure.

The preceding table gives the standard sizes and principal dimensions of wrought-iron pipe. From this the amount of pipe required for a given radiating surface can readily be computed.

To determine radiating surface. 1. Find the radiating surface by dividing the area of glass in square feet by the results in Table I. Hot-water pipes can be kept at a temperature of 180° F. if desired.

2. Find the amount of pipe by dividing the radiating surface by the number of feet required per square foot of radiating surface, as given in Table III. Do not use pipe less than $1\frac{1}{2}$ inches in diameter for hot-water radiation, nor less than $1\frac{1}{4}$ inches for steam radiation, except on short runs.

3. Find the size of main pipes by Table II, using the size next larger when the radiating surface comes between the figures given. It is usually better to have several main and return pipes, and divide the radiating surface in sections or coils, as shown in figure 21.

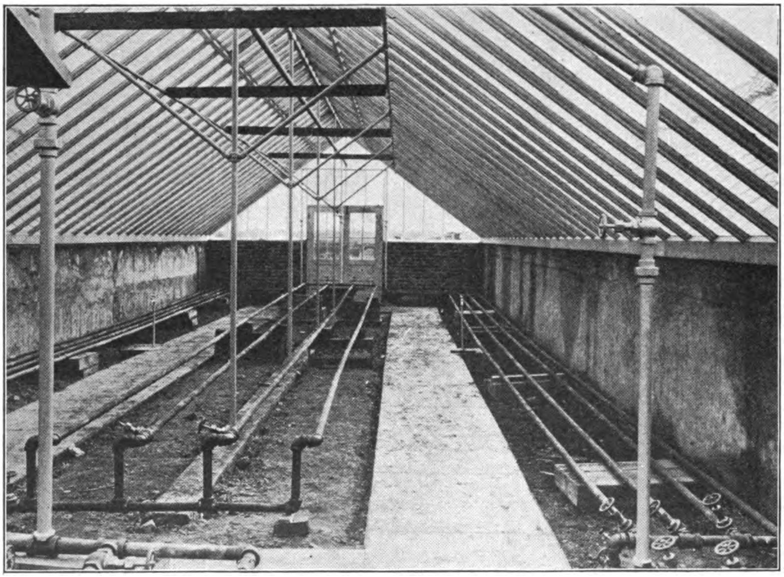


FIG. 21. Arrangement of heating pipes for bottom heat

Distribution of heating pipes in the greenhouse. In greenhouse heating two systems of piping are used, — so far as the distribution of heat is concerned, — namely, so-called bottom heat and top heat. Bottom heat is secured by placing the pipes beneath the benches on which the plants are grown. This, of course, necessitates the construction of raised benches which will carry soil from 4 to 6 inches deep, under which the pipes are arranged as shown in figure 21. The second system of heating is called overhead heating and is extensively employed in houses used for forcing such vegetables as lettuce and cucumbers. Here the benches are usually made solid; that is, they rest upon the soil and, if elevated, are only 18 or 20 inches above the general surface of the surrounding soil. The heating pipes are distributed 18 or 20 inches above these benches or are bracketed to the side walls and roof supports.

Many of the best modern houses for forcing lettuce, cucumbers, and tomatoes have no benches. The soil, if suitable, is enriched and used without further modification. If the natural soil is not suitable it is replaced by the desired compost, which is renewed only once in several years. This long-continued use of the soil is made possible by sterilizing it by means of steam heat at least once each year. The fertility is kept up by the use of stable manure and mineral fertilizers. The piping in these houses is usually accomplished by using coils suspended from the side walls, or posts under the gutters when ridge and furrow construction is employed.

Both of these systems of heating are well adapted to steam plants but are not so well suited to the use of hot water. Steam, because it can be conducted in small pipes and is more efficient, can be utilized for overhead heating as well as for securing bottom heat. Hot water, however, is most advantageously used as bottom heat only, for in order to secure a given amount of radiation much larger pipes are necessary with hot water than with steam. The larger-sized pipes require more space, and since large pipes distributed above the surface of a bed obstruct a considerable amount of light, it is more advantageous to the grower to place them under raised benches.

TABLE IV. EFFECTS OF WIND IN COOLING GLASS. (LEUCHARS)

Velocity of wind per hour (in miles)	Time required to lower temperature from 120° to 100° F. (in minutes)
3.26	2.58
5.18	2.16
6.54	1.91
8.86	1.66
10.90	1.50
13.36	1.25
17.97	1.08
20.45	1.00
24.54	.91
27.27	.81

TABLE V. PER CENT OF RAYS OF LIGHT REFLECTED FROM GLASS ROOFS AT VARIOUS ANGLES OF DIVERGENCE FROM THE PERPENDICULAR. (BOUGUER)

1°	2.5 per cent
10°	2.5 " "
20°	2.5 " "
30°	2.7 " "
40°	3.4 " "
50°	5.7 " "
60°	11.2 " "
70°	22.2 " "
80°	41.2 " "
85°	54.3 " "

EXAMPLE. If a ray of light strikes a pane of glass at an angle of 20°, approximately 2.5 per cent of the efficiency of the light is lost by reflection.

TABLE VI. ANGLES OF ROOF FOR DIFFERENT HEIGHTS AND WIDTHS OF HOUSES. (TAFT)

Height (feet)	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	9 ft.
Width (feet)						
6	33° 21′	39° 48′	45°	49° 24′	53° 8′	56° 18′
7	29° 44′	35° 32′	40° 36′	45°	48° 49′	52° 07′
8	26° 33′	32°	36° 52′	41° 11′	45°	48° 22′
9	23° 57′	29° 3′	33° 5′	37° 52′	41° 38′	45°
10	21° 48′	26° 33′	30° 58′	35°	38° 39′	41° 59′
11		24° 26′	28° 36′	32° 28′	36° 2′	39° 17′
12		22° 57′	26° 33′	30° 15′	33° 41′	36° 52′
13		21° 2′	24° 47′	28° 18′	31° 36′	34° 42′
14			23° 12′	26° 34′	29° 44′	32° 44′

This table gives the angles which the roof makes with the horizontal. The height is the distance from a point directly under the ridge to a point on a level with the bottom of the sash or eaves of the roof; the width is the distance along this level to the eaves.

Ventilation. Ventilation in greenhouses should not be looked upon as a means of lowering the temperature, but as a means of changing the air; that is, pure air is admitted for the benefit of the plants and for the purpose of increasing the growth, rather than for the purpose of securing better temperature conditions.

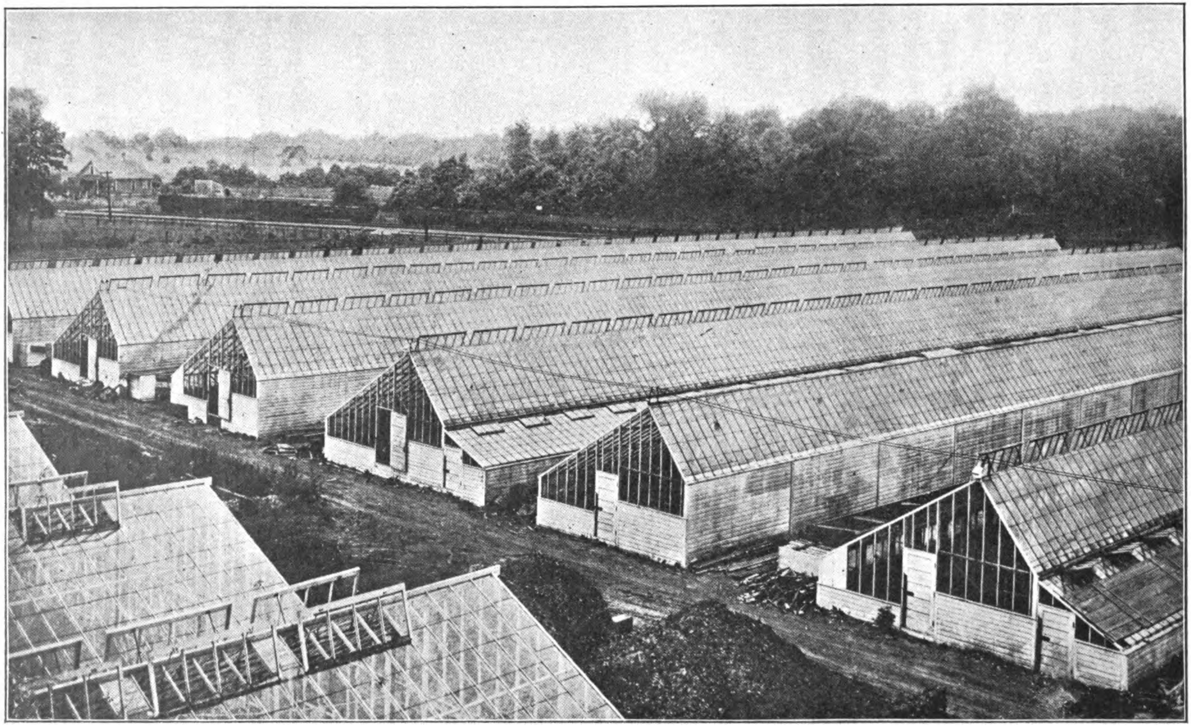


FIG. 22. Greenhouse constructed with long slope to the south

Pure air is as essential to growing plants as it is to animals. The greenhouse should be provided with ventilators which will permit the introduction of air, even during days when the temperature outside is very low. Confined air gets supercharged with moisture, and the plants soon rob it of its carbonic acid and other elements essential to their growth. Greenhouse ventilators, especially for a large structure, should be arranged not only along the ridge in such a way as to admit air with the least possible draft upon the plants but also at the side, either above or under the benches, near the ground line. Ventilation is absolutely necessary during the early spring months, when the sun temperature begins to increase and before it is desirable to shade the house with whitewash or paint.

Various devices for lifting the ventilators are in use by florists. There are two prevailing styles of arranging the ventilator sash. One is to place the sash end to end in continuous rows on one or both sides of the ridge, and to hinge them either to the ridge or to the header, according to whether they are to be opened separately or together, as shown in figure 18. Another plan is to use the ventilator sash at intervals, and so to arrange them that they alternate with one another on each side of the ridge ; when so arranged they are usually hinged to the ridge. For vegetable forcing individual sash, consisting of about 6 of the panes of glass used in the structure of the roof, placed at intervals of from 4 to 6 sections of glass, will as a rule be found sufficient for the ridge ventilation. For other crops such as carnations, roses, etc. a more liberal system is desirable.

Construction of the greenhouse. The construction of the greenhouse may be that of a shed with a long, flat roof exposed to the south, a short, comparatively steep side which is often shingled, and a high board wall which is made as nearly cold proof as possible by double boarding and by the use of paper at the north. This wall is frequently 10 or 12 feet high, with the ridge of the building 2 or 3 feet higher. The flat roof extends from the ridge-pole to within 4 feet of the ground on the low side, as shown in figure 22. A house constructed on this plan may be increased to any desired length, provided steam heat is used. While the shed construction is a common and popular style in some localities, in others the ridge-and-furrow type of structure with posts 7 or 8 feet high (see figure 23) is popular. In still other sections the type of building in common use is an even-span house with the ridge running north and south, or a three-quarters-span house with a long slope to the south. The tendency at present is toward the large even-span house (see figure 23). Since all types of construction give good results it is impossible to say which is best.

Pitch of the roof. The proper angle of the roof is a very important factor in the construction of a forcing house. At the time of year when it is desirable to use these artificial structures for the growth of plants, the sun is at its lowest point in the horizon; that is, it is farthest south and least effective in the northern hemisphere.

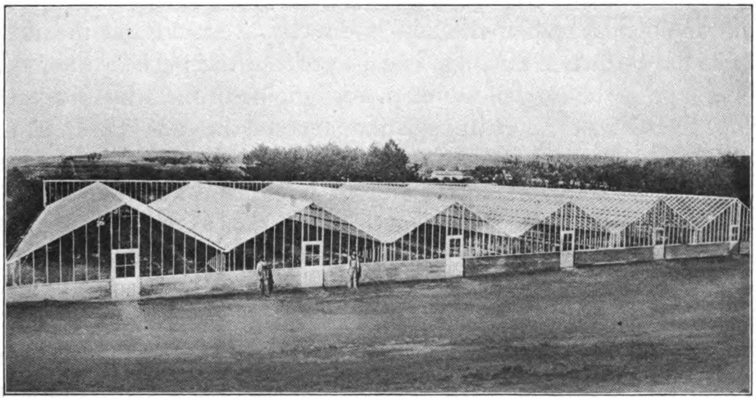


FIG. 23. Ridge-and-furrow type of greenhouse construction

The pitch of the roof of the house should be such as to allow the rays of the sun to strike the roof as nearly as possible at right angles when the sun is at its zenith during these short days. In the vicinity of New York and Boston a roof with a pitch of 34° is near the ideal. Farther south, where the sun's rays fall more nearly vertically, the angle of the roof should be increased rather than lessened. It is quite as desirable to have a large percentage of the sun's rays reflected when the power of the sun is more intense as it is to have a large percentage of them pass through the glass during midwinter. The slope of the roof for a forcing house will therefore depend upon the latitude in which it is erected, the position of the house, and the purpose for which it is intended.

Direction of the ridge. There are many different ideas in regard to the direction of the ridge of the greenhouse. Many growers contend for the uneven-span house with the ridge running east and west, while others have equally as strong preferences for even-span houses with the ridge running north and south. An analysis of the problem of securing the maximum amount of light in a greenhouse indicates that the even-span house, with ridge running north and south and the angle of the roof such as to give the sides a slope of about 45°, is preferable to any other style of structure. This style of structure allows a maximum amount of light to enter the house in the morning and afternoon, when the sun's rays fall almost perpendicularly upon the roof, and give the greatest reflection at noonday, when the sun is directly overhead and the rays strike the surface at an angle equal to that of the pitch of the roof. This type of house will admit more light than one with the long slope to the south, even though the slope of the roof is such as to form a perpendicular to the rays of the sun when at its lowest point in the southern horizon. This is explained by the diurnal revolution of the earth, which permits the roof to occupy the ideal position for but one moment at midday on the shortest day of the year. At all hours before and after noon the sun's rays strike the roof with greater or less obliquity, being greatest early in the morning and late in the evening, thus tending to shorten the shortest days of the year. The even-span house with ridge north and south counteracts this tendency somewhat.

The construction of solid benches. The construction of beds in forcing houses is, as a rule, very simple. Planks, 3 × 12 inches, are usually placed about 18 inches apart along the line of the walks to form the sides of the bed. The planks are placed end to end, the lower edge being sunk into the ground 3 or 4 inches. If a deeper bed is desired, a second plank is placed on top in such a way as to break joints, and is firmly fastened to stakes, preferably cedar, which have been set in the soil. This boxlike compartment is then filled to within an inch or so of its top with a fine compost made from thoroughly decomposed turf and manure, in the proportion of 1 part of manure to 2 parts of soil, except in the top layer, where it may be made somewhat richer. A deep bed of soil prepared in this way need not be removed for a number of years.

The crops are removed as soon as mature; the soil is spaded up and, by the addition of sterilized manure, fine ground bone and lime may be kept in very satisfactory condition for three or four years.

Disinfecting the greenhouse. The houses, however, should be thoroughly disinfected during the summer months when they are empty, by burning sulphur and by spraying them thoroughly with a solution of 1 part of formaldehyde to 50 gallons of water. It is also a good idea to whitewash or paint all of the exposed parts of the woodwork. Fumigation with cyanide of potassium is one of the most effective methods of disinfecting empty greenhouses.

In many large plants the annual renovation includes sterilizing the soil of the houses by the method described on pages 23–26 or by means of perforated steam pipes buried a few inches beneath the surface. Live steam at a pressure of from 60 to 80 pounds is forced into the perforated pipes for a sufficient period to kill all organic life and germs in the soil.

Construction of benches for bottom heat. There are many types and methods of constructing greenhouse benches. A satisfactory arrangement is to provide carriages made of 2 × 4 inch or 3 × 4 inch dimension stuff, and so arranged that a front board can be placed outside the support next to the walk, in order to provide a smooth wide board next to the walk, as shown in figure 24. This can be accomplished by using 2 × 4 inch or 3 × 4 inch stuff for legs and ripping it to the depth of the bench so as to leave a portion 1 inch thick to carry the side boards. Saw out the remaining portion at the proper height above the walk for the bottom of the bench and place the bench carriage on the shoulder of the leg so produced. The bench leg on the other side of the carriage should be constructed in exactly the same manner except that the side board should be placed inside rather than outside the leg, as shown at *A*, figure 24, the leg itself being placed against the side wall of the greenhouse. By this arrangement an air space 1 inch wide is secured between the back of the bench and the side wall of the greenhouse. This is of great advantage where an even distribution of heat is required and where a low temperature is maintained in the greenhouse at night. Benches which are arranged tight against the side wall and close to the glass are apt to be much colder at the wall side than they are near the front of the bench; in fact, in some instances plants at the wall side of the bench will be frosted while those at the front will be unharmed. The space between the bench and the wall will allow the heat to come up and warm the air in the angle between the roof and the top of the bench.

Materials of construction. Greenhouse benches may be made of wood, metal, or concrete. Probably the ideal material is concrete, but as there are few available designs for cement greenhouse benches at the present time, and as it has not yet been fully tested, little can be said of its value. Iron, however, either in the form of cast supports or of gas pipe has long been in use; and when it is used merely as supports for slate sides and bottoms

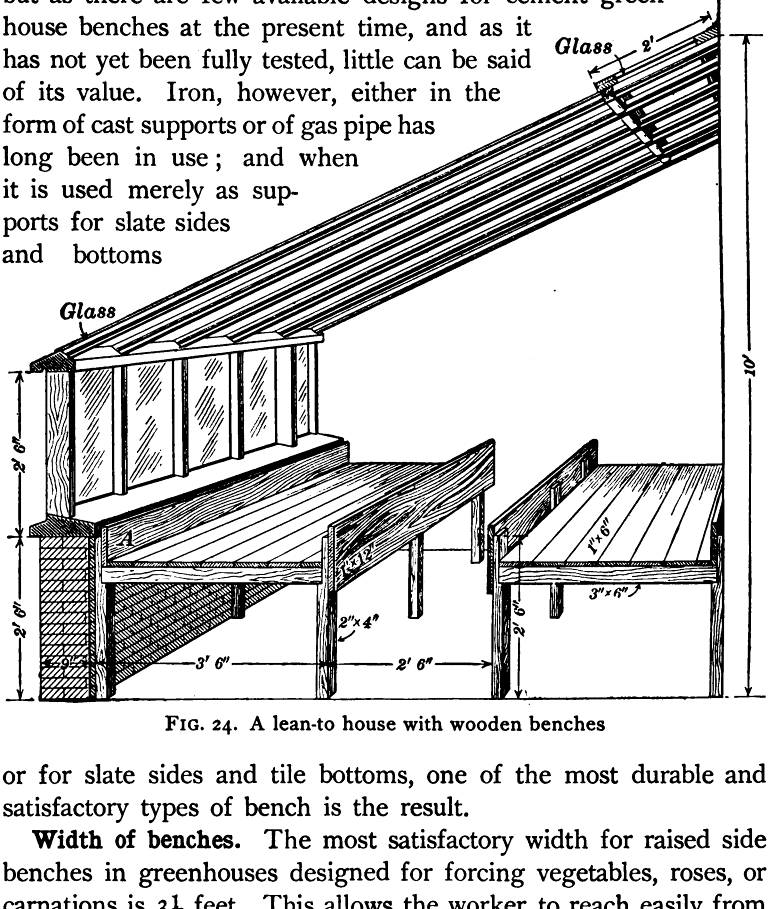


FIG. 24. A lean-to house with wooden benches

or for slate sides and tile bottoms, one of the most durable and satisfactory types of bench is the result.

Width of benches. The most satisfactory width for raised side benches in greenhouses designed for forcing vegetables, roses, or carnations is 3½ feet. This allows the worker to reach easily from the front to the back of the bench, provided the bench is not too high. The proper height of the bench is that of a desk; that is, the top of the bench should be about even with a man's waist. The center bench of a greenhouse is almost ideal when it is 7 feet in width. This admits of working from each side 3½ feet and thus the whole distance across the bench. Solid benches are usually much wider and the walks are made narrower. A common method is to provide walks about 18 inches wide, next to the outside walls only. Sometimes a center walk only is provided, but in wide houses the beds are often arranged 16 or 18 feet wide. As

FIG. 25. Workmen cultivating plants on solid beds

the ordinary length of lumber is 16 feet, a board of this length placed on the heating or water pipes, which are distributed about 18 inches above the surface of the bed, enables the laborers to work the soil in the bed by reclining upon the board, as shown in figure 25. This is a common practice with solid benches.

The solid bed is, of course, the most economical so far as construction is concerned and is one of the most satisfactory for forcing lettuce, cucumbers, and plants of this description which do not require bottom heat. With roses, tomatoes, melons, and plants which require bottom heat it is necessary to have raised benches, unless some system of conducting the heat through tiles placed in the soil can be devised.

Watering. There is no one feature of greenhouse management which is more important than the supplying of water. Since nearly all the forcing crops contain a large percentage of water, — lettuce and cucumbers being over 90 per cent water, — the importance of this factor is at once evident. The method of watering is also important, because certain plants, like lettuce, with a large leaf

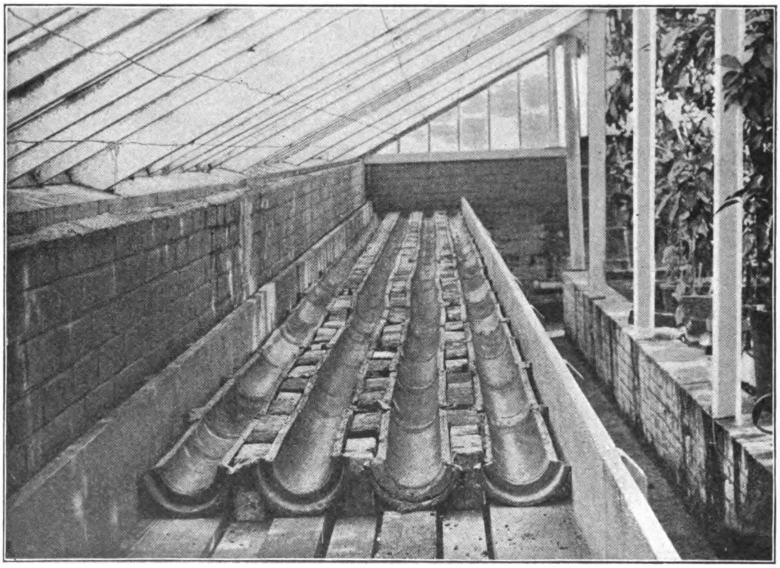


FIG. 26. Bench built of brick and split sewer pipe for subirrigation

surface close to the ground, are susceptible to attacks of fungi, which destroy them if the surface of the ground is too wet. This has led to a system of watering called subirrigation, which means simply a method of applying the water to the soil beneath its surface. This can be accomplished by constructing from lumber, cement, or metal, a bench with a tight bottom, and providing means of distributing water to the plants in the lower strata of the soil, either through drain tile or perforated metal pipes, or by placing hollow bricks upon the bottom of the bench. Another very satisfactory method is to use split sewer pipe, laying it perfectly level along the lines where plants are to stand. If the bench is capable of carrying 5 rows of lettuce, a line of pipe should be placed under each row, the joints of the pipe being cemented so as to make a trough which will hold water, as shown in figure 26. The trough should then be filled with coarse gravel or clinkers, and an upright provided to admit water. Bricks should be placed between the lines of tile, and the bench filled with soil in the ordinary manner. This will be found an efficient means of subirrigation. This construction is quite expensive but it is durable and efficient. If the moisture in the soil is to be maintained by surface watering, care should be exercised to thoroughly wet the soil and not repeat the operation until the plants indicate that water is again needed. This is expressed by the plants assuming a slightly darker green tint. Do not keep the soil saturated with water but do not allow the plants to flag before watering again. In hot weather much can be done to safeguard the plants by wetting the walks.

CHAPTER V

ROOT CELLARS AND STORAGE HOUSES

Storage cellars a necessity. Root cellars, like fruit storage houses, are a part of the producer's insurance of his crop. Not only do they enable him to dispose of his crop at a period when the markets are not burdened, thereby often making a substantial profit, but they actually reduce the cost of harvesting. The saving, at harvest, consists largely in being able to move the crop more quickly. Sorting and grading can be done more leisurely and at less expense as the crop is removed from storage. Hauling and loading on cars can usually be done more cheaply at other seasons than during the harvest period. With a good cellar the crop can be quickly stored under safe conditions, thus preventing loss.

Storage cellars are naturally better adapted for carrying potatoes, carrots, and beets than cabbage or fruit; but good cellars will be found to be of great advantage for either of the last-named crops, provided the storage period does not extend beyond the normal cool season. Cellars have an advantage over storerooms not always considered; they are usually more moist than ordinary storage rooms — a decided advantage when dealing with succulent vegetables and fruits which suffer in quality from loss of moisture.

With the advent of the cement age the problem of constructing on the farm satisfactory, and at the same time cheap and durable, root cellars has been solved.

In no part of the United States is the storage cellar so important a factor as in the great potato sections of Maine and Colorado. This great crop must be given the full benefit of every day of the growing season; but as soon as the vines are cut by frost, harvesting must begin and must progress with the utmost rapidity to save the crop from being frozen in the field. In order that growers may handle from 2000 to 20,000 bushels of potatoes within two weeks, advantage must be taken of every convenience and device that will facilitate the work.

Colorado pits. The pits used in Colorado are all built on the same general plan, but vary greatly in size and capacity. In general the excavation varies from 24 to 30 feet in width, and from 2 to 8 feet in depth. It is also true that some very satisfactory storage pits are built entirely aboveground. The one shown in figure 27 is of this character. The side walls are of concrete, about 10 inches thick and 4 ½ feet high. It is 30 feet wide and is roofed over with poles covered with brush and rough grass, and on

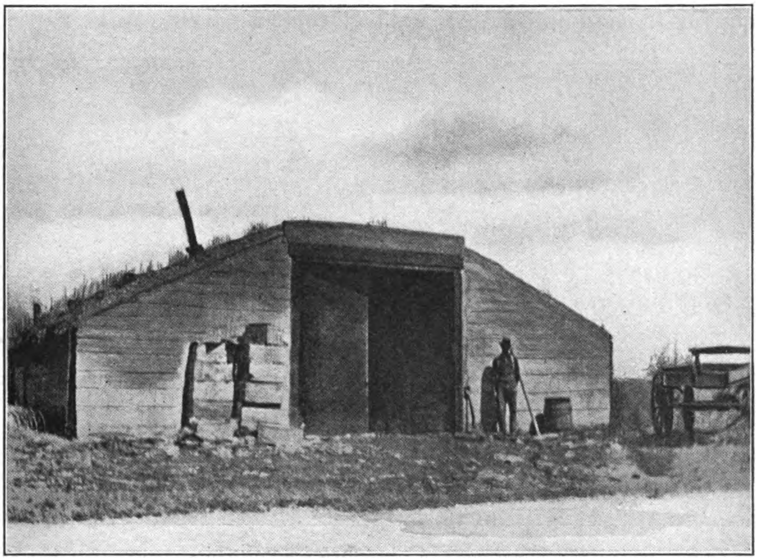


FIG. 27. An aboveground storage pit

top of this is a layer of earth. Three rows of posts are used to support the roof, one under the ridge and one on each side, halfway between the ridge and the side wall. This house, which is near Greeley, Colorado, is used for the storage of celery. Modifications of this type of structure are quite commonly found in connection with Northern market gardens. Some consist merely of an excavation covered with a temporary roof and protected from low temperatures by straw or manure heaped over the roof.

Colorado potato pits. The Colorado potato pit, such as is shown in figure 28, is usually a permanent structure. The excavation, when most carefully planned, runs parallel with the prevailing winds and has a roadway extending from end to end, which greatly facilitates the work of filling and emptying the pits. The excavation is often roofed with poles covered with brush and hay, and over this is a layer of earth. More expensive pits are walled up at the sides and roofed over with concrete. The driveways are often from 2 to $2\frac{1}{2}$ feet above the bottom of the bins. At each end of the driveway are doors opening into a vestibule which is also provided with doors. This arrangement allows the pit to be cooled quickly in autumn because a direct current of air can be carried

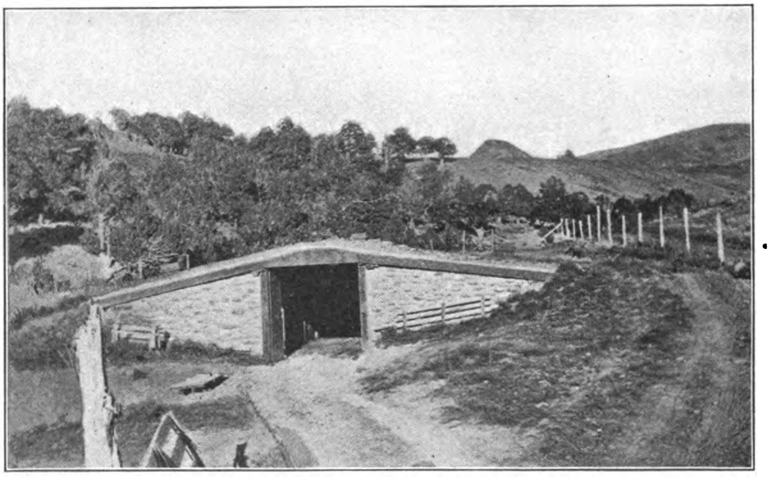


FIG. 28. Colorado type of storage pit

through it. In some cases the bins are provided with board floors, but more often there is no covering for the earth. The roof is provided with ventilators and also with openings through which the tubers or roots may be dumped into the bins from the outside, as soon as it is no longer convenient to unload from the main driveway. By closing the hatches and shutting both sets of doors the temperature of the pit can be maintained with little variation. Some of the best pits can be held at 34° F. for four months.

Maine potato cellars. In Maine, and in the East in general, potato storage is provided by cellars more like a house cellar than the pits just described. A cellar of this character is shown in figure 29. This is an excavation walled up like a house cellar, which can be filled from the outside by means of chutes but is not provided with a driveway, as is the pit shown in figure 28. Frequently such cellars are not partitioned into bins but are entirely filled with one huge heap of tubers.

The farm root cellar. For the farm on which potatoes are not the leading money crop, but where a storage cellar for the family supply of vegetables is needed, an excavation 10 or 12 feet wide, 6 feet deep, and any desired length, roofed over with reënforced concrete, will be found a most admirable type of root cellar.

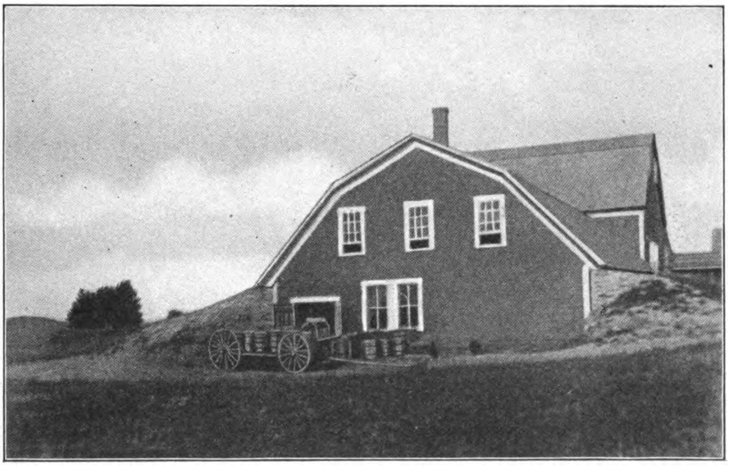


FIG. 29. Potato storage house on Maine farm

The side walls need be only 8 inches thick, and just heavy enough to retain the earth and support the roof, which can be made by using inch boards bent over the opening so as to form a kind of boat deck or jack arch. The boards should be cut so as to fit between the side walls and should be supported by temporary staging or posts except through the center, where there should be a good ridge supported by substantial posts. Stretch strong, close-mesh, woven-wire fencing over the boards about 2 inches above them. Run the fencing over the ridge in the same manner as the inch boards. On top of this structure place a layer of concrete from 6 to 8 inches thick so as to thoroughly embed the woven wire. After this has set for several weeks cover the whole with a layer of earth from 8 to 10 inches deep.

Ventilation should be provided by placing a terra-cotta tile 8 or 10 inches in diameter every 10 feet along the ridge of the pit. Such a pit, provided with a well-insulated door, is a more satisfactory storage place than the dwelling cellar. Every farm at the North should be equipped with some such frost-proof storage cellar.

A Southern storage pit. At the South a simple but very effective root storage is made with poles cut about 8 feet long and split so

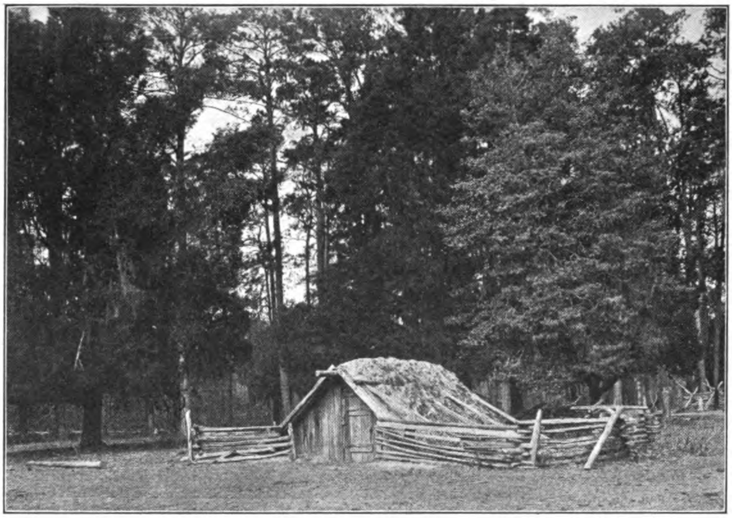


FIG. 30. Southern storage pit covered with earth

that the two parts are about equal. Parallel trenches are made about 1 foot deep, 1 foot wide, and 8 feet apart. A ridgepole is then arranged between the two trenches, and against this the flattened poles, with ends cut like the rafters of an even-span roof, are placed. The other end of each pole rests in the trench. The ends of the structure are boarded up and the roof is covered with a layer of sods and earth, as shown in figure 30. Such a structure is adapted for the storage of turnips and is often used for sweet potatoes.

Frost-proof storage houses. Besides the types of storage structures already described, there are in use, among producers and dealers, frost-proof structures designed to carry safely through the winter products that are injured by freezing. The crops which are thus stored are cabbage, squashes, onions, sweet potatoes, Irish potatoes, and celery. The general principles governing the construction of storage houses for the different vegetables are practically the same. The houses are usually built aboveground, or as bank structures, with only a part of the basement below the general surface of the ground. The materials of construction are determined by locality and by the proposed cost of the structure, and may be stone, concrete, brick, or wood. The walls must, of course, be made as nearly frost proof as possible. For brick structures, the bricks are laid so as to provide a dead-air space in the wall, furring strips are fastened to the bricks on the inside, and the wall is lined with paper and matched lumber. If stone or concrete is used in the construction of the walls, the same plan is followed. In frame structures, 2 × 6 inch or 2 × 8 inch studding is employed, and a paper partition is placed between the studding so that the space between will be divided into two chambers when the siding, ceiling, and linings are put on. It is customary to place sheeting, a layer of paper, and weatherboarding on the outside of the studding; and on the inside matched lumber, furring strips, paper, and another layer of matched lumber, thus making three dead-air spaces in the wall. Such structures, built entirely aboveground, are practically frost proof. They are usually found in the extreme northern potato regions of the United States. The precaution to be taken in the storage of perishable products in such buildings is to keep the vegetables from contact with the outside walls and to provide stoves for use in the severest weather.

Sweet-potato storage house. The sweet-potato house is built after the manner just described, but in the region in which sweet potatoes are grown it is not necessary to provide so many dead-air spaces in the outside walls. Sweet potatoes are stored in crates or in bulk in bins. When stored in bins they are kept from contact with the outside wall by a slat partition which is placed far enough from the outside wall to provide a passageway between it and the wall. Eighteen inches is the customary distance for this offset.

Sweet potatoes are harvested as soon as the frost has injured the vines, and are allowed to dry as thoroughly as possible in the field. They are then *carefully* gathered in bushel crates or small baskets holding from $\frac{5}{8}$ to 1 bushel, and carried, preferably in spring wagons, to the storage house. The storage room is kept by artificial heat at a temperature of 85° or 90° F. for the whole period through which storing is in progress, and for at least ten days or two weeks thereafter. The temperature during the remainder of the storage period should be held constant and as near 55° F. as possible. The potatoes are placed in layers or beds about 2 feet deep, which may be separated by pine needles or some dry absorbent material that will act as an insulation to the different layers of potatoes. The roots should not come in contact with an earth or concrete floor and should not be disturbed after storage. The storage room should have a board floor, elevated 15 or 18 inches above the level of the earth, so arranged that the cold air shall not be admitted after the curing period has passed. In such a house sweet potatoes can be kept very successfully until February or March, or even till the bedding period for the next year's crop.

Irish potatoes may be stored in bulk in cribs similar to those used for sweet potatoes, but a common practice is to store them in bushel crates or in gunny sacks. If they are stored in crates, they are arranged in tiers about 5 or 6 crates wide, and as high as the crates can be conveniently placed in the room. If stored in sacks, the tiers are 3 or 5 sacks wide, and sometimes as much as 10 sacks deep. This arrangement provides alleyways between the different lines of stored material, whether in crates or in sacks.

Storage for onions. Onions are sometimes stored on racks or shelves which are about 6 or 8 feet wide. They are carefully spread from 8 to 15 inches deep, sufficient space being allowed above them to admit of inspection. The usual practice is to store onions in bushel crates like those so universally used by farmers for gathering the crop. The storage buildings are perfectly insulated and vary in capacity from a few hundred to 50,000 bushels. In some regions where onions are carried over for seed purposes, the bulbs are spread on slat racks in open buildings where they may freeze at the beginning of winter and remain frozen throughout the whole storage period. In these cases it is very important that the bulbs be protected from all possible injury. Even the jarring of the building must be guarded against, otherwise the bulbs may rot at the approach of warm weather in the spring.

Celery storage pits. The storage houses or pits for celery are quite different from others in construction, usually consisting of a half-cellar arrangement. A well-drained location is selected, preferably on soil which is sandy or of a sandy-loam character, and the building so arranged as to give sufficient head room for storing and caring for the crop. Buildings for this purpose vary in width from 12 or 14 to 28 or more feet. The side walls are insulated to protect the plants next to them, either by banking up the outside or by a frost-proof construction like that already described. A roof is then made of boards, with battens or paper. In some cases where the industry is of a permanent nature the houses are constructed of concrete and have a shingle or slate roof. Enough ventilating flues must be provided to control the temperature inside the pit, and windows must be cut in the roof to furnish necessary light for those who care for the crop during the storage period. Large storage houses designed for sweet potatoes and onions must have flues and ventilating arrangements to remove moisture and to keep the temperature within the limits of safety. In some cases this necessitates both a heating apparatus and a ventilating and cooling apparatus. In the case of Irish potatoes and celery it is desirable that they be stored in as close contact with the earth as is practicable. Thus the product is on a firmer foundation, and the moisture of the earth has a beneficial influence on the quality of these vegetables if they remain in storage for any length of time. There are now a few growers of celery who have provided themselves with cold-storage facilities for holding their crop of celery. Under cold storage the crop cannot be held for more than three months, but a few weeks often makes a great difference in the value of a perishable crop of this character.

CHAPTER VI

TRANSPORTATION OF TRUCK CROPS

Problems of transportation. The transportation of truck crops involves two distinct problems: (1) the carrying of the products to the market; (2) the extension of the trucking area. The first problem involves the question of harvesting, packing, and shipment of truck crops; the second, the extension of old areas and the development of new ones.

Transportation facilities have extended the zone tributary to the great centers of consumption from the limits of the wagon haul to the confines of our nation and even beyond. The great centers of population have been made possible by facilities for feeding such great numbers. The work of growing garden vegetables has been extended from a zone of twenty-five miles about each city, with its intensive market gardening and greenhouse industries, to the limits of transportation. Quick transportation and refrigeration facilities now enable producers located in regions remote from the market to take advantage of their home climatic conditions to grow in the open those crops which could be produced in the wagon zone of the cities only by means of greenhouses. Improved transportation has made truck farming an *extensive* industry as compared with market gardening, which is one of the highest types of *intensive* horticulture. This change in the character of the industry has had the effect of making many crops which formerly had a restricted season almost perennial in the market. Field-grown lettuce is to be found in the markets throughout almost the entire year. The same is true of tomatoes, beets, peas, string beans, and other short-season annuals which, before transportation joined the crop regions of Maine and Florida, had restricted market seasons determined by the climatic conditions of the zone immediately tributary to the market.

Specialization. Still another important result of present transportation conditions is specialization among growers. This is more apparent among truck growers than among market gardeners. There are those who make a special feature of some one crop like strawberries, asparagus, tomatoes, cabbage, kale, etc., giving little attention to other crops. While this specialization is productive of large returns, it is apt to be overdone and is open to greater disaster than the more rational method of a more or less fixed crop rotation. Single-crop regions, which are the final result of extreme specialization, are sooner or later overtaken by disaster. It is safe to say, however, that the dangers of specialization are less in truck farming than in grain growing, because of the more intimate relation of the truck farmer to market conditions and the greater care necessary to maintain maximum crops.

Coöperative shipment. The saving which results from shipping in carload lots serves to encourage extensive operations in regions remote from the market. Such a saving is much greater in long-distance shipments than in local shipments; in fact, many of the prosperous trucking communities now existing could not thrive if the producers were obliged to ship independently and by local freight or express. Coöperative production and shipment in regions possessing the advantages of soil and climate which allow them to command the markets for a limited period each year, enable small producers to market their crops profitably. The satisfactory results secured by growers in remote regions, who take advantage of this method of shipment, are often used as an argument to induce those within a short distance of the market, who use local facilities, to ship in car lots. The small grower located in a region remote from market is obliged to coöperate with others of his kind in self-defense. Carload shipment from such regions is the grower's only means of existence. The result is coöperation among small growers, or extensive production by individuals or corporations. The coöperative shipping arrangements carried out by the winter truck growers of southwest Texas are a notable example of the good results to be obtained from such a combination. The extensive production of individual growers at various points along the Atlantic coast, notably Charleston, Norfolk, and Wilmington, is another proof of the advantages of carload shipments. The corporation operating in cabbage and potatoes at Meggett, South Carolina, attests the advantages of extensive specialized industries, for in 1905 it produced a head of cabbage for every inhabitant of the nation.

Preparing for shipment. In the transportation of perishable products, the great distances covered and the changes in climate to which the products are subjected in transit have made it necessary to develop certain types of packages to meet these conditions. The style of package is determined by the character and value of the product. Strawberries deteriorate so quickly under certain conditions that in order to transport them successfully the fruit, after being cooled as rapidly and completely as possible in some shaded, airy place, must be carefully selected, graded, and packed in wooden quart cups, which are arranged compactly in a compartment provided with division slats to separate one tier of boxes from another. After the storage space has been filled, an ice pan is put in position and the case is removed to a cool, airy place to reduce the temperature of the fruit. Before the carrier is placed on the train, the ice is replenished so that the temperature inside the case will remain practically constant during shipment. This is the most elaborate and expensive type of carrier used in transporting truck crops.

Styles of packages. The "barrel high" Delaware basket is the favorite throughout the Atlantic coast region for transporting lettuce, cucumbers, peas, and beans. Cabbage and beets are usually packed in crates constructed of rough lumber. Potatoes are either barreled or sacked, while spinach is either barreled or shipped in the "barrel high" Delaware baskets. Kale is carried in ventilated barrels. Tomatoes grown in the Atlantic coast region are most often wrapped and shipped in six-basket carriers of the style used for peaches, while those grown in Texas and California are wrapped and packed in shallow compartment trays or boxes. Late cabbage and potatoes grown at the North for autumn delivery are generally shipped in bulk. Cattle cars are often employed for bulk cabbage and for watermelons. Early in the season potatoes are sometimes shipped in relined cattle cars, but they are usually shipped in cars like those used for grain; during the winter insulated refrigerator cars are employed, which are provided with oil stoves to prevent freezing if the weather is severe. Cucumbers have been successfully transported in bulk from Texas to Boston in refrigerator cars which have a false slat floor raised 4 inches, and halfway between this and the ceiling a second slat floor, thus making a double-deck car carrying from 400 to 500 bushels of bulk cucumbers. After being loaded with cucumbers, the cars have their bunkers stocked with ice, and in other respects are treated as regular refrigerator cars.

Transportation alone does not in all cases determine the type of package to be used, as is evident from the styles of packages employed for tomatoes. In the case of long-distance shipments of strawberries, there are special requirements both as to refrigeration and a suitable carrier. The character of the product, the season, and the length of the haul are all factors which must be taken into account in deciding upon a suitable package or carrier for any crop. In the case of truck crops which are not dependent upon refrigeration, the style of the package is largely a matter of local convenience. For the shipment of potatoes from regions remote from a suitable timber supply for the manufacture of barrels, sacks are chiefly employed; while in sections where timber is plentiful and barrels are extensively employed for other crops, the potato is also shipped in barrels.

Transportation a large factor. Transportation facilities not only determine the possible supply of truck products for any center of consumption, but also, to a great extent, the prices. The time of the appearance of staple truck products in any particular market is determined by the transportation facilities. Modern transportation has proved the greatest competitor of the producer of forcing-house products. Together with refrigeration it has overcome the restrictions which the seasons formerly placed upon the markets, so that now the door of the market opens into the garden at all seasons.

Transportation has also been an important factor in developing the trucking industry, as is evidenced by the history of the transportation of truck crops recorded in the following quotation:

"The transformation of industries, brought about by modern methods of transportation, is nowhere more clearly evidenced than in vegetable gardening. Until the last third of the century just closed, vegetables were grown within a short distance of the market for which they were intended. Canal and early steamboat and rail transportation had in large measure provided for the distribution of staple farm crops and manufactured articles, but these methods of transportation were too slow to be advantageously employed in carrying the more perishable products. The transition from early conditions to the possibilities of to-day in the way of varied diet, when fresh meat may be had in any variety, and when the most delicate garden products of the far South and the Pacific coast may be found at any time of the year in the markets of New England, is a marvel; yet this has been brought about within forty years, and all but the mere beginnings of it belong to the history of the last two decades.

"In the fifties the raising of vegetables for Northern markets began at Norfolk, Virginia. In 1854 the steamer *Roanoke* carried the first shipment of 200 barrels of garden truck to New York. To secure proper ventilation, however, it was necessary that these should be carried on deck, so that the quantity which might be transported on any trip was not large, 400 packages being about the limit. The boats then in use required at least thirty-six hours to reach New York, and hence the shipment of even small quantities of highly perishable articles was attended with great risk. At the present time forced ventilation allows of loading between decks, increased tonnage enables a vessel to carry as high as 25,000 packages, and the trip is made in nineteen hours.

"The first all-rail shipment of garden truck from the South Atlantic States to New York was made from Norfolk, Virginia, in 1885; the first from eastern North Carolina was in 1887; and the first from Charleston, South Carolina, was in 1888. Florida sent her first carload of oranges to New York in 1888, and her first refrigerated car of strawberries in 1889.

"In the states farther west, where water carriage was not available, rail transportation of vegetables and fruits for Northern markets began at an earlier date. There were shipments of peaches from Crystal Springs, Mississippi, on a small scale in 1866, and by 1874 they had reached 20,000 pounds daily during the season, and by 1877, 40,000 to 60,000 pounds. Nearly as great quantities were shipped from Terry, Mississippi, and small amounts from other stations. In Mississippi and Tennessee the cultivation of strawberries for the Northern markets began about 1875. It proved profitable and later spread to Louisiana and Arkansas. The tomato industry about Crystal Springs, Mississippi, began about 1875. In 1878 less than one car a day was shipped from that point; in 1885 from 5 to 8 cars a day, and in 1895 from 40 to 50 cars per day. This illustrates the early development of many districts of the South now noted for their truck shipments. In some cases, as at Crystal Springs, the industry began as an experiment in a shipment by farmers of the small surplus of their garden product. This was found profitable and led to further shipments.

"In all sections the trucker is dependent on transportation facilities for increase in his industry. He needs cheap rates and rapid transit; but improvement in carrying facilities is even more important than increase of speed, and of equal importance with lessened cost of transportation. This improvement is especially manifest in ventilated and refrigerator cars, the former being constructed like ordinary box cars except that they have lighter springs and openings in the ends and sides to provide for circulation of air. These openings are covered with fine wire netting. Cars of this type of construction answer perfectly for carrying hardy vegetables, such as watermelons and potatoes, as well as the more delicate kinds, for short distances.

"To meet the needs of the more perishable fruits and vegetables for long transit, the refrigerator car has been evolved. After many years of discouraging experiment the first successfully refrigerated car of strawberries was shipped into Chicago in 1872. In the spring of 1888 strawberries were successfully shipped from Florida, and in June of the same year a carload of ripe apricots and cherries was successfully sent from Suisun, California, to New York without re-icing. From a beginning of 6 cars in 1887, 60 cars were operated in 1888, and 600 in 1891. In 1901 it was estimated that there were operating in the United States, Canada, and Mexico, upwards of 60,000 refrigerator cars, or nearly one twentieth of the whole number of freight cars in use. This total includes the cars used in carrying the products of the meat, dairy, beer, and other industries, and it is impossible to say just what proportions of the whole were used in fruit and vegetable transportation. Yet the total is so large that if not more than one tenth of these cars were so used the increase would still be enormously great. These cars are operated by some 50 or more companies, but the operations of many of them are not extensive, and the larger part of the business is controlled by a few large lines. Many of the railroads are now operating their own refrigerator cars, and in some instances are attempting to exclude private car lines from their roads as far as practicable.

"The following table illustrates the growth of California fresh-fruit shipments under the influence of transit refrigeration:

ANNUAL FRESH-FRUIT SHIPMENTS FROM CALIFORNIA: 1890-1900

Year	Pounds	Year	Pounds
1890	74,646,000	1896	115,300,000
1891	98,680,000	1897	145,250,000
1892	111,689,000	1898	139,530,000
1893	159,900,000	1899	193,900,000
1894	179,576,000	1900	182,375,000
1895	132,587,000		

"Previous to 1888 large quantities of foothill fruit had been shipped as far as Chicago in ventilated cars on express-train schedules. But only the best of foothill fruit permitted of such handling, and even this was forwarded at great risk. Moreover, the fruit had to be disposed of quickly after reaching Chicago, and hence could not be very widely distributed from that point, little of it ever reaching New York. To-day 95 per cent of the deciduous fruits shipped East from California are carried in refrigerator cars, solid trains of these following each other across the continent. Fruits thus handled remain in fairly good condition for at least ten days, and one carload of peaches and prunes, held up by a strike in 1894, was sold in good condition twenty-six days out from the shipping point. The fruit spoiled quickly after being exposed to the air, however, showing that the limit of safety had been passed.

"Formerly, much of the early garden truck of the South was sent to the Northern markets by express, but express rates are, and must continue to be, entirely too high for any but a very small volume of business. Moreover, truck sent by express must generally be loaded hastily and carelessly while the train waits, and heavy losses are likely to result from this source. As showing how rapidly the refrigerator cars are coming into use, and the effect of their introduction upon the express business in hauling vegetable and fruit cars, it may be noted that from the North Carolina truck districts the business carried by the refrigerator cars increased from 1897 to 1900, 152.3 per cent, while that carried by express companies increased only 31.8 per cent and that forwarded by open and ventilated cars decreased 82.2 per cent. As a net result of these changes, the proportion carried in refrigerator cars in 1900 was 80.7 per cent, while in 1897 it was only 67.1 per cent.

"The use of refrigerator cars in increasing the transportation of fruit and vegetables finds a powerful ally in the cold-storage warehouse, which has been developed in the last forty years. This development moves along lines parallel with the growth of rapid transit for vegetables and other perishable articles.

"Transportation by water is always cheaper than by rail, and cargoes are subjected to less injury from dust, heat, cinders, and jolting. Hence, where time can be afforded, it is very suitable. A very large share, for instance, of the truck from southern Michigan to Chicago, Milwaukee, and lake ports generally, is sent by water; and likewise that from Norfolk, Virginia, to Baltimore, New York, and Boston. For longer distances, however, and particularly from the most recently developed truck centers in Florida, Louisiana, and Texas, high-speed transit is an almost absolute essential, and lines forwarding by water have not been able to compete with those forwarding by rail."[1]

[1] Census of 1900, Vol. VI, pp. 304–305.

CHAPTER VII

PRECOOLING AND COLD STORAGE OF VEGETABLES

Present-day problems. The horticultural problems of to-day are markedly different from those of a generation ago. Precooling, shipment under ice, and cold storage were not matters which bothered market gardeners twenty years ago. It was not until that type of vegetable culture which we now call truck farming began to assume important proportions that the artificial protection of vegetables for a period longer than they normally "stand up" on the market became necessary. Slow transportation, such as was afforded by vessels propelled either by sail or by steam, made apparent the need of artificially protecting the vegetables while in transit, but this type of transportation was soon superseded by the more rapid express and freight service of the railways. This change for a time diverted attention from the problems of preservation in transit and upon the market to the extension of the area of production.

Refrigerator-car service. No single factor has done more to extend the area of vegetable production within recent times than the refrigerator-car service. Perishable products, such as lettuce, tomatoes, radishes, cauliflower, muskmelons, and strawberries, are now shipped from Florida and California to our Eastern markets. This is made possible by fast freight service and shipment in car-load lots under ice. While a great deal of attention has been given to the transportation of citrus and other fruits, comparatively little attention has been paid to the movement of vegetables.

The extent and importance of this modern method of transportation is shown in the following statement from a private letter:

> Taking muskmelons as an example of what refrigeration has done for that industry: the Imperial Valley of California is a very hot section with dry air and little rain. It is therefore admirably adapted to the production of a high-quality cantaloupe.

By the use of refrigeration facilities there were shipped from this valley during the present season 2562 cars, of which about 2100 came to Eastern markets and arrived generally in good condition. Without refrigeration cars they could not have been transported much beyond Los Angeles, or an equal distance eastward.

This gives an idea of the value to our vegetable industry of this method of transporting perishable products. While transportation charges upon such shipments are extremely high, the fact that the product reaches the market at a time when it cannot be supplied locally makes the result, as a rule, satisfactory to the producer. The advantages of car-lot shipments under refrigeration are further illustrated in the following quotation, under date of September 4, 1911, from the General Freight Agent of the Florida East Coast Railway Company:

Formerly the highly perishable vegetables, such as snap beans, peppers, etc., were shipped exclusively by express. On account of the highly perishable nature of these vegetables, and the schedules, they would not ship in satisfactory condition by express except to the Eastern markets. The result was that production frequently exceeded the consumption, and there were gluts in the markets and serious losses to shippers on account of arrival in bad condition.

During last winter some of the shippers (from the Florida section) tried shipment by freight in iced refrigerator cars. The results were entirely satisfactory. This method of shipment enables the producers to get a wider distribution for their products. A large part of the shipments were distributed through the West, and it is very probable that the acreage will be increased and the bulk of the shipment during the coming winter handled under refrigeration. Handling the shipments by freight under refrigeration made a lower charge than the express charge and resulted in shipments reaching market in better condition.

Shipment of mixed cars. Another important problem of transportation under refrigeration in carload lots is being worked out by some of the railways operating in the trucking section. This is the shipping of mixed cars of vegetables to cities and towns too small to handle a straight car of any particular sort. This will work to the advantage of the small producer, for only the largest operators grow a sufficient quantity of any particular vegetable to enable them to ship solid cars.

"Pick-up" trains. A large proportion of the vegetable shipment is, of necessity, handled in exactly the same way as fruit.

The railways operate "pick-up" trains through the territory. By this means shippers having a few packages for the different markets get their products quickly handled; for as soon as a car is loaded for any particular point, it is iced, sealed, and placed in a fast freight for its destination. By this method of shipping, growers can so plan their crop rotation as to obtain a much wider distribution of their products than has heretofore been possible. Such coöperation will make it practicable to ship mixed cars, under refrigeration, to distant points other than the few large centers which now enjoy quick freight service.

Importance of proper packing. It is impossible to give any statistics showing the influence of the proper packing of vegetables upon the whole industry, but the author wishes to call attention to a paragraph from "Perishable Goods," a part of the proceedings of the International Railway Congress held at Berne in 1910. This report deals not only with vegetables but with other perishable products, such as dressed meat, dairy products, eggs, fish, etc.

> The highest state of perfection in the transportation of perishable property is wasted effort in the absence of proper preparation for its shipment, and proper facilities for its receipt and distribution at destination. The carrier has the same ground for expecting the profit-taking shipper of perishable freight to adequately prepare and deliver his goods for transportation as exists in the case of the shipper of ordinary merchandise.

This is a most significant paragraph, for it shows clearly that unless perishable products which are to be transported long distances are carefully grown, properly harvested and packed, and offered in suitable packages to the transportation company, satisfactory transit cannot be secured, no matter how well equipped the common carrier may be for doing the work or how carefully the products may be handled in transit. The preservation of food products en route is of greater importance than accelerated transportation, since it is clear that where long distances are to be traversed the most rapid handling practicable will not prevent the deterioration of highly perishable products. The multiplication of the organisms which set up fermentation and decay is most effectively checked by low temperatures. Temperatures below 50° F. cause decided inactivity on the part of all putrefactive organisms. The shipment of perishable products under refrigeration, therefore, is merely one method of taking advantage of the retarding effect of cold on the action of such organisms.

Precooling. Another important use of artificial cold which will aid producers to deliver highly perishable products to distant markets in a satisfactory condition is precooling. Precooling can be accomplished in a measure by natural means and a little extra care.

Precooling reduces the temperature of perishable products to a point below which putrefactive organisms do not work rapidly. By lowering the temperature before shipping the product, less work is thrown upon the refrigerating equipment of the car. The processes of ripening and decay are quickly checked and do not become active so long as the temperature of the car remains below the danger point.

The difficulty with the present system of loading directly from the field to the refrigerator car is the great amount of latent heat which the products carry into the car. Before refrigeration can become effective the temperature of the vegetables or fruit must be lowered by the refrigerating apparatus of the car to a point below which destructive organisms work. Precooling supplements refrigeration and makes it a more effective agency in transportation. Under the ordinary method of loading truck from the field to the car, enough time elapses between loading and the cooling of the mass in the car to allow ripening to progress, often to the detriment of the shipment, particularly where long hauls are involved.

However, in order that precooling and transportation under refrigeration may be most effective, it is absolutely essential that only perfect products be handled. Precooling and shipment under refrigeration cannot correct the effects of rough handling, bruising, wilting of the products, or improper grading, particularly as regards the stage of development and maturity of the products. In the investigation which the Department of Agriculture has conducted in the transportation of citrus fruits from California and Florida to the Eastern markets, it has found that the losses in transit and upon the market are due quite as much to mechanical injury to the product before it was shipped as to any other cause. A perfect product—one free from mechanical injury and from disease—even though it be a highly perishable one, can be successfully transported great distances with perfect safety and satisfaction. The great losses which were reported in citrus fruits shipped under refrigeration were found to be due more to rough handling either at picking time or in the packing house than to defective transportation conditions.

While no experiments comparable to those carried on with citrus fruit have been tried with vegetables, we are convinced that the same laws will hold good within certain limits. Gardeners have long known that their products would carry better and present a much more attractive appearance in the market if harvested during the cooler part of the day, especially early in the morning when they are full of sap and, as botanists say, in a "turgid" condition, rather than at the close of the day when they are wilted or "flagged." This, in a way, shows what may be expected from precooling highly perishable vegetables in connection with refrigeration in transit.

While the area of production has been greatly extended and the supply to our markets made almost continuous throughout the twelve months of the year by means of rapid transportation and refrigeration, yet by taking advantage of conditions such as packing in the cool of the morning, immediately placing the product in the shade or, preferably, in a cold-storage compartment, and loading from a cold-storage compartment directly into the iced refrigerator car, great improvement may be secured in the quality of vegetables shipped from distant fields of production.

At the present time many of the vegetables which have been produced for distant markets are of the Ben Davis type. With these refinements in handling and in transportation may we not expect high quality in our vegetables?

Cold storage. Cold storage will probably never be of as great importance to the vegetable grower as it is to the fruit grower. Only a few of our highly perishable vegetables can be held in cold storage long enough to lengthen the season materially. The supply of short-season perishable vegetables must come largely from a succession of plantings in different latitudes, supplemented by greenhouse facilities. Many of our garden products which, like fruits, have a definite season and distinctive cultural zone, can be held several months without the intervention of cold storage. Cabbage, onions, squashes, carrots, beets, turnips, and potatoes can all be carried for a considerable period in ordinary storage without serious deterioration or loss.

Celery is perhaps the only crop which is more or less handled under refrigeration. Certain types of celery which mature late in the season can be kept for several months in ordinary storage. The celery, however, which reaches our Eastern markets from Florida and California is more perishable than the types which are grown for winter storage in the East. In order that this product may be economically transported from California and Florida to our Eastern markets it is necessary to ship in carload lots either in ventilated cars or under refrigeration. The fact that celery can be successfully held in cold storage for a considerable period enables dealers in small towns, who cannot quickly dispose of a carload of celery, to handle this product in carload lots; otherwise the supply of such towns would be furnished by local shipments from distributing points. The cold storage of celery has come to be an important factor in marketing the autumn crop from many districts. It prevents the crop from being dumped upon the market at one time. Well-grown, disease-free celery, placed in storage immediately after harvesting and quickly cooled, will keep three months. The temperature at which celery will keep best and longest has not been established, but most dealers attempt to maintain the storage chamber in which celery is held between 31° and 33° F., with a high degree of humidity. It will thus be seen that cold storage is an important factor in the marketing of this valuable crop.

Kale and spinach, when well grown and carefully handled, can be successfully held in cold storage, at a temperature of about 32° or 33° F., for periods ranging from ten to ninety days. The preservation of these products seems to depend more upon their condition than upon the temperature of storage, provided it is not below 30° nor above 35° F.

Cabbage can be held in cold storage, but the low value of the crop together with its bulk practically exclude it from this type of storage. The autumn crop, when disease free and carefully handled, can be held much longer in cold storage than the softer and more perishable product of the early season.

Cauliflower can also be held in cold storage for several weeks. The heads must be carefully crated so as to protect them from mechanical injury and so wrapped as to protect them from pressure or moisture, which would cause discoloration. The storage period for cauliflower is much shorter than for cabbage, but the temperature requirements are much the same — 32° F. with low humidity.

Potatoes can be successfully held in cold storage, but as a commercial enterprise this is seldom profitable or desirable, except when it is necessary to hold seed potatoes in a dormant condition for planting late in the season. This practice is followed to some extent by Southern growers, to enable them to hold Northern-grown seed of the previous season's crop for July planting, in order that they may produce seed for the succeeding year.

In some localities where the forcing of rhubarb is a profitable industry, and winter conditions are not favorable for forcing it by the ordinary method, the roots can be placed in cold storage, frozen for a short period, removed, and successfully forced. Many other crops, such as beets, carrots, turnips, parsnips, cabbage, cauliflower, celery, and onions, can be successfully held in cold storage, but it is seldom necessary to handle them in this way.

The greatest good to the vegetable industry is to come from the use of refrigerator cars in connection with careful handling, special packing and grading, and the precooling of highly perishable products that are to be shipped long distances.

CHAPTER VIII

THE HOME VEGETABLE GARDEN

Economy of the home garden. The home vegetable garden is an important economic factor in both country and suburban towns in these days of rapidly increasing cost of living. The value of an acre wisely developed as a home garden can be made about ten times as great as that of the same area devoted to ordinary farm crops. But the cash value of such a garden depends upon what the products are worth as additions to the daily ration of the household. The fact that a carefully planned garden will contribute something to the bill of fare every day in the year should not be overlooked. During the spring fresh vegetables not only are greatly appreciated, because they offer a change from the heavier diet of the winter season, but they have also a real dietetic value.

No area on the farm is worthy of more careful study than the home vegetable garden. Its location, plan, and planting should be as carefully studied as that of the chief money crop of the place. If the garden must be confined to a lot in town, the scheme of planting the vegetables to be grown and the succession of the crops should be worked out well in advance of the planting season. The location of the farm garden should be convenient to the kitchen, but it must have good soil conditions, an exposure which will make it possible to plant early in the season, and good air drainage to give it protection from late spring and early autumn frosts.

Plan of the home garden. The plan of the garden should provide for the best possible utilization of the soil, giving to each crop space in proportion to its importance. All the long-season and perennial crops should be grouped together; the short-season crops, which are soon out of the way and can be followed by a succession crop, should be planted in contiguous rows. This will make it possible to plant the area occupied early in the season by several crops with a single autumn crop.

The general outline of the town garden will be determined by the shape of the lot, but if the garden is on a farm the tract should be long and narrow and all the vegetables planted in rows so as to permit cultivation by horse power. Such a system will not secure the maximum yield per acre, but it will secure the greatest yield with the least hand labor.

Preparation of the home garden. The preparation of the garden should be thorough, and so planned as to permit the use of at least a part of the area early in the season. If the soil is light and sandy or loamy, the part intended for early spring use should be plowed in the autumn and left rough; but if the soil is inclined to be heavy and does not dry out quickly in the spring, that part necessary for the first early crops should be thrown up in ridges or lists. The tops of the ridges will dry out early in the spring, and if they are split and thrown both ways into the trenches, a seed bed can be secured earlier than by flat culture.

The seed bed for the garden should be deep, rich, and well prepared. It is a good practice to run a disk harrow over the garden area before plowing. This makes the bottom of the furrow-slice loose and friable, and the newly exposed earth when well tilled after plowing gives a seed bed that has been worked to the full depth of the plowing.

Application of fertilizers. The garden area must be abundantly supplied with available plant food. Stable manure should be the chief fertilizer, but some early crops, like lettuce, radishes, and early cabbage, will be benefited by the use of nitrate of soda at the rate of 200 pounds to the acre in addition to a liberal dressing of well-rotted stable manure. From 20 to 30 two-horse loads of manure to the acre are not too much, and for potatoes a dressing of potash of 600 pounds per acre should be used in addition.

Selecting seed. As has already been suggested the entire seed supply should be secured early in the season, as soon as the scheme of the garden has been determined. The seed should be of the best quality obtainable and always of well-known standard sorts. The sorts chosen should allow the greatest range of season possible. When early, medium, and late sorts are available the best of each should be selected, and succession planting should be made in addition.

Early plants. Early plants for outdoor use, such as lettuce, early cabbage, tomatoes, eggplants, and peppers, may be started in the hotbed.[1] Early crops of lettuce and radishes are also profitably grown in hotbeds. Hardy plants like lettuce, radishes, beets, peas, parsnips, and salsify may be planted very early in the open. In fact, gardeners often risk losing the seed of corn and beans in order to obtain an early product if the season should prove a favorable one. This is advisable in the home garden, for even if the crop is cut down by frost, the loss is small and no time has really been lost. Extra early potatoes may be obtained by starting them in boxes or flats and transplanting them like tomatoes; but if this is considered too much trouble, the crop can be hastened by bringing the seed for the early crop into a warm, light room three or four weeks before planting time and allowing the tubers to sprout. By taking advantage of these simple methods much earlier products can be secured from the garden. When the hotbed is employed it will be found that in many cases the cold frame will play an important part both in the spring and in the autumn. Early cabbage, tomatoes, eggplants, and peppers should be hardened in the cold frame before being planted in the open. The discussion of thinning and transplanting on pages 37–42 should be reviewed in this connection.

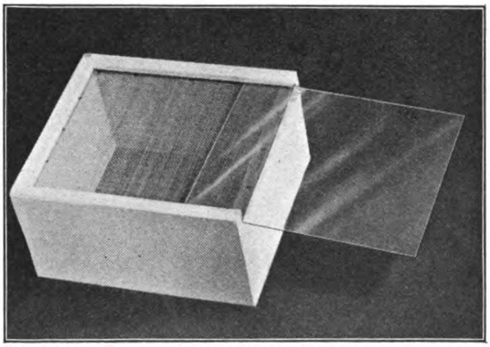


FIG. 31. Combination forcing box and plant protector

In addition to the hotbed and cold frame there is the hand box, or forcing hill; that is, a box about 6 inches deep and 10 × 12 or 12 × 14 inches square, covered with a pane of glass. Such boxes are used in connection with crops which must be seeded in place in the field. They will protect against light frosts as well as insects, and if wire screening is combined with the glass, the frames

[1] See pages 57–61 for construction of hotbeds.

will answer the double purpose of a forcing box and a plant protector. Such a combined box is shown in figure 31, and the method of using it in the field is suggested in figure 32.

Some of the popular early and autumn vegetables cannot be successfully grown during the hottest weather. Slat screens made from plastering laths nailed together to form 4-foot squares will be found very useful in furnishing shade in which such plants as lettuce and celery may be grown in hot weather if abundant

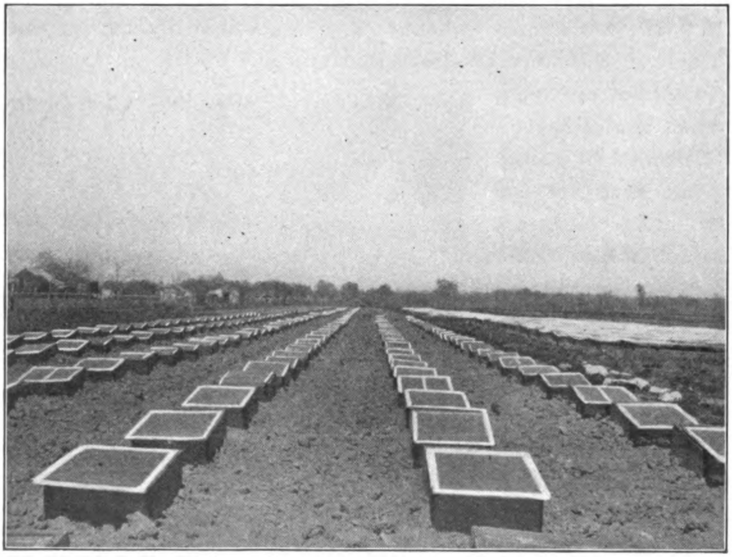


FIG. 32. Method of using forcing boxes in field

moisture is provided. The slats may be placed on a framework 2 or 3 feet above the soil. The larger the area under shade the greater the result.

Cultivation. Frequent shallow culture not only eliminates the competition of weeds but produces a mulch of loose soil which conserves the moisture for the benefit of the plant. In small gardens the cultivation will be carried on chiefly with hand tools, such as the wheel hoe. In the farm garden few special implements, besides a good seed drill, will be actually needed, but a harrow-tooth cultivator will be found very useful. The Meeker harrow, shown in figure 33, is one of the best implements known for fitting the land for planting fine seeds of any sort.

Irrigation. There is no question that it pays to irrigate in the arid sections of the country. The so-called humid sections of our country are subject to frequent droughts of greater or less duration, and often the strawberry crop or a part of the vegetable crop is entirely lost from lack of moisture. Considering the value of the garden, no cheaper insurance can be provided, where water under pressure is available, than the installation of one of the simple methods of sprinkling now in use. A gas pipe with perforations laid on the surface of the ground will serve to distribute water, but if the pipe can be supported at some height and

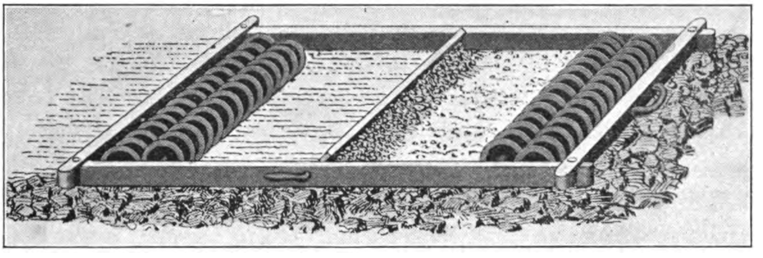


FIG. 33. Meeker harrow

the water supplied either directly from a tank or pump under pressure, so much the better. A much larger area can be covered by rotating the pipe in such a way as to direct the water first to one side and then to the other. It is still better to place small nozzles or orifices, made especially for the purpose, in holes drilled in the pipe. When these methods are too expensive, if water is available it may be conducted through a hose made by tearing unbleached muslin into strips about 10 inches wide and sewing the edges together so as to form a 3-inch tube, with a piece of 3-inch tin spouting slipped into the end and connected with a reservoir. The hose should be closed at the far end, and as soon as it is filled, the water will pass through the meshes of the cloth and wet the area near it. This method has been successfully employed by celery growers and market gardeners. Such an arrangement is suited for watering seed beds before the seedlings appear, as it can be rolled from one side of the bed to the other as the wetting progresses.

Storage. In order to get the greatest good from those crops capable of being kept, means should be provided for storing them. Under some circumstances it is permissible to use the house cellar for this purpose, but in general, whenever possible, it is better to store vegetables as well as fruit in specially constructed pits or cellars. Such crops as Irish potatoes, sweet potatoes, beets, carrots, turnips, squash, cabbage, late cauliflower, parsnips, salsify, and celery can all be stored to good advantage under proper conditions. More attention should be given this branch of garden farming than has heretofore been customary.

No area will yield a greater return either in money value or in pleasure than that devoted to the home garden. The initial cost of the equipment of sash, frames, implements, and seeds is not great. The sash and frames, if properly cared for, will last several years, so the chief item of expense in the home garden is the annual supply of seeds and fertilizer. The success of the enterprise rests with the gardener. A good plan, good seed, and good culture should result in a satisfactory crop. Many are wont to say, when urged to maintain a garden, that it is cheaper to grow more corn and buy the vegetables than to care for the garden. From a financial point of view this is not true; but, grant that it were, vegetables from the market are never so fresh and good as those from the home garden. The garden is at the door, and the market may not be. The real trouble is that country people who have no garden always go without fresh vegetables.

PART II

CHAPTER IX

VEGETABLES: THEIR DEVELOPMENT, CULTIVATION AND USES

Part II is devoted to a discussion of the development, cultivation, and uses of the important vegetable crops grown in the United States either by market gardeners, truck farmers, or amateur gardeners. An alphabetical arrangement of the subjects is followed rather than the plan of grouping them by their uses or relationships. For convenience of the reader and the student this method has been followed rather than that of chapter headings for each vegetable. Primary headings, giving the name of the vegetable, are used in the center of the page, and secondary headings, such as are required in the discussion of "cabbage as a truck crop at the South; cabbage as a farm crop at the North," are also treated as center heads but are set in a different style of type. The same general style of sideheadings which has been used in the foregoing chapters will be followed in this division of the work.

ARTICHOKES

The globe artichoke. Gardeners of the world are familiar with two distinct plants with the name artichoke. The type shown in figure 34 is known as the globe artichoke, *Cynara scolymus.* It is an herbaceous perennial, producing a dense whorl of large leaves, whitish-green above and clothed beneath with dense hairs which give them a woolly appearance. A blossom stalk with a large flower bud appears, sometimes the first season, but usually not until the second year. It is this large bud with its fleshy scales and receptacle which forms the edible portion of this plant. If the bud is allowed to approach the blossom stage, it becomes tough, coarse, and unfit for use. Young buds only are edible.

The globe artichoke is not common in American gardens outside of California and the South Atlantic and Gulf States, and even there it is cultivated only to a limited extent. The plant is not hardy, unless protected, north of the latitude of Charleston, South Carolina, but with suitable winter protection can be successfully wintered at Washington.

One thing which has had an unfavorable influence on the cultivation of the globe artichoke in this country has been the use of seedling plants. Seedlings are very variable — some are good, but most are mediocre. Few of the desirable French varieties have been imported, and no effort has been made to develop high-grade seedling sorts in this country. This plant, like many others, does not "come true" from seed. High-grade sorts can, therefore, be propagated only from suckers or by division of the crown. The limited demand for this vegetable in our markets has up to this time tended to cause our gardeners to neglect it; but as the demand grows, French sorts will be introduced or good seedling varieties developed in this country to meet the need.

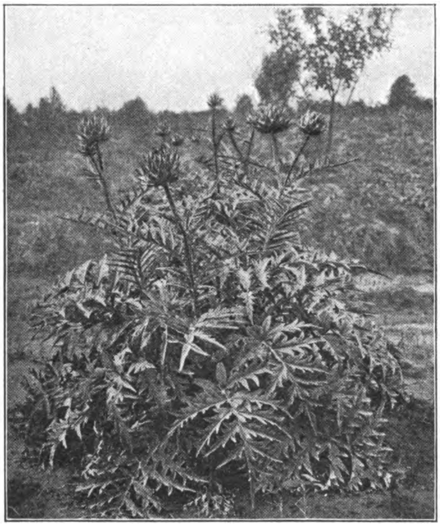


FIG. 34. Globe artichoke

The globe artichoke thrives best in a mild climate in a deep, well-enriched sandy loam. Abundant moisture is essential during the growing period; but the plant is difficult to winter on wet lands, and good drainage is therefore necessary for permanency.

As has been suggested, globe artichokes are propagated both from seed and from suckers. Plants started from seed in February or March in hotbeds or greenhouses, and set in the field after danger from frost has passed, often bear edible products the first season. Suckers, if removed early and immediately planted in rich, warm soil, may also give edible products the first year. French gardeners make special mention of the care necessary in removing suckers from the parent root so as to retain a small heel portion of the mother root, but not enough to injure the parent plant. Each plant, as a rule, throws out several suckers, all of which should be removed, except two or three, to perpetuate the original clump. The plants should be given from 2 to 2½ feet in the row, and the rows should be at least 4 feet apart.

At the present time a large quantity of artichoke burs is imported annually, and the few growers who successfully cultivate this plant in America receive a good price for their product. Like many other special crops with a limited demand, it can be profitably grown only by a few.

Artichoke (Jerusalem). The Jerusalem artichoke (*Helianthus tuberosus*, Linn.) is in reality a tuberous-rooted sunflower native to North America and, like the globe artichoke, is an herbaceous perennial. This plant differs from the globe artichoke in that it produces an edible tuber instead of a blossom bud. The plant is grown both for human consumption and for stock food; but although it is perennial, hardy, and easily propagated, the tubers, while numerous, are small and the total yield is insignificant in comparison with Irish or sweet potatoes. Its food value is practically the same as that of the potato. Artichokes are seldom grown in sufficient quantities to be shipped to distant markets, but are to be found the year round in most Southern markets.

To establish a plantation the tubers are planted in the same way as Irish potatoes, in rows from 30 to 36 inches apart, with the plants in each row 10 or 12 inches apart. The plant thrives on any fertile loamy soil, but does not do well on heavy clay. After a plantation is once established, it will maintain itself for several years unless heavily dug or pastured by hogs. In some localities the crop is depended upon for a portion of the succulent food for hogs, the animals doing their own digging.

ASPARAGUS

Asparagus is one of the most highly prized of the perennial garden herbs. It grows wild both in Europe and in Asia. The young succulent shoots which first spring from the thick, fleshy root constitute the part of the plant used for culinary purposes. The plant is known to botanists as *Asparagus officinalis*, Linn. Botanically it is interesting because the true leaves are the scalelike bodies closely folded against the surface of the fleshy shoots. The fine divisions which appear later and simulate leaves are true attenuated branches, although they perform the office of true leaves.

Asparagus is an important market-garden crop, and within the last six or eight years has become an extensive trucking crop in Massachusetts, New York, Virginia, North and South Carolina, Georgia, and California. The light, sandy soils of the Long Island, Virginia, and Carolina regions admit of planting the roots deep, thus insuring a high quality of blanched asparagus at minimum cost. As a result of the extremes of latitude covered by these districts, a succession of asparagus is provided for the Northern markets from early in March until the end of June.

Asparagus should be an adjunct to every home garden. It has a wide distribution, growing well from Maine to Florida and from New York to California. It is of comparatively easy culture, and when a bed or plantation is once established it remains in good producing condition, with moderate care, for a number of years, varying from four to ten, according to the care it receives.

Soil. Asparagus will grow on any soil available in the arable regions of the United States. In fact it will adapt itself to a great diversity of conditions. The one condition, however, under which it will not thrive is that of extreme moisture. It will endure long and protracted drought but will not endure being submerged. The selection of soil, therefore, except for market-garden and truck purposes, is of a minor consideration; but a warm, rich, well-drained situation should be selected if possible.

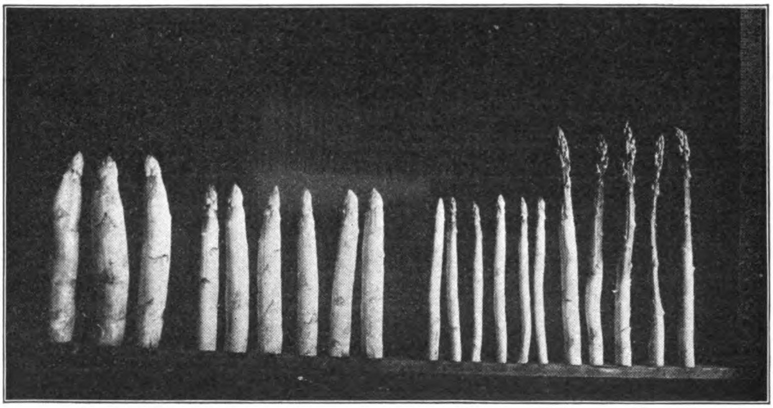
The preparation of the soil is an important part of asparagus cultivation. The soil should be thoroughly subdued, all noxious weeds and shrubby growth being eliminated before planting. It should be thoroughly plowed and subsoiled so as to give a seed bed at least 14 or 15 inches in depth. The area should then be laid off, according to the type of grass to be produced, in trenches 4 feet apart if green grass is to be produced, and from 6 to 8 feet apart if white or blanched grass is desired. In the bottom of the trenches the earth should be thoroughly loosened and liberally dressed with well-decomposed stable manure, over which a layer of 2 or 3 inches of fresh earth should then be spread. The plants are set 18 inches apart, so that the crowns will be 8 inches or more below the general surface of the soil, but are not deeply covered at first. The idea is to leave the trench open, with only about 2 inches of soil over the crowns of the plants and, as the season advances and the plants become strong, gradually to work the soil in about them until at the close of the season the surface is practically level.

The cultivation during the first year should be the same as that for corn or potatoes — level culture which will prevent the growth of weeds from smothering the plants. Such cultivation should be kept up until the third year, when the asparagus will have gained sufficient strength to admit of cutting to a slight extent. It must be remembered that the young shoots constituting the commercial product are really the forerunners of the stems and leaves, and hence are the vital parts of the plant by means of which, during the growing season, it stores up a sufficient amount of food in the roots to enable them to throw up strong shoots the following season. It is therefore important that the cutting should not be severe enough to reduce materially the strength of the plant early in its life.

Plants. Asparagus is readily propagated from seeds, and in some localities the growing of asparagus plants for extensive planters in other localities is an important commercial industry. There are growers in New Jersey who make the production of asparagus roots for use in the Southern states a large part of their business. New Jersey seems to be admirably adapted for the production of the young asparagus plants, and the growers have become very expert in their production. The planter may produce his own seedling plants or he may purchase them from some one who makes a specialty of growing them. As a rule, well-grown, one-year-old or two-year-old plants are more desirable than older roots for starting a commercial plantation. Asparagus during the first year makes comparatively little top growth, seldom producing stalks which are thicker than a well-grown rye straw but making a large number of thick, fleshy roots of considerable length. These, at planting time, should be handled carefully and spread out in normal position in the trenches described above.

Seed selection. Asparagus plants are diœcious, and for that reason it is essential that both the seed parent and the pollen parent be resistant to disease, of robust habits of growth, and bearing the character of shoots desired. By careful breeding studies it has been determined that the seed from certain pistillate plants when fertilized with pollen from particular staminate plants gives not only more robust but more disease-resistant seedlings. For best results attention must be given to the selection of both parent plants.

Two types of asparagus. In this country asparagus is placed upon the market in two ways — as *blanched grass* and as normal



a *b*

FIG. 35. Two types of asparagus

a, blanched grass; *b*, green grass

green grass. Until recently the markets have shown a positive preference for blanched grass, but consumers have now discovered that the green product carries the more delicate flavor, and in many markets the green grass now commands the highest price. The fact is that blanched grass is more profitable for the grower. There are two reasons for this: (1) the blanched stalk is thicker than the green one, and therefore fewer stalks will make a bunch; (2) green grass, because it develops aboveground, is more exposed to the depredations of the asparagus beetle. The two types of grass are produced from the same varieties, the difference in color being entirely due to cultural treatment. These types of stalk are well shown in figure 35.

Preparation of the land. The general preparation of the land and the depth of planting the roots have been described on page 114 and are the same for both systems of culture.

Distance to plant. Roots for the production of green grass should be set in rows 3 or 4 feet apart and 18 inches apart in the row, while the roots for blanched grass should be planted in rows 6 or 8 feet apart with the individual plants 18 inches apart in the row. Green grass can be grown in soil too stiff and retentive to be used for the blanched. With green asparagus, clean, level culture after cutting and a mulch during the winter and early

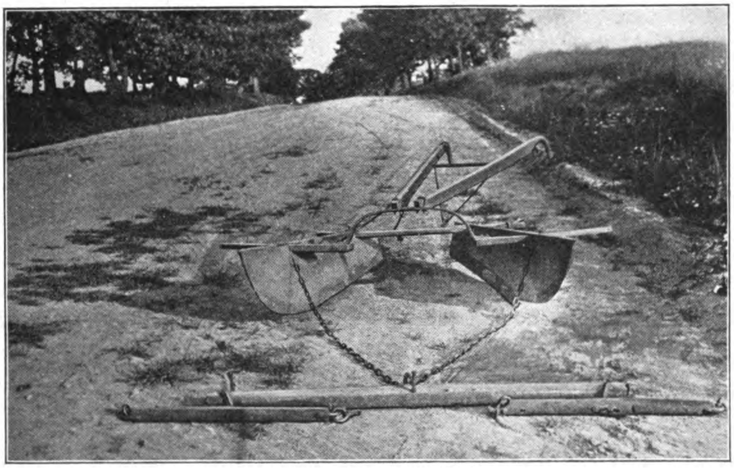


FIG. 36. Asparagus hiller

spring are usually sufficient. Frequently, however, spring cultivation is also necessary. Blanched grass, on the other hand, is economically produced only on light, sandy soils which can be easily handled early in the season. As soon as the crowns have grown strong enough, which is usually the case after two or three years of clean culture, a ridge from 18 inches to 2 feet in height is thrown up along the line of the row before the shoots have made much growth in the spring. An implement such as shown in figure 36 is used for dressing the ridges after they have been roughed up with the plow or disk. Following this the tops of the ridges are slightly knocked off by the use of a long board with tenpenny nails driven through it so as to give the semblance of a harrow. This serves to stir the soil slightly and kill young weeds. After cutting has been in progress, if there is any weed growth, this board is passed over the ridges immediately after the cutters.

FIG. 37. Cutting blanched asparagus

Blanched asparagus is cut daily during the season. The plantation is gone over each morning, and all shoots that can be detected, either by their appearance aboveground or by the lifting of the soil, are cut by thrusting a long, thin-bladed knife with a V-shaped point through the side of the bank, as suggested in figure 37, in such a manner as to sever the shoot and at the same time give it a slight upward movement. The shoot is grasped by the left hand and carefully placed in a suitable tray or basket. At the end of the row the basket is emptied into a crate or box, in which the shoots are carried to the packing and washing shed.

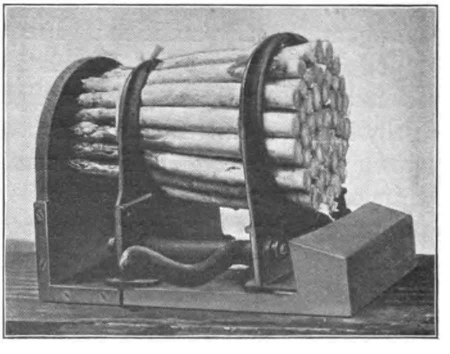


FIG. 38. Asparagus buncher

Bunching. Asparagus is usually bunched by means of some simple apparatus, as shown in figure 38. The stalks are laid in two parallel saddles, which are about five inches apart, with the tips against a board. Bands of tape, or, in some markets, rubber bands, are used to hold the stalks together. After the stalks have been laid in the saddles and tied, the butts are cut with a large knife close to the right-hand saddle, thus giving the bunch a square base. Each bunch is carefully rinsed in clean running water and stood on a moist pad to drain.

Shipment. For shipment the asparagus is packed in carriers holding one or two dozen bunches. A layer of moist sphagnum moss is usually placed on the bottom of the packing box, and on this the butts are set. The bunches are tightly pressed together, and the top of the box is nailed on carefully to prevent the bunches from

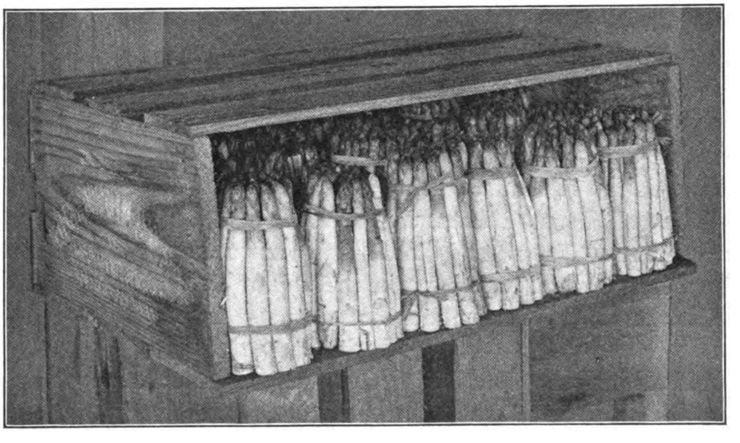


FIG. 39. Type of carrier used for shipping asparagus

moving about in shipment and becoming bruised. The type of carrier used for shipping asparagus is shown in figure 39.

The asparagus beetle. The one insect enemy of asparagus which causes serious loss is the beetle. This insect eats the young stalks as soon as they appear aboveground and renders them unsalable. Its depredations are severely felt by the green grass, as this is exposed to their attack. Blanched grass, being cut as soon as the tips appear, never suffers from this insect. The growing of blanched grass is, therefore, one of the chief means of avoiding this pest.

Asparagus rust. This is the worst enemy of the asparagus grower. While it does not directly injure the cut of the season when it first makes its appearance, its presence on the plant after the cutting period to an extent sufficient to cause premature ripening of the plants, shortens the succeeding season's harvest. The remedial measures used in the control of this pest are therefore directed to the securing of a strong, vigorous growth after the close of the cutting season. The treatment employed consists of thoroughly spraying the plants at frequent intervals with Bordeaux mixture. This helps to prolong the growth of the plants and thus enables them to store food for the production of the following season. Another precaution is to cut carefully and burn all tops without removing them from the field. A light sprinkling of straw, to insure complete singeing of the soil surface, is an advantage. The reason for this treatment is the fact that the spores of the rust are carried over on the diseased stalks. The more completely the stalks and all vegetation in the field are destroyed the less will be the danger of infection for the succeeding crop. The treatment is in the nature of sanitation rather than a remedy.

The only means of securing relief from this disease is the development of disease-resistant strains and varieties. The fact that there is a marked difference in the ability of individual plants to resist the rust leads to the belief that a resistant form will soon be developed.

Asparagus rust (*Puccinia asparagi*) is caused by a fungous parasite upon the asparagus plant. It attacks the bushy tops which come up in the summer after the cutting season has closed. If the disease is severe, it shortens the growing period of the plant, thus preventing the normal elaboration and storage of food in the roots, and in this way indirectly shortens the succeeding season's cut. The rust attacks plants of all ages, causing enlargements which are somewhat elongated and which later burst open, exposing a reddish granular surface. This form is called the summer, or red, rust. This develops from the spring rust, which may be carried over on dead tops or other refuse from the patch. Red rust is followed by the so-called fall, or black, rust, which is simply a further development of the same disease appearing toward the end of the growing season. This form may occur at any time during the season, although, as a rule, it is most noticeable during the autumn. The dark color is due to the black spores of this form of the rust.

The red rust is the destructive form; the other forms would be of little account except for their carrying the parasite from one season to another. The most successful treatment which has so far been devised, besides that of breeding disease-resistant strains of asparagus, is to spray the asparagus with a normal Bordeaux-mixture solution, to which 2 ounces of resin whale-oil soap is added, and while the plants are still moist to dust them with flowers of sulphur. Flowers of sulphur are lighter, carry better, and are less expensive than ground sulphur, known as flour. Sulphur should be applied with a blowgun which develops considerable power, so as to distribute the sulphur well through the branches of the plants.[1] The cost of an application of flowers of sulphur, which is the most economical form to use, has been found to be about $1 per acre. The sulphur should be so applied as to get a thorough coating upon the tops of the plants just about the time the rust is due to appear.

Forcing. In England and France asparagus is forced to a considerable extent. The roots may be lifted and placed in a mild hotbed and forced in that way, or, as is the common practice in England and France, brick flues or heating pipes are carried through the soil along the lines of asparagus, so as to warm the soil in the vicinity of the roots. The crowns are given protection by placing over them frames covered with glass.

Asparagus is not forced to any considerable extent in this country because of the wide territory over which it can be grown normally and because of the good transportation facilities afforded. The only necessity for forcing asparagus in America is to satisfy the demands of the owners of private estates. If it is desirable to hasten the development of the plant, the bed may be made on specially prepared soil, with heating pipes arranged so that the temperature of the soil can be brought to a desired degree, and an artificial covering of muslin or tent cloth placed over the area early in the season.

Asparagus is an interesting plant for experimental study. A number of years ago the authorities of the Ohio State Experiment Station, now located at Wooster, Ohio, carried on some experiments to compare the size of the stalks produced from

[1] For detailed information concerning the application of sulphur to asparagus, see *California Bulletin No. 172.*

staminate and from pistillate plants. Their tests showed that by selecting the non-seed-bearing plants, that is, staminate plants, very much larger and stronger stalks were obtained than when seed-bearing plants were used. This goes to show that the maturing of seed upon asparagus is a devitalizing process, and as this can be overcome to a certain extent by cutting the stalks before the seed matures in the fall, it is probable that larger stalks may be secured by observing this precaution. It is worth while for those interested in asparagus culture to pay attention to this point, for it is an easy matter to carry the plants in the seed bed sufficiently long to determine whether they are staminate or pistillate before setting them in the permanent plantation.

Seed bearing has been given an added significance since the rust has become so prevalent. Growers say that a good crop of seed indicates that the following cutting period will be a satisfactory one. The explanation of this is undoubtedly to be found in the fact that if the plants are comparatively free from rust and make a normal growth there will be normal seeding. The growth which is sufficient to enable the plant to fruit is also sufficient to enable it to store a good food supply for the production of a satisfactory harvest the following year.

Varieties. Up to the present time comparatively little attention has been given to the subject of varieties of asparagus in America, but we now have two or three which are regularly advertised by our leading seedsmen. Colossal, known also as Conover's Colossal, is one of the best-proved standard sorts. In France it is known as Argenteuil. Palmetto is of Southern origin and is a very satisfactory sort for that region. Other varieties upon the market are Barr Mammoth and Columbia Mammoth White.

BEANS

The bean belongs to the pulse family, which is one of the most important families of economic plants with which man has to deal. The members of this family vary in size from low annual plants to tall, broad, spreading trees, but there are few of greater economic importance than the bean. Besides furnishing wholesome, nourishing food for man and animal, this group of plants provides the agriculturist with a means of replenishing from the great store of nitrogen in the air the nitrogen taken from the soil by other agricultural crops. Not all leguminous plants provide food for both man and beast and at the same time increase the fertility of the soil upon which they grow. The bean, however, is one of those which has this power. It is, therefore, one of the most desirable crops to use in the farm rotation as well as in market-garden work.

While the food value of beans and peas of various kinds has been known for many generations, it is within the memory of men now living that their efficiency as soil renovators and fertility restorers has been definitely proved. Now, however, the value of these crops is being more appreciated, and as a result their cultivation is being greatly extended.

Perhaps no single agricultural crop is of greater economic importance to the people of the United States than the cowpea, yet its cultivation in this country is comparatively recent. Each year the crop is better appreciated, and its area is being rapidly extended. While the cowpea is not a true bean, it is a valuable forage crop and a great soil renovator. The seeds are valuable as grain, the hay is equaled only by alfalfa, and as a producer of organic matter for green manuring it is unsurpassed.

The bean is not so important as other crops of this family from the standpoint of forage or soil renovation, but the seed which it produces makes it one of the most valuable. While the seed is the bean's most important and valuable product, its power to gather nitrogen and to render the soil better for having been grown upon it is a consideration which should not be overlooked by those interested in maintaining the nitrogen content of their land.

Types of beans. The general term " bean " includes no less than eight distinct species of plants, native to nearly as many different sections of the world. These eight closely allied plants, descriptions of which follow, are almost universally spoken of as beans and are deserving of mention here, although not all of them are treated like the common beans, which are the primary subject of this chapter.

Broad beans. So far as is known, the broad bean (*Vicia faba*) is one of the oldest members of the group of leguminous plants. It is, however, of minor importance in the United States, although it is valued both as a garden crop and as an agricultural crop in

Canada and most European countries. In North America its cultivation is confined chiefly to the Dominion of Canada, where it is grown as a garden crop and as a companion crop to corn for silage purposes. These beans require a long, cool summer, and because of the intense heat and protracted periods of drought characteristic of most sections of the United States, do not thrive in this country.

Kidney, or haricot, beans. Kidney beans, known as haricot beans, and technically as *Phaseolus vulgaris*, are the common field and garden beans of America. According to the evidence which we have upon this point, they are entitled to the distinction of being native to the New World. It is the cultivation and uses of the kidney beans which are to claim our attention in this book.

Lima, or sugar, beans. The plants of Lima, or sugar, beans (*Phaseolus lunatus*) are normally rank-growing climbers, although within recent times a dwarf, nonclimbing variety has been developed. They thrive best on strong, well-enriched lands and under tropical or subtropical conditions.

Dolichos beans. Two familiar examples of the Dolichos group of beans, which differ slightly from the common beans, are the hyacinth bean and the asparagus, or French yard-long, bean. The hyacinth bean (*Dolichos lablab*) is a strong-growing, twining plant used in this country chiefly for ornament, in which both the flowers and pods figure prominently.

Soy beans. The soy, or soja, bean (*Glycine hispida*), while for generations known and appreciated in Japan, is a comparatively recent introduction into this country, and its cultivation has not yet become general. In Japan it is used as food for man as well as for stock, but in the United States it has received little attention except as forage for cattle and swine. It is, however, destined to become an important agricultural product, both as a grain and forage crop, in many sections of the United States.

Scarlet runner beans. The scarlet runner bean (*Phaseolus multiflorus*), also called the flowering bean, is a thick-rooted perennial at the South, but not hardy at the North. The plant is popular as an annual climber for covering arbors or as a shade for windows.

Velvet, or banana, beans. The velvet, or banana, bean (*Mucuna utilis*) is one of the most exacting members of the bean family as regards temperature, and as a result it can be grown successfully in the United States only within comparatively narrow limits. In Florida and along the Gulf coast it has, in recent years, become an important forage and green-manuring crop. In those sections where it can be successfully grown it is a worthy competitor of the cowpea and soy bean.

Cowpeas. The cowpea (*Vigna sinensis*), because of its bean-like seed and habits of growth, its economic importance as a forage crop for the production of hay and silage, and its value as a green manure, should be mentioned in connection with the other plants to which it is so closely related both botanically and economically.

Field and garden beans. For convenience in reference and in discussion, beans may be divided into two general groups,— field beans and garden beans,—which are by no means distinctly separate either in appearance or in botanical characteristics. Each of these groups may be subdivided into bush beans and pole beans. Field bush beans are recognized, for commercial purposes, under three well-marked types known as kidney, marrow, and pea beans, each of which may again be divided into colored and white varieties. The garden beans of both the bush and the pole type consist of kidney and Lima beans, but practically all the common garden varieties, whether of the bush or the pole type, are known simply as kidney beans. The kidney beans in turn may be divided into wax-podded and green-podded. The following classification may be helpful:

Field Beans	Bush	Kidney	Colored, White
		Marrow	Colored, White
		Pea	Colored, White
	Pole or corn hill		Colored, White
Garden Beans	Bush	Kidney	Wax-podded, Green-podded
		Lima	
	Pole	Kidney	Wax-podded, Green-podded
		Lima	
		Runner (Scarlet Runner)	

Geographical distribution of the bean crop. The geographical distribution of the bean crop, according to the census of 1900, is graphically presented in the accompanying map (figure 40), which shows the counties of the several states in which dry beans are grown commercially. This map suggests the influence of climate in determining the regions to which this crop is adapted. The high latitude and the peculiar soil conditions of the New England States and of New York, and the high latitude of Michigan, Wisconsin, and Minnesota, are equally favorable to the production of this crop. Considerable attention is given to the culture of beans

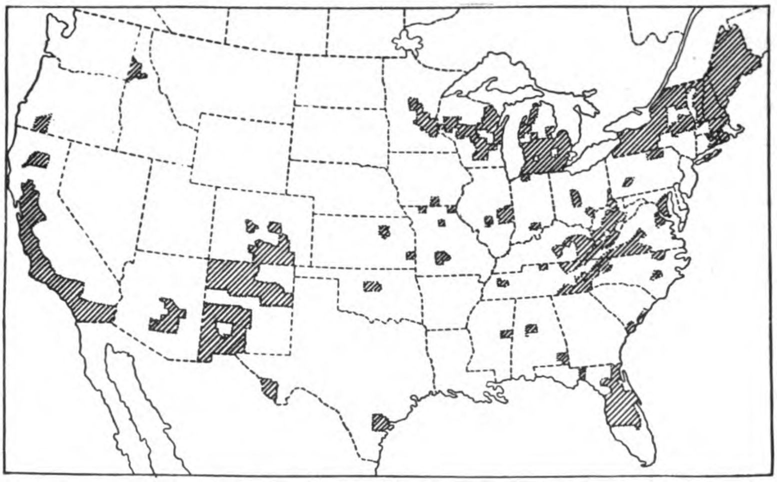


FIG. 40. Map showing the geography of the bean crop, census of 1900

in the region along the Allegheny Mountains from southern Pennsylvania to northern Georgia. The north-central part of California is also an important bean-producing center.

Within the last decade the cultivation of field beans has increased markedly in certain sections of the United States, particularly throughout New York and Michigan. In many parts of these two states beans have become as much a staple crop as wheat was a quarter of a century ago and have largely displaced it. From an economic standpoint the bean crop is a valuable addition to the farm rotation because of its capacity for improving the land on which it is grown. If for no other reason than this, the displacement of the wheat crop by the bean crop in the rotation would be an advantage. Of late years, however, the growing of beans has proved more remunerative than that of wheat, which is an additional reason for cultivating this crop at the expense of the other.

While the distribution of field beans is, to a considerable extent, determined by soil and climate, the production of garden beans is not so much influenced by these factors. The quick growth of garden beans enables the truck farmer or the market gardener to take advantage of the season that, in his locality, is most favorable to the production of the crop; for this reason the demands of the market and the location of the grower largely determine the area to be devoted to garden beans in any particular locality. Shipping facilities, of course, have as much influence on the distribution of garden beans for early market as on any other truck crop.

From what has just been said, it is evident that there are two important divisions of the bean industry in the United States — the production of field or dry beans and the production of garden beans. The latter involves two industries: (1) the growing of beans for early market and (2) the raising of string or snap beans for use by the canning factories. The regions in which fresh beans are produced for canning purposes correspond more exactly to the areas in which field beans are grown than to those which produce garden beans for the early market.

Field Beans

The map (figure 40) indicates the areas in which beans are cultivated for commercial purposes. The regions in which this cultivation is most intensive lie chiefly within the area covered by the glacial drift of the great ice age. The soils of the area are, as a rule, strong and retentive, carrying large quantities of lime and considerable potash, phosphoric acid, and organic materials. It is not strange, therefore, that a crop which is able to gather nitrogen from the air should thrive well upon soils having an abundant store of phosphoric acid and potash.

While beans produce abundantly upon strong clayey soils, yet the clayey loams, shales, and gravelly soils of the drift region are better suited to them than are the heavy clays. The growth of the vine is too much restricted upon very heavy clayey soils, and although the vines yield well in proportion to their growth, the total product is in proportion to the growth of the plant as a whole. Figure 41 shows a typical bean field in the North.

Preparation of the soil for field beans. The bean is a warm-season crop and cannot be safely planted until after danger from killing frost has passed. The preparation of the soil for field beans

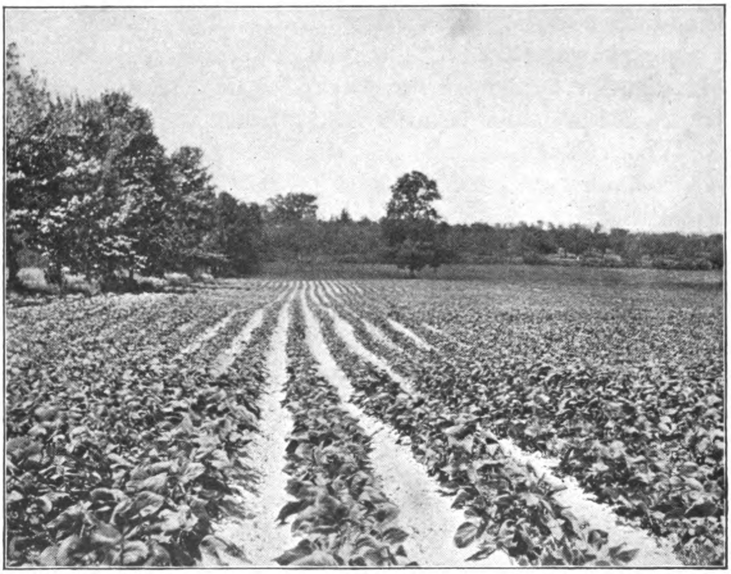


FIG. 41. A typical bean field in the North

should be deferred until the vegetation covering the area has made considerable growth, so that it may be as completely destroyed as possible during the operation of plowing, harrowing, and fitting the land for the reception of the seed. The short season required by beans permits using the land during the winter months for some cover crop, such as wheat or rye; and if the same land is used year after year for the production of beans, the turning under of winter cover crops furnishes an important means by which the store of organic matter in the soil can be maintained, a consideration of importance in sections chiefly dependent upon commercial fertilizers.

After the soil has attained proper dryness in the spring, it should be plowed from 6 to 8 inches in depth and immediately compacted and harrowed, so as to prevent the loss of moisture. The surface of the seed bed should be made smooth and fine so that the drill or planter can be economically used upon it. If dry weather follows this preparation, a good practice is to run a heavy land roller over the area just before the planting of the crop, particularly if the planting is to be done with an ordinary grain drill. If this work is to be done with an apparatus similar to the ordinary corn planter and the land has been previously rolled, it is advisable to go over it with a spike-tooth harrow or some other type of smoothing harrow *after* the crop has been planted. The surface mulch, which is produced by the use of the smoothing harrow after the rolling and planting, leaves the soil in the most desirable condition.

Planting field beans. It has already been suggested that field beans should not be planted until all danger from injury by frost is past. In fact, growers have found that it is better to postpone planting them until as late in the season as is practicable and still be able to harvest the crop safely before the vines are injured by fall frost. The late-planted crop has the advantage of escaping the most serious attacks of the bean rust. While undoubtedly there are varieties which are more or less resistant to this rust, yet the general practice of late planting has been found to be of decided advantage in avoiding the disease.

In the field crop the distance between the rows varies from 28 to 36 inches, according to the implements used; 30 inches is a satisfactory and not unusual distance between rows. The seeds are so scattered as to fall from 2 to 4 inches apart in the row, although the ideal spacing would be 6 inches if it were possible to obtain a perfect stand of plants at this distance. Experiments conducted by the writer and by other investigators have clearly demonstrated that beans planted singly in the row at intervals of from 4 to 6 inches produce a much more abundant crop than the same quantity of seed planted in hills from 18 inches to 3 feet apart. For distributing the seed in the row at these distances a bean planter or check-row corn planter may be set to drop the seeds in drills. A common practice is to use an ordinary grain drill and stop a sufficient number of tubes to be able to space the rows the proper distance. This adaptation of the drill obviates the necessity of purchasing a special implement for planting beans. By the use of range poles and a 9-tooth drill spaced 8 inches, 3 rows of beans 32 inches apart, can be planted each time the field is crossed. An 11-tooth drill can be arranged to plant 3 rows of beans 32 inches apart, if the teeth of the drill are spaced 8 inches, by driving the wheel in the preceding wheel mark on each return trip.

Those contemplating the purchase of implements for different uses should carefully study the adaptability of the implements to the work desired. It will readily be seen that an 11-tooth drill, arranged to plant 3 rows 32 inches apart, will be a much more convenient implement than a 9-tooth drill similarly spaced, as the larger implement does away with the necessity of using range poles.

Quantity of seed necessary for field beans. The quantity of seed required to plant an acre of beans varies with the size of the beans; that is, ½ bushel of small pea beans is sufficient to plant 1 acre of ground, while 1 bushel of red kidney beans is not sufficient if the seed is distributed in the ordinary fashion in drills. In planting beans of the pea and marrow types the quantity of seed varies from ½ to 1 bushel per acre, according to the quality of the beans and the preferences of the planter. For kidney beans the quantity varies from 1 bushel to as much as 6 pecks per acre. Ordinarily, with rows 30 inches apart, 1 bushel is sufficient for seeding an acre.

Depth of planting field beans. The depth at which beans should be planted is determined by the character of the soil and the season of the year. In heavy, retentive soils planting should be comparatively shallow, as the peculiar habit of growth of the bean is such that it cannot readily reach the surface if planted deep in such soils. In light soils early planting can be made as deep as 3 inches, but 1½ or 2 inches is the maximum depth for retentive soils. The cowpea and soja beans are more exacting in regard to the depth of planting than the field bean, the stalk of the young cowpea being more slender and less able to force the seed leaves through any crust of earth that may have formed after planting. All things considered, a satisfactory depth for planting is about 1½ inches.

Cultivation of field beans. Like all other hoe crops field beans require frequent shallow cultivation. The stirring of the soil for the purpose of holding the weeds in check and preserving a soil mulch over the area occupied by the growing crop is the important factor in bean culture. Implements with narrow blades which stir the soil to a depth of between 2 and 3 inches are most desirable. Those designed for the culture of corn, which have narrow blades such as are found in all implements provided with spring-teeth attachments, will be satisfactory.

At the last cultivation the plants may be slightly hilled; that is, the soil may be thrown toward the plants with small wings.

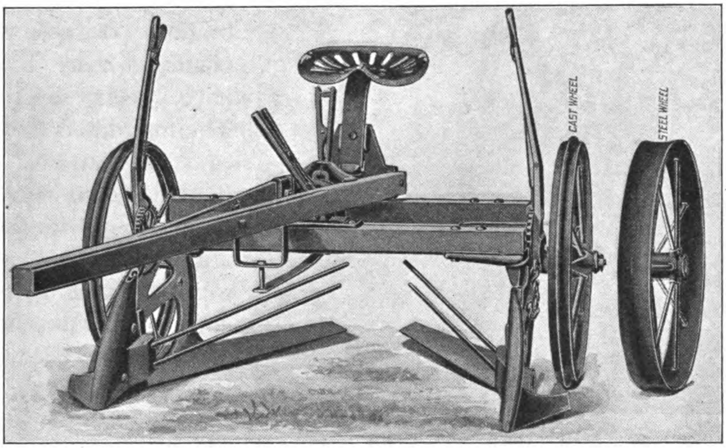


FIG. 42. Bean harvester used in the East

This has the advantage of leaving them on a slight ridge, which facilitates the work of harvesting when this is done by mechanical means. There is a tradition that beans should not be cultivated when the dew is on the vines. This undoubtedly has a foundation in fact for the reason that moisture is congenial to the spores of disease. It is known that anthracnose is communicated through the soil and that mud or dust will carry the spores to the leaves of the plant. Cultivation while the dew is on the ground will certainly scatter the disease.

Harvesting field beans. For many years the extensive cultivation of hoe crops, such as field beans, was impossible because of the great amount of hand labor necessary to gather the crop. Within recent years, however, labor-saving devices have been invented so that the once laborious practice of pulling individual plants is now done by means of a bean harvester.

This machine is built on the principle of a pair of shears and consists of two long steel blades mounted upon a strong framework carried upon wheels, as illustrated in figure 42. The long shearlike blades are so set that they will cut the roots of the plants just beneath the surface of the ground. Above these blades guard rods, or guide rods, are so arranged as to move from their original positions the plants whose roots have been severed. The machine cuts two rows of beans across the field at a time, and the plants of both rows are thrown together in a single windrow, as shown in figure 43. This clears a space for the passage of one of the animals in the team, so that it is necessary for only one to pass through the standing crop, thus making the loss by shelling much less than it would be if both animals were driven through.

FIG. 43. The two rows of beans are thrown together by the harvester

After the plants are thrown together by the harvester it is customary for men with ordinary pitchforks, either 2-tined or 3-tined, to follow and place the beans in small heaps, as shown in figure 44, to cure for several days before being stored in barns or sheds for threshing. In some instances, where the work is done upon a very extensive scale and where the loss from shelling is not considered sufficient to justify the employment of hand labor for bunching the beans with forks, an ordinary horserake is employed.

When the beans are to remain in the field for a longer period to become more thoroughly cured, and when the work of harvesting is done entirely by hand, the crop is frequently placed in shocks, which are built around a pole, 4 or 5 feet in height, both ends of which have been sharpened and one end firmly placed in the ground. A small quantity of straw, grass, or other material is placed around the base of the stake, and the beans as they are pulled are piled around the pole until a compact miniature stack about 4 or 5 feet high is formed. This operation is similar to the common practice followed by the growers of peanuts in stacking and curing this crop. The curing process in every case is carried far enough to prevent the vines from molding after they are stored in the barn prior to threshing. If the vines are thoroughly ripened in the field before harvesting and the weather is satisfactory, they will be ready for storing in two or three days. If, however, the vines have some green leaves upon them and the pods are not thoroughly dry, the period for curing in the field is of necessity much longer.

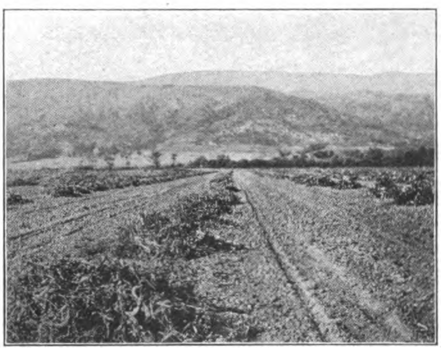


FIG. 44. Heaps of curing beans

After the beans have been properly cured in the field it is customary not to thresh them at once but to store them in barn lofts or sheds until the weather is cool. In some instances, however, if the beans are thoroughly field cured they may be threshed in the field; but ordinarily, in those regions where beans are extensively grown, weather conditions will not admit of their being cured and left in the field long enough for the entire work of harvesting and threshing to be carried on there.

After the plants are thoroughly cured they are carried as carefully as possible to the building in which they are to be stored. In fact, all operations connected with the cultivation and harvesting of beans should be done as carefully as possible, in order to avoid injuring the plants while they are growing and to prevent shelling the beans after they have ripened. Most varieties of beans shell more or less easily after the pods have become thoroughly matured. The loss from shelling will depend largely upon the care in handling them during the various operations of harvesting and storing. Most extensive growers of beans consider the loss by shelling which results from the use of labor-saving machinery of less money value than the additional cost of carrying on all operations by hand in the most careful way. In other words, the loss from the use of labor-saving machinery is not sufficient to justify the return to hand labor in the care and management of the crop.

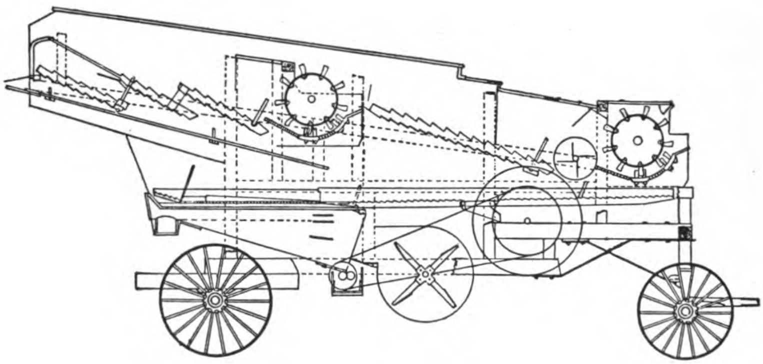


FIG. 45. Sectional view of a tandem-cylinder bean thresher

Threshing field beans. Because of the ease with which the pods of the bean are broken and split, the operation of threshing is one of the most exacting in the production of dry beans. In olden times beans were threshed almost exclusively with the flail, and small crops are still handled in this way. On an extensive scale, however, beans are threshed by machinery specially designed for the purpose. The ordinary grain thresher cannot be modified so as to do the work satisfactorily, although it is sometimes employed when other specially designed machinery cannot be obtained.

The modern bean thresher, a section of which is shown in figure 45, consists of a double, or tandem, threshing machine, carrying one cylinder which is operated at a comparatively low rate of speed and a second cylinder run at a much higher rate of speed. The slow cylinder, which is the first, separates the beans from the dry pods. The vines, together with the tougher pods, are then passed on to the second cylinder, which is better equipped to deal with pods that are tough and more retentive. By this means there is less injury to the seed and consequently less loss both from splitting the beans and from passing over beans in tough pods, which would be the result of threshing with a single-cylinder machine operated at a low rate of speed.

Cleaning and grading field beans. While the farm operations in connection with the preparation of field beans for market usually cease with the threshing of the crop, the cleaning and grading of the product is a very important item and requires much handwork. After the removal of sticks and straws by the use of the fan, the beans are passed through a machine which is provided with a broad, slow-moving belt, placed at such an angle that split beans and peas, dirt, and stones which are not removed by the fan adhere to the belt and are thrown out, while the smooth, perfect seeds fall back into another receptacle. After this the beans are usually subjected to a third operation, which consists in removing by hand all broken and discolored seeds and any foreign matter not eliminated by the other operations.

The work of hand picking is largely carried on by women and is facilitated by the use of machines, which are sometimes operated by the feet. In large picking establishments the machines are arranged in rows, fed through hoppers, and operated by steam or other power. In smaller establishments and on farms, similarly constructed machines operated by foot power are employed. These machines are very simple in construction, consisting of a canvas belt about six inches wide passing over rollers, which are operated, as already indicated, either by power or by a pedal. The beans which are in the hopper are shaken out upon a canvas belt, and as the belt is carried along, the expert picker removes all discolored or broken seeds and foreign matter, dropping them into side receptacles having spouts which carry them into barrels or baskets, from which they can be easily removed. The good beans are allowed to fall over the end of the belt into another hopper, from which they are conducted to a convenient receptacle.

Garden Beans

As has already been pointed out, garden beans naturally fall into two distinct groups — bush beans and pole beans. Each of these general classes is again divided into kidney and Lima beans. The kidney beans of both types are either wax-podded or green-podded in character. Various forms of pods characteristic of the varieties of beans of the kidney type are illustrated in figures 49 and 50. Lima beans, as is indicated in the classification on page 125, are either of the bush or pole type. The character of the so-called Lima beans

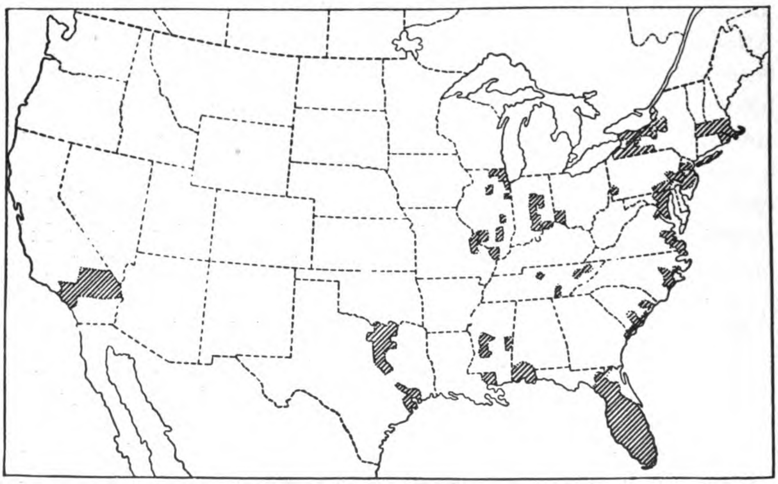


Fig. 46. The shaded portions show where snap beans are grown

varies considerably, but these differences are manifest chiefly in the size and shape of the seed and in the habits of growth of the plant, and will be discussed briefly under the Lima bean.

The type as well as the variety of garden bean to be grown is determined by the use to which it is to be put. If it is to be used as a snap or string bean for early market, quick-maturing green-podded or wax-podded varieties are selected; if for canning purposes, a different variety is selected, which may have either green or wax pods. While as a rule green beans which are required late in the season for table use belong to the pole type, the early beans are usually of the bush type.

It is to be regretted that there are no available statistics giving the acreage, yield, and value of garden beans. The map shown in figure 46 gives the geographical distribution of the snap-bean industry. The range and extent of the cultivation of this crop are coincident with the business of market gardening and truck growing. Every market gardener, whether he is catering to the demands of a small town or to the requirements of a city market, uses a part of his acreage for string or snap beans. It is his purpose to plant the crop so as to secure a succession of pickings from

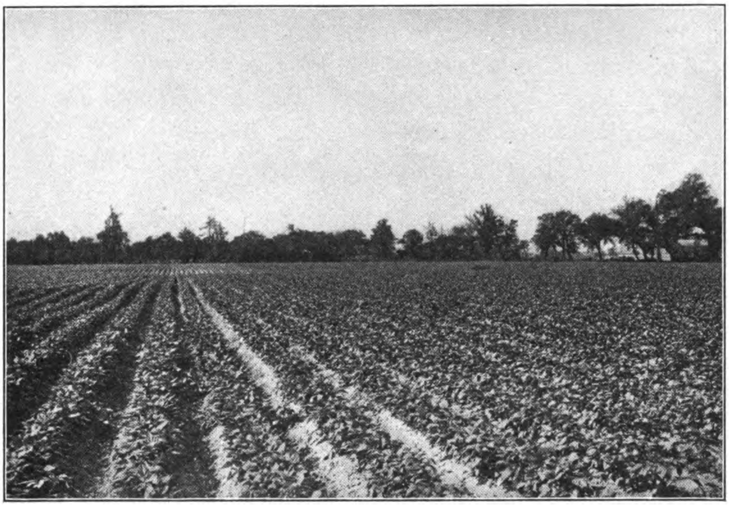


FIG. 47. A field of snap beans in the South

early in the season until the plants are destroyed by frost. With the truck grower, however, the object is quite different. He depends for his profit upon growing a large acreage of some popular variety which will come to marketable maturity at a time when the products of his locality have the ascendency in the market. He does not expect to anticipate this particular period nor to reap a benefit after the product of another section farther north and closer to the market becomes a competitor. In the one case the crop is grown for a continuous supply over a long period; in the other, the aim is to secure a large product of desirable quality for a short time only. Figure 47 shows a typical field of beans as grown in the South for use while green, and figure 48 shows a good hill of wax beans.

A third factor entering into the production of beans of this type is the canning industry. String beans are a staple canning product, and while the canneries located in the cities which are large receiving and distributing points for truck crops depend to some extent upon the purchase of the products in the open market, yet all of them attempt to have grown in the immediate vicinity of their factories a considerable acreage of each of the staple products canned.

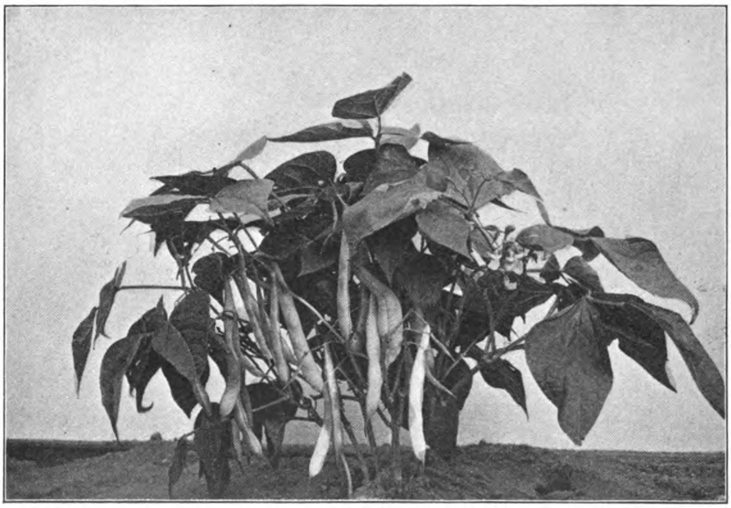


FIG. 48. A good hill of wax beans

As a result of this practice, beans are to some extent grown exclusively for canning purposes, but not so much as tomatoes, peas, and corn are.

Soil for garden beans. Beans adapt themselves to a great variety of soils and climates. In fact, garden beans, because they are of rapid growth and reach marketable maturity within a short time after the seeds have been planted, can be used at certain periods of the year in localities where they cannot be successfully grown as a staple field crop for dry beans. Because of this adaptability, truck growers along the Gulf and Atlantic coasts, from Texas and Florida northward, are able to produce a marketable bean crop by taking advantage of that part of the season best suited to its growth. The statement just made in regard to the adaptability of this crop to various soils may be proved by studying the types of soils upon which it is successfully grown from southern Florida to Maine. The sandy soils of Florida, the sandy loams of the Carolinas, the Norfolk sandy loam, gravelly loams, and the clay loams of the states north of New Jersey all produce satisfactory crops of garden beans when care in the selection of varieties and in the use of fertilizers is exercised. In general it may be said that either climate or season is as great a factor as the soil in determining the yield and profit from the cultivation of garden beans.

Preparation of the soil for garden beans. The bean is a hoe crop, and for this reason demands a soil free from obstructions — one which is quick and responsive and contains an abundance of available plant food. The preparation should be such as will enable seeds to germinate quickly; that is, the soil should be so fined that when the seeds are planted they will come closely in contact with it and thus germinate quickly. Mechanically the soil should be fine, retentive of moisture, and capable of being compacted, yet light enough to permit cultivation immediately after showers and rains, so that heavy crusts will not form and retard the germination and growth of the plant.

For the reception of the seed the area should be thoroughly plowed and harrowed with an implement which will fine and at the same time compact the soil. The depth to which the soil should be cultivated must be determined by experience. It is not wise to plow the land more deeply for beans than for other truck crops. As a general rule, however, soils used for market-garden or truck purposes should be plowed deeply and pulverized thoroughly, so as to maintain a seed bed from eight to ten inches in depth.

Fertilizers. While beans are quick-growing and early-maturing plants requiring an abundance of available plant food in the soil, yet, because of the peculiar characteristics of the family to which they belong, they make the soil better for having been grown upon it. They are nitrogen-gathering plants, and therefore require only a small percentage of this element in any fertilizer used upon them. Thus while large quantities of fertilizers containing nitrogen, phosphoric acid, and potash are used by truck growers in the production of beans, as a rule such fertilizers should be relatively richer in phosphoric acid and potash than in nitrogen. The production of snap or string beans, however, demands a larger percentage of immediately available nitrogen than does the production of field beans for the dry grain, since in the former case the crop occupies the land a shorter time and therefore has less opportunity to provide itself with a supply of nitrogen from the atmosphere. If commercial fertilizer is used, it may be distributed broadcast over the area with a grain drill or a fertilizer distributer, or it may be scattered along the row at the time the seeds are sown by means of one of the many types of seed drill having a fertilizer attachment.

Planting garden beans. Garden beans, like field beans, may be planted either in hills or in drills. It is customary, however, to plant them in drills so that they shall fall 2 or 4 inches apart and in rows far enough apart to admit of cultivation with either one-horse or two-horse implements. Because of their peculiar habit of germination — the elongation of the part between the root and the seed leaves, called the hypocotyl — the seed leaves, or cotyledons, are lifted out of the soil. A large expenditure of energy on the part of the plant is necessary to accomplish this, and the more compacted the soil and the deeper the seed is planted the more time and energy are required to do this. It is evident, therefore, that the shallower the beans can be planted without retarding satisfactory germination, the better. Upon thoroughly fine and compacted soils the seeds are planted from 1½ to 2 inches deep. Shallower planting than this does not, as a rule, give as satisfactory germination.

While garden beans are planted in extensive areas, as shown in figure 46, they are, nevertheless, frequently used as a catch crop between other plants, such as squashes and cucumbers. The bean matures its crop and is out of the way before the entire area is demanded by the companion crop. In addition to the value of the crop secured from the beans, it is claimed that the plants act beneficially as a windbreak to shelter the tender vines of the cucumber during their early life. Beans also serve to increase the income from areas upon which the most intensive systems of truck farming are conducted. Upon such areas, where both a fall and a spring crop of lettuce are grown, beans are sown between the lettuce plants just before the latter reach marketable size, so that about the time the lettuce is removed the area will be occupied by the young beans. The proceeds from a catch crop of this kind are frequently sufficient to cover the cost of the production of all three crops grown upon the land during the season, a matter of great importance in intensive agricultural operations.

Quantity of seed necessary for garden beans. The seed required to plant an acre of beans varies with the style of planting, from 10 to 12 quarts being necessary when 3 or 4 seeds are placed together in hills 18 inches apart with the rows 30 inches apart, while from 1 bushel to 1½ bushels are needed when the seeds are distributed at intervals of 2 or 3 inches in drills 30 inches apart.

Cultivation of garden beans. After the young plants have appeared above the surface of the ground, the subsequent cultivation should be carried on with implements which stir the surface of the soil only and leave it fine, loose, and almost perfectly smooth. To accomplish this with horse-power implements it is necessary that they have numerous narrow, shallow-working teeth. Cultivators with broad teeth, which tear up the earth to the depth of 4 or 6 inches, leave the ground rough, cloddy, and uneven, thus exposing a large area to the action of the sun and wind. This results in an undue loss of moisture and indirectly retards the growth of the plants. On the other hand, shallow cultivation with implements having narrow teeth, which stir the soil to the depth of only 2½ or 3 inches and leave the soil fine and loose, has a tendency to conserve moisture by preserving a blanket, or mulch, of loose earth over the compact water-carrying strata, in which the roots of the plants are fixed. This type of cultivation is of great value in connection with all quick-growing crops which require an abundant supply of moisture for their development.

At the last cultivation, when the plants are large and heavy, it is advisable to use winged teeth upon the cultivator in order to throw a small quantity of soil against the stems of the plant, which will assist in supporting them and will cover the roots slightly more than they are normally covered by level culture.

Harvesting garden beans. From the nature of the product the harvesting of beans for use as string or snap beans must necessarily be done by hand. Their extensive culture is therefore

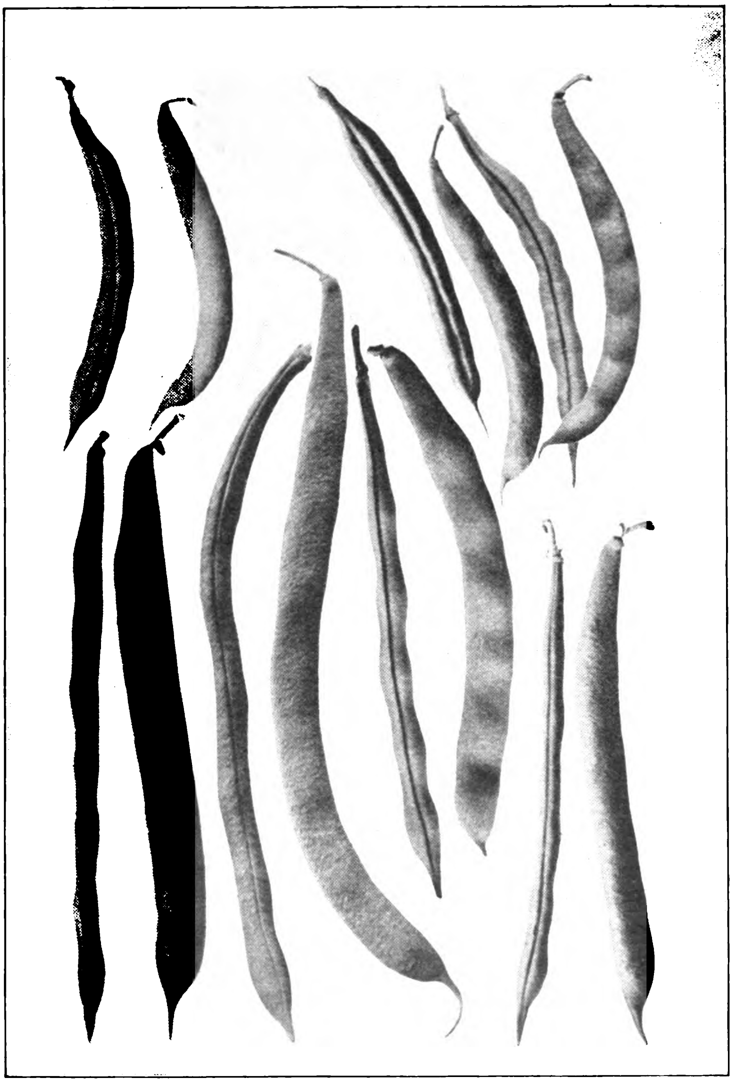


FIG. 49. Various types of pods — kidney beans

(*Note curve at proximal and distal ends, as well as in body of pod, and length and shape of point*)

a (two pods), Crystal Wax, dorsal and lateral curve; *b* (two pods), Yankee Winter, dorsal curve, saddleback; *c* (two pods), Challenge Black Wax, lateral and dorsal curve; *d* (two pods), Blue-Podded Butter, straight pods; *e* (two pods), Canadian Wonder, pod convex near center, point long, curved forward; *f* (two pods), Wardwell's Kidney Wax, point short from center of pod; *g* (two pods), China Red Eye, pods full, convex near stem, point straight from back of pod

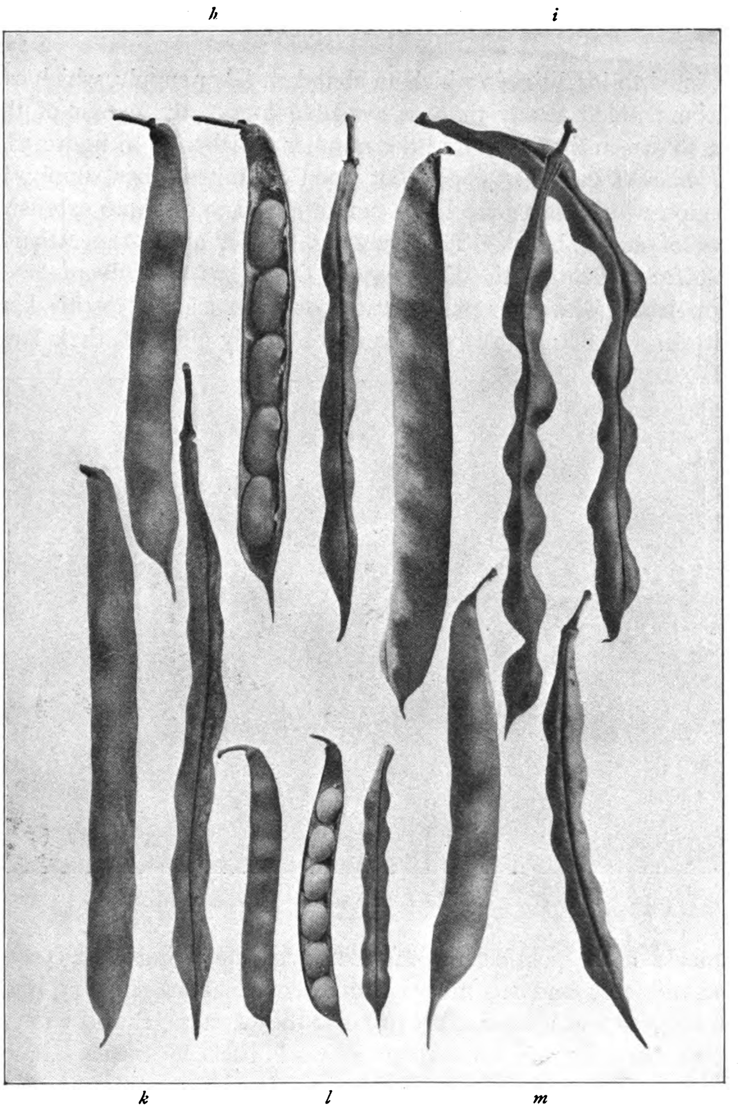


FIG. 50. Various types of pods — kidney beans

(Note curvature and distortion of pods and attachment of beans)

h (three pods), Red Kidney, pod straight, loosely filled and slightly constricted between beans; *i* (three pods), Tennessee Green Pod, pods long, straight, point short from center of pod, beans on alternate sides of suture; *k* (two pods), Improved Goddard, pod straight, full, point short, curved forward; *l* (three pods), Navy Pea, pod concave near center, point short from back of pod; *m* (two pods), White Marrow, pod straight, slightly constricted, point long from back of pod restricted to localities in which an abundant labor supply, which can be commanded at any time, is available (notice the extent of the area shown in figure 47 and the number of laborers in figure 51). The market gardener dependent upon a limited labor supply, in a region where wages are high, cannot afford to cultivate extensive areas of string beans. The trucking district along the Atlantic coast from Georgia to Washington, D.C., has the advantage of negro labor, which for many years has been trained to this kind of work. While negro laborers are not highly efficient, their large

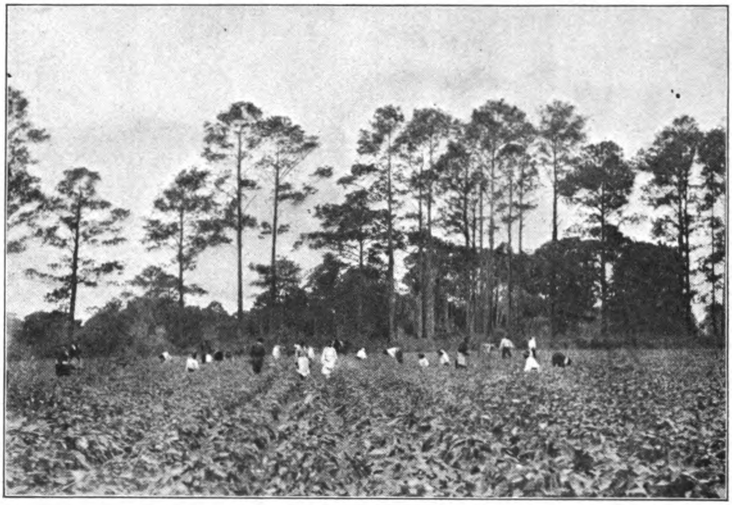


FIG. 51. A Southern bean field — pickers at work

numbers make possible the harvesting of the string-bean crop at moderate cost, and this means that extensive areas of string beans can be grown at a satisfactory profit to the planter. It is customary to harvest string beans on a piece-work basis by measure, most growers using a bushel basket as the unit of payment.

After the beans are picked they are carried to a convenient sorting table, either in the open or under shelter, where they are looked over and the diseased and broken beans rejected. The baskets are filled uniformly and shaken down preparatory to covering them for shipment. The method of assorting beans is shown in figure 52. As is suggested by this illustration, string beans are usually shipped in bushel or half-bushel baskets of the Delaware type. These are made of thin staves, with circular heads and covers, and are usually reënforced with wooden or wire hoops. A ventilator cover is also provided, which is held in place by wire fasteners. When beans are packed in baskets of this kind great care should be exercised to keep them from becoming moist, and their storage in cars or rooms where they will become heated and take up moisture should be avoided. After being assorted and packed in these baskets, the

FIG. 52. Assorting and packing snap beans in South Carolina

beans are transported, if only a short distance, by freight or express without refrigeration; but if shipped long distances, they are sometimes placed in refrigerator cars for shipment by freight. Beans are not so susceptible to injury from heating as peas, but loss sometimes occurs from this cause. In the market, beans are usually sold by measure rather than by weight, although the only satisfactory basis upon which to sell any garden vegetable is that of weight.

Yield of garden beans. Under favorable conditions the best varieties of beans yield large quantities of pods. It is not unusual to gather 200 bushels of string beans from an acre, the price ranging in a given locality from $2.50 to 50 cents per half-bushel basket from early in the season until its close.

Lima Beans

Under the name "Lima" two distinct types of beans are now recognized: pole Limas and dwarf, or bush, Limas. These types are made up from two distinct species, known to botanists as *Phaseolus lunatus*, which includes the Sieva, or Carolina, type of Lima beans, and *Phaseolus lunatus*, var. *macrocarpus*, the true Limas of the American garden, which includes the flat, or large-seeded, Lima (figure 53, *c*) and the potato Lima (figure 53, *a*). The pole Lima beans consist of the Sieva, or Carolina, Limas (figure 53, *b*), the flat, large-seeded Limas, and the potato Limas. The dwarf Limas are represented in the Sieva type by Henderson's Dwarf Lima, in the potato Limas by the Kumerle and Dreer's Dwarf Lima, and in the large-seeded Limas by Burpee's Dwarf Lima. It will be seen, therefore, that botanically the pole Lima and the dwarf Lima cannot be separated — that varietal differences alone make the distinctions which characterize these two groups.

Lima beans are of great commercial value, but are not sufficiently appreciated as a table food because it is not generally known that in a dry state they can be used in practically the same manner as are the common beans. In reality they are richer and more delicate in flavor than the common beans and can be used in as many different ways. The excellence of these types as green beans requires only a passing mention, and their value as an accompaniment of corn in succotash is well known to every consumer of canned goods.

Planting Lima beans. The common method of handling Lima beans in the northern tier of states, outside of the irrigated belt, is to plant from 3 to 5 beans in hills from 18 to 36 inches apart, with the rows from $3\frac{1}{2}$ to 4 feet apart. After all danger from cold and insect enemies is past, the beans are thinned to about 3 plants to the hill. As the Lima beans are exceedingly tender, it is necessary to delay planting in the open until about a week or ten days after the time for planting the common garden beans. After the second cultivation, when the tendency to climb has manifested itself, the plantation is supplied with poles from 5 to 6 feet high, or with a trellis running from end to end of the row, which

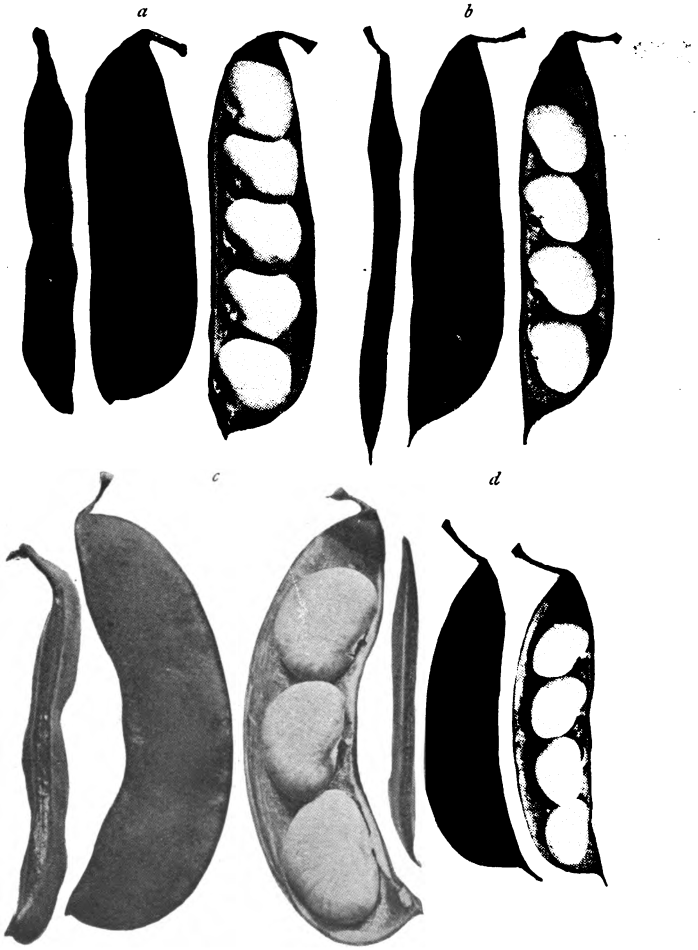


FIG. 53. Types of Lima beans

a, potato Lima, pole; *b*, Sieva type, pole; *c*, large, flat Lima, dwarf; *d*, Sieva type, dwarf

may be made by stretching two or three wires lengthwise of the row and weaving between them strands of ordinary wool twine. If the trellis is employed, the beans can be planted in practically continuous rows, so that they stand about a foot apart. In the extreme northern limit of this crop one is fortunate if from $\frac{1}{2}$ to $\frac{2}{3}$ of the pods mature their seed. Farther south the crop is proportionately heavier.

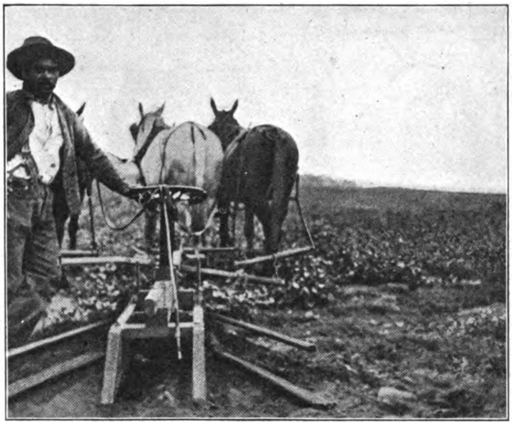


FIG. 54. Cutter used in harvesting Lima beans

In California and in other irrigated regions where there are well-marked wet and dry seasons, — the dry season, accompanied by heavy fogs, occurring during the summer months, — it is possible to cultivate Lima beans somewhat as follows: Upon moderately rich, slightly sandy valley land, seed is planted as soon as all danger from rains has ceased. The plantation will then remain dry except for irrigation. If there has not been sufficient winter rain to moisten the land thoroughly, it should be well watered and allowed to dry to a good cultural condition before planting. Seed should be planted in hills about $3\frac{1}{2}$ or 4 feet apart each way, or in drills, the beans being scattered about 1 foot apart in rows 4 feet apart. After the beans have germinated it may be necessary to cultivate them once or twice with a sweep of some kind in order to destroy any weeds which may have sprung up from the moist

FIG. 55. Lima bean cutter in action

ground. All moisture should be withheld, and a dust mulch over the surface should be preserved by running a sweep over the plantation once or twice more. The vines may then be allowed to take possession of the area. This obviates the necessity of using poles, and the crop can be grown to maturity under these conditions without irrigation, without cultivation, and without poles.

Cultivation of Lima beans. The Lima bean is naturally a long-season crop, and in its native country is practically a perennial plant; hence the necessity, in a region with a limited growing season, of taking advantage of every factor in soil and climate that will tend to shorten the period of growth and hasten maturity. It is possible to lengthen the season by artificial means, when growing on a limited scale, by planting the seed in berry boxes or on inverted sods in a hotbed or cold frame two or three weeks in advance of the regular planting season. The season in the field can be shortened by withholding nitrogenous fertilizers, which tend to induce late growth; by supplying fertilizers like muriate of potash and acid phosphate, which have a tendency to hasten maturity; and by selecting what is known as a quick soil — one which dries out and warms up early in the spring, and which, because it is normally inclined to be dry, has a tendency to shorten the life cycle of the plants growing in it.

Harvesting Lima beans. At harvest time a root cutter, as shown in figures 54 and 55, is passed under the lines of the rows, severing the roots of the plants, which, after being dried and somewhat cured, are thrown into convenient heaps for loading into wagons. They are allowed to remain in these heaps until the approach of the rainy season, when they are carried to the threshing floors, where they are beaten out by the tramping of animals or by means of a device somewhat similar to the ordinary land roller. Where Lima beans are grown very extensively, power threshers of large capacity are employed. The loss reported from the use of these machines is greater than when the old method of tramping them out is followed, but whether this is sufficient to justify the slower process of shelling can only be determined from actual field tests.

Dwarf Lima beans, because of their habits of growth, are planted and cultivated practically like the field beans. They are slightly hardier than pole Limas, and for this reason, toward the northern limit of the range of this crop, can be planted somewhat earlier in the season than pole Limas.

Diseases and enemies. One of the factors which determine the range of cultivation of field beans is the bean weevil. This pest is much more destructive to beans grown south of the latitude of New York than in areas north of this region. This is not true, however, of the high altitudes of California nor of the Allegheny Mountain region. Because of the greater destructiveness of the weevil in southern latitudes, dry beans for seed purposes or for table use are not extensively cultivated there. This crop is confined chiefly to northern latitudes and to high altitudes. In the production of string beans, where the crop is marketed in a green state, the weevil is not a factor.

Anthracnose. The bean, like many other of our valuable economic plants, is subject to serious diseases, the most troublesome of which is known as anthracnose. This disease is most destructive when it attacks the wax-podded types of garden beans; but few of the bush beans, whether of the wax-podded or green-podded type, are entirely free from this trouble. Localities may be comparatively free from it for a number of years; but as bean growing becomes more extensively engaged in, the disease becomes more prevalent and increases in severity. Growers of field beans have found that the disease is most destructive to the early planted crop, and partially to overcome the loss from its attacks they have resorted to planting the crop as late in the season as possible.

While anthracnose can be controlled to a considerable extent by spraying with Bordeaux mixture, the cost of material and of labor for applying it is so great as to prohibit its general use in the field cultivation of the crop. In market gardens and in restricted areas, where beans are sold at very remunerative prices, it may be advantageous and profitable to treat plants for this disease in this way. The greatest safeguard against this trouble, however, is the use of disease-free seed. Tests have proved that seed from plants kept healthy through immunity or through the use of Bordeaux mixture produces a crop less infected by this disease than seed not so selected.

If the severity of this disease continues, either the cultivation of both dry and snap beans must be based on seed produced by the most careful quarantine methods, or a seed-bean industry based on disease-free seed must be developed in the few regions known to be exempt from the disease. This latter plan is not necessary, since by the careful selection of seed from disease-free plants and by the use of the spray it is possible to produce seed of high quality, free from disease, even in badly infested territory.

BEETS

Distribution. The beet is a hardy vegetable of wide distribution and almost universal use. It is grown as an early crop for sale as greens, or as bunch beets, in nearly every locality where garden vegetables are cultivated. It is also commonly grown for use during the winter months; for this purpose the roots are allowed to come to full development, and at the approach of cold weather are lifted and stored. Because of its hardiness and the variety of uses to which it is suited, the beet is an important product with a wide distribution.

Types of beets. The beet is an exceedingly interesting plant from the standpoint of the horticulturist and the botanist, because of the fact that under cultivation the wild plant, which is known to botanists as *Beta vulgaris*, has given rise to three or four distinct and important types. For the convenience of discussion, they will be considered in the following order: (1) the garden beet, represented by the turnip-shaped and long-rooted beet; (2) Swiss chard, the so-called leaf beet; (3) the sugar beet; and (4) the mangel, or mangel-wurzel, as it is known in Germany. These different types are not distinct species but are simply so-called varieties or sorts which come practically true to type from seed. Their evolution is the result of careful selection through a long series of years and it is possible that, with care, any gardener could in a few years transform a beet of any one of these types into one of the others. The general treatment for all of these forms is practically the same, with the exception that the garden beet is grown as a forced crop, and for commercial purposes is handled as a short-season crop.

Soil for garden beets. The soil which is most congenial to the beet is a sandy or gravelly loam, well enriched, and one which warms up quickly in the spring. Cold, retentive soils do not give as good results. For this reason, those who contemplate growing beets as a market-garden crop, or for bunching purposes, should select a warm, quick soil, to which has been applied at least 20 tons per acre of well-rotted stable manure and, in addition to this, a dressing of commercial fertilizer carrying at least 2 per cent of nitrogen, 4 per cent of potash, and 8 per cent of phosphoric acid, at the rate of from 600 to 1000 pounds to the acre. Where means for irrigation are available or where there is no lack of rainfall, the larger amount can be used with safety.

The soil should be thoroughly and deeply cultivated prior to planting the seed. If a very early planting is contemplated, the soil should be plowed in the fall. It should be broken up from 8 to 12 inches in depth, so that the root system of the beet may not be restricted.

Seed for garden beets. The seed of the beet is a somewhat peculiar and interesting formation. The commercial article known as beet seed is really a fruit, called a seed ball, the seed itself being embedded in a corky pericarp, or outer covering. This corky development is variable in shape and irregular in size and generally carries more than a single carpel or seed. There are now in progress experiments for the purpose of securing a strain of beets which shall produce a single seed in each seed ball. If this is accomplished, it will be of decided advantage to the grower of stock sugar and market-garden beets, because it will do away with much of the labor of thinning the crop. Very encouraging results have already been obtained, and we look forward to the time when the seed ball, instead of containing several independent seeds and producing three or four seedling beets, will produce only one.

Planting garden beets. Because of the roughness and irregularity of beet seed, it is handled with difficulty by many of the drills and seed-distributing devices usually employed by market gardeners. It is necessary, in order successfully to scatter seed by a mechanical device, to use a force feed drill, either one which dips up and carries the seed to the drill point or one which forces it out through an opening. A good type of hand drill is the so-called New Model, which has an agitator constantly working over the orifice through which the seed to be planted reaches the drill tube. Beet seed should be sown from $\frac{3}{4}$ to 1 inch deep, according to the texture of the soil. Early in the season, and on retentive soils, shallow planting should be practiced. On light soils the seed may be planted deeper.

For quick marketing purposes, the seed of the beet is sown as early as possible. As the beet is a comparatively hardy plant, the seed can be planted in the open about the same time as the radish and lettuce seed, that is, as early as the ground can be successfully worked. Beet seed is rather slow to germinate, and for this reason radish or cabbage seeds are sometimes mixed with it to serve as a marker of the course of the rows before the beet seeds germinate, so that cultivation may be begun before the plants show aboveground. As soon as the beets are well up and the true leaves have developed to 2 or 3 inches in height, they should be thinned to stand from 3 to 6 inches apart in the row, according to the use to be made of the crop. Some gardeners, instead of handling the beets in this way, allow the largest and most vigorous ones to grow to marketable size, say from $1\frac{1}{4}$ to 2 inches in diameter. These are then removed, leaving the others to come on and form a succession for the market. Where land is expensive and it is desired to have a succession of plantings of different vegetables, this scheme is not a practicable one. It is most convenient and economical to have the crop mature at one time so that it can be harvested within a few days after it reaches marketable size. For this reason, then, careful thinning or transplanting at an early stage in the development of the beet is more satisfactory than thinning as the roots reach marketable size. For the local market gardener, however, who has an extensive land area the first-named practice may be most desirable and most profitable.

Cultivation of garden beets. The beet responds to careful cultivation and a rich soil as readily as any other garden crop. In order to make the crop profitable, special attention should be given to prevent competition with weeds, particularly early in the life of the plants. If the plants receive a check soon after appearing aboveground, the maturity of the crop will be greatly delayed. It should therefore be the aim of the gardener to keep the ground clean and to give every possible assistance to the young plants. Hand hoes and hand weeders should be used constantly to prevent the growth of weeds and to keep the surface of the ground loose, in order to preserve a proper degree of moisture by maintaining a slight soil mulch.

As soon as the young plants are strong enough to insure a stand they should be thinned to the desired distance. This will be from 3 to 9 inches, according to the purpose for which the crop is grown and the size and character of the variety.

Harvesting garden beets. Beets which are intended to be marketed as bunch beets are gathered as soon as they are from 1½ to 2 inches in diameter and are tied in bunches of from 4 to 6 beets, the injured or dead leaves only being removed as the crop is harvested. The bunches are then packed in crates similar to those employed for the shipment of cabbage. Such crates usually hold from 80 to 100 bunches of beets. If the weather is warm, they are shipped in refrigerator cars. If carried only a short distance, they may be shipped by express or local freight.

Garden beets as a forced crop. In some favored localities along the Atlantic coast, where the winters are mild, beet seed is sown in frames about the middle of October. Early in the season these frames are covered with cloth to protect the plants and are so arranged that the cloth can be replaced by glazed sash as the cold increases, and this, in turn, reënforced with mats and shutters when necessary. The seedling plants carried in this way through the severe part of the winter are transplanted to the open field from February 15 to February 25. In localities where severe freezing is likely to occur after these dates, the beets are set in beds so arranged as to be protected with glazed sash, cloth covers, or muslins. These muslins are like those described in connection with the cultivation of lettuce. A frame composed of 1-inch boards 12 inches wide is constructed around the area occupied by the beets, and through the middle of this, about 3 feet above the surface of the ground, is set up a ridgepole over which are sprung narrow strips to act as supports to the cloth. The cloth is then used as a cover only during periods of severe storm or during nights when the beds are liable to be chilled. As soon as the weather conditions will permit, these frames are lifted and carried to other parts of the field, and the beets are allowed to reach maturity in the open. Under favorable conditions in the latitude of Wilmington, North Carolina, the crop will be ready for the market about May 15 or May 20.

Although it is a somewhat expensive process, seedling beets are grown and carried through the severe portion of the winter in cold frames, and in February are transplanted to the cloth-covered frames, the plants being set about 9 inches apart each way. They are allowed to grow to marketable size in this closely planted bed. The alleyways between the beds are usually about 3 feet apart, so that all but a comparatively small area is occupied by the plants. It will thus be seen that in the neighborhood of 75,000 plants can be grown to the acre, which will give about 15,000 bunches of beets, 5 beets to the bunch, and even if only 2 cents a bunch were received for them, the gross receipts would be $300 per acre. It is safe to say that the crop can be grown for from $75 to $100 an acre, even when the extra expense of growing in the cold frame and transplanting to the open is necessary. On this basis even, the crop is a remunerative one.

In the Norfolk area and on Long Island, beets are profitably forced in sash-covered frames. On Long Island seedlings are started in hotbeds in the spring, and in Norfolk they are started in the autumn, carried through the winter in the sash-protected frames, and transplanted to sash-covered areas, where they are kept until the danger from freezing has passed. The sash are then removed, and the board sides of the frames are either taken for cucumber frames or are piled for the season. It is not long after the sash are removed before the beets are ready to market. Figure 13 shows a field of frame-grown beets after the sash have been removed.

Forcing garden beets in greenhouses. While cucumbers are extensively planted as the warm-weather crop in houses used for forcing lettuce, beets are almost as universally planted as a catch crop with the cucumbers. The seed of sorts that produce bright leaves and leafstalks is used for this purpose. The seed is sown broadcast or in broad bandlike rows a few inches apart. It germinates quickly, and the young plants are induced to make as rapid growth as possible. When the plants are four inches high they are harvested, washed, and sold in bulk by measure for greens. Some growers devote the entire space of the greenhouse to beet growing, but this is the exception rather than the rule.

Swiss Chard

Swiss chard does not produce a thickened root as do the other forms of beets mentioned. It is grown as a salad plant, its thickened leafstalks often developing to large proportions. The leafstalks are frequently 2 feet or more in length and from 1 inch to $2\frac{1}{2}$ inches in width. There are types of varieties which have white, pink, or red leafstalks. This plant, while grown extensively in Europe, is not at all common in this country. Its cultivation, however, requires practically the same conditions as the ordinary garden beet, except that considerably more space is needed both in the row and between the rows.

Sugar Beet

This variety of beet, which is capable of developing a high percentage of sugar in its juice, has been selected for a definite type of root. The evolution of this plant has largely been accomplished within the last century in France and Germany where, at the present time, a large amount of sugar is produced annually from this crop. Within the last twenty years the cultivation of sugar beets has assumed commercial proportions in various sections of the United States, and a number of beet-sugar factories have been built at various points near large tracts of land suitable for the growth of sugar beets. The crop is peculiar in this respect, that its sugar content is largely determined by the character of soil and the climate in which it is grown. Experiments in the United States have conclusively demonstrated that the sugar beet shows the greatest sugar content in high latitudes and where there is a relative scarcity of moisture. The region in which the sugar-beet industry is the most profitable at the present time may be somewhat roughly outlined as Colorado, Utah, California, Michigan, and Wisconsin. All these states have extensive plantations, and each of the regions supports one or more large sugar-making factories. While this crop is not as profitable as many truck crops, and while it requires more hand labor than almost all the other agricultural crops, yet the constant and annually increasing demand for sugar justifies the statement that the outlook for the sugar-beet industry is steadily growing brighter. Another reason which makes this a safe statement is that the area of the earth's surface on which sugar cane can be successfully grown is comparatively limited and is restricted to a zone in which human endeavor is less remunerative and less economically carried on than in the beet fields in the higher altitudes and latitudes.

Types of sugar beets. The most satisfactory type of sugar beet is that having a long, fusiform root about 3 or 3½ inches in diameter at the crown, with a comparatively small part of the crown exposed above the surface of the soil. The root should be 8, 10, or 12 inches in length and taper gradually from the cap to the tip. Since the part which carries the leaves and is exposed above the surface of the ground is of comparatively little value for sugar making, it is the aim in selecting mother beets for the production of seed to secure those which have as little exposure of the crown as possible. The types of sugar beets have been so carefully bred that there is comparatively little variation in them at the present time, and growers on well-prepared land have experienced little difficulty in securing suitable roots. However, the successful production of a root is dependent to a certain extent on the care given to the preparation of the soil. It should therefore be the aim of the cultivator to make the seed bed in which sugar beets are grown as deep as possible. In the Eastern states the deepening of the seed bed should be carried on through a series of years rather than in a single season. If the land has already been cultivated to a depth of only 6 or 7 inches, then instead of cultivating it to the required depth in a single year, this work should be extended over a number of years. This will permit increasing the depth of plowing an inch at a time, which will give a sufficient amount of the subsoil to be incorporated with the seed bed during any single year. Where deep plowing for the purpose of encouraging the growth of such long-rooted plants as beets has been attempted, it has usually produced ill effects because too much cold, unrefined soil was brought into the area occupied by the roots. It takes several years to aërate properly and set free the plant food contained in soil which has not been exposed to the action of wind and rain.

Planting the sugar beet. Sugar-beet seed is usually planted like that of the garden beet, in rows from 18 to 22 inches apart and the plants thinned to stand from 6 to 9 inches apart in the row, according to the strength of the soil and the size of the roots desired. The sugar content of well-grown sugar beets, in localities suited to the commercial cultivation of the crop, is from 12 to 18 per cent. The agricultural by-products of this crop are the beet tops, which, of course, can be retained by the farmer for use as stock food, and the beet pomace, which is left after the extraction of the juice. This beet pomace, or pulp as it is called, is a stock food of some value. The stockmen living in the vicinity of beet factories use it to a considerable extent to feed dairy cows, growing animals, sheep, and swine. Such a product cannot be made the whole ration of the animal, for it contains only a small percentage of actual food material. In order to secure a satisfactory ration from this it is necessary to use it in combination with such concentrates as gluten meal, oil meal, or cottonseed meal. During late years beet pulp has been dried, fortified with molasses, and extensively sold as a food for dairy cows.

Mangels, Stock Beets, or Mangel-Wurzels

Stock beets, or mangel-wurzels as they are popularly known, have been extensively used for a great many years in Germany and Holland for stock-feeding purposes and are slowly gaining favor among dairymen and stock raisers in America.

The advent of the silo a few years ago diverted the attention of the stock raisers and experimenters from root crops to the care and use of silage, but now there seems to be a growing sentiment in favor of beets and turnips as factors in the ration of dairy and stock animals. Where a green food of this nature is needed for the winter the question of economy must determine for each individual and place whether the ration shall consist of silage or of roots.

The cultivation of the stock beet does not differ materially from that of the garden beet. The soil to which it is best adapted is a sandy or gravelly loam which has been thoroughly enriched by the application of stable manure and deeply cultivated for a number of years. If possible, a beet crop should be preceded by a hoe crop, such as corn or potatoes. If this is not possible, clover is the next best preparatory crop. Stock beets, because of the large size to which they grow, must be given more room than garden beets or even Swiss chard. The large-growing types of stock beets frequently attain a length of 2 or 3 feet and a diameter of from 4 to 8 inches. The individual roots frequently weigh 20 pounds or more, and for this reason require rich soil and sufficient room for their development. A common distance between the rows of stock beets is 30 inches, the plants being thinned to stand 10 or 12 inches apart in the row, according to the variety. At the approach of cold weather in the fall, the roots are lifted by means of a root digger. The tops are cut off and fed to animals, and the roots themselves are either stored in root cellars or buried upon high land in small heaps, so that they can be secured for feeding purposes during the winter season. Because of the size of the roots, it is necessary that they be broken up or cut into small pieces before they can be fed to animals. For this purpose there are a number of so-called root cutters which slice or break the roots into comparatively small pieces. The watery, juicy nature of the root makes it a laxative and an appetizer for the stock, and while its food value is not high, it is valuable at a season of the year when the rations of the dairy cow are chiefly confined to dry foods.

BRUSSELS SPROUTS[1]

Brussels sprouts, *Brassica oleracea* var. *gemmifera*, is the name by which one of the many peculiar variations of the cabbage is known. While cabbagelike in leaf and stem, this plant does not form a head like true cabbage, but instead forms a number of small heads, or sprouts, in the axils of the leaves. The leaves nearest the ground produce sprouts first, those at the summit of the long stalk sprouting last.

Brussels sprouts is a hardy plant and produces its main crop after cool weather comes in autumn. In fact, in southern Europe and in the milder climates of the United States, from Long Island southward, the crop is chiefly harvested from October 15 to April 1. In mild winters, even as far north as Long Island, the harvest continues throughout the winter. In localities of severer climates the mature plants are lifted at the approach of cold weather and

[1] For a botanical consideration of this crop, see Cabbage.

replanted in moist sand or sandy loam in cool cellars. This storing cannot well be carried out on a commercial scale but is perfectly practicable for a home supply of sprouts.

Cultivation. Brussels sprouts require a somewhat longer time for development than late cabbage. Therefore, for the latitude of Long Island, seed should be planted so that the plants may be set in the open about June 10, instead of June 20 as for late cabbage. The young plants should be treated the same as those of cabbage, and the same precautions should be used in selecting the seed bed as for cabbage, since the clubroot attacks Brussels sprouts as readily as it does other forms of this plant.

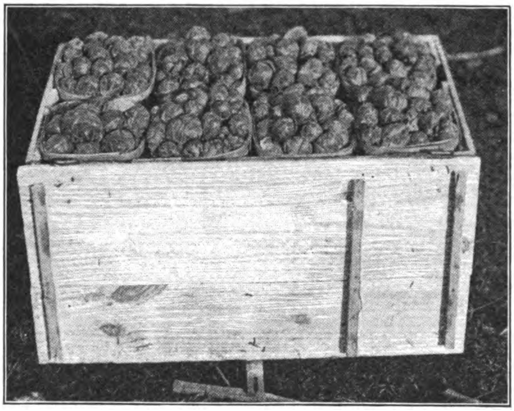


FIG. 56. Brussels sprouts packed for market

In setting the plants in the field fully as much space should be allowed as for late cabbage — 30 inches one way by 36 the other is a good distance. In other respects the cultivation of the plant is the same as that of cabbage. It is a gross feeder and requires an abundant supply of readily available plant food; 20 tons of good stable manure per acre is none too much to apply to the soil on which it is grown. Its soil requirements are the same as those of cauliflower.

Harvesting. As has been suggested, this crop is not all harvested at one time. In fact, several successive cuttings are taken from the same plant. In favorable localities the plants remain in place throughout the winter, and the sprouts, as they reach full development, are cut away, the leaves of the plant having been broken and removed from the field earlier in the season. The sprouts, after being cut, are placed in baskets or crates and carried to a room, where they are carefully assorted and packed into one-quart berry cups, the top layer being faced with well-developed sprouts of uniform size, as shown in figure 56. Much hand labor is required in the harvesting and marketing of this crop, and for this reason its culture is confined to a few localities where economic conditions are favorable. Sprouts usually sell for as much per quart as strawberries, and as a result the return per acre from the crop is high, since the yield is usually far greater than that of berries.

Types. There are two forms of this plant: a tall plant much used in Europe, and a dwarf plant, which is the common type found in American gardens. The type desired should be carefully specified in ordering seed.

CABBAGE

Distribution. Cabbage is a robust, hardy plant, naturally adapted to a variety of soils and uses. Its cosmopolitan habits make it one of the group of plants which are almost universally found in the kitchen garden. Its general consumption and diversity of uses give it high rank both as a truck crop and as a farm crop. Some idea of the extent of its cultivation can be gained from the area of the crop in New York State in 1900, which, according to the census report, was over 25,000 acres. Cabbage is unfortunately one of those crops the acreage and value of which fluctuate greatly from year to year.

Cabbage can now be obtained in the market at all seasons. The stored product of the autumn crop of the North no sooner disappears from the markets than its place is taken by the early truck crop from Florida. This is followed by the product from Georgia, the Carolinas, and Virginia.

Types of cabbage. Because of the relationship of four important market-garden and truck crops, namely, cabbage, kale, cauliflower, and Brussels sprouts, they can well be discussed together. These plants, which are now of immense commercial value, all have a common origin in the wild cabbage native to Europe and western Asia. The varied forms which have received these names have all developed under cultivation. The wild plant is a perennial, with broad-lobed, undulating, thick, rather smooth leaves, and is covered with a heavy bloom. The stem of this plant sometimes attains a height of from 2½ to 3 feet, in this respect resembling somewhat the giant cabbage now grown in the Jersey Islands. As is naturally to be inferred, this wild plant has no head comparable with that which is characteristic of our improved forms.

Of these four plants, the true cabbage, known to botanists as *Brassica oleracea*, var. *capitata*, is undoubtedly the most valuable and the most extensively cultivated. It is grown as a market-garden crop, as a truck crop, and as a general farm crop. It is handled in many ways, being grown as an early spring crop, as a summer and fall crop, and in some localities as a winter crop. There are also a great number of different forms and varieties of cabbage, differing in color and conformation of head and leaf, each type possessing some peculiar merit which gives it prestige in a particular market. Cabbage also has an advantage over the other members of the family to which it belongs in that it can be kept longer and is capable of being put to a greater variety of uses. All these features conspire to give the heading cabbage its exalted position in the cabbage family.

Cabbage as a Market-Garden Crop

Cabbage as a market-garden crop is handled at various seasons and in different ways, according to the locality in which it is grown. North of the latitude of New York City very early cabbage is cultivated in one of the following ways: The seeds may be sown in September in the open or in cold frames, the young plants being brought on slowly until freezing weather, when they should be about 2½ or 3 inches high. It is well to transplant the seedlings from the bed in the open to the cold frames about the first or second week in October, in order that they may become thoroughly established before freezing weather sets in. In the frames they should stand at intervals of 1 inch in rows 2 or 3 inches apart. When cold nights come, sash should be placed over the frames in order to prevent hard freezing of the plants; and when the severe winter weather sets in, board shutters, straw mats, or a covering of hay over the frame should also be used to prevent hard freezing. Cabbage plants which have been carefully hardened will not be killed by severe freezing, but if they are once frozen it is necessary so to cover the frames that they cannot thaw and freeze again. It is the alternate freezing and thawing that is so harmful. It is therefore necessary during cold weather to take care in ventilating the frames not to let the temperature rise and cause the plants to start into growth, and also to avoid keeping them in the dark too long at one time. The litter or cover should be removed on bright days, and when the temperature rises above the freezing point, the frames should be opened slightly to give the plants plenty of air. The object of thus wintering cabbage plants in cold frames is not to induce growth, but to keep them in a dormant condition from the first of December until planting time in the spring. The plants should not be started into growth until about the 10th or the 15th of March, at which time the covers should be removed during the day and everything possible done to bring the plants into slow and sturdy growth.

Another method of handling plants to secure an early crop is to sow the seeds in specially prepared hotbeds or in a greenhouse about the first of March, and then to force the plants as rapidly as possible until they are large enough to be transplanted to cold frames, which should be the last of March or early in April. Keep the plants in cold frames until they are thoroughly hardened, give them plenty of air on bright days, and cover them carefully at night to prevent injury from severe cold. The plants should be carefully watered and ventilated until they have attained good size and have become thoroughly hardened, when they will be ready for planting in the open, which will be from the 10th of April until the 1st of May, according to soil and climatic conditions.

Preparation for market-garden planting. Whether the plants are grown from seed sown in the field or from seed sown in the hotbed in the spring, sturdier plants will be secured if they are transplanted at least once before being shifted to the field. This is not essential, however, and is seldom practiced by commercial growers of early cabbage. At the time of transplanting to the field, lift the plants carefully from the cold frame or seed bed, with as much earth adhering to the roots as possible. As they are lifted, collect them into a compact bundle in the hand — all that can be grasped between the thumb and fingers of one hand — with the roots even. Then with a sharp knife cut the tops about halfway between the tip and base of the largest leaves. This gives a strong, stubby stem with about one half its normal leaf area remaining. Place the roots of the plants so trimmed in a pan containing a puddle (a mixture of cow manure and garden loam in equal parts make a very satisfactory puddle for this purpose). Plants which have been trimmed in this fashion and the roots properly puddled can be set rapidly with a dibble, as shown in figure 9, page 40. If the soil is heavily charged with organic matter or is mucky, it will be necessary to have a steel-pointed dibble, but in loamy or sandy soils, a wooden dibble will answer the purpose.

It is customary in most market-garden operations to grow an extra early crop of cabbage as a succession crop with other quick-maturing plants. In some instances it is set in alternate rows with lettuce and radishes, the rows of cabbage plants standing about 3 feet apart with 2 rows of radishes and 1 row of lettuce between the rows of cabbage, as suggested in figure 1, page 6. This intensive system can be practiced, however, only on soils which are exceedingly rich and have been carefully prepared. Where land is not so valuable and it is more economical to cultivate by means of horse power, it is better to set the plants 18 inches apart in rows 30 inches apart than to follow the intensive system noted above, which necessitates carrying on all the cultivation with hand implements.

Soil for the market-garden crop. Cabbage is grown on soils very diverse in character. The early crop, however, always requires a soil which warms up quickly in the spring, and which can be cultivated when heavier soils would be too wet to admit of cultivation. A soil charged with organic matter but with a large percentage of sand is, therefore, necessary for the early crop. In general, such soils are not ideal for the cabbage plant, but they are best for the early crop because of the advantage which early tillage gives. On these it is necessary to do practically all the deep cultivation in the fall. It is a common practice to plow the soil deeply in September or October, or as soon as the fall crops can be removed, and at the same time to apply a heavy dressing of stable manure — 40 to 60 loads to the acre. After plowing under the manure and thoroughly cultivating the land just previous to severe freezing, the soil should be thrown up in ridges with a lister, the center of the ridges being the proper distance apart for the rows of plants, and left in this condition during the winter. In the spring, the furrows between the ridges will act as surface drains to carry off the surface water and will draw any excess of moisture out of the ridges. As soon as the ridges are dry enough they may be split with a plow or lister, the middle filled, and the whole surface brought into condition for planting several days sooner than it could be made ready if preparation had not been begun in the fall. Plants prepared as described above can then be set in the ridge, or along the line of the furrow, fresh earth from the top of the ridge having been thrown into the furrow.

Fertilizing the soil for the market-garden crop. The preparation of the soil should be very thorough, and fertilization should be heavy. Cabbage is an exceedingly vigorous feeder and requires a large amount of available plant food. Commercial fertilizers are an advantage as a supplement to stable manure, and it is not wise to depend exclusively on either; the two should be combined. Stable manure should be reënforced by the use of a commercial fertilizer particularly rich in phosphoric acid and potash — potash being of special importance in the production of cabbage. A fertilizer containing nitrate of soda, 300 pounds; cottonseed meal, 700 pounds; acid phosphate, 750 pounds; muriate of potash, 200 pounds; applied at the rate of 500 pounds to the acre, in addition to 20 or 30 loads of stable manure, should produce a satisfactory crop of either early or late cabbage.

Cultivation of the market-garden crop. It is an old saw among market gardeners that "Cabbage should be hoed every day," and it is not far from the truth. It is almost impossible to give the cabbage plant too much cultivation. Frequent shallow stirring of the soil has a tendency to conserve the water supply, which, if maintained at a high point, renders a large supply of plant food available and induces a corresponding growth in the cabbage. In market gardens where the most intensive systems of cultivation are practiced and where cabbage is used as a succession crop with lettuce, radishes, or spinach, it will not be possible to carry on cultivation with horse power; but where cabbage is planted by itself, cultivation can, as a rule, be more economically conducted by horse power, in which case narrow-toothed, shallow-cutting implements should be used, and the operation repeated at least once a week. Weeds should never be allowed to appear in the cabbage patch, either early or late.

Harvesting and marketing the market-garden crop. The early cabbage crop is usually harvested by cutting the heads from the plants as soon as they have attained marketable size. If the land is to be cleared, the plants may be pulled and the heads then cut and trimmed of all loose leaves prior to marketing or crating for shipment. When cabbage is not grown as a companion crop, the heads are cut and hauled directly to the packing house and the stumps then plowed under; but when it is used as a companion crop, the stumps cannot be treated in this way. A solid, compact,

FIG. 57. Cabbage packed in ventilated barrels for shipment

conical head of medium size is the type most desired in an early cabbage. In shipping, the heads are usually placed in crates carrying from 50 to 100 plants or in ventilated barrels like those in figure 57. Crates are usually made from 8 to 10 inches wide, 24 inches deep, and from $3\frac{1}{2}$ to 4 feet in length, and so arranged as to have two compartments, as shown in figure 58. In "close-by" marketing, however, cabbage is carried in bulk to the market stands or to the wholesale market. Early cabbage deteriorates much more quickly than late cabbage, due partly to its texture and stage of maturity and partly to the season at which it must be marketed. Great care is therefore necessary in handling this crop.

Cabbage as a Truck Crop

The cultivation of cabbage as a truck crop at the South is quite different from that at the North and is one of the most interesting industries of the truck-crop group. The winters of the Atlantic seaboard from Baltimore southward are comparatively mild. Cabbage grown from seed sown in September and transplanted to the open in December can be successfully carried through the winter if planted on the side of ridges at right angles to the prevailing winds so as to protect the plants. Most varieties of

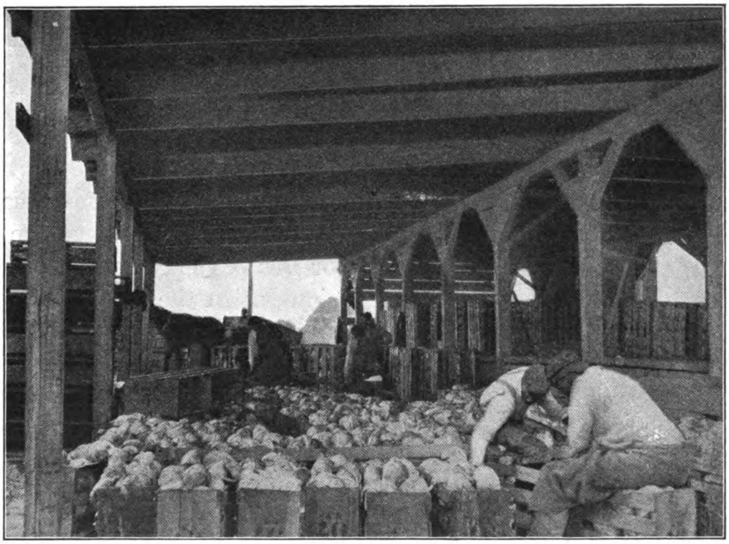


Fig. 58. Double-compartment cabbage crates

cabbage are hardy enough to live through the winter and at the same time make considerable root growth. Cabbage which has safely passed the winter under such conditions can make rapid growth on the approach of warm weather in the spring. As a result cabbage so handled is ready for market early in the season. Another plan is to protect the plants by frames and sash until after January 15, and then transplant them to the field. The seed for this crop is sown at the same time as that for transplanting in December.

Soil for the truck crop. While cabbage will thrive on many different soil types, that which is usually selected for truck-farm operations is what gardeners call a "quick soil" — one composed of sand, with a small percentage of lime or clay. Much of the soil of the important trucking region of the Atlantic seaboard consists of the type known as "Norfolk sand" or "Norfolk sandy loam." While this cannot be said to be the ideal soil for cabbage, yet on account of the season at which the crop is desired, it is better than the more retentive soils. Quick growth and development is a prime requirement in all truck-farming operations. Sandy soils, because they contribute to this end and can be cultivated at a season when it would be impossible to handle heavy soils, are almost universally chosen for truck crops.

Fertilizers for the truck crop. If possible, cabbage should be grown on an area where a green crop or a liberal application of stable manure can be turned under before planting in the fall. If fertilizers are used at planting time, they should carry normal quantities of phosphoric acid and potash, but only a small percentage of nitrogen. There are two reasons for this: (1) A slow vegetative growth is desired at this season, in order that the plants may become strong enough to withstand the most trying period of the winter. (2) Because of its solubility, nitrogen, if applied liberally when the plants are young, would be lost, since the plants would not be able to use it as fast as it became available. Then, too, a liberal amount of nitrogen available at this period would induce a rapid succulent growth, which would make the young plants tender and unfit them for passing the severe weather of the winter season.

A satisfactory fertilizer for the planting season will carry 1½ or 2 per cent of nitrogen, 6 or 8 per cent of phosphoric acid, and about 10 per cent of potash. This fertilizer should be scattered broadcast over the area at the rate of from 1000 to 1500 pounds per acre. At the approach of the growing season the development of the cabbage should be stimulated by a side dressing of from 150 to 200 pounds of some fertilizer carrying a high percentage of nitrate of soda or sulphate of ammonia, with little or no phosphoric acid or potash.

Experience has proved that it is best to induce only a moderate growth in the cabbage immediately after planting, so that the leaves shall be firm and tough to resist any severe temperature which may occur during the winter months. The nitrogenous fertilizer, therefore, is largely eliminated from the application made at planting time and reserved until the opening of the true growing season, which will vary in different localities according to the latitude in which the work is being conducted.

While this method of fertilizing the growing crop is of the utmost importance, it should not be forgotten that potash is the important element in the cabbage fertilizer.

The truck crop in the seed bed. Cabbage plants for the truck crop are grown in large beds in the open field. The seed is usually sown broadcast or in close drills in September or early in October in order that the young plants may be available for transplanting to the open in November or December, according to the locality. The seed should be sown thinly, so as to insure stocky plants.

In some localities the production of plants for transplanting purposes is an important commercial industry. A few growers in the neighborhood of Charleston, South Carolina, conduct a business which enables them to supply plants for transplanting purposes in carload lots. Under ordinary conditions, however, the plants for transplanting are grown by the trucker and transferred directly from the seed bed to the field. Under normal conditions $\frac{1}{4}$ pound of seed will supply plants for setting an acre in the field.

Transplanting the truck crop. When the work of transplanting to the field is done by hand, the plants should be lifted, puddled, set with a dibble, and firmed by a second thrust of the dibble. If the work is done by a transplanting machine, the soil will be firmed by the compression wheels or firming blades of the machine. The usual practice throughout the Southern trucking area is to throw up ridges at right angles to the prevailing winds, which usually means that ridges run east and west. On the south side of these, about a third of the distance from base to top, the cabbage plants are set from 13 to 18 inches apart. If, at the time of transplanting, the weather is warm and evaporation is rapid, it is advisable to prune off about half the leaf area of the plants for the purpose of lessening the evaporation, so that the growth of the plant will not be checked. At this season of the year little cultivation will be necessary, as weed growth will be slow.

Truck-crop cultivation. Most of the work of cultivation can be deferred until the active growing period in the spring. Care should be taken, however, to prevent weed growth which would in any way interfere with the development of the young plants. After the side dressing of fertilizer has been applied in the spring, cultivation will tend to bring the soil more nearly to a level condition. The side dressing is applied, as shown in figure 59, to every other "middle." The distributors are so constructed that two rows of

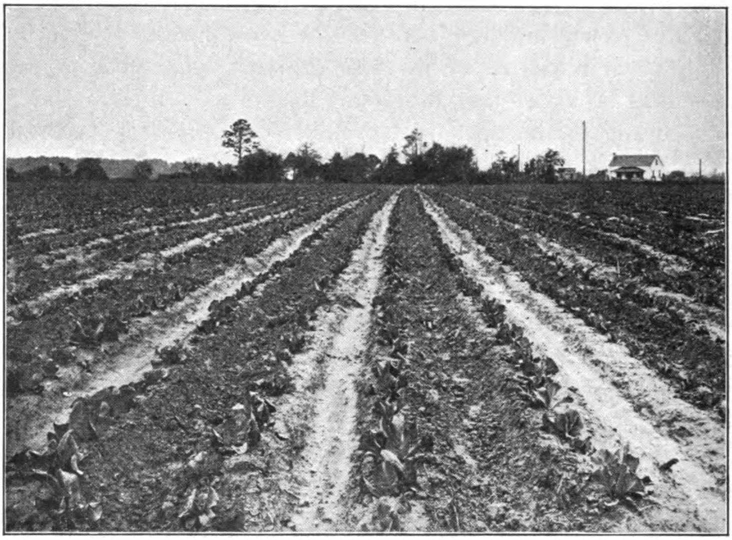


FIG. 59. A cabbage field after a side dressing of fertilizer has been given

plants are fertilized at one operation. If a second application of fertilizer is necessary it is applied to the alternate middles.

Enemies and diseases of the truck crop. In the trucking region the chief enemies of the cabbage are the harlequin cabbage bug, which sometimes causes considerable damage to the plant beds in the fall; the green cabbage worm, which, in some instances, causes considerable loss; and the cabbage louse, which is the worst enemy of the cabbage in this region.

Among the diseases which are at the present time causing considerable annoyance to cabbage growers is one of a physiological nature which has been brought about by the improper handling of the soil. This trouble, it is believed, is due chiefly to the fact that excessive quantities of mineral fertilizers have been used in a system of farming which has not provided a proper rotation. The result is that the organic matter, which is naturally very low in these soils, has been used up and is not present in sufficient quantity to counteract or neutralize the effect of the mineral fertilizers. As a result the plants are practically starved to death in the presence of an abundant food supply because it is not presented in the proper form. Investigations conducted by the

FIG. 60. Cutting cabbage

Department of Agriculture have clearly demonstrated this to be the case, and from what we know of the value of organic matter, such as stable manure and green crops, turned under in other agricultural operations, is it not reasonable to suppose that the benefits which have come from proper crop rotation in other localities will be equally as great in the trucking region?

Harvesting the truck crop. Cabbage which is grown as a truck crop is harvested as soon as it has attained sufficient size to be placed upon the market, regardless of its stage of development. The first shipments from the trucking regions consist of small, immature heads, often having many loose leaves. As the season advances, the quality of the product improves until the heads are closely trimmed and carefully packed. The customary practice is to drive a horse and cart through the cabbage fields. This is followed by a gang of men provided with strong knives, each man looking out for two or three rows, according to the stage of development of the cabbage, and cutting all well-developed heads as he goes along. Later in the season, when the crop can be cut much more completely, each cutter follows two rows, and as the heads are severed from the stalks tosses them into the cart, as shown in figure 60. The cabbage is packed either in crates or in barrels according to the locality in which it is grown. Cabbage from the Florida and Charleston regions is largely shipped in crates similar to those shown in figure 58, while cabbage from the Norfolk area is extensively packed in ventilated barrels similar to those shown in figure 57, although a considerable quantity from this region is also packed and shipped in crates.

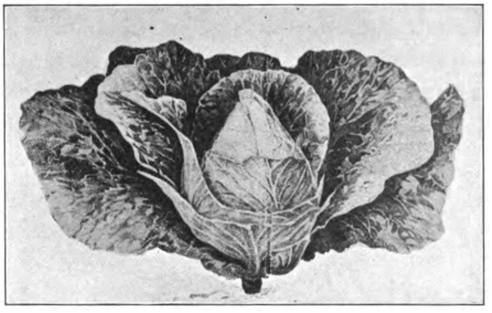


FIG. 61. Jersey Wakefield type

Varieties of the truck crop. The cabbage that is produced in the trucking section is practically limited to the Wakefield type. There are two strains of this type now extensively raised: the true Jersey Wakefield, with its small, acutely pointed tip and very firm, tender flesh of high quality; and the Charleston Wakefield, which

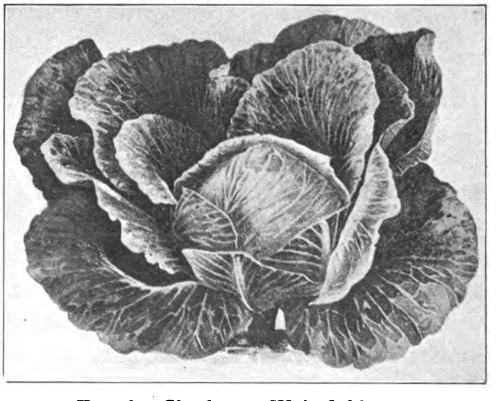


FIG. 62. Charleston Wakefield type

is broader, somewhat flatter and more obtuse-pointed, and slightly more angular in cross section than the Jersey type. These two types of cabbage are well illustrated in figures 61 and 62.

Marketing the truck crop. Cabbage from the trucking region is chiefly marketed in carload lots. Long-distance shipments of truck crops of all classes are most economically handled in this way. In fact it would be impossible to carry on the trucking enterprises of the country in their present magnitude if it were not possible to ship in carload lots. The truck-crop cabbage business is at present chiefly conducted on a commission basis, although in a few sections crops are grown under contract. It is probable that because of the perishable nature of early cabbage it will always be extensively handled on a commission basis. Truck-crop cabbage cannot be shipped in bulk in carload lots as can the autumn crop. It is either packed in crates like those shown in figure 58, or in burlap-covered ventilated barrels like those shown in figure 57.

An item that should be considered by the grower of early cabbage for the Northern markets is the quantity of cabbage placed in storage from the Northern fields. A short crop of late cabbage at the North means good prices for early Southern-grown cabbage. Low prices and heavy storage of Northern-grown fall cabbage usually means small returns for early Southern-grown cabbage. This clearly indicates that it is important for the truck farmer of the South to keep close tab on the hold-over crop of the North in order that he may not be the loser.

This late crop of cabbage, as has been shown, is grown as both a field and a market-garden crop. In certain sections of New York, Michigan, Wisconsin, Illinois, and Ohio, cabbage forms a regular crop in the farm rotation, each farmer planting from 2 to 15 acres and, in some instances, even larger areas than this. These crops are cultivated much like corn or potatoes, and as the cool weather of fall and early winter approaches, the heads are cut and packed in cars similar to those used for shipping cattle. Later in the season ventilator or box cars are used, and during the winter and spring standard refrigerator cars are required in order to secure insulation during the winter and icing in the spring. This is a cheap way of handling the crop, which in some seasons brings a very satisfactory return.

Cabbage as a Farm Crop

Cabbage as a farm crop is produced chiefly in the northern tier of states, including New England, the states bordering on the Great Lakes, and to a less extent in Kentucky, Tennessee, Missouri, and Colorado. New York grows almost three times the acreage of any other state. It is this farm crop of cabbage which finds its way to the kraut factories, to the cities of both the North and the South, as the cool days of fall and early winter come, and to the large storage houses distributed through New York and Wisconsin.

Soil for the farm crop. The soil upon which cabbage is most extensively grown in this region is either rich alluvial bottom lands or the rich prairie soils of the states west of New York and Pennsylvania. While cabbage is a bulky product and usually does not sell for a very high price per ton, yet the large tonnage produced per acre and the fact that it is so universally consumed by all classes account very largely for the extensive acreage devoted to its cultivation throughout the area of dense population.

Preparing the soil for the farm crop. When cabbage is grown as a farm crop it is used as one of the factors in a crop rotation and, with potatoes, occupies the area in which clover has been grown the year previous and turned under. A common rotation is to follow corn with oats and clover sown together; the clover is cut twice during the season and turned under the following spring, and the area then devoted to cabbage and potatoes. The part of the clover sod to be devoted to cabbage is enriched by a heavy dressing of stable manure. If this is not available, the necessary supply of plant food is secured by the use of a high-grade fertilizer carrying 3½ or 4 per cent of nitrogen, 6 or 8 per cent of phosphoric acid, and 8 or 10 per cent of potash, applied at the rate of from 1200 to 1500 pounds to the acre.

The seed bed for the farm crop. The seed bed should be made in rich, well-drained soil which has not previously grown cabbage for at least five years. The soil should be thoroughly cultivated, fined, and compacted, and the seeds sown in beds 6 feet wide with 18 inch alleys between them, or with a seed drill in drills 12 or 14 inches apart, so as to allow cultivation with the wheel hoe. A seed bed which is a quarter of an acre in extent and uses 3 pounds of seed sown in drills should furnish a sufficient supply of plants for 10 acres.

A still cheaper method of handling cabbage is sometimes resorted to — that of planting the seeds in drills where the crop is to be harvested. After the young plants appear above the ground, they must be thinned with the hoe to stand at the proper distance apart. This would seem to be a cheap way, but it is a question whether it is of any special advantage, as the cost of weeding and thinning small plants is frequently equal to that of transplanting.

Planting the farm crop. Even now the great bulk of the cabbage grown in the United States is transplanted from the seed bed to the field by the old laborious, backaching hand methods. The size of the crop and the difficulty of securing labor are rapidly forcing growers to a realization of the value of the transplanter. A carefully operated machine does more and better work than can be done by hand, and since the machines are equipped with watering devices, the grower, after carefully preparing the land, is not compelled to wait for a certain season to plant his crop — the machine makes its own season.

After the plants are in the field, cultivation cannot be too frequent, and it should be the rule to use the cultivators at least once a week. If there are frequent showers, a cultivator should be run over the field as soon after each shower as is practicable. Never allow a crust to form over the area occupied by this crop. Cultivation should be carried on with implements which do not work the soil deeply, 2 or 3 inches being a satisfactory depth. A cultivator with narrow blades which leave the soil practically level is to be preferred to those which have broad, deep-working teeth and leave the soil in ridges. Level cultivation tends to lessen the area of soil exposed to evaporation, while deep cultivation will leave ridges and furrows and has a tendency to increase the loss of moisture by increasing the area exposed to the action of sun and wind.

Fertilizer for the farm crop. A good fertilizer with which to supplement stable manure is one containing about 3 per cent of nitrogen, 6 per cent of phosphoric acid, and 6 or 8 per cent of potash. Apply this at the rate of from 400 to 800 pounds to the acre, according to the quantity of stable manure used. If it is used independently of stable manure, it may be applied at the rate of from 800 to 1500 pounds to the acre.

The time and manner of applying the fertilizer to the late crop has a marked influence upon the yield. If the needs of the succeeding crop are to be considered as well as those of the cabbage, broadcasting is the most desirable method of applying the fertilizer. If, however, the yield of cabbage is the important desideratum, then the hill or drill application will be found most profitable. The best practice is to apply half of the fertilizer broadcast and half in the drill.

Enemies of the farm crop. Cabbage is beset by four serious insect pests — the flea beetle, the cabbage worm, the harlequin cabbage bug, and the cutworm.

The *flea beetle* attacks the young seedlings both in seed beds and in the field, as they appear above the surface of the ground, and sometimes defoliates or even destroys the plants before its presence is noticed. Care should be taken to prevent such loss. A good plan is to dust the plants frequently with fine wood ashes, lime, bug death, tobacco dust, or some insecticide which will keep off or destroy the flea beetles without injuring the plants. It is easier to treat the plants for this insect when they are grown in seed beds than when grown in drills in the field. This is one reason why many growers prefer the seed-bed system to the field method of growing the seedlings.

The second important enemy which should be mentioned is the *root maggot*, which works at the root of the cabbage, cutting it off just below the surface of the ground and causing the plant to wilt and fall over without any apparent cause. This maggot is a small worm which eats the pith out of the stem of the young plant, cutting off its food supply from the root. The maggot is the larva of a fly which infests cabbage fields and lays its egg at the surface of the ground on or near the stem of the cabbage. It cannot be treated with an insecticide, but can be satisfactorily held in check by placing a disk or square piece of paper, slit from the edge to a small hole in the center, around the stem of each plant as it is set in the field. A simple device for cutting out these disks was made some years ago by the late Professor Goff of Wisconsin. While this is a satisfactory plan for controlling the maggot in home and market gardens, it is not practicable under field conditions.

In soils which have been in sod for years, *cutworms* are frequently a great annoyance and quite destructive. Such soils should be plowed in the fall and allowed to remain exposed to the action of the weather during the winter. Land which has been used for hoe crops, such as corn or potatoes, is preferable for cabbage. A new clover sod, however, is not usually infested with cutworms.

The flea beetle and maggot are the two insects which as a rule are most troublesome. In some instances, the *green cabbage worm* which appears on the heads at any time during their growth, and which is the larva of the yellow butterfly common to cabbage fields, is sometimes very troublesome. This insect, however, can be successfully treated with a dilute solution of Paris green or hellebore, or if it is not thought desirable to use such an insecticide, a sprinkling of bug death will accomplish the same result.

In latitudes south of New York City, the *harlequin cabbage bug* is the most annoying and destructive pest of late cabbage. This pest is seldom troublesome on early cabbage, but in some localities and during some seasons breeds sufficiently on the early crop to become extremely annoying to the late crop. These insects are more difficult to destroy than any of those yet mentioned because of the fact that they obtain their sustenance, not by chewing the leaves of the plant they infest, but by sucking its juices. Sucking insects are most difficult to deal with because they cannot be destroyed by the use of arsenical poisons. The only alternative therefore is to destroy them by contact insecticides. But unfortunately a contact insecticide of sufficient strength to destroy the insects is detrimental to the cabbage. The usual method of treating this pest is to provide a decoy crop, such as turnips or preferably mustard, which shall come on in advance of the cabbage and is preferred by the bugs, and then to destroy both the crop and the insects by the use of kerosene applied as a spray.

The *cabbage aphis* or *louse* is sometimes an annoying pest on late cabbage, cauliflower, and Brussels sprouts. Like all other plant lice, it obtains its nourishment by extracting the juices of the plant and can therefore be treated only with contact insecticides. It seldom proves troublesome during seasons of abundant moisture, but when there is a period of drought during the cabbage season there is apt to be a scourge of this pest. The use of kerosene emulsion as a spray upon the plant is practically the only effective way of controlling this troublesome insect.

Diseases of the farm crop. The only disease which is important enough to be mentioned in connection with the cabbage industry is the clubroot, the ravages of which are not confined exclusively to the cabbage plant but are felt by all members of the cabbage family, including turnips, cabbage, cauliflower, kale, Brussels sprouts, etc. This is a disease which is capable of propagating itself in the soil from year to year. The only way to eliminate it from the infested area is to stop growing cabbage and all related plants for a number of years. By excluding from infested soils all crops belonging to the cabbage family and growing on them cereals or grasses, in the course of five or six years they will become free from the clubroot scourge and it will again be safe to use them for the cultivation of cabbage. This disease is known to botanists as *Plasmodiophora Brassicae*. Young plants from a seed bed severely affected by clubroot are shown in figure 63.

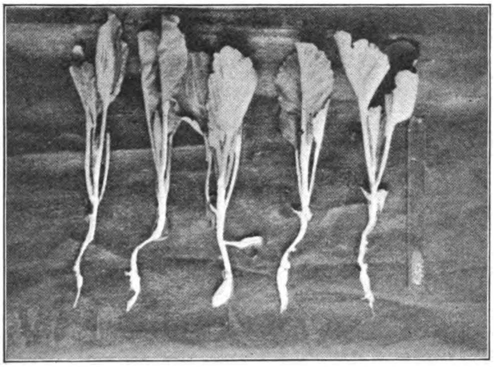


FIG. 63. Cabbage seedlings affected with clubroot

Harvesting and marketing the farm crop. The common, and usually the most advantageous, method of handling the farm crop is to cut the heads at the approach of cold weather, and ship them directly to the market. When cabbage is grown on a large scale, say from 5 to 20 acres, it is almost absolutely necessary to handle it in this way, unless one has extensive storage facilities at his command. The market gardener, however, who grows only a limited quantity of cabbage for local use can store his crop through the winter so as to make it available for his local market as it is needed.

At harvest time, whether the cabbage is to be shipped, carried to the kraut factory, or stored, a wagon provided with a deep body is driven across the field, the two rows of heads having been cut in advance of the team and laid to one side. Men gather the heads which have been cut carefully by the cutters and toss them to some one in the wagon, who lays them carefully in tiers in the bottom of the wagon. Cabbage which is intended for long shipment or for storage should be carefully handled so that it will not be bruised or injured in any way. In unloading it to the car or storage house the same precautions as to careful handling should be observed.

Pitting the farm crop. There are various ways of storing cabbage for winter use, the most common of which is to select a well-drained ridge which has a somewhat gravelly soil. On this is opened up a trench from 18 inches to 3 feet in width, according to the number of heads to be stored on the bottom layer. If only 2 heads are to be placed side by side, 18 inches will be sufficient; but if 3 heads are to be so placed, the width should be at least 24 or 30 inches. The depth of the trench should be from 6 to 10 inches, according to the size of the heads to be stored.

Cabbages for storage are pulled with the roots adhering, and placed in the trench heads down. The outer leaves are wrapped closely around the head, and only those leaves are removed which are decayed or discolored, all the large, well-developed, healthy ones being left on the stem. After filling the bottom of the trench, which may be 2, 3, or 5 plants wide, the next layer must be inserted so that the heads will fit between the stalks of the bottom layer. Thus if 3 heads is the width of the bottom layer, 2 rows of heads will make up the second layer, and if the trench is wide enough for 5 heads on the bottom, 3 rows can be placed on these; while if only 2 heads are placed side by side on the bottom, the second layer will consist of but 1 row of heads. After carefully packing the heads together in this fashion, the grower must place over them a sufficient amount of soil to protect them from hard freezing. They are left in this condition until severe weather sets in, when the bank should be covered with litter, manure, or fodder of some kind both to prevent severe freezing and alternate freezing and thawing, and to enable the grower to remove the heads as desired during the winter.

Another plan which can be followed is to build a pit, similar to that used for storing celery, which consists of an excavation from

8 to 12 inches deep with sides boarded up to a height of about 2 feet, and the entire structure roofed over to keep out sun and rain. This can be made any length or width, depending on the lumber to be used. The cabbages, with roots attached, are packed into this excavation in the same way as in the trench. Good ventilation should be provided to keep the temperature at the proper degree. After severe weather sets in, it may be necessary to cover the entire structure with straw or fodder to prevent hard freezing, but all that is really necessary is to prevent alternate freezing and

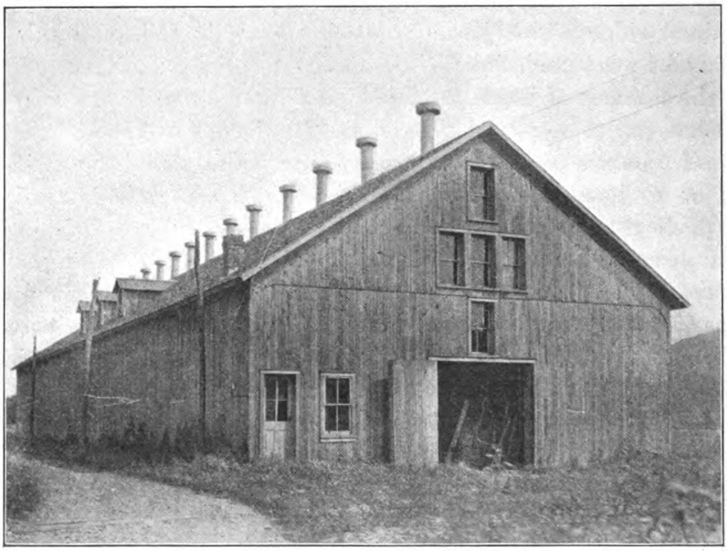


FIG. 64. An inexpensive style of structure for storing cabbage

thawing. If the cabbage freezes and remains frozen, it is not injured, but repeated freezings and thawings are very destructive. If for any reason the contents of the structure is frozen, it would be well to place sufficient litter over it to keep in the cold in order that the frost may be drawn out gradually.

Storage for the farm crop. The prerequisites for the successful storing of cabbage are: (1) carefully grown and carefully handled plants of a sort well adapted for storing; (2) storage warehouses so constructed as to prevent drip from the ceiling or roof striking the heads; (3) a control of the ventilation and temperature of the building which will prevent the condensation of moisture on the cabbage.

The Danish Ball Head from imported seed is the variety chiefly grown for storage purposes. The heads should be carefully cut and thoroughly trimmed so that no loose leaves will get into the storage house. In hauling this cabbage from the field, spring wagons should be used and the heads should be passed from hand to hand and never thrown directly into the wagon body. The same precautions should be observed in placing the heads in storage.

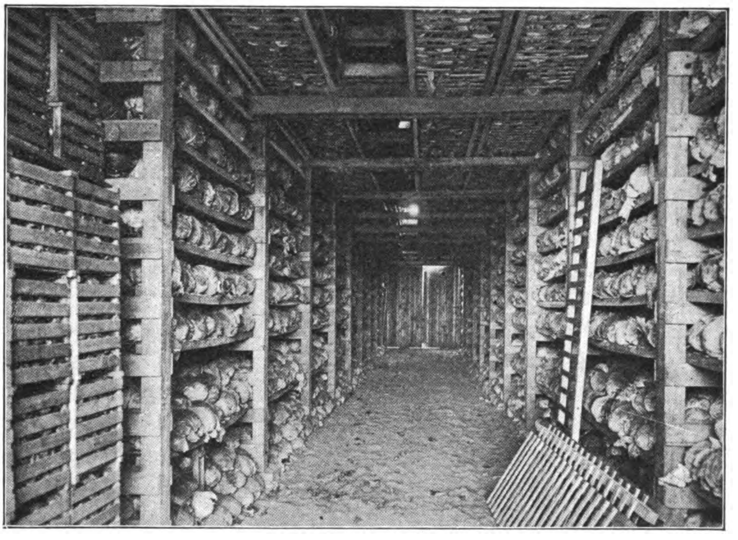


FIG. 65. Interior of cabbage storehouse
Note shelves and arrangement of heads

The general type of storage house is that of the broad, low structure with an alley in the center sufficiently wide to admit a team, as shown in figure 64, and with the storage bins or shelves arranged on either side. If bins are used, they should be narrow and not more than 16 or 18 feet from front to back, and the cabbage not more than 6 or 7 feet in depth from the floor to the ceiling. Several bins may be placed one above the other in the same tier if there is a waterproof floor between them, so that the drip from decaying cabbage or other moisture in one bin cannot reach the bin below. In general the bins are not as satisfactory as the shelves (see figure 65).

As is suggested in the illustration, the heads may be stored on the shelves in single layers or in two-layer or three-layer depths.

Precautions should be taken in all cases to provide an air space between the outside wall of the building and the storage bins or shelves. Such a dead-air space is necessary to prevent the penetration of frost. If the walls are made of brick, two 4-inch walls could be laid up and tied together by a header course so as to provide an air space 2 or 3 inches wide between them; or a solid 9-inch wall may be constructed, and by means of furring strips a tongue-and-groove or a lath-and-plaster wall may be placed on the inside. The roof, which should be provided with a suitable outer covering of shingles, steel, or composition, should have an inner lining to give a hollow space between the outer and the inner walls. If the inner lining is made of lumber, the boards should run parallel with the rafters, so that moisture will flow to the eaves instead of falling from each joint, as would be the case if the boards were placed at right angles to the rafters. Evaporation should be carried off by ventilators along the ridge provided with dampers which can be controlled by ropes extending to the passageways. Cold air from the outside can be admitted through apertures in the foundation made to receive large terra-cotta pipe which has wire netting over the outer end and suitable dampers or shutters at the inside to control the intake of cold air.

The secret of success in the management of a storage warehouse is to have disease-free, well-matured, firm, carefully handled stock grown from high-grade seed and a storage house so constructed that a temperature of about 34° F. can be maintained throughout the whole storage period. This means that as soon as the house is filled, it must be kept closed during the day and open as much as possible during the night, so as to get the benefit of the low night temperatures. Every possible advantage must be taken of the frosty nights which occur during the storage period.

Storage troubles are more often the result of careless handling and bad ventilation than of diseases. Practically all the rotting which takes place during storage is the result of saprophytic organisms attacking heads which have been badly handled or have become slightly diseased because of bad storage conditions. Poor cultivation, bad harvesting methods, long hauls to storage, and rough handling in unloading and storing are to be avoided if cabbage is to be stored successfully.

Uses of cabbage. Cabbage is chiefly used as an edible in its fresh state, but it is also manufactured into kraut. Kraut is made somewhat as follows: Clean casks are selected, and one head removed. A thin layer of salt is sprinkled over the bottom of each cask. A kraut cutter is then placed on the top of the cask, and a layer of cabbage from 3 to 4 inches deep is shaved off into the cask and packed down onto the salt. Another layer of salt is added, the quantity being sufficient to cause the cabbage to assume a whitish, salty appearance, and this operation is repeated until the cask is filled, when it is set away in a cool, shady place. It is necessary in the operation to keep the freshly cut cabbage carefully tamped in the cask in order to make it as solid as possible. The kraut cutter consists of a series of knives placed on a board about 10 or 12 inches wide and projecting through it somewhat after the fashion of a plane blade; clean heads of cabbage are pushed over the board and shaved into thin strips.

Cabbage is used to some extent for stock food, especially for feeding store cattle; it can also be used for dairy cattle, if very carefully fed. Cabbage should never be housed in stables in which dairy cows are being milked, and should be fed to milch cows in limited quantities only, and then so that none of it will be available to the cows for at least three hours before the milking period.

Varieties. Many varieties and types of cabbage are used for general field crops, and the fads of the markets must be consulted and taken into consideration in selecting the variety to be grown. Some markets demand a cone-shaped head, others a spherical, and still others a flat cabbage. Each of these different forms is represented in standard varieties — the Winningstadt and the Early Jersey Wakefield have small conical heads, while All Seasons, Danish Ball Head, and Sure Head are spherical in form, and the Flat Dutch types are all large, broad, and flat.

The first early sorts are Early Jersey Wakefield (or Wakefield) and Charleston (or Charleston Wakefield). The second early sorts are Henderson's Early Summer, All Seasons, and Henderson's Succession. The late varieties are Flat Dutch, Premium Flat Dutch, Autumn King (or World Beater), Stone Mason, Winningstadt, and many others. For storing purposes, Danish Ball Head from imported seed is most extensively used.

The variety which is best suited to any particular locality must be determined by the factors above noted, the peculiarities of the market, and the character of the soil on which it is to be grown.

Besides the ordinary types of green cabbage included in the list above, we have the Savoy cabbage with convoluted or blistered leaves. While this grows as large as does the ordinary types, it is usually less productive, but as a rule commands a higher price in the market. The red cabbages do not produce large heads, but in certain markets they command a good price, frequently being quoted two or three times as high per ton as the ordinary forms. During the winter of 1904–1905 the ordinary types of cabbage sold at from $7 to $9 per ton, while the red types brought from $30 to $35 per ton. This difference in price, however, is more apparent than real, for the yield per acre of the red sorts is so much less than that of the green sorts that the returns per acre are pretty nearly equal. There is a smaller percentage of heads from the red cabbage and they are smaller in size and weigh less, the average size of the red being 2½ pounds, while the ordinary field type of cabbage will average from 5 to 5½ pounds.

CARDOON

Cardoon is a plant of robust growth resembling the bur artichoke. Its edible part is the thickened leafstalks, which are blanched in the same manner as celery. It is little grown in this country, but should find more general favor here, since it can be held for winter use like celery.

Botany. Botanically, the plant is said by Vilmorin to be a horticultural variety of the French, or bur, artichoke, *Cynara scolymus* L., although it has been given the specific name *Cynara cardunculus* L. Horticulturally, the chief difference between these two plants is the manner of propagation — the artichoke can be propagated from seed, but as a matter of fact all its garden varieties are increased by offshoots, while the cardoon is universally propagated from seed.

Cultivation. Since the plant is of robust growth, the seeds must be planted in rich earth in hills at least 30 inches apart in each direction. As in the case of celery, the quality of cardoon suffers from any cause that interrupts or retards development. At the North, if the plants are desired for early autumn use, the seed should be started early in the season in houses or hotbeds, preferably in 4-inch pots buried to their brims. If seed is sown in large pots, the plants do not suffer a severe check when transferred to the field. At the South, where the seasons are longer, seed may be planted in the open at about the same time as corn. The plants should be kept growing vigorously, and toward the close of the growing season, as cool weather approaches, they should be prepared for blanching. This consists in drawing the leaves of the plant tightly together in an upright position, — which should be done only when both the plant and the soil are dry, — incasing the stalks in rye straw or some similar material, and earthing up the same as celery. The plants are tender to frost and should therefore be harvested or placed in a frost-proof cellar or pit before severe weather sets in.

CARROT

The carrot is one of the garden plants of secondary importance from an economic point of view. It is less appreciated in the United States than in foreign countries, yet it is found in almost every kitchen garden in this country, and is regularly grown by market gardeners both as a frame and as a field crop. As a culinary vegetable it is chiefly used for flavoring soups and stews. It is also often served as a separate table vegetable, and as such it has grown in favor in this country in recent years, although its use in this respect is limited as compared with most other garden products.

Botany. Botanically, the carrot, *Daucus carota*, belongs to the great family *Umbelliferæ*, which also includes celery, caraway, lovage, and parsnip. The wild carrot is a pestiferous weed of wide distribution throughout the northeastern part of the United States.

Cultivation. The carrot is a standard hotbed crop among gardeners supplying the larger cities of the North, and in some sections it is extensively grown as a farm crop for stock food. In the market garden it is forced in hotbeds or coolhouses as a companion crop to lettuce or radishes, for which purpose the short-rooted, quick-maturing French forcing varieties are chiefly used. Figure 16, page 60, shows a hotbed several hundred feet long devoted to this vegetable. In the vicinity of Boston carrot hotbeds are started in late February or early March. The seed is sown in place in rows from 6 to 10 inches apart, the distance depending upon the companion crop. The harvest begins as soon as the most advanced roots are large enough, the size varying in different markets, but ½ inch in diameter at the crown is usually sufficient. The harvest is continued by removing the largest plants, the crop being thinned in this way. This forced product is marketed in bunches the same as radishes.

The crop in the open. In the open the crop is handled the same as beets. The seed is sown thinly, about ½ inch deep, in drills from 14 to 18 inches apart, if the cultivation is to be done by hand. Field crops to be cultivated by horse-power implements are usually planted in rows from 22 to 30 inches apart. If the seed is scattered in a belt rather than in a narrow drill, less thinning will be necessary. The quantity of seed will vary with the width of the rows from 2 to 4 pounds per acre. The soil should be rich, loamy in character and free from weeds. Young carrot plants are small and delicate, easily smothered, and very difficult to weed by hand if once overrun with weeds. If the plants are kept free from weeds during their early life, all later cultivation can be done by simple hand or horse-power implements.

Harvesting. At the approach of cold weather the crop should be dug and stored. The manner of digging will depend upon the type of root grown — the half-long sorts can easily be thrown out with a spading fork or plow; the long sorts, however, are most easily harvested by the use of a subsoil plow. As soon as the roots have been loosened they should be gathered into heaps or into convenient receptacles to facilitate the work of topping. After the tops have been removed the roots can be stored in a cellar in the same manner as potatoes, or they may be buried like beets in conical heaps and covered with straw and earth. They can be kept in better condition in the root cellar if packed in sand, but only those roots intended for table use should be given this treatment. After the weather becomes warm enough to induce growth either in the pit or root cellar, gardeners often profit by placing the better table varieties in cold storage for a short time.

Varieties. There is as great a difference in varieties of carrots as there is in garden beets. Some sorts have a small proportion of pith, or wood, to the thickness of the bark, while in others the ratio seems to be reversed. The value of the root for table purposes depends upon this proportion, a thick bark and small core giving the highest quality of root. The age of the root, as well as the manner of growth, is an important factor; a young root that has been quickly grown is of finer quality than an old, slowly grown root.

The yield of carrots ranges from 250 to 800 bushels per acre, depending upon the soil and cultural conditions as well as upon the variety grown. The price also fluctuates from a few cents to a dollar or more per bushel.

CAULIFLOWER

Cauliflower is the most delicate and refined of the plants of the cabbage family, and, from the gardener's standpoint, the most valuable. It is not so hardy as cabbage and is more exacting as to its soil and cultural requirements. With the exception of celery no crop is so closely restricted by the limitations of soil and climate as cauliflower.

Botany. Cauliflower is known to the botanical world as a variety of cabbage, *Brassica oleracea*, var. *botrytis* D.C. Although a derivative of the cabbage, it differs from it in conformation and structure. The edible portion, called the curd, or head, is composed of the thickened flower stems, which have changed in size and appearance under cultivation into a homogeneous curdlike mass. In good strains of cauliflower the curd is very compact and free from leaves or elongated segments, as shown in figure 66. Inferior strains of seed, and sometimes bad handling, will result in segmented, leafy, or "ricy," curds.

Distribution. Cauliflower does not thrive well in hot, dry sections. Its commercial cultivation is therefore confined to the more humid coast sections of the United States and to the coolest seasons of the year. The best results are secured from an autumn or an early spring crop. Cauliflower is grown as a field crop for both spring and autumn market, but by far the largest amounts are grown in the autumn. While Long Island undoubtedly still leads all other sections in the production of this crop, extensive areas are grown on irrigated lands in southern California and, to a limited extent, in the Norfolk area of Virginia.

Soil. Soil for cauliflower should be practically the same as that for early cabbage. A rich, responsive soil which can be cultivated during the cooler seasons of the year is most desirable. Give the land a deep plowing previous to planting, and at that time supply

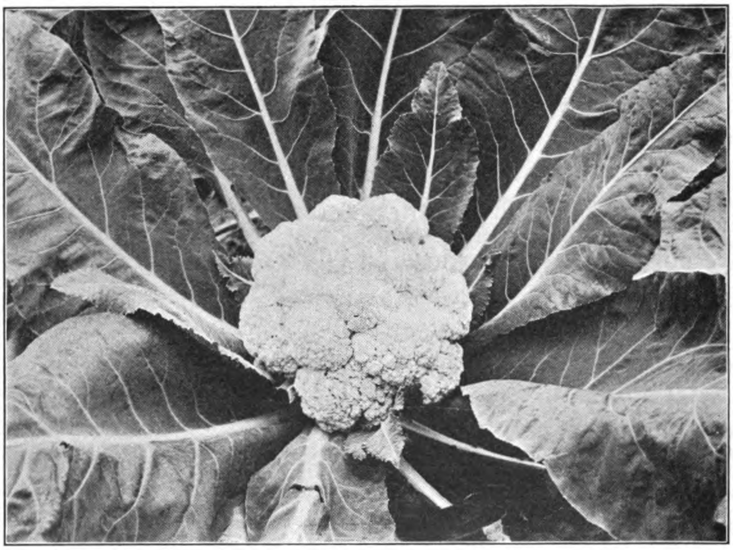


FIG. 66. A good type of cauliflower

all organic fertilizer required. If sufficient stable manure to meet the demands of the crop is not available, supplement it with a commercial fertilizer consisting of nitrate of soda, 300 pounds; cottonseed meal, 700 pounds; acid phosphate, 750 pounds; and muriate of potash, 250 pounds. Apply this at the rate of 500 pounds to the acre previous to setting the plants in the field.

Rearing the plants. For an early crop of cauliflower in northern latitudes, it is necessary to start the plants in hotbeds or in greenhouses. Transplant the young plants as soon as they have developed true leaves to the length of 1 inch, giving them about 2 inches in each direction. Before placing them in their permanent beds, trim away half the area of the large leaves. Set them about 18 inches apart in the row, and if they are to be cultivated with horse power, with a space of from 2½ to 3 feet between the rows. Young plants should be kept growing without check from the time they appear aboveground until they are transplanted to the field, after which they should be forced rapidly by means of thorough fertilization and continuous cultivation.

Cauliflower as a field crop. For the early field crop, seed should be sown in the greenhouse or hotbed about March 15, in the latitude of New York City, and at a correspondingly earlier date in more southern localities. In some sections the crop is grown in spent hotbeds or cold frames, in which case the young seedlings are started earlier than for field cultivation, the seed being sown in January or February, according to the time it is desired to transplant to the spent hotbeds or cold frames. On Long Island, where early cauliflower is grown to a considerable extent, the practice of starting plants early in the season and bringing them to maturity in spent hotbeds or cold frames is quite common. The regular season for cauliflower on Long Island is, however, the autumn. The seed for this crop is sown in May in the same manner as cabbage seed for a late crop.

The transplanting is done, preferably by means of a transplanter, between June 20 and July 10, according to the season. The young plants are set at intervals of from 15 to 18 inches in rows from 30 inches to 3 feet apart and are watered in. The same careful cultivation required for a successful cabbage crop must be given cauliflower, and when the plants begin to "button," or form heads, great pains must be taken to protect them from insects and guard the forming curd from injury or discoloration. This is usually accomplished by folding the leaves over the head so as to form a canopy and holding them in place by a peculiar method of interlocking, or by tying them with straw or bands of raffia. Sometimes different methods to indicate the stage of development of the curd are used in the same field. The first covering may be identified by the leaf lock, the second by a straw tie, and the third by a band of raffia. At cutting time it will then be easy to distinguish the more advanced from the younger heads.

In Florida and in southern Texas cauliflower is grown as a winter crop, the seed being sown in September and the plants grown under irrigation throughout the winter. This has proved a remunerative industry in many localities, as there is a good demand for well-grown cauliflower at all seasons.

Insects and diseases. Cauliflower is subject to the attacks of the same diseases and insects as other forms of cabbage, but because of its great value and its peculiar manner of development

FIG. 67. Trimmed heads of cauliflower ready for wrapping and packing

much greater care is required to protect it than is necessary for cabbage. For a description and treatment of these troubles see pages 176–178.

Harvesting. At the time of harvesting, the heads of cauliflower should be cut from the stalks, and the outer leaves trimmed down so as to project 1 inch or 1½ inches beyond the crown of the head, thus forming a frill of green stubby leaf stems. This gives the whole an attractive appearance, and the leaf stems serve as a protection to the delicate head. After the heads have been trimmed and carefully wrapped in soft white or brown tea paper, they should be packed in crates or barrels in such a way that they cannot jostle and become discolored by friction. It is impossible to market cauliflower which has been transported long distances by rail in as attractive condition as that shipped only short distances unless it is packed in small crates one layer deep, as is done by California growers.

Packing. Cauliflower grown in the East is usually packed in ventilated barrels, after the heads have been trimmed as shown in figure 67. A layer of excelsior is put in the bottom of the barrel,

FIG. 68. A partially packed barrel of cauliflower

Note excelsior and trimmed heads

and on this is packed, curd down, a layer of heads protected by tea paper. A second layer of heads is packed on these in reverse position, another layer of excelsior added, and the process repeated, as suggested in figure 68, so that when the work is completed the barrel appears as shown in figure 69. A burlap cap is then placed over the barrel and hooped down. Frame-grown and house-grown cauliflower are marketed either in baskets or boxes, while the California-grown product is usually packed and shipped in small boxes holding six heads. These are shallow carriers similar to those used for shipping muskmelons in a single layer.

For localities with suitable soil and climate conditions and reasonably quick transportation this crop affords a most remunerative industry. Like many other truck crops, it requires close attention and skill on the part of the cultivator, but the returns amply repay such attention.

Storing. Unfortunately cauliflower cannot be stored successfully for long periods, like cabbage, turnips, and other plants of the same family. It can be held for a reasonable length of time in

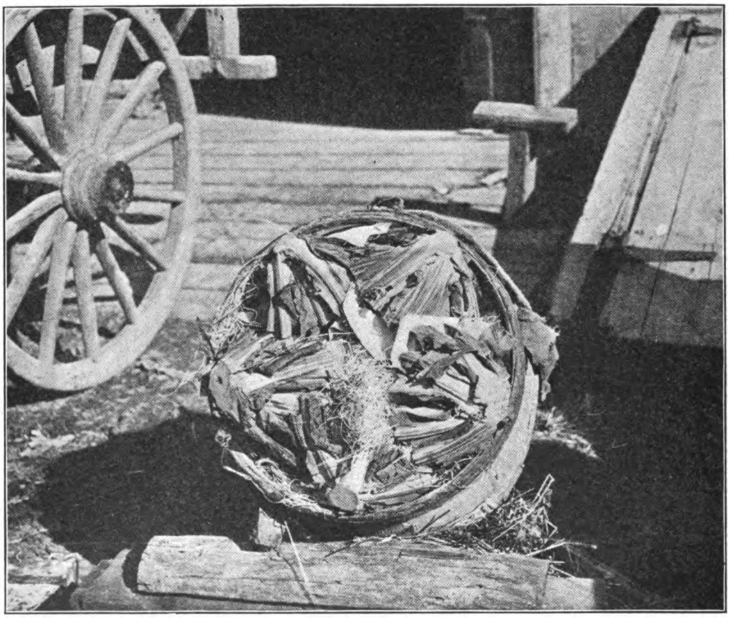


FIG. 69. A barrel of cauliflower ready for the burlap cover

cold storage, but, in general, the markets must be supplied from successive crops rather than from storage. For this reason cauliflower claims attention as a forced crop.

Cauliflower in the Norfolk, Virginia, section. The cauliflower grown in Tidewater, Virginia, is largely for home consumption, but a limited supply is shipped to the Northern markets. To secure plants for this crop seed should be sown in a cold frame late in October or in the greenhouse after the middle of December. When the seedlings show well-formed second leaves they should be transplanted to stand 2 by 2 inches in a cold frame covered with glazed hotbed sash, with shutters or mats for protection during any weather that might injure the plants.

The crop should be transplanted to the field at any favorable time late in February or early in March, and the plants set 18 inches apart in rows 3 feet apart. Just before the plants are set in the field the soil should be enriched with a chemical fertilizer carrying about 7 per cent of nitrogen, one half of which should be derived from nitrate of soda. The fertilizer should be worked into the soil along the line of the rows in which the plants are to be placed, at the rate of 15 pounds to 100 yards. After the seedlings have been transplanted, they should be given a side dressing of this same fertilizer, 15 pounds to 100 yards of row, at two succeeding ten-day intervals, with frequent cultivation.

The crop matures and is harvested during May. The heads are cut with a rim of leaves attached. The leaves are not trimmed, as is the usual method with this crop, but are folded over the curd and packed in half-barrel hampers, from 15 to 18 heads being considered a good pack from this section.

Forcing cauliflower. As soon as cold weather has ended the field cultivation of cauliflower, a coolhouse, with solid benches similar to those in a modern lettuce house, should be available. The plants should be made to grow vigorously throughout their whole life, a necessary procedure with field plants, but doubly essential with house-grown stock.

Only the best seed of special forcing strains should be used for forcing purposes. The plants can be set from 9 to 15 inches apart in the benches, according to the size of head desired. If an "individual portion" is desired, plant 9 inches each way; if a 6-inch curd is desired, plant 15 inches apart. No lopping or tying will be required. The temperature of the house should be about the same as for lettuce, 45° F. at night and from 60° to 65° F. during the day, and a high degree of humidity should be maintained. The soil should never be soggy, but should be kept wet enough to furnish a continuous supply of moisture for the plants. An abundance of moisture is essential, but excessive moisture is as harmful to this as to other crops. It is, of course, necessary to keep the plants free from insects.

Seed production. Practically all the cauliflower seed of the world is of European production. Efforts to produce good cauliflower seed in the United States have been successful only in the Puget Sound region of the state of Washington. Recent attempts at producing high-grade forcing strains by seeding the plants in greenhouses have proved very satisfactory, and open up the way for the maintenance of a high-grade forcing industry, which may be the solution of the cauliflower-seed problem for American field cultivators.

Varieties. The Snowball strains of cauliflower are the best varieties grown in America. The Dwarf Erfurt is a somewhat closely related strain of much value.

CELERY

Celery is a garden delicacy of wide distribution. It is extensively used for flavoring soups and dressings and for side dishes, but it is not a standard vegetable in the sense in which potatoes, cabbage, or turnips are standard vegetables. The crisp texture and the nutty flavor of well-grown celery, together with the decorativeness of well-blanched stalks, make it a favorite. Besides being almost universally grown in the home garden, celery is extensively cultivated for market in several localities which possess peculiarly favorable soil and climatic conditions.

Botany. Botanically, celery is known as *Apium graveolens*, whose native habitat is the moist lands bordering the Mediterranean Sea. It is a biennial plant producing long, thick leafstalks and a fairly large root stalk. Naturally the leafstalks are green in color, tough, and bitter to the taste; but by careful cultivation and selection the wild plant has been modified into two important forms — one with thick, fleshy leafstalks less bitter to the taste than the wild plant, and the other with a thick turniplike root stalk. This latter form, known as celeriac, is not widely cultivated as a field crop, but is grown to some extent in gardens and is chiefly used to flavor soups.

Celery does not normally produce seed until the second year, but sometimes plants will be found throwing up seed stalks the first season. This can usually be explained by faulty handling, wrong cultivation, or poor seed.

Nature of the soil. The soil best suited to celery is moist, low-lying alluvial muck or loam. Muck lands which are too wet for other crops can often be made to produce excellent crops of this vegetable. In some cases in order to cultivate such areas it is necessary to provide the horses with large leather or wooden shoes to prevent them from miring. The soil best adapted to this crop is not common; it is usually found only in small isolated areas, yet good celery can be grown on any rich, well-tilled garden soil. The commercial cultivation of celery, however, is almost entirely restricted to low, moist muck soils. Kalamazoo, Michigan, has long been famous for its celery fields. Horseheads, New York, Wellsboro, Pennsylvania, areas in northern New Jersey, the San Joaquin and Santa Ana valleys of California, the vicinity of Painesville, Ohio, and areas near Sanford and Tampa, Florida, now produce the bulk of the celery grown for market. It is also grown in a small way in many other localities. In fact, it is an important crop with many of the market gardeners about Cleveland, Ohio, and Boston, Massachusetts, but the products of these regions rarely find their way into other markets.

Seed and seed sowing. Celery seed is small, light, highly aromatic, and retains its vitality for from two to four years. It is used for flavoring soups and in other forms of cookery. The small seed naturally produces a small plant. The young celery plant is not only small, but delicate, and requires more than ordinary care during the early days of its life. The seed should be sown on fine, rich, well-prepared soil in a protected place. If the seed bed is not too large, a layer of sand a quarter of an inch deep over the surface will add greatly to the ease of caring for it. Large seed beds are often protected by slat shade arranged high enough to permit cultivation beneath it. During the critical stage in the life of the plant — when the seeds are germinating and before the young plants have established themselves — the seed bed should have most careful attention from a skilled grower. Neglect which results either in lack of water or in excess of water just at this period means failure. As soon as the seeds germinate, the young seedlings should be kept growing in a healthy, vigorous manner. Checked or stunted celery plants mean an inferior crop. No amount of care or skill in field management can overcome poor seed-bed treatment.

If only a few plants are desired, the seed may be sown in a box or cold frame and the young plants, when 1 inch or 1½ inches high, may be transplanted and set 1 inch apart in rows 2 inches apart. The advantages of transplanting are shown in figure 70. The plants with large root systems were transplanted, the others were not.

If a large number of plants are desired, specially prepared cold frames or seed beds will be required, and special arrangements for watering and shading the plants must be made. Since it is

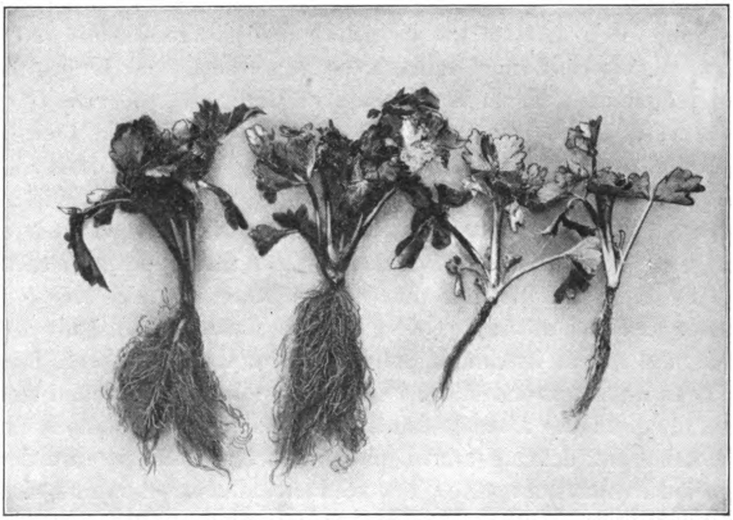


FIG. 70. Celery plants

At the left, transplanted; at the right, of the same age, not transplanted

not practicable to transplant large numbers of plants, if hundreds of thousands are to be grown, it is necessary to take extra precautions to make them strong and stocky. To this end the seed should be scattered thinly in close drills or broadcast. It will also help to make the plants stocky, without severely checking their growth, if they are sheared or clipped. A small area can be clipped with sheep shears or grass shears, but very large seed beds are usually clipped by means of the field mowing machine.

If the seed is covered at all, it should have only a sprinkling of sand, but it is better to scatter the seed on a freshly raked surface and bring it in contact with the soil by placing a board across the bed and walking over it, repeating the operation until the entire surface of the bed has been firmed in this way. Large beds can be firmed by means of a light garden roller.

On a small scale the seed may be germinated under boards laid flat over the surface of the bed. If this method is employed, the boards must be removed as soon as the seeds begin to germinate; to neglect to do this would result in the loss of a large percentage of the plants.

Preparation of the soil. Ideal celery soils are as a rule drained swamps or marshes. These soils contain a large percentage of decayed vegetable matter and a surface percentage of sand or loam, but usually they require several years' preparatory cultivation before they are suitable for celery growing. It is necessary to provide sufficient drainage to insure a dry surface, but the water table should at all times be within easy reach of the roots of the plants. Soils which have been flooded or charged with moisture for many years are often quite sterile for the first few years after being drained, but improve with age. Drainage admits air, and oxidation takes place, which produces congenial conditions for bacterial action; a beneficial soil flora soon develops, and the inert organic compounds are rapidly worked into available form for plants. Immediately after being drained, such soils as a rule respond best to the use of stable manure, chemical fertilizers often producing little effect; but lime is frequently necessary in large amounts.

Superior grades of celery can be produced only on soils having a deep, rich root zone. For best results the surface layer should be from 12 to 15 inches deep and very fertile.

Cultivation should be deep and thorough. The ordinary turning plow may be used to stir the surface to a depth of 10 inches, and the subsoil plow may be used to loosen and aërate the next 8 inches. The surface should then be thoroughly fined and compacted. In fact it should be made fine enough for a seed bed by use of the disk, the acme, and the Meeker harrows.

Fertilizers. As already stated, celery requires rich, well-prepared soil for profitable results. When it can be secured, thoroughly composted stable manure is the best fertilizer to use. From 30 to 40 two-horse loads per acre, disked in after the land has been plowed, will be none too much. If such an application is not possible, and the celery is to be planted in rows 5 or 6 feet apart, before planting is begun manure can be scattered in narrow belts along each row with a manure spreader having a special rowing attachment, and can be worked in with plow or cultivator. When the plants are to be set in rows 3 feet apart or closer, the broadcasting method should be followed.

When it is not possible to procure stable manure, commercial fertilizers will be found of great value. Fertilizers can be used independently or to supplement a light application of stable manure. When used alone the quantity will depend upon the character of the soil. The rich, moist muck lands of the North, after they have been thoroughly subdued, will require from 1000 to 1500 pounds per acre. Growers should carefully test their soil to determine the quantity of each ingredient that can be safely and economically used. The requirements of different sections will be found to vary with the treatment given, the length of time the area has been in use, and the character of material from which the soil was derived. The muck soils of the North are, as a rule, easily prepared for celery culture, while some of the swamp soils of the South Atlantic States are more difficult to subdue. The difference in the two soil types is due to the material from which they were originally derived.

Planting. There are three general methods of planting celery, depending upon the locality, the season, the variety grown, and the disposition to be made of the crop. For convenience these methods will be called (1) the narrow-row method, (2) the broad-row method, and (3) the new celery-culture method.

1. The narrow-row method of planting is used where land areas are limited, and for most early crops that can be blanched by the use of boards. A common plan is to set the plants at intervals of 6 inches, in double rows 6 or 8 inches apart and a space of 3 feet between each double row. In other cases single rows of plants 6 inches apart in the row are set at intervals of 3 feet.

2. The broad-row method is used for autumn crops where the blanching is accomplished by banking the plants with earth. This method differs from the one just described only in the distance between the rows of plants. The usual spacing is 5 or 6 feet, but the plants may be set in either double or single rows. This

arrangement is well suited to the robust, nonblanching types of celery such as Giant Pascal.

3. The new celery-culture method consists in setting the plants singly in squares at intervals of 8 or 10 inches in each direction over the whole area. A common plan is to lay off areas from 6 to 15 feet in width, leaving walks or paths between, and to set the plants 8 or 10 inches apart each way. As soon as the plants begin to shade the ground, a board frame 12 inches wide is placed around each bed. The crowding of the plants soon causes the leafstalks

FIG. 71. Transplanting celery to the field

to grow tall, and the shading keeps them from growing green. This method is economical of space and produces a grade of celery not much, if any, inferior to that blanched by the use of boards.

Although celery is grown on an extensive scale, the work of planting in the field must all be done by hand, as shown in figure 71. The distance between the rows, and not the method of planting, determines the number of plants required per acre. The close interval between the plants in the row renders impossible the use of horse-drawn transplanting machines.

Cultivation. Whatever the method of planting, celery must be given the best possible cultivation from the very start. When the plants are too small or too close together to admit of the use of horse-power implements, they must be tended with the wheel or hand hoe. There are special horse-power implements designed for use in large fields while the plants are small, one of the best of these being a modification of the ordinary harrow-tooth cultivator, as shown in figure 72. The modification consists in the separation of the two side pieces of the harrow by inverted U-shaped braces, which permit the distance between the two parts to be varied. A metal guard is placed about two inches above the points of the teeth and on the inside of the V. This implement is drawn by two horses, with the row of celery between the wheels, and can be used while the celery

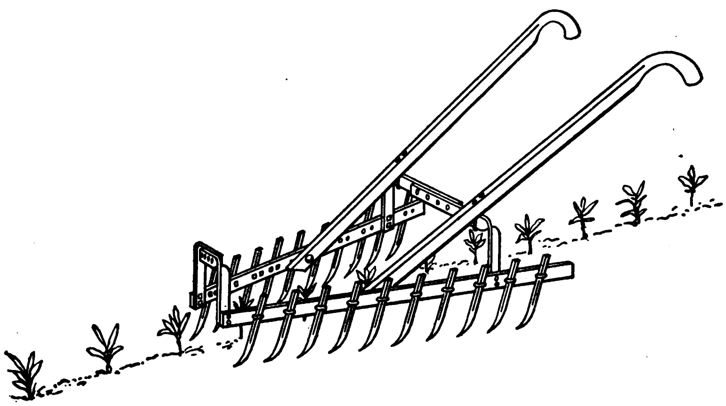


FIG. 72. A modified harrow-tooth cultivator — for use when plants are small

is quite small. As the plants grow larger the guard is raised. Finally, regular cultivators, such as are used for corn, with guards to prevent throwing the earth against the plants, are substituted for this combined harrow and scraper. In some sections two-row cultivators operated by four horses, as shown in figure 73, are used; in others the cultivation is done entirely with harrow-tooth cultivators having from three to five rows of teeth. As soon as the plants are well grown and banking can be undertaken, earth may be thrown to the plants by means of cultivators with wing teeth, and the banking completed by use of the double-moldboard type of celery banker with lifting guards (see figure 74). In some sections, particularly in California, the banking is accomplished by a broad wooden

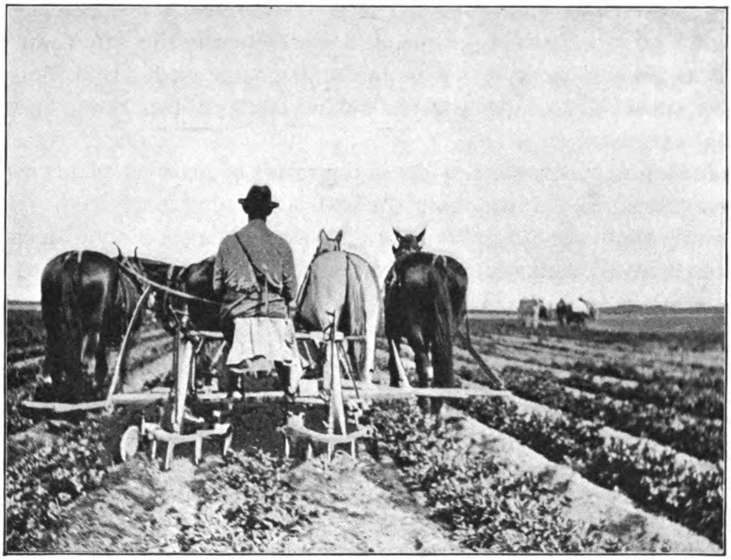


FIG. 73. Cultivating celery with a two-row cultivator in southern California

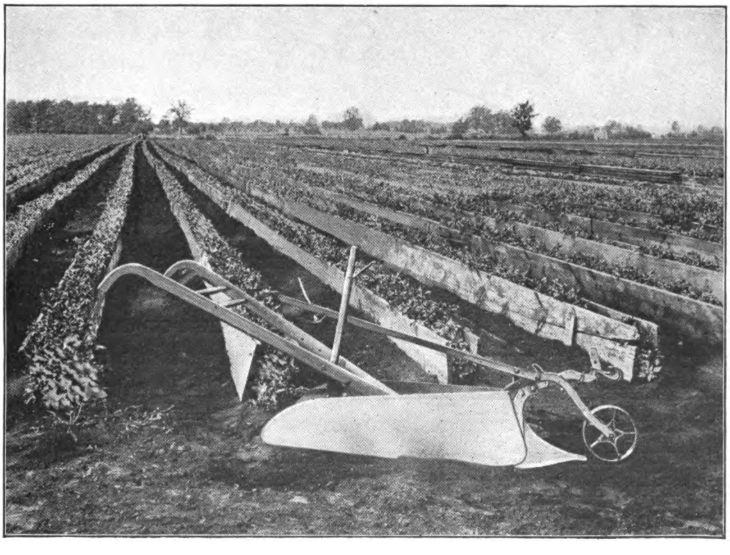


FIG. 74. Double-moldboard type of celery banker

sledlike scraper, which is operated in essentially the same way as the asparagus hiller shown in figure 36, page 117. It works on both sides of a single row instead of between two rows, and is therefore more effective.

Blanching. Blanched celery is the result of growing plants away from the light. In blanching the leafstalks only are covered. This permits the leaves to grow normally, but the development of chlorophyll in the stalks is hindered because this substance cannot be formed in the absence of light. Any material or device, therefore, which excludes light, and which can be arranged about or close to the stalks of the plants, can be used for blanching celery. In large commercial fields boards, paper, and earth are the principal means used for this purpose.

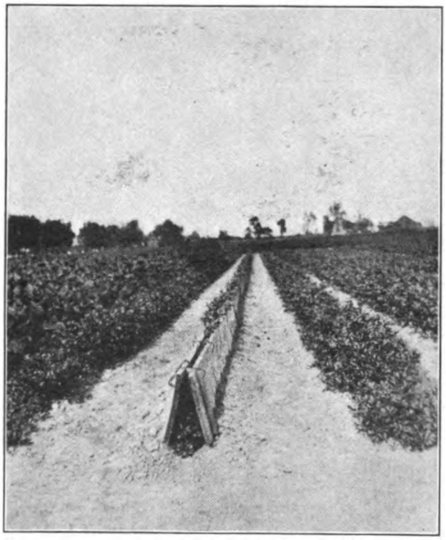


FIG. 75. Celery plants confined between boards, for blanching

Blanching with boards. Practically all the early crop of celery at the North and the Florida product are blanched by means of boards. For this purpose pine or cypress lumber 12 inches wide, 1 inch thick, and 16 or 20 feet long is used. The boards are placed flat on the ground on both sides of the row of plants to be blanched, with the edges close to the base of the plants. Two men, one at each end, tip the boards up against the plants by taking hold of the outer edges. In raising the boards the outer spreading leaves of the plant are lifted and confined. The plants are inclosed between the boards (as shown in figures 74 and 75), which are held in place by wooden or wire yokes made for the purpose.

The quality of celery blanched in this way is not so good as that blanched with earth. The varieties usually grown as early celery, such as Golden Self-Blanching and White Plume, do not stand earthing as well as the green sorts. In some sections the self-blanching sorts are banked, but the general practice is to blanch without earthing. One objection to boards is that new lumber, particularly pine, imparts a resinous taste to the stalks. Old lumber is not apt to do this, however. One advantage in the use of boards is that the celery can be held longer in the field after it is in marketable condition than when banked with earth.

Blanching with paper. There are two methods of using paper for blanching. One that can be used only on a comparatively small scale consists in wrapping the individual plants in sheets of strong manila wrapping paper and tying them snugly with cord, as shown in figure 76. This is slow, tedious work and is practiced only by

FIG. 76. Celery plants wrapped with manila paper, for blanching

the market gardeners who grow small areas for local use. The other method is to use one of the better grades of building paper that is opaque and waterproof, which comes in rolls 3 feet wide. In order to suit the paper to the work the rolls must be sawed into 12-inch sections, giving rolls 12 inches wide. These strips are placed on edge close to the plants, the same as the boards, and held in place either by light stakes made of laths or by wire loops. A good quality of paper carefully handled will last for more than one crop, and as it can be rolled and packed away when not in use, it has decided advantages over lumber. It is lighter to handle, not much more difficult to adjust, and costs less. Manufacturers of composition roofing are now offering 12-inch rolls of material especially prepared for blanching celery, which are tougher and more durable than the building papers.

Blanching with earth. The late green sorts of celery, which are also those of highest quality when properly grown, are all blanched with banks of earth. This method has the advantage of requiring no great outlay for material, but the disadvantage is that much less celery can be grown per acre than by the other methods. Celery to be blanched with earth is usually planted in rows from 4 to 6 feet apart, the distance being determined by the variety. The dwarf sorts may be planted 4 feet apart, while the giant sorts must be planted at least 6 feet apart in order that earth enough may be available.

The cultivation of celery during its early growth is without reference to blanching; in fact, celery is given level culture until the crop is grown and ready for blanching. The first earthing of the plants is often accomplished by using wing teeth on the cultivators, to be followed by either the double-moldboard type of hiller or one made after the fashion of an asparagus ridger, which scrapes the earth on both sides of a row at one operation.

In small gardens banking is done by hand. A man stands astride a row, and as he gathers the leaves of each plant together into a compact upright body, men on each side of the row shovel earth against it. In this way the work can be done neatly and effectively. Another method is to pass heavy twine about the leaves of each plant to hold them in place after they have been lifted. The cord is tied about the plant at the end of the row. The ball of twine is placed in a cup or holder, which can be strapped to the right arm, so that the cord may be carried between the thumb and forefinger of that hand. As the leaves of the individual plants are lifted into position the cord is passed about the plants in such a manner that it holds them in a position in which they can be banked by earth shoveled against them. Sometimes plants to be earthed up by horse-power implements are tied in this manner, but as a rule such implements are provided with lifting rods which raise the leaves and push them together, the earth holding them in place.

Blanching with tiles. In the home garden or the small market garden, celery can be blanched by slipping a 4-inch or 6-inch agricultural tile, which is 12 inches long, over each plant. These tiles are made of clay and, for celery blanching, should be cylindrical in shape. For the dwarf sorts a 4-inch tile will answer, and for the more robust varieties 5-inch or 6-inch tile will be found best. Tiles, if handled with care, will last several seasons. They are cool, have no bad odors to be imparted to the plant, and if it were not for their weight and the labor of placing them in the field, they would prove more satisfactory than boards. Celery blanched in this way is of better quality than that blanched with boards or paper.

Harvesting. The manner in which celery is harvested is predetermined by the use to be made of it and by the system under which it has been grown and blanched. Early celery blanched with boards, paper, or tile and for immediate consumption can be lifted with a potato or spading fork. It should be carried to the packing shed, where an abundant supply of fresh, clear water should be available for filling long plant-washing troughs. The washing troughs are usually from 18 inches to 3 feet wide, 15 or 18 inches deep, and any convenient length according to the dimensions of the workroom. As the celery is brought from the field the rough outer leaves are stripped off until the plant is reduced to the number of stalks desired. The roots are then cut off, some growers making the cut at right angles to the general axis of the plant, but most packers cut the root so as to form a four-sided cone. After the plants are trimmed they are carefully washed, rinsed, and placed on racks to drain, and then are tied in bunches usually containing twelve plants (see figure 77). The neatness and attractiveness of the bunches have a great influence on the commercial value of the product; therefore appearance is one of the chief factors to be considered in marketing celery.

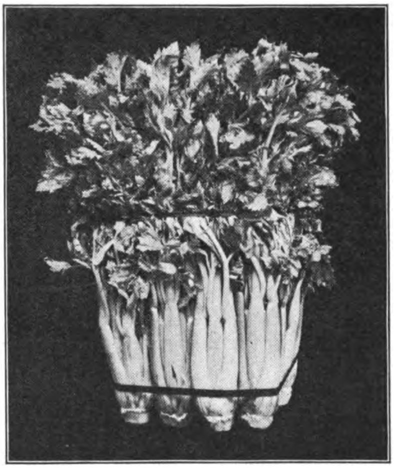


FIG. 77. Celery trimmed, washed, and bunched

If the celery has been banked with earth, the ridges are thrown down by running a furrow along the rows, so as to throw the earth away from the plants. If this reduces the ridges to the general level of the soil, a second furrow is run on one side of the row, the plow being guided so as to bring the land side close to the plants. Boxes or trays are then scattered along the rows, and the celery is gathered by men who bend the plants toward the open furrow, at the same time pulling them gently to free them, after which they are carefully placed in the trays. Celery lifted in this way will be fit for storing or for immediate shipment. If the crop is being harvested on an extensive scale for immediate shipment, a digger which operates in much the same way as a tree digger is run under the plants to loosen and cut off a portion of the root. There is

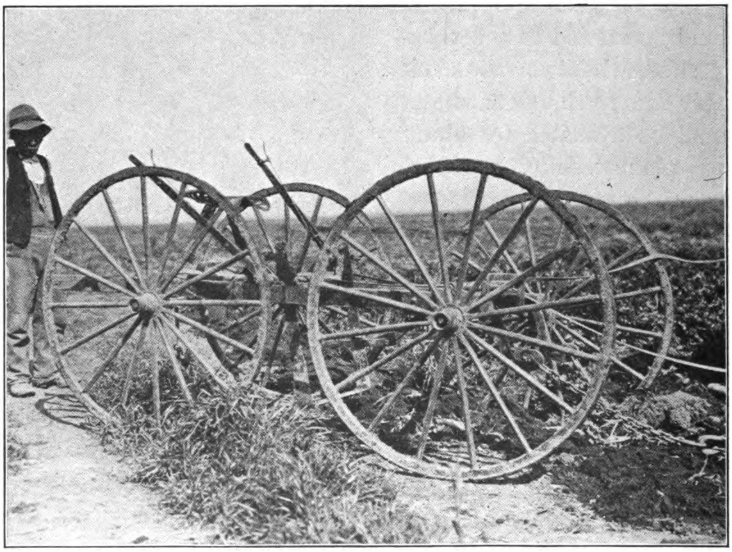


FIG. 78. Celery cutter used in large commercial fields

now on the market a hand celery cutter, but in the extensive celery fields of California the homemade device shown in figure 78 is used. This implement is a great labor-saver but is adapted only to extensive areas.

Celery grown for local consumption is planted in succession, so as to be available for the market from June or July until late fall or winter, depending upon storage facilities. When grown for the local market, only so much as will be required for a given harvest period is banked or blanched at one time. Celery cannot be kept in good condition for a long period after it has been blanched, especially during warm weather. The banking is therefore arranged so that the crop can be harvested as the market demands. The successive plantings require that the blanching be done in the order of the planting, but it is not necessary that all of one planting be blanched at the same time. If 1000 plants will be required ten or twelve days hence, 1000 plants are at once banked or boarded, the remainder of the plantation to be banked in like manner as required. This precaution of blanching only as required to supply the demands of the market is more important in warm weather than in

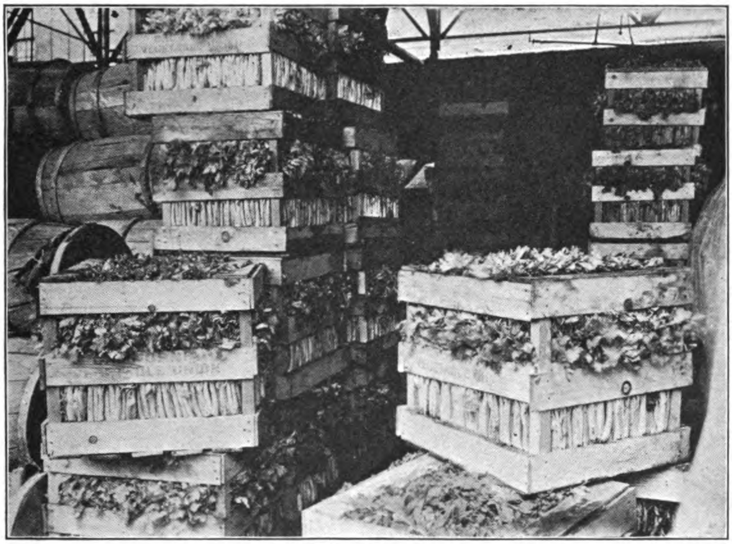


FIG. 79. The type of celery crate in most common use

cool, and is more necessary with the so-called self-blanching sorts than with the late green-stalked varieties.

Celery intended for local consumption or for express shipment is trimmed, washed, and bunched in the field. When the crop is to be shipped by freight to a distant market, it is not trimmed and the roots are not cut away. In fact, the whole plant is packed and shipped. The usual plan is to pack in crates. The California package shown in figure 79 is 2 feet long, 2 feet wide, and 20 inches deep and contains from six to eight dozen plants. The Florida package is a flat crate 2 feet long, 20 inches wide, and 11 inches deep (see figure 80), and usually carries from four to six dozen plants. Celery is sometimes shipped in carload lots, the plants being packed tightly in an upright position on the floor of the car and on one or two decks rigged up above the floor. Celery so handled is not trimmed or bunched — the whole plant with some soil attached is best.

Storing. In northern latitudes where the winters are long and cold, celery is often stored in temporary sheds or pits made from the lumber used for blanching the early crop, or in pits designed and built for this purpose. If the storage is temporary — for the

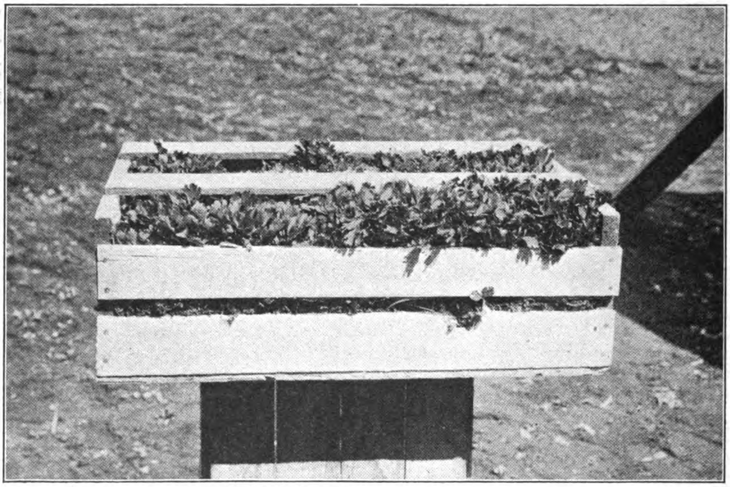


FIG. 80. The half crate used largely in Florida

season only — the structure may be a surface shed with roof sloping in one direction only, or an even-span, flat-roofed pit. An excavation 15 or 18 inches deep, covered with either of the above types of roof, may be made to receive the plants. An excavation requires less external covering to protect the plants during severe weather; but on the other hand there is more expense in making the pit than in covering the structure with litter or fodder. Permanent storage houses are almost always built on the surface in a well-drained place. The plan usually followed is that shown in figure 81, which consists of a long, narrow building with no side walls, or with walls not over 2 or 3 feet in height. The roof is made of plank and

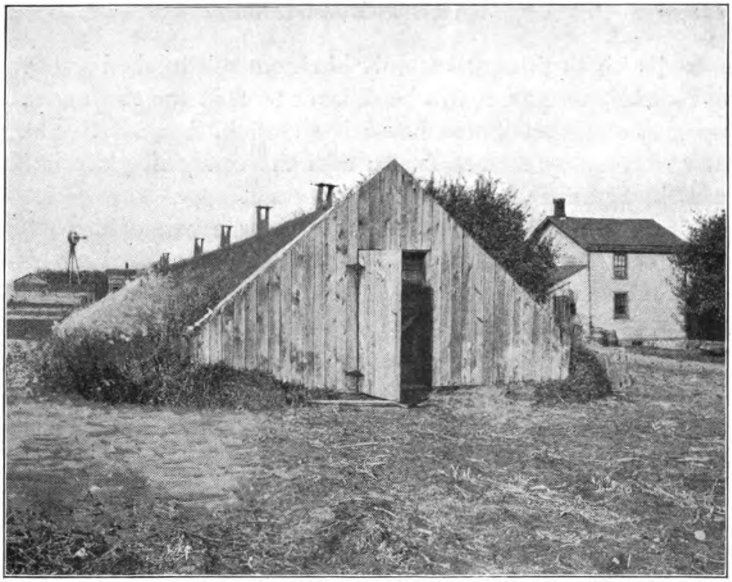


FIG. 81. A storage pit covered with earth

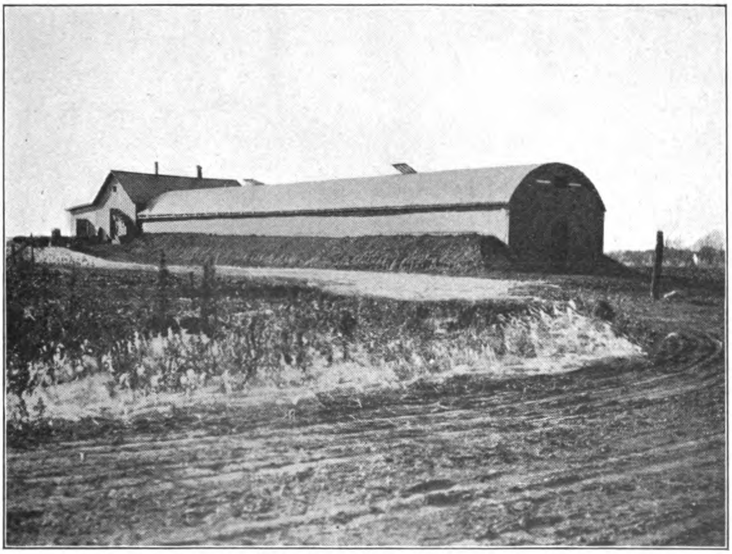


FIG. 82. A large celery storage house

covered with earth, and has only pitch enough to shed water. If the roof is too steep, it will be difficult to hold the earth cover in place. A more permanent house is shown in figure 82. The interior of a celery storage house with the celery in place is illustrated in figure 83.

Cold storage. Within recent years a large part of the autumn crop of celery grown in some of the Eastern states has been placed in cold storage at harvest time. The chief requirements for the successful storing of celery are well-grown, disease-free stock, careful

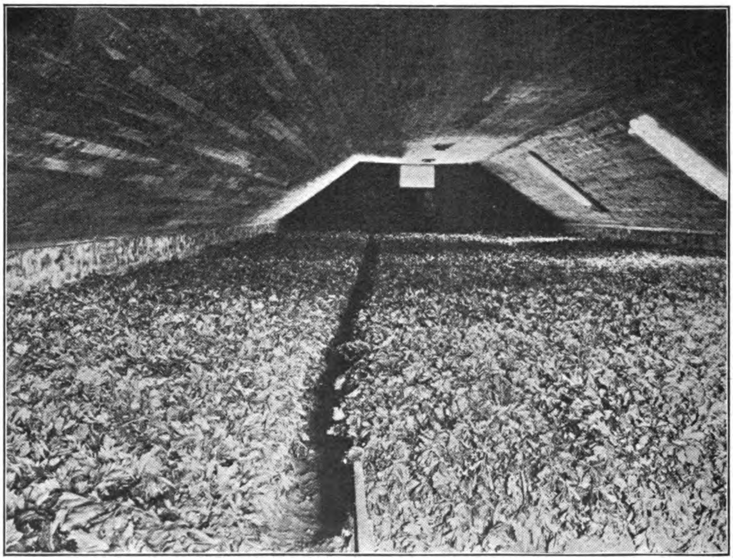


FIG. 83. Interior of celery storage house, showing celery in place

harvesting, and quick storage. The crates used for storage should be small, holding from four to six dozen bunches; if larger ones are used, they should be provided with ventilators in the bottom, by which the temperature of the contents can be quickly lowered to that of the storage room and perfect aëration be insured. The crates should be ricked so as to aid in securing a free circulation of air and so that the moisture thrown off by the contents of one crate will not affect the contents of others above it. As a rule the crates should not be piled more than four or five tiers high. The temperature of the room should be reduced as quickly as possible to 32° F. and should be maintained at that point throughout the storage period, which from the nature of the crop is short. The length of the storage period for celery cannot be extended beyond three months, and the greater part of the product must be removed in sixty days or less. The extension of the marketing period by means of cold storage is, however, of great value to the industry and to the trade.

Insects and diseases. The difficulties encountered in celery culture are of three kinds: (1) physiological troubles; (2) insect pests; and (3) diseases.

Physiological troubles. Physiological troubles are usually due to one of two causes — poor seed or improper handling of the young plants. Poor seed can be guarded against only by the purchase of the best stock from the most reliable dealers. Poor seed, as a rule, manifests itself by the running to seed of the plants the first year, and in pithy stalks. Since both these conditions may be brought about in other ways, it is necessary to consider cultural conditions carefully before charging such shortcomings to the seed. Adverse conditions in the field or seed bed which give the plant a severe check, followed by conditions which stimulate growth, often result in the plants shooting to seed; the same causes may also produce pithy stalks.

Insect pests. Celery is remarkably free from harmful insect enemies. The zebra caterpillar (*Papilio polyxenes* Fab.) is the larva of a moth which deposits its eggs upon the celery, and sometimes feeds upon the leaves in sufficient number to necessitate hand picking or the use of arsenical sprays.

Diseases. Celery blight (*Cercospora apii*) is the one great disease with which the commercial celery grower has to contend. This disease causes the leaves of the plants to lose their normal color, turn yellow, and finally brown, after which decay sets in. This is not confined to the crop in the field but attacks the young plants in the seed bed. Fortunately it yields to treatment, but eternal vigilance is the price of a clean crop. To secure a clean crop the treatment should begin in the seed bed. The young plants, if sprayed with Bordeaux mixture every ten days or two weeks, the interval depending upon the weather, can be protected from the disease. Good care in the seed bed means clean plants for the field. The better the plants which are set in the field the better the chances for a successful crop. The field treatment for the disease is the same as that for the seed bed. While the plants are in the seed bed the work can be done with a knapsack sprayer, but field treatment on an extensive scale cannot be carried on advantageously with this type of implement. One of the modern power sprayers adjusted to deliver a large quantity of mixture in a fine spray with great force will be effective. The disease as a rule attacks the self-blanching types more severely than the green-leafed types. It is more persistent and causes greater damage toward the Southern limits of celery culture than at the North. For this reason treatment both in the seed bed and in the field should be given more attention.

Celery which has been carelessly handled during the blanching period, whether the blanching is accomplished with boards or with earth, is apt to be attacked by a soft rot known as *heart rot*, which has an offensive odor. This is most likely to occur during hot, moist, sultry weather, soon after the plants have been banked or boarded. If boards are used, and the weather conditions are favorable for the development of the disease, much can be done to prevent loss by leaving the boards farther apart than usual, especially at the top, so as not to crowd the stalks too much. Earthing should not be done during such weather. Preventive measures are the only known means of controlling this trouble.

Cost of production. Under favorable conditions celery, although an expensive crop to produce, is very profitable. The following tabulation will serve as a guide to the cost of the crop and the returns which may be expected from one acre:

Rental of land	$ 20.00
Cost of preparation	10.00
Cost of fertilizer	44.00
Cost of plants (50 M. at 75 cents)	37.50
Cost of transplanting	6.00
Cost of cultivation	15.00
Harvesting	10.00
Crates and transportation	100.00
Total expense	$242.50
Receipts: 4000 doz. at 20 cents	$800.00
Net profit	$557.50

CHIVE

Outside the market and kitchen garden the hardy perennial chive finds little place in American horticulture. Like most of the alliaceous plants it is of European origin, being accredited in a wild state both to France and to Great Britain.

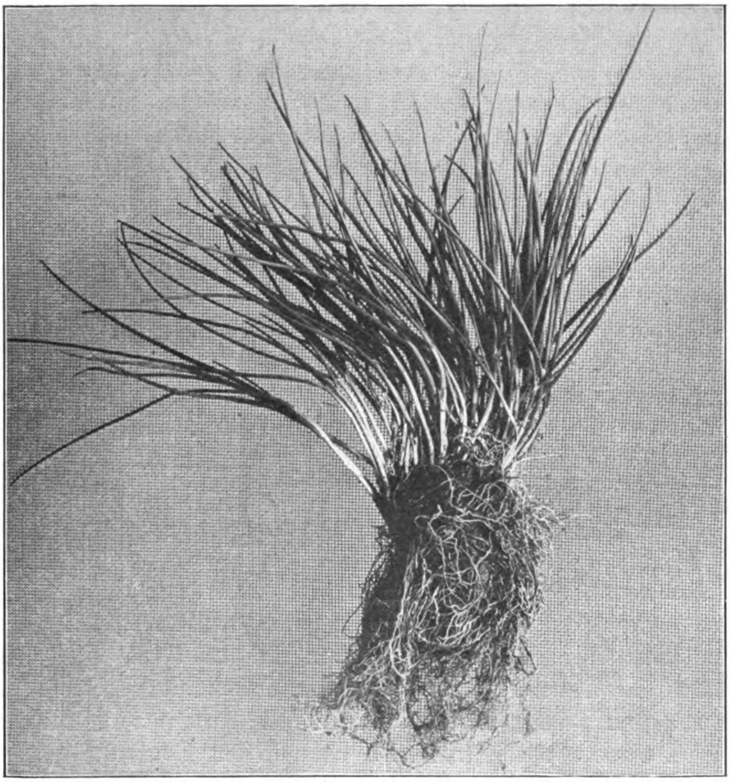


FIG. 84. A clump of chives

Botany. Botanically, the chive is closely related to the common onion, and is known as *Allium schœnoprasum*. In appearance it resembles garlic, the common wild onion of the Southern states, more closely than it does the onion of the garden (see figure 84). The leaves of the chive are awl-shaped, erect, and cylindrical, and usually 7 or 8 inches in length. The bulbs are small — from

$\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter — and white in color. The flower stalks grow as tall as the leaves and produce a globular cluster of purplish abortive flowers.

Culture. The chive thrives on any well-drained, fertile garden soil. The plant often maintains itself from eight to ten years in one place, and for this reason special care should be exercised to make the soil permanently fertile and as free as possible from weeds.

The characteristic growth of the chive is in clumps 6 or 8 inches in diameter, and, as viable seed is seldom produced by the plant, it is almost entirely perpetuated by division of the clumps. These clumps are broken up, and the bulbs are planted in groups of 3 or 4 at distances of 12 or 15 inches and in rows 15 or 18 inches apart. In the Northern states if the transplanting is done in May, the crop will be ready to harvest the following spring. After it is once established it requires little attention. The young tender leaves are the part of the plant used, and in order to keep the leaves young and tender they should be frequently cut close to the surface of the soil. Sometimes chives are gathered in the same manner and used in the same way as young onions; but, as a rule, the young leaves only are used to flavor soups, stews, and omelets, for which they are considered very essential.

SWEET CORN

Sweet corn is the popular name given to an important class of corn made up of varieties possessing more sugar and protein and less starch than those usually grown for grain. In the United States and Canada sweet corn is an important vegetable and market-garden crop. It is, however, little known and used outside of these two countries, and even in our Southern states it is not extensively grown or used. Its culture and use for table purposes is chiefly confined to the states north of the Carolinas. Its commercial cultivation began about 1825, and for the twenty-five years following this period the New England States furnished practically all the seed sweet corn. At present 80 per cent of this seed corn is grown in Nebraska.

Sweet corn is an important crop not only in the kitchen and farm garden, but also in the market garden, and every market gardener plants a succession of varieties. The chief commercial value of the crop, however, is as a product for the canning industry. In certain sections peculiarly favorable to the growth of sweet corn, the cultivation of the crop for canneries is an important business. The states at present producing the greatest pack of sweet corn are:

Illinois	1,619,897	cases
Iowa	987,038	"
Ohio	893,054	"
Maine	792,185	"
Maryland	772,828	"
New York	771,475	"
Indiana	520,401	"
Wisconsin	306,999	"
Minnesota	193,807	"
Nebraska	169,910	"

with a total output in 1909 of 7,451,265 cases for the whole United States.

Botany. According to the earlier botanists there is but one species of corn, *Zea mays*. In fact, *Zea* is considered a monotypic genus. Sturtevant, however, who has given the subject more careful investigation, finds seven well-defined species:[1]

Zea everta	Pop corn
Zea indurata	Flint corn
Zea indentata	Dent corn
Zea amylacea	The soft corn
Zea saccharata	Sweet corn
Zea amyleasaccharata	Starchy-sweet corn
Zea tunicata	Pod corn

Sweet corn is distinguished from other corns by its sweet taste and high sugar content when in the early dough stage; by its wrinkled, semitranslucent kernels when dry; and by the lack of starchy matter in the split kernel, which, as a rule, shows only chit and corneous matter. Figure 85 shows an ideal ear of sweet corn.

From a physiological standpoint sweet corn is an example of arrested development, which results in the formation of protein

[1] New York Agricultural Experiment Station, 1886 (Geneva), p. 58.

and sugar but little or no starch. This accounts for the peculiar appearance and quality of the kernels.

Cultivation. The cultivation of sweet corn is not limited by climatic conditions as that of field corn is. Field corn can be grown profitably only in those sections which have a frost-free period long enough to bring the grain to full maturity. Sweet corn, however, is not grown primarily for the mature grain. Plump, well-developed kernels just entering the dough stage are the most palatable. For this reason table corn can often be successfully produced in localities where both sweet corn and field corn would fail to mature.

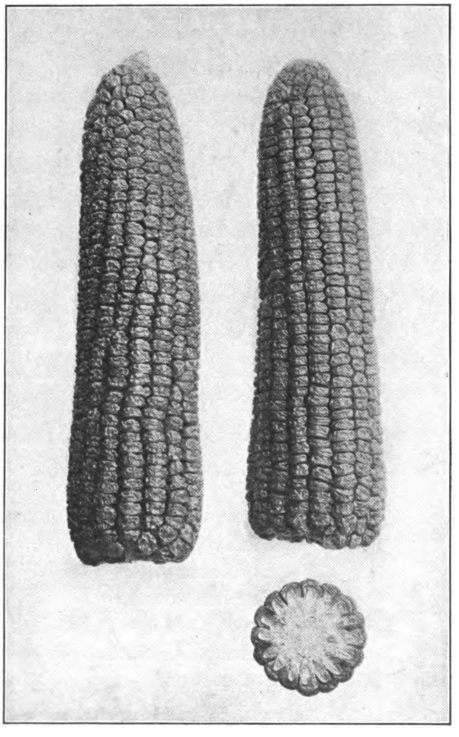


FIG. 85. Ideal ears of sweet corn

Peculiar characteristics. The length of time that corn remains in ideal edible condition is determined to a limited extent by the variety, but in a far greater degree by the weather prevailing at the time. A few hours of hot, dry wind will quickly change the ideal condition of the corn. Cool, moist, or cloudy weather will extend the condition for many hours or even for several days. Those parts of the country which have cool, moist, rather than hot, dry conditions during the period of maturation are most desirable for the production of table corn.

Another characteristic of sweet corn which is not generally understood is the variability of its sugar content. Careful observation has proved that sweet corn loses 50 per cent of its sugar content within the first four hours after it has been removed from the stalk. This accounts for the poor quality of all corn purchased in the market and of that served at restaurants and hotels. Canners have not been aware of this peculiarity of corn, at least none have thus far taken advantage of it to produce a brand par excellence. With the modern methods of canning there is no reason why a brand far superior to the commercial product now upon the market should not be offered. The person who wishes table corn par excellence should have his own garden patch and gather the corn less than an hour before it is to go into the pot.

Table corn was formerly cut from the cob when in perfect edible condition and dried by artificial heat. This homely household practice provided a winter vegetable considered by many to be superior to canned corn. The chief objection to this is its dark color, but it invariably has the quality of sweetness not always possessed by the canned product.

Influence of climate. Sweet corn like field corn is influenced in size of stalk and time of maturity by climatic conditions, and these variations are transmitted to the succeeding crops through the seed. It is desirable, therefore, that those varieties in which earliness is the important characteristic should be grown as far north as they can be fully ripened and cured.

The question of the influence of climate on the sugar content of sweet corn is an open one. New England growers maintain that sweeter corn can be produced from Northern-grown seed than from Southern-grown. On the other hand, Maryland packers insist that best results come from the use of seed grown in the immediate vicinity. Their contentions are borne out by the results of careful experiments covering a period of years, the conclusions being that seed corn grown in any locality for a series of years gives better results in that locality than seed of the same variety equally well grown in any other locality.

Gardeners in general have a prejudice against Western-grown seed corn, which seems to be justified by a number of reasons. In fact, the prejudice is so firmly grounded that it has influenced the commercial value of the seed corn. The difference between corn produced from Eastern-grown seed and that produced from Western-grown seed under Eastern conditions is more apparent in the early sorts than in the late-maturing ones, but there is a wide difference in the behavior of different sorts.

"The difference in quality may be accounted for as follows:

"The climatic conditions in the Western corn-growing sections, especially during the season when corn is earing, are often such as to induce a marvelously rapid development — much more rapid than is often seen in the East. In the West it is sometimes difficult to find ears of sweet corn green enough to be in prime boiling condition in fields where it was equally difficult to find ears which were mature enough to be palatable forty-eight to seventy-two hours earlier. Seed grown under such conditions would often transmit the rapid-maturing habit of the plants that produce it. The quality of green corn, particularly as to tenderness and sweetness, is very dependent upon the stage of maturity at which it is cooked, sometimes the growth of only a few hours affecting the discernible sugar content. If the corn in a field from Western seed in which the rapid-maturing habit was transmitted was gathered for canning when most of the ears were in prime green-corn condition, some of the ears would be so mature as to lower the average quality of the pack, but it would be impracticable to reject such slightly over-mature ears, and the resulting poor quality of the pack would be charged to generally inferior stock rather than to the effect of the few older ears.

"One indication that rapid development, with the consequent short period of prime canning condition, is an important, if not the chief, objection to Western-grown seed is the fact that experienced canners who insist upon Eastern-grown seed of the earlier sorts, like Crosby, do not seriously object to well-grown Western seed of the later- and slower-maturing sorts, like Evergreen and Country Gentleman.

"Whatever may be the facts as to the relative merits of Eastern- and Western-grown seed, the writer believes that it is always true that the character of green corn is more or less affected by that of the soil on which the seed was grown. Seed grown in moderately rich but warm, well-drained, gravelly soils, like those common in Connecticut, New York, Ohio, Michigan, Wisconsin, and some sections of Iowa, Nebraska, and Minnesota, will give better and sweeter corn than seed grown on very rich mucky or prairie soils which would give large crops of field corn. It appears to be impossible to grow on a cold, heavy clay soil sweet-corn seed which will produce green corn of the highest quality.[1]

"**Cultural methods for the production of seed sweet corn.** In a general way the fertilization and preparation of the soil and the methods of culture which will give the best results with field corn will be equally effective with sweet corn, but because of liability to crossing with volunteer plants it is important that a crop for seed corn should not follow one of any other variety of corn and that care should be taken to prevent bringing into the field viable grains of corn and spores of corn smut or other corn diseases in stable manure or by stock.

"Sweet-corn seed is usually of lower vitality than that of field sorts, and planting should be delayed until the soil is well prepared, warm, and dry, special care being taken that the seed is not covered too deep. The small-growing, extra-early sorts, like Cory, Crosby, etc., may be planted in drills as close as 3 feet apart or in hills 3 feet apart each way and so as to secure from 4 to 8 plants to the yard of drill or 3 or 4 plants to the hill.

"The stronger-growing sorts, like Evergreen and Country Gentleman, partly because of their greater liability to abundant suckering, need even more room than most varieties of field corn and should be planted in drills from 42 to 60 inches apart or in hills the same distance from each other and so as to secure 2 or 3 stalks to the hill or to the yard of drill. Experience has demonstrated that with seed sweet corn equally large yields and better-matured seed can be obtained from a somewhat thinner stand than would give the largest yield of field corn.

"**Cross-pollination.** The location and character of soil are of less importance in the production of seed corn from which the best results may be expected than that the fields be so situated as to avoid as far as possible liability to mixture through the pollen. This is a far more common cause of inferior quality than is generally supposed. Seed growers object to growing Black Mexican corn because they say it crosses so freely with other sorts. There is no evidence, however, that this variety crosses more readily than others, but when crosses of Black Mexican and other varieties do occur the

[1] Bureau of Plant Industry, *Bulletin No. 184*, W. W. Tracy, Sr.

effects are more readily seen. Instances are known where Moore's Concord was evidently crossed with Black Mexican corn growing nearly two miles away; but in another case, where the Black Mexican and the Moore's Concord varieties were planted side by side on the same day, there was no indication of mixture beyond the sixth row from the dividing line.

"Difference in season of maturity is not always a protection against crossing. The writer knows of a case in which there was clear evidence of mixture in both directions between Extra Early Red Cory and Stowell's Evergreen corn growing side by side, although the Cory was planted some days before the Evergreen; but in another instance there was no sign of mixture between the Cory and the Black Mexican varieties planted side by side on the same day, all of the silk and the tassels of the Cory being ripe and dry before even the earliest tassel appeared on the Black Mexican, and in this case there were no late-blooming suckers on the Cory to furnish pollen for the earliest Black Mexican plants.[1]

"Experience shows that neither a distance less than several miles nor any varietal difference can be relied upon as a certain protection against a mixture of pollen. In most farming regions it is impracticable to locate a field of seed corn so as to guarantee that there shall be no mixture through pollen, though much can be done to lessen the probability of a mixture. How this may be best accomplished is a different problem in each case. Usually the most practical way is to plant each lot of seed as far as possible from any other corn, and also to have as much difference as possible in the dates of ripening of the seed corn and of the corn in the nearest field.

"Fortunately, the effect of crossing in corn is rarely masked for a number of generations, as it often is in leguminous plants. It frequently shows so plainly in the grain which is the immediate result of the cross that much of the hybrid corn can be removed by careful sorting before shelling, and it is well to throw out the whole ear rather than to pick out the mixed grain, as is the common practice, because crossing does not always change the appearance of the grain the first season, and there is a strong probability that on

[1] Adapted from Bureau of Plant Industry, *Bulletin No. 184*, "The Production of Vegetable Seeds," by W. W. Tracy, Sr.

an ear on which crossed grains are visible there are other crossed grains which show no external sign of mixture.

"**Harvesting.** The value of seed corn, especially sweet corn, is largely dependent on the way it is gathered and cured. The average American farmer has drifted into such careless methods of handling corn that it is hard for him to recognize and use the care necessary for the production of good seed. The crop should be harvested as soon as the grain has fully passed into the dough state. The stalks should be cut and put into small shocks, but seed sweet corn can very rarely be well cured in shocks, no matter how small or how carefully they may be set up.

"As soon after cutting as the stalks are well wilted, which will usually be in from three to six days, the corn should be husked and put into the drying cribs. It is important, especially with the short-stalked early sorts, that this be done promptly. If allowed to stand long in the shock the stalks will settle so that the ears are likely to come in contact with the soil and the grain be injured in appearance and viability.

"Some growers, particularly those of Connecticut and Ohio, do not put the stalks into shocks, but go through and "top" or remove the part above the ear, and sometimes slip down the husk so as to fully expose the grain to the sun and wind, when it will dry out very rapidly and perfectly and can be gathered from the standing stalk. A disadvantage of this method is that if such "stripped" corn is exposed to even a slight frost before it is quite dry its viability as well as its vitality is lessened, often entirely destroyed.

"In the Western states there is usually so little rain and such high dry winds are prevalent during the autumn months that harvesting can often be safely delayed until the corn is nearly cured in the field on the still standing stalks, and then the corn can be gathered directly into large cribs to complete the drying; but even here early husking and cribbing are desirable.

"The best way to handle sweet corn in the field is to husk into baskets or crates, as there is liability to serious injury by dirt, showers, or breaking of the skin if the ears are thrown on the ground or into a wagon, and if this occurs while some of the grains are still in the milk they will become discolored and so injure the appearance of the lot of seed as to render it unsalable.

"**Curing and drying.** The essentials to the proper curing of sweet corn are that each and every ear shall be exposed to circulating air until the grain is perfectly dry and that this be accomplished without exposure, even for a few hours, to a temperature below 34° or 36° F. The vitality of green corn while it is still in the milk or dough state will be destroyed by long exposure to a low temperature, even if it be one several degrees above the freezing point, but as the grain matures and dries out it will endure lower temperatures without serious injury, although long exposure to temperatures much below 32° F. lessens its vitality.

"One of the best and safest ways to cure seed corn is that commonly practiced by the New England growers, the corn being spread in open sheds or barns on scaffolds formed of rails or slats so placed as to allow the air to pass freely between them. The corn should be spread very thinly at first — not more than two or three ears deep — or, better still, in a single layer, but it may be piled deeper as it dries out, care being taken not to do this until the corn is so dry that it will not mold.

"A second method of curing seed corn is by the use of drying sticks about 1 by 2 or 3 inches and about 4 feet long. Old fence pickets are often used for this purpose. They are prepared as follows: Bore a half-inch hole about 2 inches from the end, and drive into each of the four sides of the stick, about 3 inches apart, a series of eightpenny or tenpenny round-headed wire nails, so that they will enter the wood about $\frac{3}{4}$ inch and project at a uniform angle of between 15° and 20° F. toward the end of the stick having the hole. On each nail jam the butt of an ear of corn so that the ears stand out in four directions from the sticks, which should then be hung on nails in the rafters of a low, open shed or on scantling placed at proper distances apart in such a building as a tobacco shed. It takes some time to stick the ears on the nails, but when this is done the corn can be well cured with little further attention.

"A third method is to husk into lath crates holding from 1 to 2 bushels of ears, and stack these crates either in the field, well protected from rain, or on the floor of barns where there is a full circulation of air. In either case the crates should be so stacked that the wind can pass freely through and between them.

"A fourth method, requiring fewer special facilities but greater care, is to put the corn into rail or slat cribs built quite open and not over 20 to 30 inches wide at the bottom, but wider at the top. In filling these cribs, spread the corn to a depth of from 12 to 18 inches, and then place a series of slats, about 2 feet apart, across the crib and just above though not resting on the corn, the slats being supported by the sides of the crib. Fill in from 12 to 18 inches of corn above these slats; then place a second layer of slats in the same way, but so as to break joints with the first layer, and repeat until the crib is full.

"These slats are to prevent the corn settling together so as to hinder the free access of air. The cobs of sweet corn are not so stiff as those of the field varieties, and if green or partially dried ears are piled without support they will, even in a very narrow crib, settle together so as to prevent thorough drying.

"Seed sweet corn can be cured so as to obtain a fine crop of high viability by any of the preceding or similar methods, but it is essential that the work be done promptly, so as to take advantage of bright weather and secure the thorough drying out of the corn before it is exposed to continuous damp or freezing weather. It is rarely possible to secure a good lot of seed of high viability if the work of curing is delayed until after the season when favorable weather conditions can be expected.

"It is possible to cure corn by artificial heat, but this requires the most skillful use of warmed — not hot — air, kept in constant motion. Even with these precautions there is always a liability of the corn being ruined for seed purposes by mold, rot, or overheating, and for these reasons the method is not recommended.

"As soon as the corn is perfectly dry it may be shelled, though it will generally keep much better on the cob. In a temperature below freezing, corn, either on the ear or shelled, will seem to be dry when it is not. Before shelling, it is therefore well to make a test sample of a quart or more, composed of a few grains from a great number of representative ears. If this, after standing for a day or two in a temperature considerably above freezing, becomes soft and damp, the shelling should be delayed until the corn is quite dry.

"Well-cured corn is easily shelled by machine, by flails, or by hand, and the grain should be immediately run through a fanning mill, when it may be sacked, but it should be closely watched, and if it does not remain perfectly dry in a temperature above freezing it should be again fanned and spread to dry, and this process repeated on the least indication of the presence of moisture.

"In order to produce good sweet-corn seed one must be prompt to cut it when ripe, husk it as early as possible, and immediately get it under shelter where it will be exposed to every wind that blows until it is thoroughly dry, using every hour of bright sunshine in order to accomplish this before freezing weather."

Kind of soil. Sweet corn demands the same general qualities of soil as the more robust field sorts. A warm loam is to be preferred, but sweet corn, like field corn, can be grown on a great variety of soils. A quick, well-drained soil should be selected for the early dwarf sorts, and stronger, more retentive soils for the robust sorts. The late plantings that are likely to be caught by frost should be made on warm, well-drained soils lying well above the valleys or draws into which frosty air drains.

Preparation of the soil. Corn is a rapid-growing plant and requires a liberal quantity of food. It is capable of thriving on manures which cannot be used to advantage on many garden vegetables, and the roughest manure and compost may safely be applied to the sweet-corn patch. While commercial fertilizers cannot, as a rule, be profitably used on field corn, they may prove advantageous on some soils for this crop. A well-manured clover sod turned under forms a most satisfactory foundation for sweet corn.

The preparation of the seed bed should be more thorough than for field corn, for two reasons: (1) the young plants are less robust, and (2) the seed requires more perfect conditions for its successful germination. The plan followed in preparing the seed bed should be one which will successfully control weeds. One of the most satisfactory methods of weed control for the midseason plantings is that of plowing just before the planting is begun. Other plantings may be most successfully kept free from weeds by early plowing.

Planting. The dwarf varieties may be planted much closer than the robust sorts. The small sorts will do well when planted with 15 or 18 inches between rows and 8 or 10 inches apart in the row, or in hills in check rows 24 inches apart. The larger sorts should be planted in rows which are 30 or 36 inches apart and at intervals of from 10 inches, for a single stalk in a place, to 30 or 36 inches in checks. The seed should not be planted deeper than 1 inch in retentive soils, nor more than 1½ inches in the looser and lighter soils. Planting which is done early in the season should be shallower than is necessary later when the soil is warm and dry.

The climatic conditions must also be taken into consideration in determining what system of planting to follow. Early crops on land which is subject to heavy rains or which has a high-water table should be planted on a slight ridge, but in most places in the humid section flat planting and cultivation is best. In the dry belt corn usually does best if planted in a slight furrow. A lister is frequently used for preparing corn ground in such sections. In order to secure a continuous supply of corn for the table for the longest period possible, both early and late sorts must be employed, as well as a succession of plantings. Gardeners usually gamble with the weather on their early and late plantings; the great value of early corn compared with the cost of seed justifies them in taking chances on the early plantings. If the normal season for planting corn is May 1, in any given locality, one is justified in planting his sweet corn the first or second week in April. Three out of five plantings at this date may be caught by frost, but the successes will amply repay the risk, for the only loss sustained in any event is the cost of the seed and its planting. Late plantings should be made with both early and late sorts, since an early sort will sometimes escape an autumn frost when a long-season sort would fail. The precaution of planting both the early and late plantings on the most frost-free soils should also be observed.

For a limited family supply of sweet corn a few 6-inch or 8-inch pots may be used to advantage for bringing on from 25 to 50 hills. These may be started three or four weeks in advance of the normal planting season, and after all danger of frost is past (in fact, after the first outdoor planting is a few inches high) these potted plants may be transplanted to the open. A greenhouse or hotbed will be necessary to start them in, for they will not thrive under the more rigorous conditions of the cold frame.

Methods of cultivation. The cultivation of corn should be shallow and frequent. Deep cultivation with broad blades increases the soil surface exposed to evaporation and thus decreases the available moisture supply for the plant. Deep cultivation is a root-pruning process, usually to the detriment of the plant. The objects of cultivation should be to eliminate weeds and to conserve moisture by the maintenance of a loose surface layer of soil. On some soils the crop is actually increased by cultivation which merely eliminates weeds without disturbing the soil.

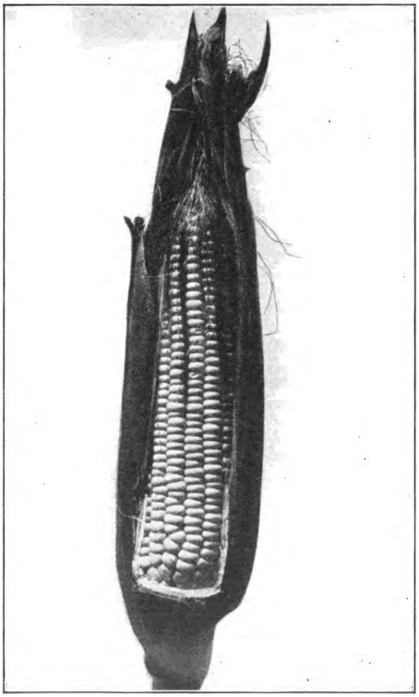


FIG. 86. An ear of sweet corn in ideal condition for table use

Harvesting. Sweet corn carries its maximum sugar content when the kernels are fully developed but are still in the dough state. Harvesting in order to insure the maximum yield of product as well as the highest sugar content should be done at this stage. Harvesting for table use should be delayed so that the shortest possible interval will elapse between gathering and cooking. If it is possible to reduce this to one hour, so much the better. Figure 86 illustrates an ear of sweet corn in ideal condition for table use.

Insects and diseases. Sweet corn, like field corn, is subject to attack by smut, *Ustilago zeae*. This disease can be combated only by sanitary measures: the use of clean seed, soil free from the disease, and manure which has no smut spores in it. Farmyard manures made on farms where corn stover and ear corn are fed is more likely to carry spores than manure from city stables. As a rule, this disease occasions little loss in the sweet corn if sanitary measures are observed, but it is the cause of considerable loss in field corn.

The corn-ear worm, or bollworm, *Heliothis obsoleta* Haw., a large repulsive larva, causes more injury to sweet corn than all other pests and diseases combined. This worm is not so common toward the northern limit of sweet-corn culture as it is farther south; but it is a pest to be reckoned with from New York southward and westward to the Pacific. The unfortunate fact about the bollworm which makes its case different from that of most other insect pests is its food habits — it is not selective but is a great glutton. It does not stop short of cannibalism, the stronger larvæ eating the smaller and weaker ones when they chance to meet. The pest is injurious to tomatoes, corn, cotton, and other important crops. Crop rotation or isolation does little good, and effective preventive or remedial measures are not known.

Now that there are inexpensive canning outfits for use where only small quantities of a given product are available, more attention should be given to husbanding the products of the farm and garden. The following plan for handling small quantities of corn will prove advantageous.

Home canning of corn. Contrary to the general opinion, corn is one of the easiest vegetables to can. Select the ears with full grains before they have begun to harden, as this is the period of greatest sugar content. Husk them and brush the silks off with a stiff brush. Shear off the grains with a sharp knife, and pack the jar full. Add salt to taste, usually about a teaspoonful to the quart is sufficient, and fill up the jar to the top with cold water. Put the rubber ring around the neck of the jar and place the glass top on loosely. Be careful *not to press down* the spring at the side of the jar.

[A common wash boiler provided with a false bottom made of slats or heavy wire cloth may be used as a sterilizer.] Place the false bottom in the boiler and put in as many jars as the boiler will conveniently hold. Don't try to crowd them in. Leave space between them. Pour in about 3 inches of cold water, or just enough to form steam and to prevent the boiler from going dry during the boiling. It is not necessary to have the water up to the neck of the jars, as the steam will do the cooking. Put the cover on the boiler and set it on the stove. Bring the water to a boil and keep it boiling for one hour. At the end of that time remove the cover of the boiler and allow the steam to escape. Press down the spring at the side of the jar. This clamps on the top and will prevent any outside air from entering. The jars can now be removed and cooled or allowed to stand in the boiler until the next day.

On the second day raise the spring at the side of the jar. This will relieve any pressure from steam that might accumulate inside the jar during the second cooking. Place the jars again in the boiler and boil for one hour. Clamp on the top as on the preceding day and allow them to cool. Repeat this operation on the third day. In removing the jars from the boiler be careful not to expose them to a draft of cold air while they are hot, as a sudden change in temperature is likely to crack them.

After the sterilization is complete the jars may be set aside for a day or two and then tested. This is done by releasing the spring at the side and picking up the jar by the top. If there has been the least bit of decomposition, or if sterilization has not been complete, the top will come off. This is because the pressure on the top has been relieved by the gas formed by the bacteria. In this case it is always best to empty out the corn and fill up the jar with a fresh supply. If canning fruits or some expensive vegetable, however, examine the contents of the jar, and if the decomposition has not gone far enough to injure the flavor, place it once more in the boiler and sterilize over again. If the top does not come off, you may feel sure that the vegetable is keeping. Corn is often subject to the attack of anaërobic bacteria. The spores of these are sometimes very hard to kill and remain alive even after boiling for one hour. In case any jars spoil, increase the time of boiling to an hour and a half.[1]

WATER CRESS

Water cress is extensively used for garnishing purposes and in the preparation of sauces for the dressing of meats. It is most extensively used during the winter season, but when it can be had in prime condition it is in demand throughout the whole year. The commercial production of the crop is remunerative both as a greenhouse crop and as a product of springs or streams suited to its growth.

Botany. Water cress, as its peculiar pungent flavor and its inflorescence would indicate, belongs to the Mustard family, being classed by botanists as *Nasturtium officinale*. Its closest garden relative, according to those versed in plant genealogy, is the horse-radish, which it by no means closely resembles, although in the same genus.

Methods of cultivation. Water cress is grown in two ways in eastern United States: in greenhouses as a winter forcing plant, and as a bog or water plant in open streams or springs. Under

[1] Adapted from *Farmers' Bulletin No. 359*, "Canning Vegetables in the Home," by J. F. Breazeale, Bureau of Chemistry, Department of Agriculture.

glass the plant is grown directly on the ground in cool, moderately lighted houses which have no benches. The seed is sown where the crop is to mature, or it may be sown in a forwarding bed either in a greenhouse or cold frame and later transplanted to the house where the crop is to mature. Sometimes the crop is increased by division. A cool atmosphere, rich, somewhat retentive soil, and abundant moisture are all essential to the well-being of this plant as a greenhouse crop.

Cress is also extensively grown in large open springs and streams, chiefly throughout eastern Virginia and West Virginia. Limestone springs issuing from the rock in great volume at a temperature which prevents freezing even in severe weather are made use of for the production of the crop. While cress will not grow well in a rapidly flowing stream, it thrives in a sluggish brook or pond in which the water movement is slow. Growers take advantage of this fact and cut broad, shallow ditches or canals to lead the warm water from the spring through a long channel. The grade of the channel is made such that it will hold the water at a suitable depth. With a little engineering skill a small stream can be utilized to provide water for a large cress bed. Dams a few inches in height can be used to produce a succession of pools adapted to the crop, since it is not necessary that the beds be on a common level.

Establishing the crop. In establishing the crop in artificial beds it is well to excavate the canals, place a rich compost of good garden soil and cow manure two or three inches deep in the bottom of the trenches, and sow the cress, using only water enough to make the compost moist. After the cress becomes well established the water may be turned into the canals to a depth of not more than two inches at first, which should be increased only as fast as the growth of the plants will justify. Seed should be sown early to induce a strong growth, so that at the opening of the harvest season in November the beds may be covered with a vigorous crop.

Harvesting. The harvested crop consists of young, tender shoots. A man equipped with hip boots and a suitable knife cuts the tender tips. The plants are grasped in the left hand and cut by the knife in the right. The stems of the plant are tied in a compact bunch before being released from the grasp. Some shippers pack the cress in berry cups instead of tying it in bunches; but whatever the plan used, the product is always packed in barrels and well iced before shipment.

Since well-established beds last several years and produce abundantly, water cress, if properly handled, is a profitable crop.

CUCUMBERS

Few if any of our garden vegetables have shown greater variation under cultivation than the cucumber. These differences are most strikingly seen in the size and shape of the fruits. The extreme smoothness and great length of the cucumbers which have been developed under the intensive cultural systems followed in England, where this plant is grown almost exclusively under glass, are in marked contrast to the types usually found in American gardens, either under glass or in the open. This is especially true in the case of the English cucumbers as compared with the types which are extensively grown for pickling purposes in this country. There is also a decided difference in the shape and texture of the leaves of the American and English types. These wide variations of leaf and fruit, however, are not considered sufficient by botanists for placing the two types under different species. Nevertheless they are decided and distinct horticultural varieties.

Botany. To botanists all the horticultural varieties of cucumbers, whether of the type of the English forcing cucumber or of our American garden sorts, are known as *Cucumis sativus*. The cucumber, like many other plants which have been under cultivation for many centuries, has a very incomplete history. Investigations and researches of De Candolle, however, are to the effect that the native home of the garden cucumber is undoubtedly in northwest India. It was carried from this region into China during the second century before the Christian era. It was also known and cultivated by the ancient Greeks under the name of *sikuos*, which remains as *sikau* in the modern language. These investigations have also shown that prior to its distribution in China and to the west, the cucumber was undoubtedly long cultivated by the inhabitants of the region to which it was native. For a more complete synopsis of the history of the garden cucumber, the student is referred to De Candolle's "Origin of Cultivated Plants," pages 264–266.

The garden cucumber and the muskmelon, or cantaloupe, belong to the same genus, but to distinct species. The fact that botanists have regarded these plants as closely related has led cultivators to believe that they intercross when grown near each other in the field. This assumption has been used as the basis of the explanation of any inferior quality which might appear in muskmelons, if they had been grown near cucumbers. Many years ago Naudin carried on experiments to determine whether such intercrossing was possible, and arrived at the conclusion that it could not be accomplished under normal conditions. The experience of the writer has confirmed the results obtained by Naudin, and the reason for poor quality in muskmelons must be sought elsewhere than in cross-fertilization by the cucumber. In fact, were the inferior quality referred to the result of cross-pollination, this would be equivalent to saying that the immediate effect of the pollen of the cucumber upon the muskmelon was sufficient to change the flavor of the fruit. Careful work in the crossing and hybridizing of plants has led to the conclusion that only in a few instances is there any immediate effect of the pollen. In a few plants which have multiple nuclei in the germ cell such immediate effect of pollen is possible; and where the germ has become differentiated, as it is in the case of corn, there may also be an immediate effect of pollen. This, however, is rare; and the fact that careful attempts to hybridize the cucumber and muskmelon have failed, renders modification by cross-fertilization with the cucumber practically out of the question.

Cultivation. Cultivation of the cucumber may be conveniently considered under the three following topics: (1) the cultivation of the cucumber in the open for slicing purposes; (2) the forcing of the cucumber; and (3) the cultivation of the cucumber in the open for pickles. Each of these three branches of cucumber culture presents interesting and distinctive methods.

Cucumbers for slicing purposes. The cultivation of cucumbers for slicing purposes is extensively carried on by truck growers along the Atlantic coast and in the various truck centers of the United States as well as by market gardeners and greenhouse growers near the large cities of the North. Shipments from these regions are made at various seasons corresponding to the latitude in which the work is conducted. Early in the season cucumbers from southern Florida and southern Texas reach the Northern markets, and as soon as those from more northerly points become sufficiently developed, the more southern shipments give place to them in succession until the most northerly sections in which intensive truck gardening is conducted are reached; when the field product is no longer available the greenhouses contribute their supply. This is in conformity with the general plan of truck-crop production throughout the country.

Starting the plants. In the extreme South, where there is little or no danger from frosts, cucumbers can be started in November or December and the crop gathered for the Northern markets during the early spring months. In more northern localities, where there is danger of frosts, the gardener may resort to muslins or hotbed sash to protect the beds and bring the plants on under cover, transplanting them to the field as soon as danger from frost is past — in February, March, or April, the exact time depending upon the locality.

Transplanting. A common practice in the frost zone is to start the seedling plants in seed beds, which may be protected by sash or muslins. When the plants are large enough to transplant to the open and conditions are right, disks of soil are cut out with a hollow cylindrical-shaped iron implement, fashioned somewhat after a section of stove pipe, but having a total length of not more than 8 or 9 inches and a diameter of about 5 or 6 inches. These disks of soil containing the roots of the plant are shifted to a carrying board by means of a shingle or trowel slipped under the cutter, and are left on this board until the plants are slipped out of the rings into their permanent place in the field. The rings are then removed and carried back to the seed bed to receive another supply of plants. With 50 or 100 such metal rings it is a very easy matter to transplant a large number of cucumbers.

Another, somewhat simpler, means of accomplishing the same result consists in the use of wooden boxes like those employed by strawberry growers for shipping fruit. The boxes are filled with rich soil in which the seeds are planted, and then plunged to the rim in the soil of a cold frame protected by muslin or sash. When it is desired to transplant to the field, the boxes are lifted, carried to the field, and planted; that is, the berry baskets are not removed from the balls of earth. Some growers use a paper pot, constructed of heavy manila-paper boards, to accomplish the same end.

Still another method of transplanting in those regions where the cucumber cannot be planted early in the open is to cut pieces of turf about 6 inches square, and 2 or 3 inches in thickness, from an old pasture. These are placed, grass side down, on the surface of the hotbed or cold frame, and in the center of each are planted 3 or 4 seeds. By this treatment the seeds can be planted from four to six weeks earlier than they could be planted in the open. By giving careful attention to the watering and ventilating of the hotbed or cold frame, the plants can be carried in the frames until they begin to run, which will be five or six weeks after the seeds are sown, depending on the temperature and treatment given. In localities where it is desirable to secure a limited supply of very early fruits, one of these methods can be used by market gardeners with success and profit.

Starting the plants in the open. While the earliest field crops of cucumbers are handled in this way, such crops constitute only a small percentage of the total area cultivated in any section. The main crop of the region is usually produced at a season when the seeds can be safely planted in the open, and is cultivated much after the manner of squashes. When planted in the open, from 6 to 10 seeds are usually placed in hills 6 feet apart each way, and spaced in the hill so that the plants will stand 3 or 4 inches apart in each direction. After all danger from insects is past, the plants are thinned, usually to 3 or 4 to the hill. In some instances the planting is done in drills rather than in hills, and the plants are thinned to stand at intervals of 1 foot, with the rows 6 feet apart.

In outdoor culture the cucumber is frequently used as a companion crop to other vegetables like beans. Beans, being of rapid growth, "come on" quickly and form a partial protection or windbreak for the young cucumber plants. When grown with beans, cucumbers are planted in drills or in hills 6 feet apart, and 1 row of beans is placed between 2 rows of cucumbers, a method which insures a complete and satisfactory use of the ground. Because of the quick maturing of the beans they can be harvested and removed from the area before it is required for the cucumbers.

Preparation of the soil. The soil best suited to the early crop of cucumbers is of necessity one which warms up early in the spring and is well drained. A light, sandy loam is generally selected as the site for this crop. Like all the vining plants, it thrives on a rich soil and an abundance of available plant food. While the light, sandy soils are favorable to the crop, it is necessary, in order that the best results be obtained, to make sure of a liberal supply of available plant food. For this purpose a fertilizer carrying nitrate of soda 300 pounds, cottonseed meal 700 pounds, acid phosphate 750 pounds, and muriate of potash 250 pounds, applied at the rate of 500 to 1000 pounds to the acre should give satisfactory results.

If the hill system of planting is followed and a supply of well-rotted stable manure is available it is a good plan to place a small shovelful of this compost under each hill in addition to the general distribution of the fertilizer just mentioned. When the stable manure is not available, the fertilizer should be applied broadcast with a grain drill and thoroughly incorporated with the soil before sowing the seed. It is not well to concentrate the fertilizer too much about the roots of the plants. Injury is more apt to occur when there is a heavy application over a restricted area than when the fertilizer is used broadcast.

In Southern trucking regions where cucumbers are extensively grown, it is the common practice to turn the land up into broad ridges and to plant rows of cucumbers on top of them. To form the ridges, the area is back-furrowed with a turning plow, the width of the lands corresponding to the distance between the rows of plants; a dead furrow falling between each two rows provides for the necessary drainage. At the North, however, where cucumbers are grown in the open, the common practice is to plant them either in hills or in drills and give them level cultivation, the land seldom or never being ridged.

Time of planting. The time for planting the cucumber in the open is determined by the frost-free period of the region. Cucumbers are exceedingly susceptible to injury by frost, and it is never safe to plant them in advance of the time when garden beans can be safely planted. The frost-free period of any region, therefore, determines the time when outdoor planting can begin. The earliness of the crop will depend on the earliness of this period, but time is gained by planting the seed in cold frames or hotbeds, as suggested above.

In the vicinity of Charleston, South Carolina, the planting of cucumbers in the open can begin between March 20 and April 1. It is seldom that hard frost sufficient to destroy the cucumbers will occur after the first of April, particularly in the Sea Islands, adjacent to the coast. The mainland plantings must be deferred until somewhat later.

A plan which has been resorted to in some instances with good success is to sow rye in the fall on the area to be devoted to cucumbers, and in the spring after the cucumbers have been brought forward in a cold frame as described above, turn back-furrows through the rye to prepare a suitable place for planting the cucumbers. The cucumber plants are then transferred to the ridges in the rye field, the rye acting as a windbreak and protection to the young plants to the extent that they can be safely set in the ground considerably earlier than would otherwise be possible.

Insect enemies. The cucumber grower is annoyed by the so-called striped cucumber beetle more than by any other insect. It frequently happens that unless radical preventive measures are taken the first plants in small plantations are entirely destroyed by this pest. Because of its aggressiveness and persistency this beetle is a formidable enemy to combat. Where cucumbers are grown on an extensive scale and an abundance of seed is used, it seldom happens that the beetles are sufficient in number to destroy entirely the stand of plants. In the South no preventive measures are resorted to except those of using large quantities of seed and delaying the thinning of the plants until the season of greatest damage by these insects is past. After the plants become well established and possess several true leaves, there is less danger of their being destroyed than during the early stage of their growth.

There is no specific remedy for the striped cucumber beetle. Direct applications of poison, such as Paris green or other arsenical compounds, will destroy the beetles when they occur in moderate numbers. Arsenicals are used alone or mixed with finely sifted plaster in the proportion of 1 to 75 by weight and are dusted over the young plants. Pyrethrum applied with a powder bellows is too expensive for general use, but is valuable in small gardens. It should be applied early in the morning before the dew is gone.

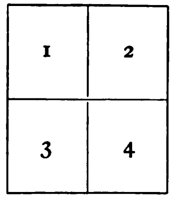
Owing to the inefficiency of poisonous applications when the insects are most abundant, recourse must be had to preventives, repellents, and cultural methods.

Covering young plants. Market gardeners and others growing cucumbers on a small scale have resorted to many devices to check the ravages of this insect, among which may be mentioned a small screen-covered box or frame 12 or 15 inches square, made of boards ⅞ inch thick and 4 inches wide, and covered with wire cloth similar to that used for mosquito netting. This proves a very effective barrier against these insects, but the difficulty of storing such protective devices and the cost of their manufacture are almost prohibitory to their use. Other growers use cheesecloth or mosquito bar, cutting it into squares 18 by 18 inches. By placing a peg 6 or 8 inches high in the center of the hill of cucumbers, and throwing the square of mosquito netting over the peg so that it will fall about it in the form of a little tent, the edges of which are held in place by a ridge of earth, a very satisfactory barrier against these insects is formed. Because of the low cost of the mosquito netting and the fact that as soon as the plants are established it can be removed and used again for several successive years, this is one of the cheapest and most satisfactory ways of dealing with these pests.

A cheap frame may be made by cutting a barrel hoop so as to form two semicircles, which are placed at right angles to each other and the ends inserted in the ground with the curve uppermost, or by bending two strong wires into the form of croquet arches. The frame is covered with gauze or similar material, held in place with earth packed about the edges so as to prevent the beetles from working under it. The first cost and the expense of adjusting these devices greatly limit their use, although it is necessary to keep the plants covered only while they are young, and the same covering may be used year after year.

Early planting. Where no covering is used it is advisable to start the plants in frames or hothouses, or to plant the earliest varieties and set them out as soon as possible, so as to get them well established before the beetles appear. The planting of late varieties should be postponed until after the first appearing beetles have laid their eggs and disappeared.

Planting an excess of seed. A certain degree of relief from the beetle can be secured by planting an excess of seed. After the first danger is passed the hills can be thinned out as desired. A good method is to plant in squares, one each week, as shown in the accompanying diagram. The first planting, 1, is frequently killed and may be followed by 2 and sometimes 3. So long as any insects remain, applications of an arsenical are made, and this is continued until a stand of plants is obtained. It is seldom that all four plantings are destroyed.



Clean culture and trap plants. Much injury by the beetles may be prevented by attention to clean methods of cultivation. As soon as the crop is harvested the vines should be covered with straw or other inflammable material and burned. A few plants left standing throughout the fields will attract such insects as may not have been reached by the fire, and these can be easily destroyed with a spray of strong kerosene emulsion or by Paris green. As trap crops for the last generation, plant later or use later varieties. By destroying the beetles at this time the numbers for the ensuing year will be greatly diminished.

Some exemption from injury may be secured by planting beans in alternate rows before the cucumbers are planted. The beetles congregate on the beans and, having an abundance of food, are not forced by hunger to attack the young cucumbers. Gourds planted in the vicinity of other cucurbits are claimed to act successfully as a trap.

Driving with air-slaked lime. In certain melon-and-squash-growing sections "driving" is resorted to as a means of controlling this insect. In the morning, when the beetles are active, air-slaked lime is dusted over the plants with the wind, and the beetles fly before it to the next patch, which is treated in the same way.

Arsenicals, with ashes, dust, or plaster. A remedy frequently suggested is to dust most of the plants with sifted wood ashes or land plaster, and cover the remainder with an arsenical. The beetles congregate on the clean plants, where they are killed by the poison, not always, however, before they have fed to such an extent that the plants will be more or less damaged.

Repellents. Land plaster, or gypsum, thoroughly saturated with kerosene or turpentine acts as a repellent. The odor of turpentine is said to be especially distasteful to this insect. Tobacco dust sprinkled on the hills, particularly when the soil is moist, also has the advantage of being a good repellent, and in addition acts as a fertilizer and mulch for the plant. Direct remedies must be applied repeatedly, when rainfall necessitates their renewal, until the plants have obtained a good start or the insects have disappeared.

A considerable degree of exemption from injury results from the stimulation of a crop by heavy manuring and frequent cultivation. Fertilizers should be productive of the same results.

Through the exercise of good judgment in planting and the combined efforts of growers throughout the country in the use of any of the above-mentioned remedies, the total damage from the striped cucumber beetle should be greatly lessened.

Diseases. In the South the cucumber is affected by two fungous diseases which are very destructive — mildew and blight. The only means of treating these in the field at the present time is to spray the plants persistently with Bordeaux mixture from the time the runners are a foot in length until the crop is harvested, repeating the treatment every ten days during ordinary weather, and if it is hot and muggy with frequent showers, much oftener than this, for it is during such weather that these diseases are most prevalent.

One of the cheapest and best devices for spraying is a barrel mounted on a two-wheeled truck that can be drawn by horses, coupled far apart so that the wheels will straddle a row of cucumbers. The man who operates the pump can drive the team. The pump should have a double-discharge orifice from which two lines of hose can be carried over swinging booms pivoted at the bottom near the base of the barrel, and fastened at the top at an angle which will allow them to swing both forward and backward. Sufficient length of hose should be provided to allow the nozzle man, standing on the ground with an extension pole in hand, to walk 25 or 30 feet in each direction. From either side of the spraying device a man with a double-discharge Vermorell nozzle attached to an extension pole can spray from 6 to 8 rows of cucumbers each time the field is crossed. With such a device the cost of spraying is greatly reduced and, with due care on the part of the nozzle man, a more perfect treatment can be given than by any automatic device yet designed.

For directions as to making the Bordeaux mixture see page 14.

Harvesting. As soon as cucumbers which are grown for slicing have attained a length of 8 or 10 inches, they are carefully cut from the vines and placed in suitable receptacles. Either splint baskets or boxes may be used for this purpose. They are then carried to a packing house, where they are graded and carefully packed into baskets similar to those used for the shipment of peaches and lettuce. These baskets are after the style known as the Delaware basket, and range in size from a half bushel to a half barrel. The earliest products, which command the highest prices, are frequently packed in bushel boxes. These boxes are lined with paper, and the selected cucumbers are arranged in tiers so as completely to fill the receptacle.

Besides the two cases already mentioned, cucumbers are sometimes shipped in the regular six-basket peach carrier. The fruits are harvested when they are of proper length to lie crosswise of the carrier basket, and are arranged in tiers. In such packages they make a very attractive appearance, but the cost of the package is a drawback. The bulk of the cucumber crop is handled in the Delaware form of basket holding one half bushel. These baskets are somewhat stronger than those used for the shipment of lettuce, since the weight of the cucumbers is much greater.

There are usually two grades of cucumbers: those which are of uniform size, about 8 inches in length and 1½ inches in diameter, constituting the first grade; and those which are in any way deformed or are larger or smaller than the first grade, classed as second grade. Because of the irregularity in size of the seconds, it is impossible to pack them so as to make as neat an appearance as do those of uniform size and shape, and on this account the No. 2's are frequently shipped in ventilated barrels.

When properly grown the cucumber is very productive and usually brings a remunerative price, ranging from 75 cents to $1.50 a basket for the half-bushel or five-eighths size.

The Forcing of Cucumbers

In addition to the field culture of cucumbers, there is in this country and in England a considerable industry in the forcing of this crop. Forcing is a term used by gardeners to designate the growing of plants out of their normal season under an artificial environment. The cucumber is one of the few garden plants which lend themselves to this manner of cultivation in addition to their more extensive cultivation in the open.

Types of forcing cucumbers. Under the influence of field and forcing conditions, two distinct types of cucumbers have been developed. These are recognized in the trade as the English type and the American type. The English type is purely a product of forcing-house conditions, as the climate of England is not congenial to the growth and development of the cucumber in the open. The

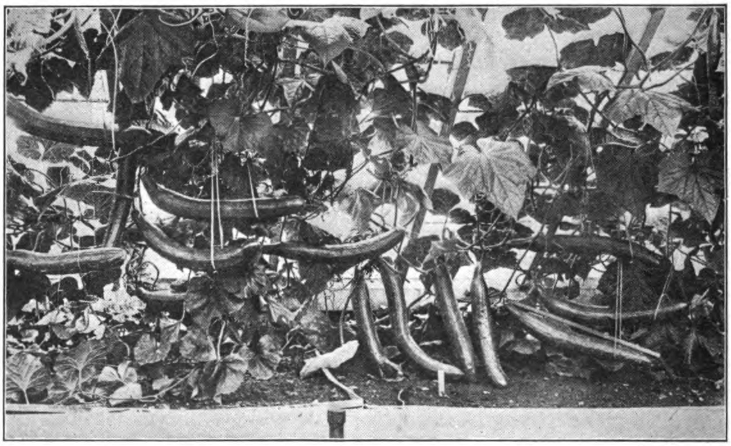


FIG. 87. English cucumbers showing type and method of supporting the fruits

American type of cucumber is primarily a product of field conditions, and the few varieties which have been developed to meet the requirements of the forcing house are simply modifications of the existing field or outdoor forms or crosses with the English.

The English type of cucumber, shown in figure 87, is a long, cylindrical, uniformly green fruit, without spines, and with few seeds and a very fleshy seed cavity; in fact, the normal seed cavity is almost entirely wanting in the English cucumber. The triangular shape characteristic of the normal outdoor variety has been lost, and the cylindrical outline almost perfected. There is considerable difference in the size of the English varieties of cucumbers, the length varying from 18 inches to 3 feet, and the diameter from 1½ to 2½ inches. The edible period of the English forced cucumber is much longer than that of the American type.

Strange as it may seem, the English forcing cucumber does not sell readily in most of the American markets. Outside of New Orleans and a few special markets the taste of the American consumer has not been developed, as yet, to the point of accepting this type of cucumber, but there is always a ready sale for well-grown hothouse or forcing cucumbers of the American type.

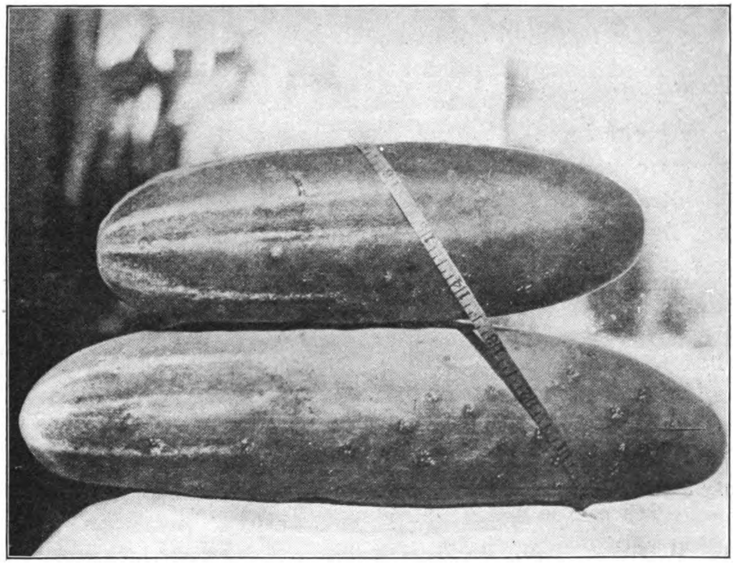


FIG. 88. American type of cucumber used for forcing and growing in the open

The American type of cucumber, shown in figure 88, is chiefly grown in the field, and the product is used either for pickling or slicing. Only a few of the field varieties producing fruits large enough for slicing are used for forcing purposes. Among these is the White Spine, the Arlington White Spine being the variety which has been especially developed for forcing. The Long Green, or a modification of it, is also sometimes used, but aside from these there are few varieties that ever find their way into the forcing house. The cluster varieties and the Boston Pickling, the Chicago Pickling, and the like, are not adapted to forcing purposes.

The American ideal of a forcing cucumber is naturally based upon the type grown outdoors, and in general shape and size the fruits must conform to this. This ideal forcing cucumber has a slender form, good length, is cylindrical rather than triangular in shape, and of a uniform green color. At the present time there is no variety upon the market which has all these characteristics. The White Spine is objectionable because of the white markings of most of its fruits, and now and then an albino appears, which is exceedingly objectionable for forcing purposes. The chief objection to white markings upon cucumbers is that as soon as the fruits are removed from the plant these spots have a tendency to turn yellow, suggesting age and deterioration. Fruits which are uniformly green in color do not show these changes so quickly, and if they are well preserved in cold storage and maintain their crispness of texture, they can be held upon the market much longer than those showing the white markings. From the standpoint of the buyer this characteristic of the white markings is an advantage, in that he can determine whether or not the cucumbers have been upon the market for a long time.

Frame culture. The cultivation of cucumbers in cold frames is most extensively developed in the vicinity of Norfolk, Virginia, where several thousand frames are annually devoted to this crop. By planting the cucumbers under the frames the last of March or early in April, a product can be brought into the market from about the middle to the last of May. There are some advantages in this method of cultivation, in that the grower not only has under his control the temperature and moisture conditions but can very easily protect the plants from insect enemies. Experienced growers who operate frames make a handsome profit from this enterprise.

The details of starting the plants are not different from those already described for growing plants in cold frames. The cucumber is seldom started in special frames and transplanted to fruiting frames, although in some instances this may be more economical than sowing the seeds where the plants are to mature.

If the frames have been devoted to a crop of lettuce prior to using them for cucumbers, seeds of the latter are usually planted among the lettuce before harvesting, so that as soon as the lettuce is out of the way the cucumbers come on and occupy the space.

In other respects the treatment is the same as that for cucumbers in forcing houses. It is the common practice to plant only a single row of cucumbers through the cold frame, making the hills at intervals of 2 or 3 feet through the center of the continuous frame. Such frames are made of boards about 12 inches high at the back and about 8 inches high at the front, which are held in place by stakes driven in the ground or by cleats used as guides for the sash.

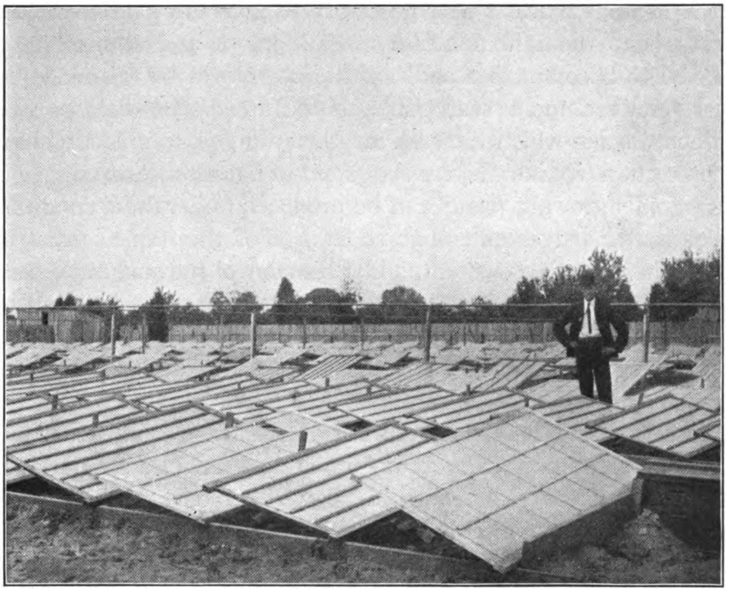


FIG. 89. The methods of arranging frame sash to avoid drafts and still secure ample ventilation

In length these frames are multiples of 3 feet, the size in each case depending upon the area which is to be occupied. The construction and arrangement of such frames is illustrated in figure 12.

Watering and ventilating. Special attention to the ventilation of the frames and to the application of water is necessary to prevent disease and keep the plants in a healthy, rapidly growing condition. To facilitate the work of watering or irrigating plants in cold frames, pipes can be arranged upon the surface of the ground or at a convenient height overhead, so as not to interfere with cultivation, from which water can be drawn to sprinkle the surface of the beds at regular intervals and as the plants may require. The work of watering should be carefully done. The same general precautions necessary in the care of plants in cold frames should be observed here — that is, watering should be done in the morning on bright days only, when air can be admitted and when the sun will soon dry the moisture from the leaves. In this way much can be done to prevent such diseases as the damping-off fungus and mildew. Extreme care is also necessary to give the plants sufficient air to keep them in a healthy condition. If the atmosphere is allowed to become close and hot, the plants will be weakened and thus rendered more susceptible to the attacks of diseases. The various ways in which the sash may be arranged, to give air, shade, or protection from drafts, are suggested in figure 89. Strong, vigorous, rapidly growing plants can be produced under these conditions by skillful management. The advantage of the frame is that the grower has, to a large extent, under his control the amount of water which the plants receive, the time at which it is applied, and the temperature of the surrounding air. These, as will be observed, are important factors at a time of year when the plants cannot safely be placed in the open.

Forced with lettuce. In some instances where lettuce is used as a companion crop, the cucumbers are started in a separate cold frame, hotbed, or greenhouse in quart berry boxes, which, when the plants have attained a height of from 8 to 12 inches and the cold frames are ready for their reception, are buried at intervals of 2 or 3 feet through the center of the cold frame, just as are the seeds when planted directly in the soil. This plan is economical of space in the cold frame during the early life of the cucumber plants, and if the plants are started in a greenhouse or hotbed, it enables the grower to bring them on earlier than he could normally in the cold frame. It also allows the cold frame to be used a longer time during the season for the production of lettuce.

Successful forcing. The key to success in this work is a thorough understanding of the needs of the cucumber, good equipment as regards sash, a sufficient water supply always at one's command, and great diligence in regard to the manipulation of the sash to prevent direct drafts of air and to provide at all times sufficient fresh air to keep the plants in a temperature which will induce a sturdy, rapid growth. With this treatment it is possible to bring cucumbers into fruit in the latitude of Norfolk by the middle of May.

As soon as the weather is sufficiently settled and the danger of cold waves or chilly nights is past, the sash are removed and stored until needed in the autumn. The boards of the frame are stacked until required for other purposes, and the cucumbers are given the entire area. Cucumbers produced under these conditions are of necessity more expensive than those grown in the open, but since they mature several weeks in advance of the field crop they find a market in which there is little competition except from cucumbers grown in forcing houses. The result is that, as a rule, satisfactory prices are obtained for this product. Cucumbers grown in this way are usually marketed in boxes or half-bushel peach baskets of the Delaware type.

Greenhouse forcing. The forcing of cucumbers presupposes an adequate forcing house or greenhouse. The chief requirements of such a house are a maximum amount of light, sufficient headroom, and radiation adequate to maintain a temperature varying from 65° to 85° F. The amount of radiation will, of course, depend upon the style of heating employed, whether steam or hot water, and upon the locality, whether at the North or at the South, the outside temperature determining to a considerable extent the amount of radiation required.

The greenhouse for cucumbers may be a broad, even-span house, with a ridge running north and south, as shown in figure 23. It should have foundations extending 18 or 20 inches above the surface of the ground, and glass from the foundations to the angle formed by the eaves, which should be of sufficient height to give good headroom inside the house. A distance of 5 feet from the floor level to the angle of the eaves is not too great, and 6 feet is more desirable. The angle of the roof should be about 30° in the latitude of Philadelphia and northward. In large houses it is the common practice to use solid benches — that is, the earth of the benches in which the plants are to be grown rests directly upon the surface of the ground.

In houses from 40 to 60 feet wide, walks are provided along the sides, and the A-shaped trellises for the support of the cucumbers run crosswise. In other cases the plants are set in rows 6 feet apart, at intervals of 3 feet. A single stalk is carried to an overhead wire support, which is horizontal and covers the entire area of the house. This is a common method of training in the Irondequoit section near Rochester, New York. In other cases the walks, as well as the A-trellises, run lengthwise of the house, as shown in figure 90. This trellis is high enough and broad enough to permit workmen to pass beneath it for the purpose of spraying and harvesting the fruit.

Soil for the benches. The soil for the best development of the forced cucumber should be a rich compost which would be classified

FIG. 90. An A-trellis for cucumbers running lengthwise of the house

as a sandy loam. Sods from an old pasture with a good turf overtopping a clay loam, composted with about one third its bulk of cow manure to which, at the time of placing it in the greenhouse, about 15 per cent of its bulk of sand is added, should make a good soil. From time to time during the growth of the cucumbers they should be watered with liquid manure from a leach containing fresh horse manure and sheep manure. It should be the aim of the grower to keep the plant in the most vigorous condition possible.

Propagation. There are a number of methods of propagation followed by successful cucumber growers, all of which have some merit. Four of the more common practices are as follows: (1) to plant the seeds in the soil of the bench where the plants are to grow and mature; (2) to plant the seeds in 3- or 4-inch pots filled about half full of soil, and after the seeds have germinated and the hypocotyl or stem of the seedling has elongated, to fill the pots well up to the seed leaves with soil; (3) to plant the seeds in cups similar to those used for harvesting strawberries, but made of Georgia pine; and (4) to sow the seed broadcast in a pure sand covering about ½ inch deep, and as soon as the seedlings are up and before the true leaves appear, to lift and transplant them to veneer cups about 5 inches square, four plants to each cup. Transplanting must be done in a shaded place and the plants watered thoroughly as soon as transplanted.

In the first case, where the seed is planted directly in the soil on the benches, cucumbers are usually employed as a crop to follow lettuce. The seeds are planted before the lettuce crop is entirely removed, heads of lettuce being taken out at proper intervals to allow for the correct spacing of the cucumber plants. In the other two cases the plants for forcing purposes can be grown in a small house specially designed for this purpose or in a general propagating house, thus obviating the necessity of heating and maintaining normal conditions in the growing house during the period previous to which the plants begin to run.

Planting on the benches. As soon as the plants show well-developed runners and are 10 or 12 inches long they should be placed in their permanent position in the greenhouse benches. Plants grown in pots must be carefully removed from these receptacles, but those grown in the wooden cups referred to above can be planted, cups and all, in the soil of the bench. The utmost care should be taken to keep the plants growing rapidly at all times. If they receive a severe check or are developed under conditions which are not entirely congenial to them, they are apt to become dwarfed and stunted, and as soon as vigorous growth ceases they are the prey of melon aphis, mildew, and other pests and diseases which are so annoying to growers of cucumbers under artificial conditions.

After the plants have attained a height of 10 or 12 inches and are in a vigorous growing condition, they should be placed about 15 or 18 inches apart in single rows upon the side benches of the greenhouse, which are normally 3½ feet wide. If planted on the 8-foot benches referred to above they should be set about 10 or 12 inches from the edge and from 15 to 18 inches apart, parallel to the edge of the bench. In the broad benches, where more than a double row can be carried, plants can be set at intervals of 18 inches to 3 feet in rows 6 feet apart. A satisfactory plan for an 8-foot bench is a row parallel to, and 10 inches from, each edge of the bench and a double row 18 inches apart through the middle of the bench. It is well, however, to allow as much space as possible. The cucumber is a rank-growing plant, and many side branches will develop if sufficient space is allowed.

Training the plants. As soon as the plants show a tendency to run they should be trained so that they will fill all the space on the trellis, but will not become unduly tangled. The trellis can be made of light edging ⅞ inch square, tacked to the side of the bench, if the cucumbers are grown on wooden benches, and set up in the form of the letter A, as shown in figure 90. Galvanized wire No. 16 can be run lengthwise of the house and stapled to the supports, which should be placed about 6 feet apart. If elevated side benches are used, it will be necessary to train the cucumbers to the framework of the greenhouse. For this purpose screw eyes about 8 inches in length can be placed in the sash bars at intervals of 4 or 5 feet, and the parallel wires to which the vines are to be tied can be stretched 12 inches apart lengthwise of the house through these screw eyes and firmly fastened at the ends. The vines should then be loosely tied to the supporting wires with raffia or soft cotton yarn. When the fruits become very heavy, as in the case of the English varieties, it will be necessary to truss them, as shown in figure 87, to prevent their weight breaking the vines. Heavy fruits will cause the supporting wires or bands of raffia to break or girdle the vines unless they are supported independently. The American varieties seldom attain sufficient size to require this precaution. Fruits of these varieties, as soon as they are from 8 to 10 inches in length and 2 inches in diameter, are harvested for market.

Pollination. The cucumber, like the other members of the Gourd family to which it belongs, bears two kinds of blossoms on widely separated parts of the plant. The staminate or nonfruit-bearing flower, shown in figure 91, is the first to appear and usually grows near the base of the plant. The pistillate blossom with the embryo cucumbers at its base, shown in figure 92, appears later and is borne near the extremity of the newly forming and rapidly

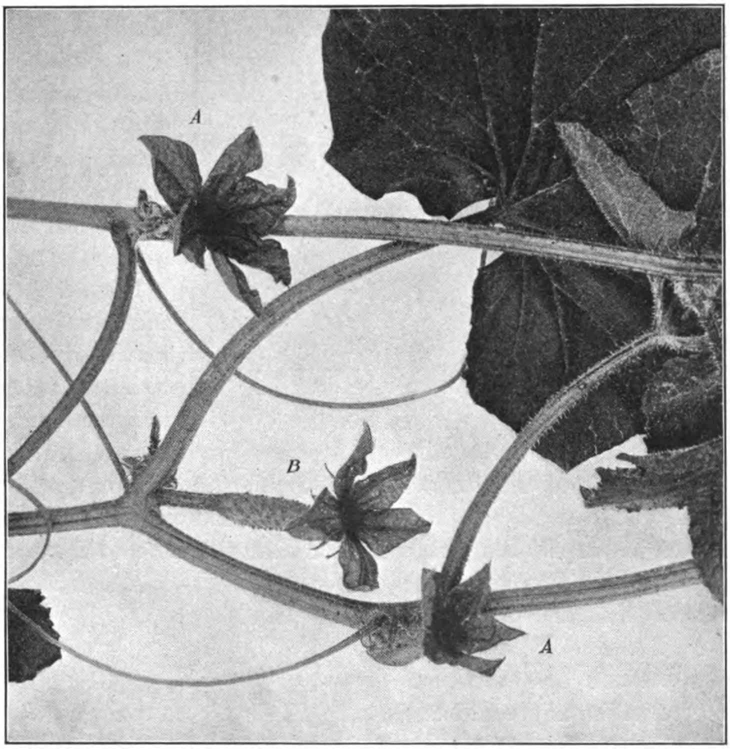


FIG. 91. Flowers of the cucumber

A, *A*, staminate; *B*, pistillate

growing shoots or on short lateral branches. Since these flowers are normally produced in this way, it is necessary that a transfer of pollen be made from the staminate to the pistillate flowers through the agency of insects or by other artificial means.

Under greenhouse conditions, and at the time of year that the cucumber is forced, it is necessary to provide for pollination. In small establishments this work can be done by hand. The staminate blossoms are removed, the petals turned back so as to allow the anthers to project, and the pencil thus produced is thrust into the cup of the pistillate flower in such a way as to distribute pollen upon its stigma. In large establishments where hand pollination is out of the question a colony of honey bees is placed in each house to accomplish the work.

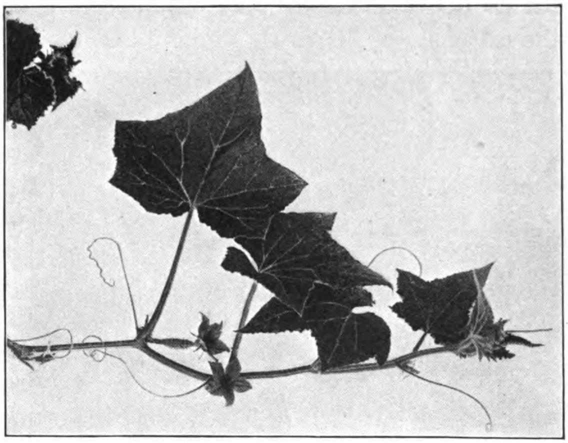


FIG. 92. Branch of a cucumber plant carrying a pistillate flower

Preparing cucumbers for market. Cucumbers which are forced in greenhouses are prepared for market in one of the following ways. The American types of cucumbers are usually gathered from the plants when from 7 to 8 inches in length, being selected according to size and ripeness, and are packed in boxes about 8 inches deep and 24 inches square, like that in figure 93, which shows a box of cucumbers grown in a greenhouse, prepared for shipment to the Northern markets. Cucumbers grown in frames, as well as those grown for slicing purposes in the open ground, are usually picked when about this size and are commonly marketed in the Delaware type of basket, which holds from half a bushel to a bushel, the size of basket depending upon the season and the condition of the market. The outdoor crop, as has been

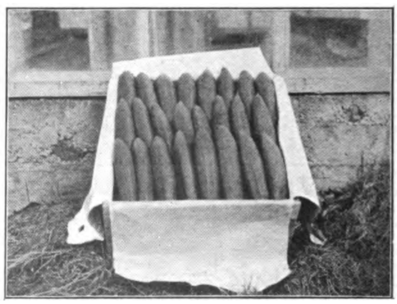


FIG. 93. A box of forced cucumbers ready for market

noted, is usually marketed in bushel or half-barrel baskets. English cucumbers when grown for shipment are carefully wrapped like oranges or tomatoes, and packed in boxes similar to those first described, but of dimensions suited to the size of the fruits.

Enemies and diseases. To get the best results from greenhouse cultivation untiring attention must be given to the maintenance of proper moisture and temperature conditions. A keen watch must be kept for the appearance of aphis or mildew, and, upon the occurrence of either, prompt and effective methods must be employed for stamping it out.

The cucumber is a tender plant and will not endure some of the severe methods of combating aphis and mildew employed on other plants. The careful spraying of cucumbers with ammoniacal carbonate of copper solution, which is made by dissolving 5 ounces of carbonate of copper in 3 pints of strong ammonia (26 degrees), is recommended. This stock solution should be diluted to 45 gallons when used; that is, 1 pint of the solution will make 15 gallons of the spraying mixture. This should be applied with a strong force pump through either a Vermorell or a similar nozzle, and ought to keep the house free from mildew.

An additional safeguard is to keep the heating pipes at all times covered with sulphur. When it is not practicable to moisten the foliage of the plants with a spray, the distillation of sulphur in accordance with the following plan is very effective. This is accompanied by some danger, however, and the novice should carefully observe and carry out every detail of the directions given below.

The apparatus for distilling sulphur for the treatment of mildew in a greenhouse consists of a small, single-burner oil stove. One with a top 6 inches square will serve the purpose. Secure two iron or tin pans similar to those used for the baking of layer cake, and, if possible, have one pan 2 inches larger in diameter than the other. In the larger pan place a layer of sand, as free from organic matter as possible, about ½ inch deep. Upon this set the second pan, which contains flowers of sulphur in sufficient quantity to fill the pan about half full of sulphur when it is molten. Light the lamp, heating the sand to a sufficient degree to melt and maintain the sulphur in a molten condition, *but exercise the greatest care* *in regulating the flame of the lamp, so that it shall never touch the edge of the pan containing the sulphur, and observe every precaution to keep the sulphur from becoming ignited. Burning sulphur in an inclosure containing living plants is certain death to all plants contained in the area.* The distillation of sulphur which is kept in a molten condition over a sand bath is perfectly harmless to the plants, but is destructive to parasitic fungi like lettuce mildew and cucumber mildew. The device which is used for the distillation of sulphur as above described is shown in figure 94.

FIG. 94. Device for distilling sulphur in greenhouses

The melon aphis, which is frequently troublesome upon cucumbers under greenhouse conditions, can be controlled by spraying with whale-oil soap or kerosene emulsion. Under ordinary conditions a treatment with one of the commercial smudges of nicotine will usually be sufficient.

GROWING CUCUMBERS FOR PICKLING PURPOSES

The cultivation of cucumbers to supply the demands of the pickle trade has assumed important commercial proportions in certain sections of the United States. As a rule, however, this industry is not of long duration in any locality; a period of eight or ten years is about the maximum. The salting stations, as they are called, which are the gathering points used by the pickle factories, are generally of inexpensive construction, and those parts which are most durable can be moved as necessity requires.

In general the price received for cucumbers is remunerative, and if the industry could be carried on extensively it would be a profitable one. The fact that only a small acreage can be handled by a single grower renders it a less attractive and less profitable crop on the whole than it would be if large acreages could be handled. The reason that only a small area can be grown by individual farmers is that a large amount of hand labor is required to gather the fruits. During the bearing season it is necessary to go over the patch at least three times each week in order to secure the fruits within the range of the sizes which will be accepted by the pickle factories, that is, from 2½ inches to 4 or 5 inches in length. Few farmers have sufficient assistance to allow them to grow more than one or two acres. If the picking of cucumbers were work which could be carried on by children, it would not present so many difficulties, but it is men's work, owing to the heaviness of the fruits and to the fact that it requires experience to find them under the leaves.

Soil. The soil which is best adapted to the growing of cucumbers in the open ground is a sandy, gravelly, or clayey loam. The sandy loams are best suited to the cultivation of cucumbers for early markets, and gravelly and clayey loams are best for those intended for later harvesting, such as are demanded by the pickle factories.

The commercial cultivation of cucumbers intended for use by the pickle factories is largely confined to the higher altitudes and latitudes, the long warm season of the South not being as congenial to the growth and development of this plant as are the cooler and more retentive soils of the North. The pickle industry is therefore chiefly confined to latitudes north of the city of Washington.

Planting. The soil is first thoroughly prepared as for the reception of any hoe crop, and is then usually laid off in checks 6 by 6 feet or 3 by 6 feet, or in drills 6 feet apart. The particular system employed is a matter of choice to the grower, some claiming that one system is more economical than another. In the long run, however, it is usually best to employ the check-row system, as the cost of cultivation is thereby reduced. The operation of keeping the land free from weeds when the plants are grown in check rows can be almost entirely accomplished by the use of horse-power implements, but when seed has been sown in drills it is difficult to keep out weeds without resorting to hand weeding. When the check-row system is adopted, sufficient seed is scattered promiscuously over an area about a foot in circumference to insure a stand of from 4 to 6 plants after the hill has been thinned. From 10 to 12 seeds are usually planted. After all danger from injury by insects is past, the plants are thinned, some growers reducing them to 3 or 4 to the hill. Clean cultivation then follows until the vines are sufficiently large to occupy the entire area.

The time for planting varies somewhat, according to the locality, but for central western New York it is from the first of June to about the first of July. The harvest from the early planted seeds begins the last of July and continues without interruption until the vines are destroyed by frosts, unless they are seriously affected by some fungous disease, which of course is apt to occur in areas where cucumbers have been grown for a number of years.

Harvesting. Cucumbers intended for pickling purposes are harvested when they have attained a length of from 2½ to 5 inches. Because such cucumbers are bought by weight it will readily be seen that the small-sized pickles are less profitable to the grower than the larger ones; on the other hand, they must be secured before they have attained an unsalable size, for which purpose it is necessary to harvest the areas at regular intervals and to continue this routine throughout the bearing season.

Another point which is of special importance in the management of the cucumber patch is that none of the fruits be allowed to come to maturity. The ripening process, which means the development and maturing of the seeds, produces a heavy strain upon the growing plant, the life and yield of which is in proportion to the number of fruits which are allowed to ripen. If no fruits are allowed to come to maturity the plants will remain green and in an active vegetative condition longer and will produce a much larger aggregate number of fruits.

Cucumbers are usually pulled from the vines and placed in suitable receptacles, either baskets with handles or crates. The slat bushel-crate so extensively used in harvesting potatoes and apples is employed in many localities. The cucumbers are hauled directly from the field to the salting stations, where they are weighed and credited to the account of the man delivering them. The usual price per ton of cucumbers suitable for pickling purposes is $15, and the crops range from 3 to 8 or 9 tons to the acre. It is not at all unusual for farmers to secure a gross return of from $100 to $120 per acre from this crop.

As has already been stated the chief expense in connection with the production of pickling cucumbers is in the harvesting. There have come to the notice of the writer several instances of farmers offering one half the crop, after it has been grown, in return for harvesting the whole, and even on these terms the offer was not quickly accepted, indicating the attitude of labor toward this crop.

The salting station. The gathering points, or receiving depots, maintained by pickle factories in communities where cucumbers are commercially grown are called salting stations. The equipment of the salting station consists of a long, low building provided with a large number of wooden tanks, a common size of which is 10 feet in depth and 16 feet in diameter, with a capacity of about 1500 bushels. An ordinary salting station will hold 40 of these tanks, with a total capacity of 60,000 bushels.

As the cucumbers are received, if they are of comparatively uniform size, they are dumped directly from the receptacles in which they are delivered into the vats. The vats are first provided to the depth of from 12 to 18 inches with 75-degree or 80-degree Baumé brine, which is made by adding 2 pounds of salt to each gallon of water. As cucumbers are added, 100 pounds of salt for each 1000 pounds of cucumbers are scattered over the fruits, which means approximately 5 pounds of salt to each bushel of cucumbers. If it requires more than a single day to fill a tank, a quantity of salt should be scattered over the fruits before suspending work at night; and if Sunday or a holiday intervenes, the cucumbers should be salted and pressed under the brine from time to time during the interval. This will keep them from becoming soft and yellow. If the tank is not too large, a false head can be employed, which will serve to hold the cucumbers under the brine. In large tanks this is a troublesome process, and the customary means of protecting the cucumbers is to push them under the brine with a suitable paddle.

After the tank is full, and before the false head has been put in place, the weight of the cucumbers in the tank should be estimated and 1 pound of salt added for each 100 pounds of fruit. A part of this salt can be placed on top of the cover, and the tank then filled with fresh water until the liquid stands from 4 to 6 inches above the top of the cover. The salt should not be washed off the cover by pumping water on it, but the water should be pumped into a tube made of 6-inch boards long enough to reach from the top to the bottom and fitted to one side of the tank, so as to carry the fresh liquid to the bottom.

After this additional quantity of salt has been given, the brine should test between 65 and 70 degrees on Baumé's salt scale. After the tank has stood three or four days, the top brine will have lost strength until it has fallen to 35 or 40 degrees, when 4 or 5 pounds of salt to each 100 pounds of fruit should be added. After another period of four or five days, or as soon as the brine falls to 45 or 50 degrees, another addition of 4 pounds of salt to each 100 pounds of fruit should be made in the way above noted. After a week's time the brine will test about 55 or 60 degrees, at which point the cucumbers should keep well, the only additional attention necessary being to pump the brine over by means of a pump placed in the wooden box at the side of the tank, every five or six days for the first month, and once in three weeks or once a month thereafter as long as the pickles are held in the brine. The pumping over is for the purpose of raising to the top the heavy brine, which naturally settles to the bottom, and to cause the contents of the tank to be more evenly salted.

During the time the tank is being filled the brine is kept deep enough to cover the pickles at all times. After the tank has been filled with cucumbers, — that is, heaped up to a height of from 18 inches to 2 feet above the rim of the tank, — 1 pound of salt to each 100 pounds of cucumbers is placed over the top layer, as noted above. The false head of the tank is then put in place, stringers are laid on top of it, and the whole is weighted with barrels of salt or other material to force the cucumbers down into the tank and beneath the surface of the brine.

The gathering and handling of cucumbers at the salting station involve comparatively little expense, but because the cucumbers are not used immediately by the factories the capital invested is tied up for a long time. The fact that this salt stock can be held without material loss for several years places the pickling industry upon a comparatively safe basis. A crop failure in one locality in any particular year does not, as a rule, affect the work of the factory or change the price of fresh stock, for the reserve stock can be drawn upon for the needs of the factory.

There is no reason why the work of salting pickle stock should not be economically and satisfactorily done on the farm. The equipment necessary for this need not be expensive, and can be proportioned to the acreage of cucumbers grown. Small tanks or large casks can be used instead of 1500-bushel tanks. The brine will not freeze readily, and for that reason the shelter of any clean, fairly tight storage building will afford sufficient protection. Those engaged in the production of cucumbers for slicing purposes should provide an equipment sufficient to enable them to care for the product of their own fields when the shipment of slicing fruits becomes unremunerative. Such stock has a market value and would probably find a ready sale if the practice of salting were to become an established custom among growers.

Dill pickles. There is another alternative open to growers of cucumbers either for pickling or slicing purposes — the preparation of dill pickles, which are much prized and command the highest price among pickles. These can be made from fresh cucumbers as they come from the vines, or from vat stock which has been carried for some time at the salting station.

Dill pickles from fresh cucumbers are of high quality, but do not keep quite so well as those made from salt stock. In preparing fresh stock for dill purposes, fresh cucumbers as they come from the field are placed in wine casks from which one head has been removed. A layer of pickled dill and 1 quart of dill spice is placed in the bottom of the barrel. The cucumbers should be assorted carefully as to size, one grade of about 4 inches in length being placed in one receptacle and another grade of approximately 5 inches in length in another. After a cask has been filled, a layer of dill is placed over the fruits before the head is replaced. After the cask has been reheaded, the commercial practice is to remove the bung and fill the cask with a 45-degree Baumé test brine, adding 1 pound of porous alum[1] to each 45 gallons of brine. The cucumbers are left in this brine five days. The first brine is then replaced by a 30-degree brine, to each 40 gallons of which ½ pound of porous alum and 4 gallons of 80-grain vinegar are added, the whole heated to a temperature of 160 degrees before being placed in casks.

[1] Many hygienists and physiological chemists who are charged with the testing of foods to determine their purity and healthfulness discourage the use of alum in any form in food products, regarding it as deleterious to health. Some of the best manufacturers of pickles in this country state that they do not use alum in their preparations.

To make dill pickles from salt stock, the cucumbers are removed from the brine, placed in a processing tank and covered with fresh cold water, and allowed to remain twenty-four hours, after which the water is drawn off. The tank is then again filled with fresh water, to which are added 2 pounds of alum[1] and 2 ounces of turmeric to each barrel of pickles in the tank. The whole mass is then heated up slowly to a temperature of 130° F. The fruits are allowed to stand in this cooling mixture for twelve hours, and then are sorted and packed.

In filling the cask first place a layer of pickled dill herb at the bottom, then fill it half full of processed cucumbers, and add another layer of dill herb, at the same time inserting a quart of dill spice. This spice should consist of the following proportions of whole spices: 4 ounces of allspice, 2 pounds of crushed black pepper, 4 pounds of coriander seed, and 1 pound of bay leaves. After adding this spice and the layer of dill herb, complete the filling of the cask, but before replacing the head of the cask scatter another layer of dill herb over the top. After being reheaded, the bung is removed and the cask filled with dill brine consisting of ¼ barrel of dill herb, 1½ pounds of alum[1] and 100 gallons of 30-degree brine. At the time of filling the barrel 1 gallon of 50-grain vinegar is added to each 10 gallons of the brine. The brine should be allowed to stand twenty-four hours before using it to cover the processed cucumbers in the barrels.

DANDELION

Botany. The cultivated dandelion is the same as the wild plant so common in yards and in the fields of our Eastern states. It is a perennial introduced from Europe, but now naturalized over a considerable portion of the United States. The leaves, which are long, deeply and often sharply lobed, are all radical. The hollow flower stalk carries a single blossom head several inches above the root. The seeds are small, oblong, brownish in color, and retain their vitality two years. A gram contains 1200 to 1500 seeds.

Cultivation. The dandelion as a weed thrives in a variety of soils and situations, but when cultivated as a salad plant it gives

[1] See footnote, page 257.

most satisfactory results if grown upon friable, well-enriched garden soil. As the leaves are the part used for salad purposes, conditions which stimulate rapid luxuriant growth are most desirable.

The dandelion is extremely hardy and can therefore be planted early in the season. The plants which are to supply the markets are usually grown from seed sown early in the season, either where the plants are to mature or in seed beds from which the young plants are transplanted to rows from 14 to 18 inches apart and set from 6 to 10 inches apart in the row. When the seed is sown where the plants are to stand, the rows should be from 14 to 18 inches apart and the young plants thinned to give sufficient room for growth. The thinning should be done early in the season so as to give the plants ample time and space for development.

The plant is greatly improved in quality by blanching. This can be accomplished by mulching with straw in the autumn, covering with boards or earth, or by the use of inverted flower pots placed over the individual plants after the whorls of leaves have been lifted, drawn together, and tied with a soft material so that they stand in an upright position. The pot should be large enough not to press upon the mass of leaves. By placing a frame of boards, similar to that used for a cold frame, about a section of the dandelion area and covering it with sash early in the season, the plants can be forced into growth and the crop harvested several weeks in advance of the normal season. If the work of forcing and blanching under the frame is to be successful, the plants must be protected.

Varieties. Although the dandelion has not received attention as a garden plant for more than half a century, yet a number of distinct forms have been developed, differing widely in season of maturity, in type and size of leaf, as well as in yield.

EGGPLANT

History and tradition accredit the eggplant to India. In the New World it has become an important market-garden and truck crop, though not rivaling its close relative the tomato. It is raised over a wide extent of territory, but always in comparatively small areas. Its preparation for the table is not simple, and hence its use, while general, is restricted as compared with that of many other vegetables. The eggplant is a subtropical plant and tender to frost. It requires a long season for growth and maturity, and therefore is not cheap to produce.

Botany. Botanically, the eggplant belongs to the Nightshade family, which includes the potato and the tomato, but it is more closely related to the pepino than to either of these two. The Latin name given the plant by Linnæus is *Solanum melongena.* The cultural varieties of this species include a diversity of forms and colors chiefly in the fruit. In fact there are certain varieties of the

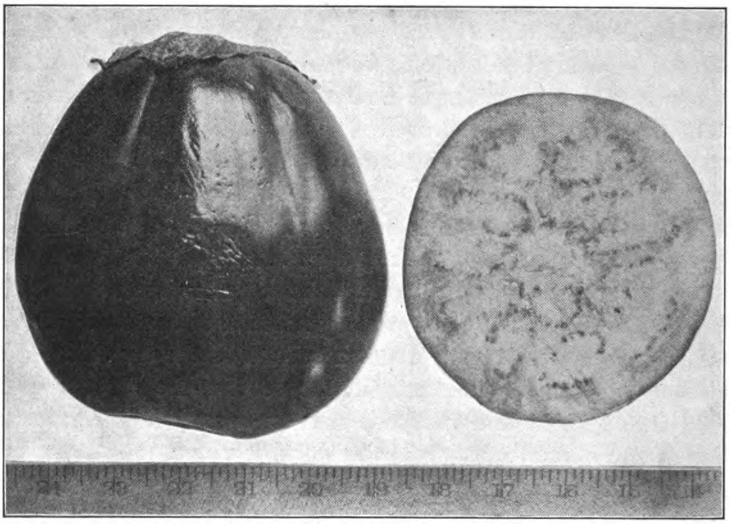


FIG. 95. Fruit of eggplant; whole, and cut to show seed cavity

eggplant which so closely resemble the pepper on the one hand and the tomato on the other, that only those familiar with these varieties can indentify them easily. In color the fruits vary from shades of purple and red to white; in shape some are like an egg, others like a tomato, while others are large and globular or elongated. Figure 95 shows the outline and cross section of a New York Purple eggplant.

Practically all the important commercial sorts of eggplant belong to botanical varieties of the species *Solanum melongena.* The common eggplant, or Guinea squash, to which our large-fruited forms like New York Purple belong, are grouped under the variety *esculentum.* The serpentine, or snake, eggplants are placed under the variety *serpentinum* by Bailey, and the Dwarf Purple eggplants, which are chiefly distinguished by their smaller fruits and the diffuse branching habit of the plants, under the variety *depressum*. An ornamental sort with strong spines and tomato-like fruits, known to the trade as Chinese Scarlet Eggplant, Ethiopian Eggplant, etc., which is of coarse, bushy habit, 3 feet or more in height, is classified as *Solanum integrifolium*. This sort probably came from Africa. Although there are a number of important varieties of eggplant varying in size, color, and form, the New York Purple Improved is the sort most universally grown.

Soil. Like many other garden plants, the eggplant gives good results on a great variety of soils if supplied with a liberal amount of plant food. A strong, moist loam, well stocked with plant food, supplies a most congenial environment for this plant.

Propagation. Since the eggplant is a subtropical plant requiring a longer growing period than the normal season at the North, to grow the crop successfully in the latitude of New York it is necessary to start the young plants either in the greenhouse or hotbed about March 10 or March 15. Young eggplants are more delicate than peppers or tomatoes and require more attention during their early life and a little higher temperature than either of these plants. The seeds are slower to germinate and must be guarded against all extremes of moisture during the germinating period. As soon as the first true leaves appear the seedlings should be transplanted to flats or pots, and kept growing, which will require both careful watering and a warm soil and atmosphere. Few garden plants must be grown with such close attention to certain requirements as young eggplants, but under congenial conditions they grow rapidly. It is not safe to place them in the open until all danger from frost is past and until both the soil and atmosphere are warm. Cold weather and adverse soil temperatures are very discouraging to this plant. The plants, when set in the field, should be placed so as to allow the use of the horse hoe in one direction — from 30 to 36 inches between rows, and from 18 to 24 inches apart in the row according to the soil and the variety.

Methods of cultivation. The plant should have the same general culture as the tomato or the potato. Horse tools, however, must not be used after there is danger of injuring the developing fruits. The area must be kept free from weeds by the use of hand tools. In some localities the plants are started early and carried in 6-inch pots in greenhouses until conditions in the open are favorable. Such large plants come into bearing immediately and give an early crop that can usually be marketed at a good profit.

Enemies. Young eggplants are apt to suffer severely from the flea beetle, which is often troublesome on garden plants, and also from the Colorado potato beetle, which seems to relish the eggplant quite as much as the potato. Bordeaux mixture is the best-known remedy for the flea beetle, and Paris green or arsenate of lead is the best means of destroying the potato beetle.

Harvesting. As soon as the fruits are well developed and colored they are marketed. The hard, woody stems are cut so as to leave the calyx attached to the fruit. Some of the earliest product is marketed by wrapping the fruits and shipping in splint baskets, but the greater part is shipped in crates like those used for strawberries or for muskmelons, holding from 32 to 60 quarts. The eggplant is not highly perishable, stands shipment well, and retains its form upon the market, but nevertheless it is not a highly remunerative crop.

GARLIC

In sections of the Gulf States garlic is grown commercially, but the home product forms only a small part of the total consumption of the country. Garlic is little used by the American born, but is found in all markets catering to the peoples of continental Europe.

Botany. Botanically, garlic is classed as an onion. It is perennial and differs from the common onion in that the commercial part of the plant is an assemblage of bulbs called cloves instead of one large bulb. The group of cloves composing the bulb is covered with a thin, parchmentlike, translucent skin or pellicle. The flower stalk, which is from 15 to 18 inches high, is similar to that of the onion, and bears both seeds and bulblets in the same head. The seed, which is black and angular like onion seed, is seldom used for propagating the plant, the cloves and bulblets giving better satisfaction.

Cultivation. Garlic thrives best on a well-enriched sandy loam. At the North the plantings should be made in April or May by placing the cloves 4 inches apart in rows from 14 to 16 inches apart, and covering them with 1 inch of soil. The soil should be kept loose and well tilled so as to prevent weed competition. As soon as the tops ripen down the bulbs are mature and should be harvested. The common practice is to harvest the bulbs with the tops adhering and to weave them together in such a way as to hold the bulbs on the outside of a braid of considerable length. If these braids are suspended in an airy place and protected from rain and frost the bulbs will keep for a long time.

The cloves are the only part of the plant used in cooking, and the chief use of these is in flavoring soups and stews.

HORSE-RADISH

Horse-radish was considered an essential of every old-fashioned garden. Somewhere about every old house site throughout the eastern United States horse-radish will be found; sometimes in a fence corner, sometimes near the pump. In many places it is the only mark left to indicate the site of an early habitation.

While formerly cultivated chiefly in amateur gardens, horse-radish is now extensively grown in a few localities as a commercial product. A section of country in the immediate vicinity of St. Louis is at present the chief center for the production of this crop. While always available in the markets, it is used only as a condiment. Its chief value lies in the pungent flavor, which renders it a pleasant relish much used in America during the winter and spring months in connection with cold meats and shellfish.

Botany. Botanically, this plant belongs to the same genus as cabbage, but, specifically, it is different from it, being known as *Cochlearia armoracia* L. (*Nasturtium armoracia* Fries). In its natural state it revels in moist lowlands, but under cultivation it thrives upon well-drained uplands. The chief drawback to its cultivation is the fact that when once planted upon an area it is difficult to eradicate; for this reason it is looked upon with disfavor by truckers and market gardeners. An interesting peculiarity of the horse-radish is that in this country, under normal conditions, it never produces seed. In fact, it reproduces itself so readily by division and by offshoots that it has practically lost the power of seed production. It frequently throws up blossom stalks, but seldom or never produces a capsule; and even when the capsules are produced, they contain only abortive seeds.

Propagation. Commercially, horse-radish is propagated by vegetative parts. The experiments conducted at Cornell University Experiment Station some years ago showed that good commercial horse-radish can be produced from cuttings not more than 1 inch long, planted in drills in much the same way as are beans. The usual practice, however, is to use the slender side roots, which vary in size from that of an ordinary lead pencil to ½ inch or more in diameter and from 2 or 3 inches to 6 or 8 inches in length. Long straight cuttings are best. These are set at intervals of 10 or 12 inches, in rows at such a distance apart as will permit cultivation with horse-power implements. The cuttings or roots are usually transplanted with a sharp dibble in the same manner as cabbage or other truck plants; that is, by using the dibble to make small openings for the roots and to firm the soil about them. This firming is done by inserting the dibble 3 or 4 inches from the root and with it pressing the soil in such a way as to fill up that part of the hole not fully occupied by the root and thus to establish the cutting. The long cuttings may also be set by means of a spade the same as is nursery stock.

Preparation of the soil. The land to be used for horse-radish should be carefully prepared by deep plowing, subsoiling, and the application of a liberal dressing of stable manure and fertilizer. Planting should be done early to give a long season, and the soil should be tilled deeply to permit the development of a long, straight main root. The larger and longer the root, the more valuable it becomes. Long cuttings set in subsoiled land and well cultivated should give good results. Clean cultivation such as is given potatoes will suffice for this crop.

Harvesting. At the approach of cold weather, horse-radish is harvested by plowing out the roots, cutting off the tops, and storing the trimmed roots in sand in suitable pits or cellars. Such of the crop as can be disposed of immediately is shipped in barrels to various markets, the stored roots being shipped as the market requires.

Marketing. In some of our larger cities, horse-radish can be marketed in carload lots, the price varying from $20 a ton to as high as $100 per ton. As horse-radish frequently yields from 4 to 6 tons per acre it is in general a profitable crop; but as the amount which can be used by any one market is limited, it would be an easy matter to have an overproduction of it. Before marketing, the roots should be washed to make them clean and bright and a part of the top should be cut away. For retail trade straight, well-formed roots are frequently offered for sale in small bunches; the usual practice, however, is to offer them in barrels.

Some growers, instead of selling their product as roots, grate and bottle it. While this requires a much larger outlay of both time and money, it is the most profitable method of marketing the crop. In nearly every city market place, there are stands where the grated fresh roots are offered for sale. It is also used to a large extent by pickle packers in the preparation of various mixed pickles.

KALE

Kale is the name given to a variety of nonheading plants of the Cabbage family. The diversity of forms in this group is well illustrated by the dwarf curled kale commonly cultivated for market in the neighborhood of Norfolk, Virginia, and the marrow kale, which is grown to some extent as a stock food in the Puget Sound region of the state of Washington. Figure 96 shows a field of kale of the dwarf type, while figure 97 shows a plant of the marrow kale.

Distribution. Kale culture in the United States presents an extreme illustration of the localization of an industry. Commercial kale culture is confined almost wholly to the immediate vicinity of Norfolk, Virginia, and to a limited area on Long Island, New York. This is not because kale cannot be grown in other localities, but is the result of peculiar economic and climatic conditions. Kale, like many other members of the cabbage group, thrives best under maritime conditions, such as are found in the Norfolk area and on Long Island. In order that kale may be harvested and marketed to the best advantage it must be grown where it can be harvested at any or all times during the winter. The mild climate characteristic of both Long Island and Norfolk provides these conditions. Kale is a cheap but bulky crop — two factors which require the least expensive type of transportation. As a rule it cannot be profitably grown at a great distance from the market unless cheap water transportation is available. Both Long Island and Norfolk have the advantage of water transportation and, as a result, the industry thrives in these localities.

Botany. Botanically, kale belongs to the Mustard family — Cruciferæ — and is known as *Brassica oleracea* var. *acephala.* It is in many respects more closely related to the wild cabbage

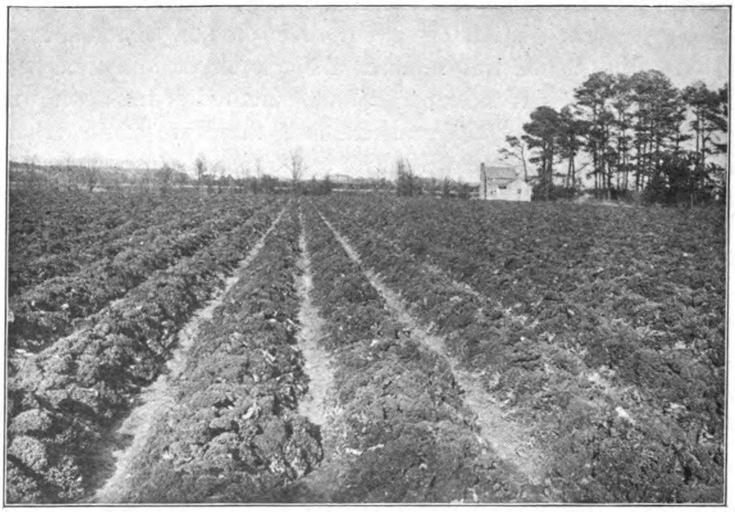


FIG. 96. Field of Scotch kale

than is the true cabbage of our gardens. The kales are interesting because of the great variation shown in size and conformation of leaf. Some idea of the range of this variation can be obtained from figures 96 and 97. The thickened stem of the marrow kale is an unusual development which marks a gradation between the true cabbage or kale and the kohl-rabi. The kohl-rabi is in reality a marrow kale with a globular stem instead of a long fusiform one, as is characteristic of the large stock-feeding form.

Kale is used almost exclusively as a boiled green, and for this reason it is most palatable when quickly grown and when very small and tender. At the prevailing prices it is not possible to market it at a profit when in prime condition, and as a result the markets are supplied with a large, coarse, bulky product which is apt to be tough and stringy. Kale such as can be had from the private garden is never found on the market.

Soil. The soil upon which kale is produced both on Long Island and in Virginia is a sandy loam full of organic matter. This, however, cannot be said to be the ideal soil for it, because, like other members of the family, it thrives best on strong, retentive soils. Like other cabbages it requires a liberal supply of immediately available plant food. Stable manure is the best fertilizer for it, but the same precautions must be observed for the control of clubroot, maggot, etc., as in the case of cabbage.[1]

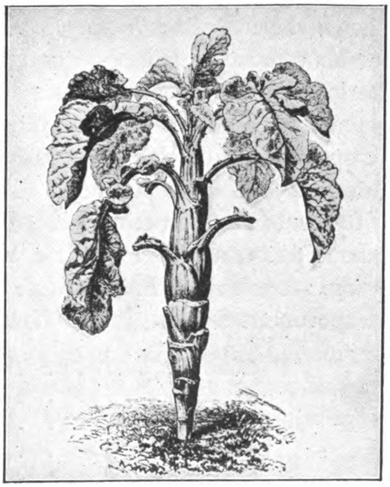


FIG. 97. Plant of marrow kale (after Vilmorin)

Planting. Kale is a winter crop and for this reason is handled much like late cabbage. It is planted early enough in the season so that the plants can attain their full development before cold weather. The seed is usually sown in the field where the plants are to grow, either in drills or with a hill-dropping drill. The usual time for sowing in the Norfolk area is from August 5 to August 20. A few growers are willing to risk seeding as late as September 10, but as a rule such late plantings do not return a profit. While kale is a hardy plant, it does not grow much after winter sets in, and as the value of the crop depends largely upon its bulk per acre, it is essential that it be well grown before severe weather.

Method of cultivation. The general culture of kale is the same as that of late cabbage. From the time the growing plants appear above ground they should be kept free from weeds. They should be thinned to stand 6 or 8 inches apart, to allow space for the development of the thick whorl of leaves at the top of the stalk.

[1] See pages 176–178.

As a rule kale is less affected by insects than heading cabbage, although sometimes seriously infested with aphis, the treatment of which is the same as for cabbage aphis.

Harvesting. The crop is harvested between December 1 and April 1, depending upon the state of the market. The crown of curly, fleshy leaves at the summit of the stalk is cut and packed in half-barrel baskets, or in veneer barrels 16 inches in diameter at the head and 28 inches high. Most of the crop is marketed in these barrels, which are closely packed and heaped above the chime. The burlap covering is drawn tightly over the whole by driving down the loose top hoop.

Kale must be shipped immediately after cutting, for it soon deteriorates. The large sorts usually cultivated for market yield, under favorable conditions, from 250 to 500 barrels per acre, and superior crops sometimes yield 600 barrels. The average yield is probably about 250 barrels per acre. The price is sometimes as low as fifty cents and sometimes it reaches $2.00, but the usual price is about $1.00 a barrel in New York. The cost of harvesting the crop, according to Professor T. C. Johnson of the Virginia Truck Experiment Station, is as follows:

Cutting	$0.05 per barrel
Barrel	.17
Burlap cover	.015
Cartage from farm	.05
Freight, Norfolk to New York	.15
Icing	.03
Total	$0.465

The crop is not expensive to produce, and when the yield and the price are normal it gives a fair profit. At $1.00 per barrel in New York the average crop of 250 barrels per acre should net the grower $100.00 per acre.

Varieties. The so-called Scotch kales are the strains chiefly grown for market in the Norfolk area, the Dwarf Green Scotch being the most popular. This is a good grower and returns a large yield per acre. Siberian, or Blue, kale is grown to a limited extent for the late spring market, as it can be planted from three weeks to a month later than the Scotch, but the latter is the standard for the autumn and the winter markets.

KOHL-RABI

This plant is little known and is not appreciated by Americans as much as it deserves. It is a near relative of the turnip and marrow kales, being in reality a turnip above ground. In quality and delicacy, however, it ranks with the cauliflower, and because of its simple cultural requirements and its high quality when well grown and harvested at the proper stage, it might with propriety be dubbed the "lazy man's cauliflower." The reason the plant is not popular is to be explained by the lack of knowledge of it. It is as delicate as a radish, must be quickly grown during the cooler seasons of the year, and must be used while young and tender, for it becomes passé as quickly as do spring radishes.

Soil. Rich garden soils and conditions suitable for the production of crisp, tender radishes are ideal for kohl-rabi.

Culture. Kohl-rabi can be seeded in place and thinned to stand 6 or 8 inches apart in the row, and will produce a good product at any season when quick growth is possible. Therefore to secure best results it should be planted in succession. Planting at intervals of two weeks should secure the proper sequence to maintain plants in prime condition. Kohl-rabi is one of the hardier members of the Cabbage family, and because of this hardiness it should find favor in those localities where the more exacting cauliflower cannot be grown.

Harvesting. The quickly grown, swollen stems should be harvested when not over 2 inches in diameter. Larger, slowly grown specimens are inferior in flavor and texture.

LEEK

Judging the popularity of these plants by their presence in American gardens, it is safe to say that the leek ranks next to the common garden onion. While it is not grown by truck farmers, it is frequently found in both market and kitchen gardens.

Botany. The leek is a hardy biennial producing a thickened stalk which resembles a "thick-neck onion," from the base of which roots are profusely developed. The arrangement of the leaves in a single plane gives the plant a peculiar fanlike appearance quite distinct from that of any of its close relatives. It is known as *Allium porrum*, but is coarse and more robust than most other garden alliums (as is indicated by figure 98).

Cultivation. This hardy, long-season plant thrives best on rich but well-drained garden soils. Alluvial soils, and mucks in which the organic matter has not become so finely divided as to become sticky, are well suited to it. It is propagated entirely from seed,

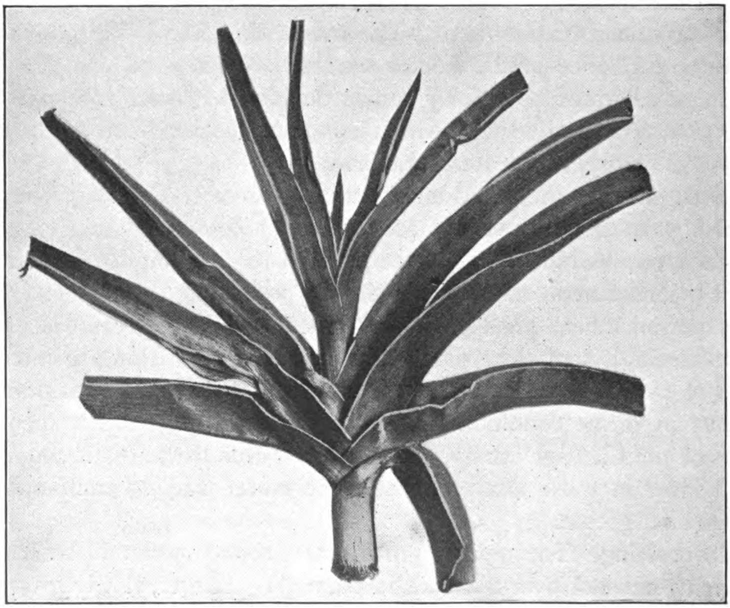


FIG. 98. Leek

which is much like that of the onion both in shape and in appearance. For the main crop the seed should be sown at the same time as early radishes, either broadcast in beds from which the plants are to be transplanted later, or better, in drills where the plants are to mature.

The lower part of the stem of the leek is the edible portion, and to render this mild and tender it is necessary that it be produced underground. This is accomplished in either of two ways: (1) by sowing the seed in furrows from 4 to 6 inches deep, covering it with about $\frac{3}{4}$ inch of soil, and after the plants have been thinned to intervals of 6 inches in the row, filling the trench with earth as the plants develop; (2) by sowing the seed in drills 15 or 18 inches apart, 1 inch deep, the same as onion seed, and banking earth against the plants as they develop. The young plants grown in the seed bed can be transplanted either to trenches or to level soil, the method to be followed in any case depending upon the texture of the soil, the rainfall, and the drainage. It will be best, however, to test each method of culture to determine the one best suited to a particular soil and given conditions.

High quality in this plant is obtained by vigorous growth and careful blanching. Seeds sown in the open in early spring should give a product for autumn use. An early crop can be obtained by sowing the seeds in a hotbed and transplanting the young plants to the open as soon as good growing conditions obtain. For winter use the plants should be lifted at the approach of freezing weather and stored in sand in a cool root cellar.

Uses. The chief use of the leek is for flavoring soups, salads, and stews, although the blanched stalks are sometimes boiled and served with a cream or butter dressing the same as onions and asparagus.

LETTUCE

Botany. Lettuce, known to botanists as *Lactuca sativa,* is the most important of the economic salad plants grown in America. It is represented in the United States by a wild form, a weed of considerable importance in some sections of the country. This "wild lettuce," *Lactuca scariola,* possesses many characteristics common to the cultivated form, and some botanists consider the two plants identical. The two intercross readily, thus showing their close kinship. Whatever the parentage of these plants, it is certain that the hand of man has worked miracles with the one which has been subjected to selection and cultivation.

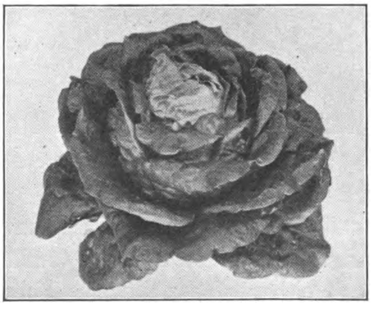


FIG. 99. Head lettuce, var. *capitata*

Types. In the lettuce of commerce three distinct types are recognized; namely, head, cutting, and Cos lettuces, as shown in figures 99, 100, 101. Besides these there is a fourth type, called asparagus lettuce, little known in this country but resembling the Cos type (see figure 102). Both the asparagus and the Cos resemble the wild lettuce of the fields more closely than do either the head

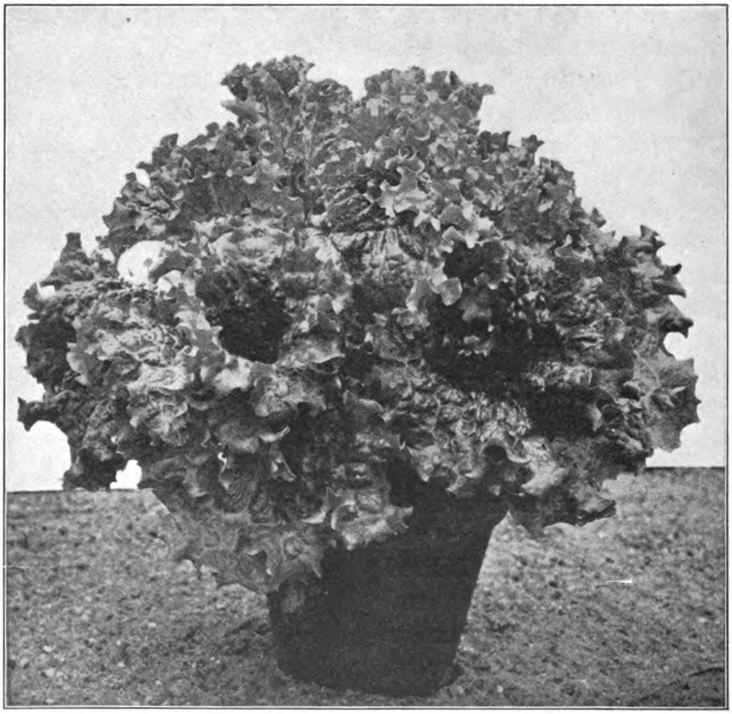


FIG. 100. Cutting (or cut-leaved) lettuce, var. *intybacea*

or the cutting type. They have long lanceolate leaves like the *scariola* and resemble it further in having a more acrid flavor than either of the others. These forms are regarded as botanical varieties and are recognized under the following names: head (or cabbage) lettuce, var. *capitata;* cutting (or cut-leaved) lettuce, var. *intybacea;* Cos lettuce, or romaine, var. *Romana;* asparagus lettuce, var. *angustana.*

Cultivation. Lettuce is the most universally cultivated salad plant grown in the United States. It is undoubtedly the most valuable from a commercial standpoint and holds an important place in the market crops of gardeners and truck growers. This is a result of the fact that it lends itself readily to a variety of methods of handling and with proper facilities can be grown at almost any season of the year. In fact, all the larger markets of the country are at present supplied with lettuce every month of the year.

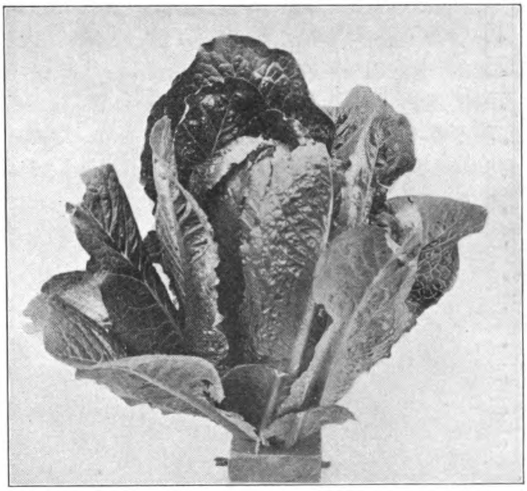


FIG. 101. Cos lettuce, var. *Romana*

Lettuce can no longer be spoken of as a crop of any special season, for even at the North it is grown as a field crop in spring and autumn and as a forcing crop during winter. At the South it is treated both as a field crop and as a frame crop. In order to treat the subject adequately, taking into account the conditions under which it is produced, it will be considered, as a field crop at the North; as a field crop at the South; as a frame crop; and as a forced crop.

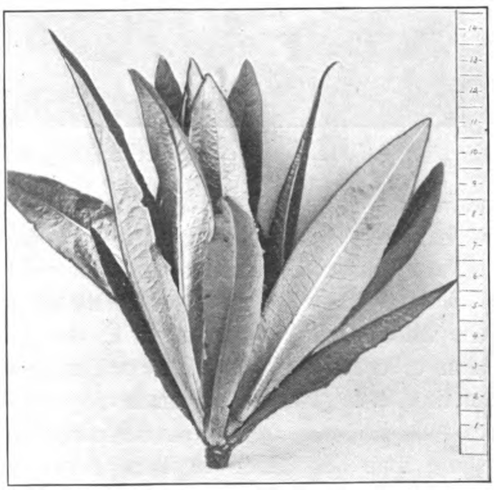


FIG. 102. Asparagus lettuce, var. *angustana*

Lettuce as a Field Crop at the North

The outdoor culture of lettuce is a minor industry in localities north of Baltimore as compared with that in the truck-growing regions south of that point. At the North but few extensive areas are devoted to lettuce alone, the almost universal practice being to use it as a catch crop with later maturing plants. For this reason the crop is usually started in hotbeds or frames and transplanted to the field, so that, strictly speaking, the plants are not field products but the result of a mixed system of handling. The young

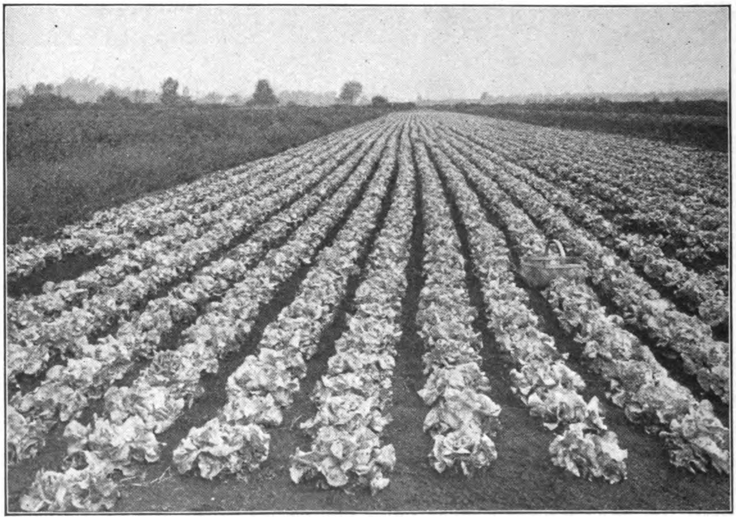


Fig. 103. Head lettuce in the open field at the North

plants are sown early enough in frames or hotbeds to allow them to have leaves 2 or 3 inches in length by the time the ground can be worked and it is safe to plant them in the open.

When lettuce is grown as a field crop, as shown in figure 103, the whole area is given up to it, and it is often one of a succession of crops such as beans, cabbage, or potatoes. A common method is to grow it as a catch crop between early cabbage, beets, carrots, potatoes, or some other crop which can be planted at the same time but which requires a longer period for its maturity. When grown as a field crop it is planted in hotbeds or cold frames, and later transplanted to the open or is sown in rows where the crop is to mature. If frame or hotbed plants are used, they are set at intervals of 10 or 12 inches in the row, and the rows as far apart as the method of culture to be practiced requires. If land is valuable and the greater part of the cultivation is to be done by hand, the rows should not be more than 12 or 14 inches apart; but if, on the other hand, the cultivation is to be done by horse power a greater distance must be allowed, from 18 to

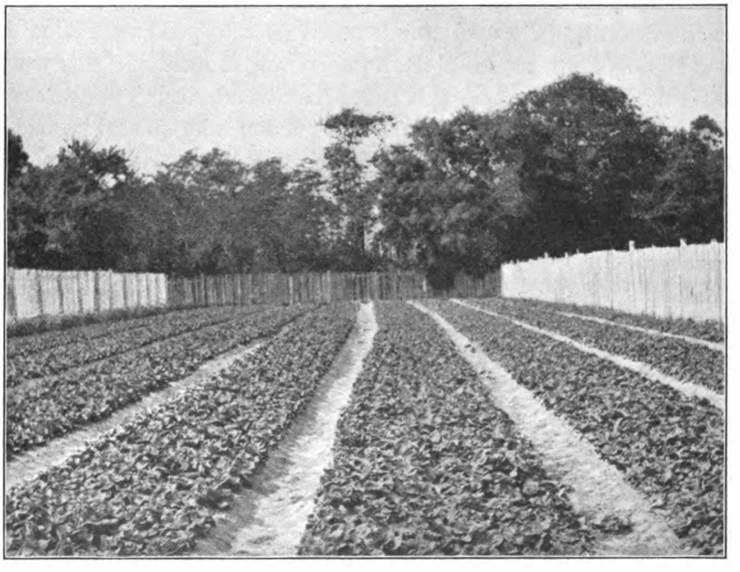


FIG. 104. Lettuce planted in beds protected by windbreaks

24 inches usually being sufficient. If the most intensive plan is to be followed, the land must be laid off in beds about 6 feet wide and the plants set 10 inches apart each way, with 18-inch alleys between to facilitate the work of cultivation and harvesting (see figure 104).

Kind of soil. When grown by this intensive method land which is rich and fertile, but sandy and well drained, is best. Such soils are what truck growers term quick, or early, lands. They come into condition early in the spring and admit of cultivation sooner than heavier and more retentive soils. While autumn crops may perhaps do best on a retentive soil, the spring crops must have a quick, warm soil in order to mature in time to be profitable to the grower.

Preparation of the soil. In growing lettuce as an early crop to occupy the entire area it will be an advantage to have the land cleared of all rubbish in the fall, deeply plowed, and thrown up into rough beds of the desired width; or if the crop is to be grown in rows the soil may be listed. With such fall treatment the spring preparation need not be delayed for the soil to come into condition for deep tillage. The surface of the beds and ridges will come into condition quickly and can be raked over to produce a suitable bed for the plants or seed. If horse power is available this work can be done with a weeder of the Breed weeder type, or with the Meeker harrow; if done by hand the garden rake should be used.

If, for any reason, deep spring cultivation is necessary the land should be plowed with a turning plow and then carefully pulverized and compacted. Pulverizing can be accomplished by using first the disk harrow, then the Acme harrow or a spike-tooth drag; followed by a plank drag or compress roller of the McColm soil pulverizer type, and as a finishing treatment the Meeker disk harrow. The soil will then be in fit condition for planting seed or setting the plants.

Seed sowing. The most convenient method of planting in cold frames or hotbeds is to sow the seeds ½ inch deep in rows about 3 inches apart. The marks should be made wide and the seeds scattered in a band or belt rather than in a narrow drill. Seed sowing in frames or hotbeds must, from the nature of the case, be done by hand. In the field, however, the seed drill can be brought into use and the seeds planted not more than ½ inch deep in continuous rows and thinned down to one plant, at intervals of from 8 to 12 inches, as soon as the plants are large enough. The plants taken out of the rows in thinning can be transplanted to extend the area. In fact, it is not an unusual practice to sow the seed in a few rows, which really constitute the seed bed for the whole field. Notwithstanding the succulent nature of its leaves and the fact that it flags quickly if exposed to sun and air when out of the soil or when it lacks an adequate supply of water, lettuce is a plant which stands transplanting well, for it recuperates quickly if proper precautions are taken at the time not to weaken the plants permanently. If the seedlings are lifted in clumps with earth adhering to the roots, placed in receptacles which will allow of moistening the earth and roots, and protected from the sun, the plants will not be severely checked and will recover quickly, provided the work of transplanting is done toward evening or upon a cloudy day. The mechanics and technique of transplanting were discussed in an earlier chapter (see pages 38 to 43).

Watering. If the soil in the field is dry and the use of moisture seems desirable, do not apply the water after the plants have been set unless it can be done in the form of irrigation either by flooding or by an overhead sprinkler system. If only a limited amount of water is available, it is better to apply it, at the point where the plant is to be set, twenty minutes or half an hour before transplanting. Under ordinary circumstances watering will not be necessary. Early in the season the soil is moist and the air is cool and carries a large percentage of moisture, which are congenial conditions for the young plants. Watering after the plants are set, by saturating a small area about the roots of the plant, has a tendency to cause the soil to bake; while if the water is applied before the plants are set, so that the soil has an opportunity to absorb it, the disturbance of the soil in setting the plant does not prove injurious. The skillful planter will leave a little loose, dry earth over the moist area after the plants are set, to act as a blanket to prevent rapid drying and baking of the surface.

Lettuce as a Field Crop at the South

Under favorable soil and climatic conditions in Florida lettuce is grown in the open as a garden crop during the winter for shipment to Northern markets, where it finds as its only competitor the forcing-house products from New England and the neighborhood of the large Atlantic coast cities. Outside of Florida, strange to say, it is in the vicinity of Norfolk, Virginia, that lettuce is most extensively grown as a field crop without protection. North of Norfolk conditions are too uncertain for such a crop. South of Norfolk, about Wilmington, Charleston, and Savannah, the plan is to grow two crops, — one to mature about Christmas time and the other in April, — but here lettuce is a frame crop rather than an outdoor crop.

The field crop at Norfolk, Virginia. About Norfolk lettuce is grown in the open in beds 5 or 6 feet wide and of any convenient length, the plants being set about 10 inches apart each way. The areas used for this crop are usually well-drained, sandy loam heavily treated with well-composted stable manure. In spite of the fact that the region where winter lettuce is grown in the open is almost entirely surrounded by the sea and has a naturally warm soil, the grower should take the added precaution to choose a location protected from the prevailing winds by natural barriers. An area in the lee of a forest of sufficient density and extent to break the wind is considered a desirable location. Growers seldom feel satisfied with this, and those who are most successful increase the safeguard by the erection of fences of various kinds around three sides of the area to be used for the cultivation of tender or extra early crops. The plan is to shut out chilling winds and husband the warmth of the sun. The fence acts as a windbreak and also as a reflector. The fenced areas vary in size from ½ to 1 acre and are usually somewhat longer than wide, having the opening to the south or southeast, in order to take advantage of the sun when lowest in the south. The beds usually run parallel with the longest line of fence.

Well-hardened lettuce plants set out in October will survive the winter and come into growth early in the spring in normal seasons, giving a marketable product early in April. There is always more or less risk in growing a crop as tender as lettuce in this manner, but the fact that it is successfully done with the present varieties by our most skillful cultivators indicates that, with the breeding of varieties especially adapted to this method of culture, the industry might be considerably extended. This is, to be sure, the most extensive plan of cropping used in the cultivation of lettuce.

The field crop in Florida. In Florida on suitable soil the crop can be successfully grown in the field, as shown in figure 105, with even less expense in the way of screens and windbreaks. The question of profit, however, takes on a different aspect. Lettuce can be successfully shipped only within certain limits; the express rates are also a limiting factor. This matter of expense can only be dealt with by each grower for himself. When express rates exceed 75 cents or $1.00 per half-barrel basket, it is questionable if a grower can make a profit on his crop even if his only competitors are the forcing-house men at the North.

To secure plants for the field crop the seed should be sown in a seed bed about September 15, and the seedlings transplanted to the field about October 15 and set in rows 2 or 2½ feet apart, at intervals of 10 or 12 inches. The area to which the young seedlings are to be transplanted should be thoroughly prepared and enriched by the use of stable manure and high-grade fertilizer. As a rule, it will be impossible to secure stable manure when the

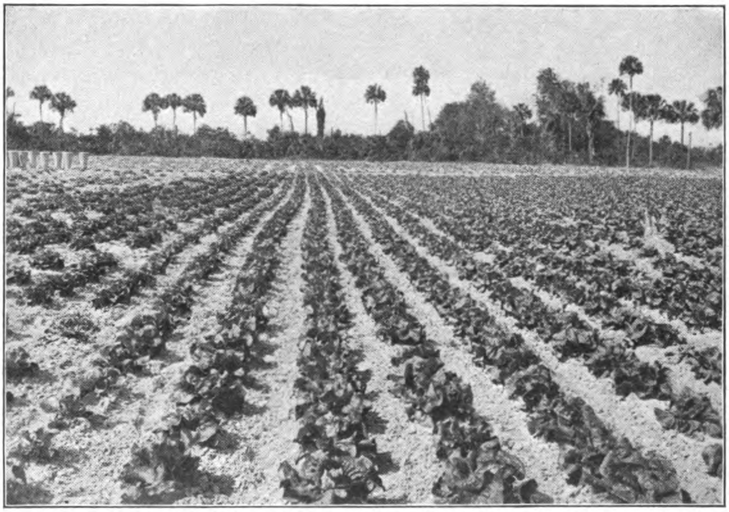


FIG. 105. Lettuce as a field crop in Florida

crop is grown on a commercial scale; but fertilizers carrying from 8 to 10 per cent of nitrogen, from 6 to 8 per cent of phosphoric acid, and about 6 per cent of potash, applied at the rate of 45 pounds to 100 yards of row, is the usual application. Fifteen pounds of this should be applied along the row at the time of transplanting, and the remainder divided into two side applications of 15 pounds each at intervals of two or three weeks after the crop has been set in the field.

The variety chiefly used for field culture in Florida is Big Boston or selections from it adapted to Southern conditions. The crop is harvested between December 15 and January 15. It is usually packed in half-barrel, Delaware-type baskets, or hampers, as shown in figure 106, and shipped by express; if shipped in carload lots, it can go by fast freight under refrigeration.

Lettuce as a Frame Crop

The use of frames, that is, hotbed sash over unheated areas, is not practiced at the North as much as at the South. At the North frames are used to bring on plants in the autumn and to

Fig. 106. Lettuce packing — Delaware-type basket

protect them during the winter without inducing growth. In this capacity frames prove useful with many half-hardy crops such as lettuce, cabbage, and rhubarb. North of Washington, D.C., frames are used only to a limited extent for bringing crops to maturity. If crops are to be forced in that latitude, it is considered more economical to grow them in regularly constructed, heated forcing houses or hotbeds than in frames. Farther south, however, where artificial heat is not necessary and where protection alone will serve to carry the plants through the winter, frames are more economical than cold houses. Even in localities where lettuce might be successfully grown in frames with glass protection, it is seldom done unless the sash are required for protecting some other crop. About Baltimore, Washington, and Norfolk, lettuce can be successfully wintered and brought to maturity in sash-covered frames in time to allow the same sash to be used for the protection of a frame crop of cucumbers. Such a system of cropping is very remunerative, for both a fall and a spring crop of lettuce and a crop of beets or cucumbers can be taken from the same area in a single season. This plan provides for a succession of crops and keeps the frames in constant use from December to May.

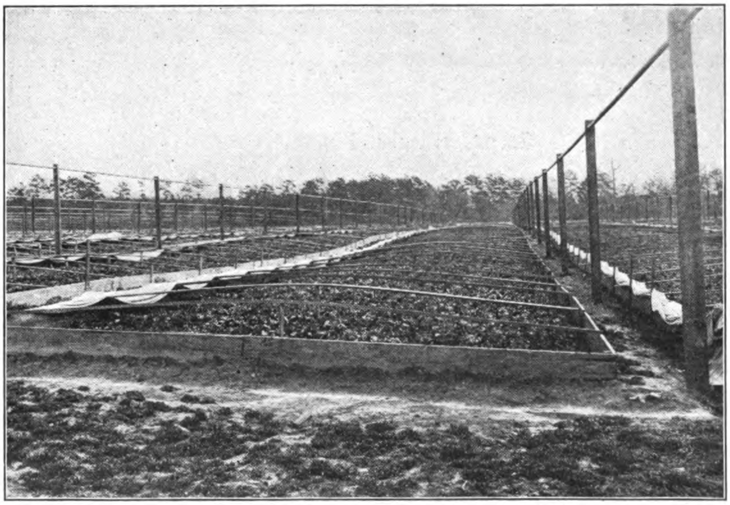


FIG. 107. Lettuce in muslin-covered frames

South of the limit for the economical use of glazed sash, lettuce is extensively grown in muslin-covered frames about 15 feet wide and from 100 to 150 feet in length, like those shown in figure 107. The treatment of plants in muslin-covered frames is the same as for those in sash-covered frames. The plants are grown in properly protected seed beds and, when large enough, are transplanted to the frames. In the neighborhood of Wilmington, North Carolina, the plants are set the last of October and harvested for the holiday market. A second crop is sown in December and put in the frames in January or February, to be harvested in April. This crop is usually followed by beans or cucumbers.

In the vicinity of Charleston, lettuce and cucumbers are used in succession under muslins or muslin-covered frames, but south of that point lettuce growers depend on natural conditions. The production of lettuce under muslin involves certain difficulties which cannot be dealt with as economically and as satisfactorily as in forcing houses. Yet because of the small expense involved in the erection and maintenance of cloth-covered frames, a grower can afford to take chances which would not be justified under glass. When successfully grown under muslin the crop is nearly if not quite equal in appearance to that grown under glass, but it is doubtful if its quality is as good. This is an open question and must be decided by each consumer.

Lettuce as a Forced Crop

The forcing of plants, as previously defined, consists in growing them out of their normal season. Lettuce when grown in greenhouses, hotbeds, or cold frames at a season when it cannot be grown in the open is a forced crop. No other salad plant and no other garden vegetable is so extensively forced as lettuce.

In the neighborhood of the large Eastern and Northern cities acres of land are covered by glass for the purpose of forcing this crop. The improved varieties of head and cutting lettuce, when grown under glass, possess a delicacy of texture and flavor which cannot be developed even by the most careful culture in the open; and for this reason the products of the large forcing establishments find a ready sale in the large cities where the superiority of such products is understood and appreciated.

Lettuce being a cool-season crop requires a forcing house, the temperature of which can be so maintained as to approach closely the normal spring conditions under which the crop thrives best.

The greenhouse. The majority of the houses constructed for the cultivation of lettuce are nowadays of the even-span type. They are usually frame structures from 4 to 6 feet high at the eaves, with glass sides carried to within 15 or 18 inches of the ground, the height of the ridge depending upon the width of the house. No benches are used, the beds being constructed on the surface of the soil. Paths are usually provided along the outside wall, from 6 to 10 inches below the level of the surface of the beds, and also at intervals of from 12 to 16 feet parallel with the long axis of the house.

In the early years of the extensive cultivation of lettuce under glass, flat-roofed, shedlike houses, with the long slope toward the south, were the type chiefly used. These houses were 4 or 5 feet high at the eaves on the south side, with a ridge 12 or 14 feet high, and a short span to the north with a wall of boards from 8 to 10 feet in height, as shown in figure 22, page 73. Houses of this type have been constructed to cover as much as 3 acres of land. While this was previously the prevailing type of structure for forcing lettuce, the even-span house on the ridge-and-furrow plan with solid benches is the type now preferred by the best lettuce growers.

Planting under glass. The seed is sown broadcast or in drills in the benches of a house, where a few degrees of bottom heat can be maintained. As soon as the lettuce has developed its first true leaves to the length of ½ inch or less, it is transplanted to an intermediate house, where the plants are set 3 by 3 inches apart and grown until the leaves begin to crowd. If only a small crop is to be grown, the young plants are set in thumb pots and remain there until the roots fill the pots and the leaves are 3 inches or more in length. From the intermediate house or from the thumb pots the plants go to the finishing house, where they are set 10 × 10 or 12 × 12 inches apart, the distance depending upon the type of lettuce grown. Cutting lettuce of the Grand Rapids type is usually set closer, 9 × 9 inches. Head lettuce, such as Tennis Ball and Big Boston, are set at the wider distances.

Soil for greenhouses. The soil for the seed bed should be a rich sandy-loam compost. The soil for both the intermediate house and the finishing house should be a rich clayey-loam compost containing enough sand and organic matter to prevent it from becoming puddled under heavy watering. As a rule, in the lettuce-forcing sections, if the soil in the houses is of a heavy, clayey nature, it can be easily and satisfactorily modified to meet requirements by the addition of well-composted manure and sand. The soil for large houses with solid beds is not prepared like potting soil; it is prepared in place upon the bed itself. The soil at the start is usually rich garden soil, which can be modified by the use of sand or clay to obtain the type desired, and enriched with composted manure and chemicals. Such soils can remain in the houses for many years, and in order to maintain maximum crop production on them it is necessary not only to keep up fertility but to use the utmost care to keep the soil free from harmful organisms. Many of the most destructive greenhouse diseases develop in the soil, and it has been demonstrated that they can be most successfully controlled by sterilizing the soil with steam (see page 24).

Temperature of greenhouses. Two methods of piping are chiefly employed in large houses. One is to place the heating pipes about 18 inches above the surface of the beds in such a manner that the posts supporting the roof can carry them. It is essential that the pipes be given a uniform grade. It is customary to space them so that they can be used as supports for boards upon which the workmen lie in planting and cultivating the crop. The other method of heating involves the use of manifolds to carry the required number of pipes to provide the necessary radiation. These coils are suspended well up on the side walls or division posts. If the house exceeds 30 feet in width and is located in a region of rigorous winter climate, additional coils are suspended on the posts supporting the ridge of the house. Because of the great length of these houses, and the difficulty of securing a sufficiently rapid flow of water to maintain the desired temperature with hot water, steam is generally employed in heating such structures. The temperature at which lettuce develops best has been found to range from 40° to 50° F. at night, and from 55° to 65° F. during the day. With the solid-bed system of construction these air temperatures will give soil temperatures somewhat lower than would be the case with raised benches.

Watering in the greenhouse. Lettuce, because of its habit of growth, is very susceptible to diseases, and, to overcome those which are most annoying and most destructive, growers resort to special methods of watering. The most satisfactory of these is subirrigation, by which it is possible entirely to prevent water from coming in contact with the foliage. When it is not practicable to use subirrigation, as is often the case with solid benches, water is applied from the open end of a hose carried close to the surface of the soil and between the plants, so as to avoid wetting the foliage, especially after the heads begin to form. When surface watering of this kind is practiced, the soil is thoroughly saturated, and as soon as the surface becomes sufficiently dry to admit of cultivation, it is stirred to prevent baking and to lessen direct evaporation. This makes a surface mulch of dry soil which helps to conserve the moisture of the soil and at the same time maintains a surface condition more satisfactory for the healthy growth of the plant than that produced by subirrigation.

Excessive moisture in the atmosphere, a wet surface soil, and sudden temperature changes are conditions most conducive to the development of rot and mildew. It will therefore be seen that watering is one of the most essential and most exacting operations connected with the cultivation of lettuce under glass. Some growers who make a specialty of head lettuce overcome the dangers of surface watering by providing a very deep soil containing a large percentage of organic matter. Such soils have a large water-holding capacity, and if they are thoroughly saturated before the crop is transplanted, it is found possible to bring the crop to maturity without overhead watering after the plants are once well established.

Ventilation of forcing structures. In constructing the forcing houses adequate provision should be made for ventilation,[1] for this is one of the most important factors in lettuce culture, whether in frames or in forcing houses. Intelligent ventilation aids in the control of the moisture conditions of the air and also of the temperature. With well-arranged ventilators it will be possible to provide for a constant change of air without permitting cold drafts to blow over the plants. Sudden changes in temperature are as detrimental to the crop as currents of cold air, and both should be avoided.

Insects. In both field and house culture lettuce is subject to diseases which often cause the grower much trouble, and sometimes result in a marked loss in the crop.

The green aphis, or green fly, is one of the most persistent and annoying insect enemies of lettuce, both in the open and under glass. This insect is a plant louse and, like all insects of its class, secures its nourishment by sucking the juices of the plant upon which it lives. Insects of this class are not provided with mouth parts for biting or eating the tissues of the host plant, but

[1] See Chapter IV, Forcing and Forcing Structures.

have a proboscis, or bill, which they force into the tissue of the plant to suck its juices. When present in sufficient numbers these insects make such a draft upon the juices of the plant that the infested leaves lose color, curl up, and soon die.

Treatment. Because of the manner in which the insect obtains its food it is evident that it cannot be contrȯlled by the use of poisons. The use of poisons on lettuce would also be precluded because of the fact that, although the plant grows from the center out like cabbage, yet its leaves are usually greatly convoluted and are capable of holding the poison on their surface. Moreover, both the outer and the inner leaves are used for human food without cooking, and even if they were cooked it would be dangerous to human life to use arsenical poisons upon them. The habits of the insect and the character and use of the plant make necessary an insecticide which is not poisonous but which kills by contact or by inhalation. This insecticide has been found to be suffocating gases, one of the best of which is the fumes of tobacco in some one of its forms. The burning of tobacco stems, and the destructive fumes of liquid tobacco extract, either evaporated over a low flame or placed in metal vessels into which hot irons are plunged, are effective. Other more convenient preparations, in the form of burlap or paper impregnated with a concentrated tobacco extract, are now on the market. These when burned in the atmosphere of a cold frame or greenhouse produce fumes destructive to insect life. Such insecticides, to be most effective, should be used in the following manner. Give three light treatments on consecutive nights and then wait until the presence of insects gives evidence of the need of another treatment. A good rule is to use the " smudge " for three nights, as above suggested, and then withhold treatment for ten days. The reason for the three treatments is that a few insects will escape destruction the first time and even the second, while the third treatment should kill all except those protected in some manner. The three light treatments are more effective in destroying the insects, and at the same time less harmful to the plants, than a single strong treatment.

While there are other insects which sometimes prove annoying to lettuce growers, there are none so persistent as the aphis and none which demand special consideration or treatment.

Diseases. Both forced and field lettuce are subject to two serious diseases — mildew and blight. These diseases are the result of an attack by a low form of plant life known as a fungus, which is a parasitic organism; that is, an organism which lives upon and derives its sustenance from other growing tissue.

Mildew. This is undoubtedly the most troublesome disease that the grower of lettuce under glass has to contend with. Plants affected with this show slightly discolored areas, — areas of a less intense green color or of a slightly yellow cast, — which later become either dry and dark or soft and flabby, according to the conditions in the house. In the advanced stage of the disease the tissue of the plant becomes covered with a growth which, to the casual observer, looks like ordinary mold and is the result of the development of the fruiting or reproductive portions of the mildew. All plants which show even the early stages of the disease should be removed and destroyed.

The best way to avoid mildew is to exercise special care in watering the plants. Water should be applied in such a manner as to prevent its coming in contact with the leaves, and then only on mornings of bright days; for cloudy, close, rather warm weather is particularly conducive to the development of both rot and mildew. Thorough ventilation and a careful regulation of the heat so that a night temperature of from 40° to 50° F. and a day temperature of from 60° to 65° F. can be maintained are the best safeguards against the mildew. If the disease makes its appearance in spite of these precautions, the heating pipes should be coated with sulphur, and, if possible, as a precautionary measure, such a coating should be kept on the pipes during the entire forcing season. In addition to this, if the outbreak is severe and threatening, sulphur should be distilled over a sand bath heated by a low flame, as described on page 251.

Rot. Lettuce rot, or drop, is the result of a parasitic organism, similar in many respects to the one causing the mildew but different in its effect upon the growing plant. While the rot sometimes causes considerable damage to lettuce under glass, as a rule it is much less troublesome under such conditions than when the crop is grown in the open or in frames where muslins are used for protective purposes. If the weather is extremely wet, or if it is unusually warm and moist, a large proportion of the plants may be destroyed by rot. In some cases a whole frame of several thousand heads of well-developed lettuce will be destroyed in two or three days. It is a trouble which is communicable from plant to plant; diseased plants should, therefore, be removed as soon as discovered.

The first indication of the disease is a slight wilting of the plant, followed by a quick collapse of all the tissue, and if the plant is not removed it soon turns into a putrid, decaying mass. The rapidity with which this rot spreads under favorable weather conditions renders it a much-dreaded disease. Besides the weather conditions mentioned above, excessive amounts of decaying organic matter in the surface soil of the lettuce bed are conducive to the development and spread of the rot. All stable manure or compost used to enrich the soil on which the crop is grown should be thoroughly rotted previous to its use, and when applied should be thoroughly incorporated with the soil. If the soil is highly charged with organic matter, and the rot is known to be troublesome in that region, a precaution which can usually be taken at small expense is to cover the surface of the bed to the depth of half an inch with clean creek or bank sand, preferably sand that has been sterilized by being heated or by having steam forced through it. If such sterilization is impossible, before setting out the plants use a mulch of clean bank or creek sand which is as free as possible from clay and organic matter. If this is impracticable, scatter a thin film of flowers of sulphur over the surface of the soil and also from time to time over the growing plants — before the formation of the heads, if a heading sort is grown. If sash are used, or are available, for covering infested areas grown in frames, the distillation of sulphur, as described on page 251, will prove of value. In regions subject to the rot, growers should avail themselves of every known means for holding the disease in check.

Varieties. There are a large number of distinct varieties of lettuce, each possessing special merit for certain purposes, but for commercial use the list is extremely limited.

The one fact which should determine the type of lettuce to be grown is the demand of the market. If the market prefers a cutting lettuce, grow that; if it demands a head lettuce, it will be financial suicide to grow any other. Having determined the type, the variety is not a hard matter to decide. There are several varieties of each type that sell well on the market. The only other point to be considered is the adaptability of a sort to the soil and climate, or, if cultivation is under glass, the matter to be considered is the preparation of a compost and the maintenance of conditions congenial to the variety to be grown.

Among the standard head lettuces are the following: (1) Big Boston, a large sort standing heat well and making good heads under rather adverse conditions; (2) Black Seed Tennis Ball, a smaller headed type of much the same character though less hardy; (3) California Cream Butter, a satisfactory sort for outdoor culture in some localities. Standard cutting lettuces are (1) Simpson's Blackseed, a strong growing sort well suited to either house or outdoor culture; (2) Grand Rapids Forcing, eminently suited to house culture.

Harvesting and marketing. The methods of harvesting and marketing lettuce are predetermined by two factors — the distance to market and the type of plant grown.

Gardeners who supply a local market where a small quantity of truck is handled frequently prepare their lettuce for market by lifting the plants with some earth adhering to the roots and placing them in small shallow boxes that will hold twelve plants. This enables the dealer to keep the plants in prime condition much longer than would be the case if the roots had been removed. This method of marketing is expensive, and when long-distance shipments are involved and railroad transportation becomes a factor, it is impracticable.

Lettuce for railroad shipment is cut close to the surface of the ground and all dead or discolored leaves removed. The heads are then packed either in barrels of cracker-barrel size made of slats or staves to give ample ventilation or, better, in tall barrel-high stave baskets of a half-barrel capacity. The cutting should be done early in the morning if possible, while the tissues of the plant are all tense and full of sap. Heads cut at this time will stand transportation better than those cut after the sun has shone upon them for some hours. The baskets, after having been packed closely, are covered with a slat top made to fit the rim of the basket, which is fastened in place by a wire or tin fastener. As soon as packed, the containers should be stored in the shade in the coolest possible location or placed in a cool room or refrigerator.

Shipment. Because of its perishable nature, lettuce must be shipped under the most favorable conditions. If less than car lots are to be shipped, express is the only satisfactory method. If carload shipments can be made, fast freight under refrigeration, on roads which give special attention to the movement of perishable products, will prove satisfactory. For distances exceeding 100 miles carload shipments must be handled in refrigerator cars, and for shorter distances cool cars will be found an advantage during trying seasons. There is one factor in the shipper's favor: lettuce for the early market is usually grown at the South in a warmer climate than that in which it is marketed, and therefore the shipments northward have a tendency to get cooled or chilled in transit. When weather conditions are favorable, artificial cold is not necessary but desirable.

Profit in lettuce culture. While lettuce is one of the most exacting truck crops grown by the gardener, when well handled it is one of the most profitable. Gardeners near the large cities in the North, who grow lettuce under glass, annually produce two or three crops of lettuce and one crop of cucumbers, tomatoes, or cauliflower. The lettuce will average from 60 to 75 cents per dozen heads for each of the three crops. Outdoor cultivators at favored locations along the Atlantic coast grow two crops of lettuce and one crop of string beans on the same soil in twelve months.

MUSHROOMS

The mushroom differs from all other garden plants in structure and conformation. Its requirements, too, are quite as distinct as is its conformation. While the cultivation of mushrooms is less certain than that of many plants, a successful crop is very remunerative, a good price usually being paid for a high-grade product. A number of gardeners in the eastern United States give the crop special attention.

Botany. Botanically, the mushroom belongs to a different division of the vegetable kingdom from the ordinary vegetables. It is more primitive both in structure and method of reproduction than any of the other vegetables. It is classified as one of the fungi, that is, plants living either as saprophytes upon decaying organic matter or as parasites upon living vegetable growths. While there is a great variety of so-called mushrooms, the only one extensively grown commercially is *Agaricus campestris*.

Propagation. The mushroom is propagated from vegetable parts known as spawn, which are really the subterranean parts of the plant known to botanists as the mycelium. The mycelium is induced to develop to a certain stage in a suitable matrix or material, such as stable manure and earth, and as soon as it is in proper condition its development is checked by drying the material in which it is growing. This material containing the dormant mycelial threads of the mushroom constitutes the commercial mushroom spawn. There are two types of spawn on the market — that made in brick form and known as English spawn, and that known as French spawn, which is loose and strawy in texture. Until a few years ago all spawn used in this country was imported, most of it being of the English type, but within recent years high-grade spawn has been manufactured in America.

Culture. The conditions congenial to the development of the mushroom are quite different from those required by green plants. The mushroom has no green parts, or chlorophyll, and therefore does not require light to carry on its normal functions, as do all green plants. While the mushroom will expand in the light, it does not require it. As a consequence its cultivation is largely carried on in sheds, cellars, caves, etc., where moisture and temperature conditions can be made congenial, but where no other type of gardening would be possible. Special pits and dark sheds are constructed in the vicinity of some of our large cities for the express purpose of growing this crop. In some localities abandoned mines are employed, as are also cellars and pits.

The requirements for success with this plant are (1) stable manure, chiefly from horses, which has not entirely lost the power of fermentation; (2) a constant mild temperature of about 65° to 70° F.; and (3) a moist atmosphere. In the moist climate of England it is possible to produce a crop successfully by ricking the manure in the open, as shown in figure 108, but this method is not to be depended upon in this country. In some seasons it will succeed, but the chances of failure in the eastern United States are great, as this section seldom has spring weather suitable for the development of the crop. It is therefore necessary to resort to pits, cellars, caves, and mines for the necessary environment, and even with good manure and a congenial environment the crop is not as certain as other garden crops. The manure for the beds should be carefully handled, fresh manure, which has been piled and carried through the first heat. It should then be transferred to the growing quarters and placed in long beds of convenient width, varying from $3\frac{1}{2}$ to 6 feet. The manure should be well mixed and

FIG. 108. Mushroom beds in the open

carefully packed, and the bed, when completed, should be about 8 inches deep. Special precautions must be taken to protect the bed from moisture, for imperfect drainage or drip from the ceiling would ruin the undertaking. After the bed has been made it is covered with from 1 to 2 inches of good garden loam. When the manure has attained its maximum heat, and its temperature has fallen to 75° F., the bed may be spawned. This is accomplished by opening the covering of loam at intervals of 10 or 12 inches in each direction and placing a piece of spawn about as large as a walnut in the manure just beneath the loam and then closing the opening. The spawn should be kept in a warm, moist place for several days before being inserted in the bed, since this treatment will stimulate its growth after it has been placed in the bed. If the manure is moderately moist and the loam is in condition to induce the germination of seeds, no moisture need be added; but if the loam is very dry it should be moistened by the use of a fine rose, but under no conditions should it be made wet. After the lapse of six weeks, provided the temperature has not fluctuated widely and the atmosphere has been moist, the crop should appear. Many different kinds of beds are made. Sometimes the manure is placed in mounds, sometimes packed in bins or boxes, and sometimes placed on board shelves, but in all cases the same directions for composting, packing, and covering should be followed.

As soon as the buttons appear the harvest may begin. The size of the plant will be determined by the uses to be made of it and by the market requirements. The plants should be removed from the bed by twisting them loose rather than by cutting. The breaks in the loam made in harvesting should be carefully filled so as to protect the living mycelium beneath and not destroy young plants. The buttons or caps are usually marketed in wooden pans holding from 2 to 6 quarts, although it is the common practice of the trade to sell mushrooms by the pound.

A few years ago one of our large native mushrooms, *Agaricus subrufescens*, was introduced into the garden. It is much larger than *Agaricus campestris* and is more easily grown, but as the spawn is not regularly prepared it cannot be used commercially.

MUSKMELONS

Because of the large number of forms and varieties of cultivated muskmelons existing at the present time, and because they were evidently widely scattered by the prehistoric peoples, it is difficult to determine the exact origin of this plant. It has been under cultivation since prehistoric times and is now found growing wild in both India and Africa; its original home may have been one of these countries.[1]

[1] For a full description of what is known about the history of this melon, the student is referred to De Candolle's "Origin of Cultivated Plants," pages 258–260.

Distribution. In America the muskmelon is more generally cultivated as a garden plant than any other melon. It is not, however, so valuable from an economic standpoint as either the watermelon or the cucumber; yet, because of the esteem in which it is held as a dessert fruit, during the last decade its cultivation has assumed important commercial proportions in those localities where it can be produced in its perfection. The superiority of melons produced in certain restricted areas is now well recognized, and the trade names in certain instances have been taken from the names of the localities in which the fruits were grown. This is true of the Rocky Ford melon, which is said to have been developed in a district in Colorado known as Rocky Ford. This melon is now widely advertised on the market under this trade name, although it was undoubtedly evolved from one of the old standard sorts known by another name, probably Netted Gem.

The muskmelon industry is somewhat localized, but much less so than the watermelon industry. In 1909 California led all other states in the production of muskmelons, according to the census report for that year, 5784 acres being grown. Colorado came next with 3970 acres, while New Jersey with 3861 acres was third; and Indiana with 3855 acres was fourth. Maryland followed with 3516 acres. Ten other states produced from 1200 to 2000 acres, but these five are the only ones which annually produced 3000 or more. Colorado, perhaps the most noted muskmelon-producing state, had an acreage of 2329 in 1899, which was much less than the acreage of 1909 in some of the states which have no reputation as melon-producing areas; however, in 1909 it stood second.

The importance of the melon industry cannot be judged by the extent of its cultivation in any particular region. It is of more universal cultivation by market gardeners and truck growers than the watermelon, which is grown as a special farm crop. In some regions, where the industry is given special prominence, it is carried on as extensively as other farm operations. The muskmelon, however, has an advantage over the watermelon in that it is grown not only as a field crop but as a forcing crop under frames and in greenhouses. In Europe, where the muskmelon cannot be successfully matured in the open, strains have been developed which are specially fitted for cultivation in the greenhouse and cold frame.

As a forcing crop. While muskmelon raising in the United States is characteristically an outdoor industry, there is an opportunity for the development of an important branch of the industry based on the very refined product of the forcing house. Such melons would find a ready sale even in cities which have a limited number of purchasers of high-grade products. The cultivation of this type of melon, either in forcing houses or in frames, is essentially the same as that of cucumbers. The most economical way of producing it seems to be as a catch crop in lettuce houses after the lettuce season has closed, in place of the usual cucumber crop.

The production of special varieties of melons in frames has grown to be an important and profitable industry in the neighborhood of certain Canadian cities, especially Montreal, from which city the industry as well as the melon grown has taken its name.

As a field crop. As a field crop the muskmelon is handled practically the same as the watermelon. The soil should be of the same general character, although the muskmelon will thrive well upon a more retentive soil than that suited to the watermelon. One composed chiefly of sand or sandy loam is most suitable. The best results are obtained in those localities where new soils from which the forests have recently been cleared can be used, but this is seldom possible, and such soils should be considered only as a possibility in the cultivation of the plant.

Preparation of the soil. The preparation of the soil should be thorough and complete. The work should be done early in the season so that several surface cultivations can be given with the harrow and other soil-stirring implements before seed-planting time arrives. Because of the more restricted growth of the muskmelon, it can be planted closer than the watermelon or the squash. A good distance is that given for planting cucumbers — 6 feet apart each way. The hills should be prepared in the same manner as for watermelons and squashes and, whenever possible, should be underlaid with a layer of well-rotted stable manure which is covered to the depth of 3 or 4 inches with soil. The seed should be placed 1 inch or $1\frac{1}{2}$ inches deep, with the surface of the hills on a level with the surrounding areas. With all cucurbits — watermelon, muskmelon, or cucumber — seed planting ought to be deferred until the soil is warm and all danger of frost is past. These young plants are very susceptible to cold and frost injury and are liable to be seriously stunted or entirely destroyed if planted too early.

Cultivation. The cultivation of the muskmelon should follow the same general plan as that of the watermelon, that is, clean cultivation during the early stages of growth for the purpose of clearing the soil of all weed growth and for the maintenance of a soil mulch to conserve moisture.

Insects and diseases. In certain localities the muskmelon is very susceptible to a disease called the wilt, caused by a fungus, Fusarium, which is able to maintain itself in the soil from year to year. Because of its unusual habitat it is impossible to treat this disease by ordinary remedial measures. The only means of preventing injury to a crop is to plant it on soil which has not been devoted to the cultivation of muskmelons for at least five years. In fact, no cucurbitaceous plant of any kind should be planted on soil which has been infested with this organism within five years.

The wilt may cause the destruction of the plants at any time after they appear above ground until the harvesting of the fruit. One of the worst features of this disease is that the plants are liable to succumb to it when the heaviest drafts are being made on them by the maturing fruits, thus leaving a large quantity of well-developed fruits without sufficient vine to ripen them properly. The result is insipid, ill-flavored fruits. Before the growers fully understood the cause of the trouble, — and, as a matter of fact, many of them do not yet properly appreciate this difficulty, — these affected fruits were placed upon the market with the result that not only has the consumption of muskmelons decreased, but buyers are very careful to secure fruits only from regions known to be free from this disease. The production of muskmelons in certain localities has been almost entirely abandoned because of this disease.

Besides the wilt disease, muskmelons both in the field and in the greenhouse are susceptible to injury from blight and mildew. Practically the same organisms which work on the cucumber affect the muskmelon, and the treatment must follow the same general plan. Spraying the plants from the time they are well out of the ground until the fruits are mature, at intervals of ten days or two weeks, with a solution of Bordeaux mixture, consisting of 3 pounds of copper sulphate and 5 pounds of lime to each 50 gallons of water, is the only known field treatment for mildew and blight. A simple yet very satisfactory device for making field applications of this mixture is shown in figure 109.[1]

The only insect enemy to whose attack the muskmelon is particularly open is the striped cucumber beetle, which must be treated as described on pages 235–238.

Varieties. As has been suggested, there is a wide difference not only in the size, shape, and color of the muskmelon, but in

FIG. 109. Device for spraying cucumbers in the field (after Orton)

the uses to which it is put. Few field varieties are well adapted to forcing and, on the other hand, none of the forcing varieties which have been developed in Europe under artificial conditions are adapted to outdoor cultivation in America.

Among the standard field varieties grown in the United States may be mentioned Hackensack, Jenny Lind, Netted Gem, Nutmeg, and Rocky Ford. These are so-called green-fleshed varieties. There

[1] See United States Department of Agriculture, *Farmers' Bulletin No 231.*

is another group which, as a rule, has a more strongly developed musk flavor and a red or salmon flesh. In this group are Emerald Gem, Paul Rose, Banquet, and Tip-Top. Besides being grouped according to the color of the flesh, muskmelons are also classified according to the markings upon the surface, and also according to the form of the fruits. There are the long, cucumber-shaped varieties, called Snake melons, and the short, turbinated varieties such as the Jenny Lind, with all the gradations from the fusiform to the globular. The markings on the skin are either netted or smooth, some of them, as in the Tip-Top, being almost smooth with comparatively few ribs, while in others the ribs and sutures are distinctly marked. Within recent years a group of soft-fleshed melons, sweet but lacking in muskiness, has been introduced from southern Europe into the irrigated sections of southwestern United States, where they have found favor. This class is little known to the Eastern markets, except in the so-called Christmas melon. The student of varieties will find this a very interesting class.

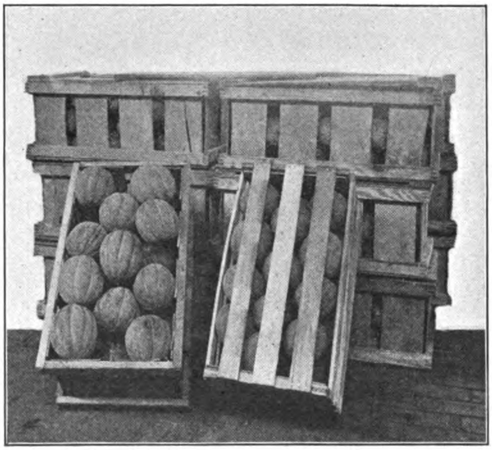


FIG. 110. Crates for shipping muskmelons

Harvesting and shipment. Muskmelons are seldom or never shipped in bulk in carload lots as are watermelons. The characteristic method of shipping them is in crates corresponding somewhat in size and character to the container for berry cups. The crates for the pint or quart boxes used in the shipment of raspberries, strawberries, etc., is one of the containers frequently employed for muskmelons. In some localities, instead of using crates of this kind, one like that shown in figure 110, which is similar to that used for the six-basket carrier of peaches, is employed. In other localities the Delaware peach basket is used, and in still others the

Climax basket, which has a handle and a raised, ventilated lid, as shown in figure 111. The fitness of these different receptacles for use in any particular section is determined by the distance to the market and the size and character of the fruits to be transported. From some localities in the vicinity of Boston, where the Montreal melon is grown, the fruits are packed in straw to prevent bruising and shipped in large hampers made of willow, which are returned to the growers after the melons are sold.

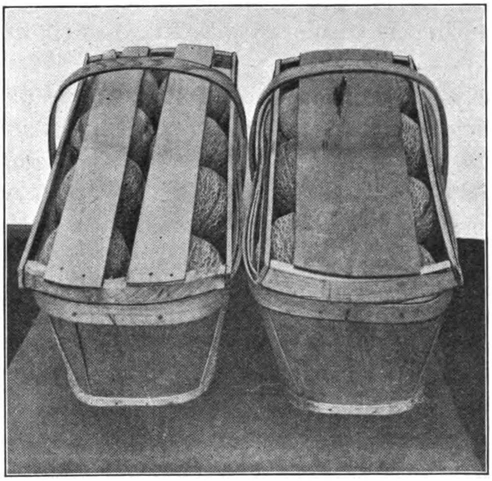


FIG. 111. Climax baskets used for shipping small melons (after Lloyd)

Muskmelons which are packed in any one of the receptacles described above can be transported long distances. The product from the Rocky Ford region of Colorado is marketed chiefly in the North and East, many of these melons finding their way into the Boston market.

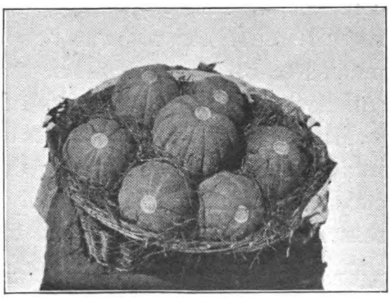


FIG. 112. Willow basket used in marketing Montreal muskmelons

Muskmelons in frames. In the Southern states muskmelons and watermelons are frequently started under forcing boxes, as shown in figure 32, or in cold frames, as shown in figure 12 (p. 55), to insure early fruit for a special market. This type of cultivation is not general. In the vicinity of Montreal, however, a very remunerative and quite extensive melon trade is wholly conducted on a plan which is a combination of hotbed and open-air cultivation. This is the center of the famous Montreal melon industry. The melons are very large, averaging 10 inches in diameter and from 12 to 30 pounds in weight, sometimes reaching 40 pounds. They are marketed in large willow hampers cushioned with straw, as shown in figure 112.

The crop is started early in May in hotbeds, and as soon as the season has advanced sufficiently to be frost free and the nights are not too cool, the sash and frames are removed to give the plants freedom. This is accomplished in a unique manner. As soon as the frames are well occupied by the plants, props are placed under the corners of the frames to lift them 4 or 6 inches from the ground. This admits air, and at the same time allows unrestricted development of the plants, the frame and sash still serving as a protection to the greater part of the plant.

The present industry does not fill the demands of the markets, and as a result this is one of the most profitable melon industries carried on in the New World.

Forcing muskmelons. As a forcing crop in America the muskmelon has not yet attracted special attention, although it is grown in a small way by nearly all owners of private estates where forcing houses are maintained. The high-grade melons with rich aroma and flavor and firm flesh, which have been developed for forcing purposes in Europe, are not properly appreciated by American consumers. This is probably due to lack of knowledge of these superb fruits. As soon as people have once acquired a taste for melons of this type, it will be only a matter of producing them in sufficient quantities to meet the demand.

Muskmelons lend themselves to the wants of the market gardener in a satisfactory way, for they can be used as a substitute for the cucumber crop, which is usually employed to fill out the forcing season after lettuce has ceased to be profitable. Plants for forcing should be started early in the season in practically the same manner as cucumbers. A good way is to take 3-inch rose pots, with about 1 inch of soil in the bottom, and place the seed of the muskmelon in these, covering it with about a half inch of soil, which will half fill the pots. As soon as the plants are well up and showing the first true leaves, fill the pots with soil, leaving only sufficient room for proper watering. After their first true leaves appear and the pots have become well filled with roots, shift the plants into 4- or 6-inch pots. As the last lettuce is being removed from the greenhouse, these pot-grown plants should be shifted to the bench, to stand about 18 inches or 2 feet apart if set in single benches. If double benches 6 feet wide are used, rows 15 inches from the edge will be satisfactory. In houses which have permanent benches of greater width the planting distance can be made 4 feet. A trellis shaped like the letter A should be provided, on which wires may be strung to act as a support for the plants, as shown in figure 113. Care should be exercised to tie them so that they will not be cut

FIG. 113. Muskmelons trained on A-trellis in greenhouse

by the wires. As the fruits develop and increase in size it will be necessary to provide a support for them also. This can be done satisfactorily by the use of ordinary quart berry cups. The fruits are placed in the cups, and a band of raffia is tied to each corner and carried over the top of the trellis. If the varieties are small, like the Blenheim Orange, the quart cup will be large enough; but if a larger-fruited variety is grown it will be necessary to use instead a board suspended by a band of raffia, tied as described above, or a piece of duck 6 inches square, to which raffia is tied at each corner.

Greenhouse cultivation. The greenhouse cultivation of muskmelons is practically the same as that of the cucumber. Careful attention to watering and ventilation is necessary. Like the tomato they demand a high temperature, ranging from 70° to 80° F. during the day and from 60° to 65° F. at night. They do not thrive well during cool weather or when there is little sunshine; they want full sunlight and a high temperature. Cool weather and lack of sunshine are conducive to enemies and diseases.

The soil for muskmelons should be a rich compost, loamy in nature, carrying a small percentage of sharp sand and an abundance of organic matter, but it should not be so rich as to produce vines at the expense of fruit. Excessive moisture and an abundant supply of available plant food stimulate too much vine growth and produce overgrown fruits which are not desirable.

In the greenhouse the worst disease of the muskmelon is the mildew, which can be held in check by carefully spraying so as to cover both the under and upper sides of the leaves with a solution of ammoniacal carbonate of copper. This does not discolor the fruits as does Bordeaux mixture and is quite as effective.

The insects most annoying to the muskmelon grown in greenhouses are the black and green aphides and mealy bugs, but careful spraying, and fumigation with mild forms of such materials as aphis punk, used at frequent intervals, will keep the house free from these insects.

Training the plants. If the plants are set 18 inches apart, two stems, each carrying two fruits, will be enough to allow to each plant. If the plants are set 2½ or 3 feet apart, three stems may be trained from each plant, with one or two fruits to each, according to the vigor of the plants. When the crop is grown early in the season care should be exercised to see that the flowers are pollinated in the same manner as described for cucumbers on page 248, as the muskmelon bears its flowers in the same way. If it is grown after lettuce, less care in this respect will be necessary.

Forcing varieties. The English forcing varieties are the only ones well adapted to this form of cultivation, the Blenheim Orange being one of superior merit for American conditions. The Netted Gem is sometimes used under glass, particularly under frames, and can be quite successfully grown in greenhouses.

MUSTARD

Mustard, as the name indicates, is a species of *Brassica.* The cultivated varieties, for the most part, belong to the species *B. alba, nigra, juncea,* and *Japonica.* The salad varieties, all of which are quite hardy, come mainly from *nigra,* although seed is taken from both *alba* and *juncea.*

Mustards are grown chiefly as salad plants, but in certain European countries and in a very restricted area of California they are grown for the seed from which is produced an oil that is extensively used. The mustard seed is also a commercial commodity in the form of the common condiment known as ground mustard. There are two sources of mustard seed—the high-grade planted crop of California and the volunteer crop separated from cereals. Mustard is seldom grown as a seed crop in the Northern and Eastern states. In the Great Plains area of the United States, mustard is a common weed in the fields of small grains, particularly oats. After threshing, the mustard seed can easily be separated from the oats because it is smaller, smooth, and round. Mustard is extensively grown in the Southern states as a salad plant. It is planted for autumn and for spring use. For this purpose seeds are usually sown in drills from 12 to 18 inches apart, and as soon as the leaves of the plant have developed sufficiently they are cut and used as greens, the same as spinach. A mustard plant of suitable size for salad purposes is shown in figure 114.

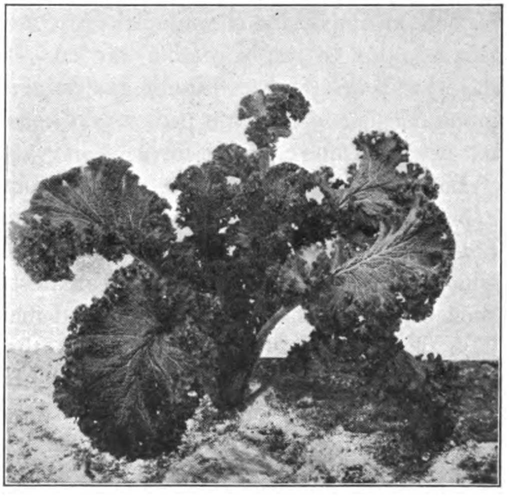


FIG. 114. Mustard suitable for salad

OKRA, OR GUMBO[1]

From time to time the list of American garden crops has been increased either by the addition of one already in use in the Old World or by the improvement and domestication of an indigenous wild species. In the case of okra the former is true, for it has been in use in the Mediterranean regions for centuries. In the Southern states it has been extensively used for many years, but up to the present time it has been cultivated to only a limited extent in the middle and northern sections of this country.

While okra has no great food value, and probably will never become an important commercial crop, a few plants make a desirable addition to the vegetable garden. It is used principally for flavoring soups, and to these it gives a pleasant taste and mucilaginous consistency. Some persons do not relish the flavor at first, but usually acquire a taste for it.

Botany. Okra, or gumbo, as it is commonly called (*Hibiscus esculentus* L.), is a tropical annual belonging to the order *Malvaceae*. This order includes some important economic plants, of which cotton and okra have the greatest commercial value, and such ornamentals as the abutilons and many varieties of hibiscus. The okra plant somewhat resembles the cotton plant, but has much larger and rougher leaves and a thicker stem. Its flowers are similar to those of the cotton in size, shape, and color. They are always single and show little variation in the different varieties.

Distribution. The original home of the okra plant is not definitely known, but it is either Africa, the West Indies, or Central America. De Candolle, after a discussion of the matter, concludes that it must have had its origin in Africa, since it is mentioned as having been under cultivation by the Egyptians as early as 1216 A.D., long before the discovery of America. The fact that many tons of okra pods are annually grown and consumed in Turkey, the northern part of Africa, and the Mediterranean region generally, and that its use in America is limited to recent years, would tend to strengthen the theory of its African origin.

The American seed-trade catalogues show okra entered under more than fifty varietal names, the greater number of which are

[1] Adapted from *Farmers' Bulletin No. 232* by W. R. Beattie.

synonymous. While the commercial value of this crop is not great, the demand is constantly increasing.

Okra may be grown throughout the greater part of the United States, but since the plant is of tropical origin and cannot endure frost, only one crop can be produced during a season in the northern part of the country. In the region of New Orleans successive plantings are made and a constant supply is maintained. Pods are produced very soon after the plants start into rapid growth and continue to form for several weeks, especially if all pods are removed while young and no seeds allowed to ripen upon the plants.

Soil. The soil best suited for okra is a rich mellow loam, plowed deeply and well pulverized. After the seedlings become established, growth is rapid and a large amount of available plant food of a nitrogenous nature is required. Quick-acting commercial fertilizers may be applied in moderate quantities, but should be well mixed with the soil. The same conditions that produce good cotton or corn will be found suitable for the production of okra.

Planting. Throughout the Northern states, on account of the short season, planting should be done as early as frosts will permit, which will usually be corn-planting time. In the Southern states, where a continuous supply of okra is desired, successive seedings four or five weeks apart should be made. Plant in rows 3½ feet apart for the dwarf types, and 4½ feet for the larger-growing varieties. Scatter the seed in drills, or plant loosely in hills, as with corn, and cover to a depth of 1 inch or 2 inches, according to the compactness and moisture content of the soil. The seeds may be planted with any good seed drill, but when placed in hills they should be separated 3 or 4 inches to allow space for the development of the stems. If the soil is reasonably warm, germination will take place within a few days; but if there should be a heavy rainfall in the meantime, the soil will need to be lightly cultivated between the rows, and the crust over the seed broken by means of an iron rake.

Method of cultivation. As soon as the plants are well established they may be thinned to 3 or 4 in a hill, or, if grown in drills, to 12 or 14 inches for the dwarf varieties and 18 to 24 inches for the larger ones. Vacant places occurring from failure to germinate may be filled in by transplanting. Cultivate the same as corn or cotton;

keep the ground well stirred and the surface soil loose, especially while the plants are small. After the leaves begin to shade the ground, very little cultivation is necessary except to keep the land free from weeds. A poor soil and insufficient moisture will produce pods of inferior size and quality. As the pod is the only part of the plant used for food, it is desirable to secure a rapid and continuous growth in order to produce the greatest quantity of marketable pods.

FIG. 115. Okra
A flower and edible pod in center; mature pods at either side (after Beattie)

Harvesting. As soon as the pods are large enough they should be gathered each day, preferably in the evening. The flower opens during the night or early morning and fades after a few hours. The pollen must be transferred during the early morning, and the pod thus formed will usually be ready for gathering during the latter part of the following day, although the time required to produce a marketable pod varies according to the age of the plant and the conditions under which it is grown. The pods should always be gathered, irrespective of size, while they are still soft and before the seeds are half grown. Figure 115 shows a flower and the pods formed the two previous mornings, the middle one of which is in the proper condition for gathering. The full-grown pods shown at the right and left of the flower were those allowed to mature for seed. The pods, after being gathered in large baskets, are sorted and packed for market in pint, quart, and half-peck berry boxes. To be in first-class condition the pods should reach the consumer within thirty-six hours after being gathered, but may be kept for several days in cold storage or in a cool cellar on wooden trays, on which they are thinly spread after being moistened. The pods should never be shipped in tightly closed crates or in great bulk, as they have a tendency to become heated.

Uses. The principal use of okra is in soups and various culinary preparations of which meats form an important part, as the so-called gumbo soups. The young seeds are occasionally cooked in the same way as green peas, and the very young and tender pods are sometimes boiled and served as a salad with French dressing. Both the stems and the mature pods contain a fiber which is employed in the manufacture of paper.

In countries where large quantities of the pods are consumed, they are dried and preserved to be used during the part of the year when a fresh supply cannot be obtained. There are several methods of drying. By one of these the pods are cut into slices crosswise and about a half inch thick; the slices are then spread upon muslin-covered frames and dried, after which the okra is stored in thin bags until required for use. By another and a more common method the very young pods are strung upon coarse threads and hung up to dry. In Turkey alone there are tons of the pods preserved in this manner each year. A variety much used for drying is that known as petite gumbo, or small okra. The pods of this variety are selected when only about a half inch in length and of uniform size. These are strung on a string of coarse fiber and hung up to dry.

No copper, brass, or iron cooking vessels should be employed in preparing okra, as the pods will be discolored. The cooking should be done in agate, porcelain, or earthen ware.

Varieties. There are three general types of okra: Tall Green, Dwarf Green, and Lady Finger. Each of these is again divided according to the length and color of the pods, making in all six classes or varieties as follows: Tall Green, long pod; Tall Green, short pod; Dwarf Green, long pod; Dwarf Green, short pod; Lady Finger, white pod; and Lady Finger, green pod. All variations from these are merely the results of mixtures, no true crosses or hybrids being formed. These mixtures are easily separated and referred to the parent type, and little attention to roguing and selection is necessary to keep the varieties pure. It is essential that the varietal strain should be pure in order that a uniform and marketable lot of pods may be produced.

ONIONS

The onion is a plant of very ancient origin and has been in cultivation from the earliest times. Because of its adaptation to a variety of cultural methods and the great number of uses to which it is put in the economy of the household, it is a vegetable of almost universal use, and is very widely and, in some localities, very extensively cultivated. It finds favor as a field crop in some sections of the United States and is grown in areas of from one to one hundred acres. With the market gardener it is both an autumn and a spring crop. In the spring it furnishes him a profitable return as bunch onions, which are usually produced from sets or top onions. In the autumn it yields a crop of mature bulbs which are always salable at a fair price.

As has already been suggested, there are numerous varieties and several types of the onion; some are adapted to Northern localities and others are best fitted for Southern latitudes; some are propagated from seeds, others reproduce themselves almost entirely by vegetative parts such as the bulblets at the top of the stalks, while still others reproduce themselves by subdivisions of the bulbs. Each of these different methods of propagation adapts the onion for a special use, which the modern market gardeners and cultivators have learned to take advantage of to meet the special demands which have grown up in the market.

Botany. Structurally the onion, *Allium cepa*, is a bulb and belongs to the same general class as the lilies. Notwithstanding the general grouping of all true onions under the name *Allium cepa*, there are a number of well-marked divisions of the species which are worthy of mention.

1. There is the general class of onions which produce normal *black seed* from which bulbs varying in size, color, shape, and flavor may be produced. This constitutes the great commercial class of onions grown from seed sown in place or sown in seed beds and transplanted to the field.

2. There is a second class of onions that normally reproduce themselves by segregation of the bulbs, in somewhat the same manner as garlic. This is the multiplier group. The potato onion, which belongs to this class, is quite hardy, requiring only

a good mulch as a winter protection. It forms the stock for the main fall-planted crop grown for early bunchers at the North.

3. A third class is also a set, or multiplier; but, instead of producing its increase by the breaking up of the mother bulb, a stalk corresponding to the blossom stalk in the common onion is produced, on top of which is formed a cluster of bulblets instead of the normal blossoms and seed. In some cases two or three clusters are produced one above the other on the same stalk, as shown in figure 116. In still other cases blossoms and bulblets will appear in the same head, and viable seed has been known to form.

FIG. 116. Bulblets produced one above the other on the same stalk

Variations occur in all cultivated plants; the multiplier and top-set onions have both developed under cultivation from the normal seeding type. These forms are distinct and breed sufficiently true to justify distinguishing horticultural names. At present they are recognized in the trade and have been mentioned in horticultural literature, but have not been given the botanical or horticultural distinction they deserve. The names accorded to these groups in Bailey's classification are recognized as appropriate; they are as follows:

1. All onions that are reproduced from ripened ovules (seed) may be classed as *Allium cepa.*

2. All onions that are normally increased or reproduced by segregation of the mother bulbs may be classed as *Allium cepa* var. *multiplicans.*

3. All onions that normally produce clusters of bulblets at the top of a seed stalk instead of blossoms and seed may be called *Allium cepa* var. *bulbellifera.*

For convenience the discussion of onions will be treated under the following heads: (1) Onions as a Field Crop at the North; (2) Onions as a Field Crop at the South; and (3) Onions as a Market-Garden Crop.

Onions as a Field Crop at the North

The bulk of the onions consumed in the United States are grown in Northern latitudes as what may be termed the autumn crop. This crop is produced in one of two ways — either from seed sown in the open where the plants are to mature, or from seed sown in hotbeds or greenhouses from which the young plants are transplanted to the field.

Kind of soil. Whatever the method of culture, the soil is one of the most important factors entering into the problem of the onion industry. The onion is comparatively quick growing, and as a large number of plants are allowed to grow on an acre, this means that a large quantity of plant food must be available for the crop. It is therefore necessary not only to have a soil that can be easily cultivated and worked early in the spring, but one that is naturally fertile, not subject to drought and yet well drained either naturally or artificially. The fact that few localities have soils possessing all these characteristics explains in a large measure the restriction of the onion industry to comparatively few and somewhat limited localities. Clayey soils that are stiff, hard to work, and slow to come into good condition in spring are not well adapted to onion culture; neither are very light, sandy soils, because these, as a rule, are subject to drought and do not hold fertilizers well. A somewhat retentive sandy loam or muck soil is preferable. Most of the great onion fields of New York, Michigan, and Ohio are located upon soils which are alluvial in character, having been laid down in early ages by streams of water or as lake beds. Usually these soils are well watered and contain a large quantity of decaying vegetable matter, which is essential to the successful growth of the onion. A sufficient quantity of sand to permit cultivation early in the season is also usually present in such soils, but this characteristic is not absolutely necessary to success in onion culture. A good sandy loam, naturally well drained, which can be easily irrigated or which is in a region not subject to droughts can, by the addition of green crops and stable manure, be made sufficiently rich to produce paying crops. As a rule, onion growers prefer dark soils to those that are light in color. Whether or not this is merely a fad is hard to determine; but, as a rule, dark soils warm up somewhat earlier in the spring than do the light ones, and since the early warming of the soil is essential to success in onion culture, this may be more than a fad.

Onion seeds are slow to germinate, and any method of cultivation or any soil that promotes the germination of the seed early in the season is an advantage.

Preparation of the soil. Soil for the successful cultivation of onions should be very rich. If the ground has not been previously used for market-garden purposes, the preparatory treatment usually consists in growing a crop of clover, cowpeas, crimson clover, or some other nitrogen-gathering plant, and plowing it under before planting the onions. This means at least one year of preparation. In addition to the turning under of the green crops, from 25 to 50 yards of well-rotted stable manure are necessary upon even the best and richest alluvial soils, and in some instances this is supplemented by from 600 to 1500 pounds of high-grade fertilizer in which the nitrogen used is in the form of nitrate of soda. A fertilizer containing 3 per cent of nitrogen, 6 per cent of phosphoric acid, and from 8 to 10 per cent of potash will be found advantageous on nearly all soils. Soils which will not be injured by exposure to freezes during the winter should be plowed in the fall. The green crops and the manure, unless it is very fine, should also be plowed under in the fall. Fine manure should be reserved for spring application and then disked or lightly plowed in. Peaty soils and those upon which heavy green crops have been turned under are apt to be acid. To remedy this, apply lime.

A deep seed bed is important for all truck crops, but no attempt to form one in a single season should be made. If the ground has already been cultivated to a depth of 6 or 8 inches, it would not be wise to plow more than 1 inch below this the first season ; but the plowing should be deeper each season until the seed bed is 10 inches in depth. As a rule, all deep cultivation should be done in the fall, and the ground left rough during the winter so that it will come into order as soon as possible in the spring. With some soils it may be advantageous to throw the earth into ridges with the lister in the autumn ; and early in the spring, when the tops of the ridges have dried out, to level the ridges and then bring the ground quickly into cultivation.

Previous to planting, the surface of the onion field should be made very fine and smooth and as level as possible. Implements suitable for this work are the disk harrow, which will thoroughly stir the soil and incorporate the manure and vegetable matter with it; the spike-tooth, or acme harrow, which will smooth the surface; and the Meeker disk harrow, which will leave the field in condition for seed sowing either by hand or with a seed drill. The Meeker harrow, illustrated in figure 33, is considered to be the most valuable implement that can be owned by the truck farmer, and especially by the onion grower; it will leave the soil in the same condition that raking with an ordinary steel-tooth garden rake would leave it. Previous to this last cultivation the fertilizer should be applied either with the broadcast fertilizer distributor, which should be followed by the harrow to work it into the soil, or with the ordinary grain drill. Drilling serves as a cultivation of the soil and at the same time incorporates the fertilizer with the surface soil of the seed bed.

Seed. Onion seed is not always of high quality. The grower should carefully test a sample of the seed he proposes to use far enough in advance of the normal planting season to allow time to replace it if it should prove not to be viable. Such a test may consist in planting a definite number of seeds, two or three hundred, in a box in a living room, or in scattering the seeds on a moist blotter and covering them with a second, the two to be placed in some receptacle that will keep them moist. Care should be taken to keep the germinating seeds at a suitable temperature — from 45° to 65° F. Either of these devices will indicate the quality of the seeds. If the seed is low in germinating power, it should either be discarded or a much larger quantity sown per acre than is normally required. It is not economy to buy cheap or inferior seed, for this is a comparatively small item in the total cost of producing a crop of onions. To secure a satisfactory stand of plants care must be used to get seed of a good strain, true to name, and of high germinating power. Onion seed contains a large quantity of oil, which readily becomes rancid, causing rapid deterioration in the quality of the seed. This means that old seed is apt to germinate unsatisfactorily. It is claimed, however, that deterioration is much more rapid in the climate of the Eastern states because the temperature and humidity are more variable than in the Pacific Coast states. Whether or not this is true, old seed is to be avoided.

Planting. In extensive plantations, where the seed is sown in the field, it is usually distributed by a hand drill of the type shown in figure 117. There are several makes of these implements upon the market, such as the New Model, Planet Jr., and Iron Age. In field planting, the seed is usually sown in drills from 12 to 18 inches apart, 30 or more seeds to the foot, and covered with

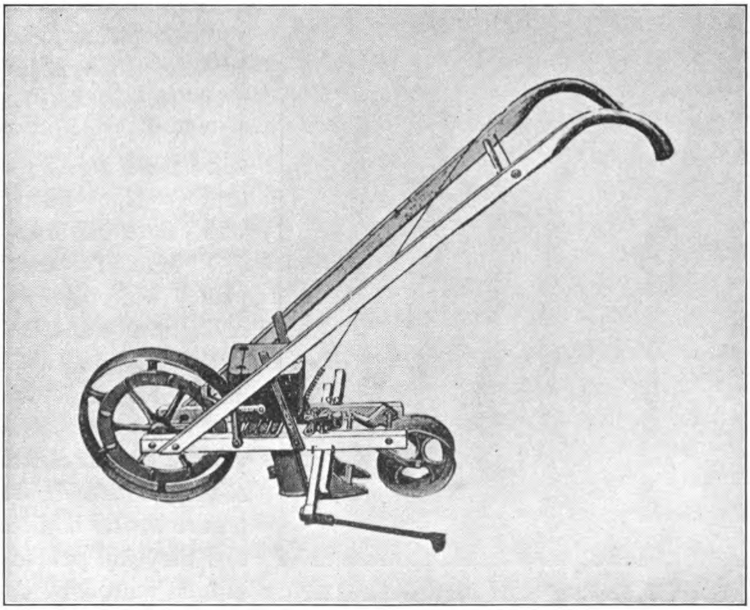


FIG. 117. Seed drill used for planting small seeds

from $\frac{3}{4}$ to 1 inch of soil. In order to insure rapid work with these seed drills, it is necessary that the ground be carefully prepared and that the surface be free from clods and vegetable débris. Ordinarily it requires from 4 to 6 pounds of seed to plant an acre when sown in this manner.

Another method of seed sowing is frequently employed by onion growers. The seed is sown in hotbeds about six weeks in advance of the time the plants can be safely and successfully transplanted to the open. The plants gain a decided advantage by this early start. In the latitude of New York the seeds may be sown in the hotbed between March 1 and March 15, while it is seldom possible to plant in the open at this time. Hotbeds are prepared in the ordinary way, heat being furnished by fermenting stable manure with 3 or 4 inches of rich soil placed over it, as described on page 59. The seeds are usually scattered quite thickly in drills about 2 inches apart, so that from 7000 to 8000 plants are produced under the standard hotbed sash, 3 × 6 feet. Since it requires something like 170,000 plants to set an acre, when placed 4 inches apart in rows 15 inches apart, it takes about 20 sash to supply plants for an acre. Between May 1 and May 15 these plants will be large enough to transplant to the field, and while danger from frost will not be entirely past, yet the plants can be so far hardened by exposure in the hotbeds that they will pass uninjured through the slight frosts that are liable to come after this date. The warm soil and the advanced growing season will stimulate rapid growth. The ordinary practice is to remove the seedling plants from the hotbeds, clip off a part of the root system, reducing the roots to stubs about ½ inch in length, and to cut the stem back so that from 1 inch to 1½ inches of the green portion remain above the white. This leaves plants about 4 inches long, as shown in figure 118. These stubby plants are then set in the field in rows from 12 to 18 inches apart at intervals of from 4 to 6 inches in the row.

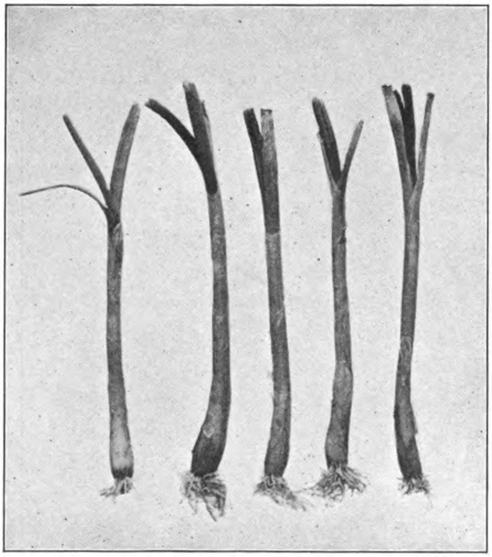


FIG. 118. Seedling onion plants prepared for transplanting

A common practice is to use a roller marker with check marks on it to give lines at proper distances for the onions. A boy inserts a dibble at each one of these check marks, a second boy drops a plant at each of the dibble holes, and a third boy follows to put the plant in position and firm it by a thrust of the dibble. The plant should stand about as deep as it stood in the seed bed. The advantages claimed for this method by its advocates are that the plants can be started very early in the season, that more tender varieties can be grown at the North than is possible under the method of sowing the seed in the open, and that the bulbs mature earlier in the season, thus placing the product on the market when there is less competition. The first crop of weeds can be killed by cultivation before the plants are set in the field. The work of thinning, which constitutes a large part of the labor of growing a crop when the seeds are sown in the open, is entirely overcome, and cultivation is no more exacting with the transplanted crop than with the seed-sown crop. Another advantage is that none but first-class plants find their way into the field. There is an unconscious selection of good plants at the time of removing them from the seed bed, as well as at the time of planting them in the field, so that a more uniform stand is secured than would be possible by the other method. Choice between these two methods, however, must depend largely upon the individual grower and the facilities which he has at his command. It is undoubtedly true that a large percentage of the onions produced in the Northern states will always be grown by sowing the seed in the open where the crop is to mature; at least until some satisfactory machine is made which will reduce the labor and cost of transplanting. The cost of the sash for starting the seedlings in hotbeds is an item to be considered and one that few extensive growers will wish to incur.

Cultivation. The after cultivation of the onion consists in keeping the ground well stirred at all times so that a slight mulch, about 1 inch deep, will be preserved over the surface and thus prevent rapid drying out and a weed growth that will compete with the onions. As has already been suggested, the crop which is grown from seed sown in the open must be thinned, for the seedling plants are often too thick to give room for the development of marketable bulbs. Thinning should usually be done as soon as the young seedlings have reached the thickness of a straw, and should leave the plants from 1 to 3 inches apart, according to the soil, the size of the bulbs, and the variety grown. This work must be done by hand, and can be greatly facilitated by any one of the forms of weeders shown in figure 8, page 38. Sometimes curved knives are employed, men and boys passing along the rows on their hands and knees, and cutting out the superfluous plants, leaving one or two in a place. If the plants are strong and large, only one is left at each place; if more than one is left, a second thinning is usually desirable.

With the crop grown from seed sown in the open it sometimes happens that the bulbs fail to mature as early as is desired. Sometimes the tendency is to produce thickened, or scullion, onions. When this is the case a light roller, made of thin boards or laths, is rolled over the field to break down the tops of the onions, bending them near the crown of the bulbs. A light, empty barrel will also answer the purpose. This operation checks the growth of the top and causes the nourishment to go to the bulb and stimulate it to more rapid growth. This practice also hastens ripening and will make it possible to market the crop earlier.

Harvesting. When from 60 to 80 per cent of the onions have ripened, — ripeness being indicated by the turning brown and breaking over of the tops, — the crop is sufficiently matured. All should be pulled and thrown into windrows, about 4 rows forming a windrow.

Pulling. Onions grown on an extensive scale are seldom pulled by hand. A common method is to equip a double-wheeled hand hoe with a U-shaped cutting blade, which can be passed along the row to cut the roots of the bulbs and at the same time slightly lift them. The bulbs are then raked into windrows to cure. If the weather is fair and the sun is not too bright, the onions will cure in from six to ten days. It may be necessary, however, to stir them lightly with a wooden-tooth rake from time to time, but this should always be done with great care so as not to bruise the bulbs, for this would result in early decay. If white onions are grown, greater care must be taken in this operation not to bruise the bulbs, for they are more tender than are the yellow and the red varieties.

If the sun is bright and hot during this curing period, it is well to scatter a very thin layer of straw over the curing windrows, or to carry the bulbs to sheds where they can be placed on elevated racks and protected from the sun but at the same time exposed to a free circulation of air. If, because of the heat or too frequent showers, some of the tops still adhere to the onions when they are to be removed from the field, the tops should be cut off to an inch above the crown of the bulb with a pair of scissors or sheep shears. The bulbs should then be spread thinly upon the curing floors, or on racks in open sheds where they can become thoroughly dried.

Topping. Topping is done either by twisting off the dry tops by hand or by clipping them off with shears of some sort. Hand methods are recommended for onions that are to be placed in storage, as the mechanical toppers often used in extensive field operations are apt to bruise the bulbs and cause them to decay in storage.

Storing and freezing. At the North, where the winters are continuously cold, and freezing and thawing can be prevented, onions are frequently stored and frozen. Sheds, barn lofts, or similar places serve as storage houses. Floors for such buildings are made of poles or of slats 2½ or 3 inches wide, with a space of 1 or 2 inches between them. This rack is then covered with clean straw or marsh hay to a depth of 3 or 4 inches, so that when the covering is pressed down it will form a mat about 2 inches thick. The onions are placed on top of this so as to make a layer from 3 to 6 or 8 inches thick. A second layer of straw is then added, and another layer of onions. It is best, however, to provide a separate rack covered with a mat of straw for each layer of onions.

If the season is not sufficiently advanced to freeze the onions at storing time, the building should be closed and the temperature held above the freezing point until settled freezing weather sets in, when it should be opened on cold nights to freeze the onions. They should be thoroughly frozen, and kept in this condition until frost is gradually drawn out of the ground by the warmth of the spring season. While the onions are frozen they should not be disturbed, neither should they be allowed to thaw before spring, as this would be destructive to them.

Storing in frost-proof houses. In localities where freezing weather is not continuous it is not safe to attempt to store onions in this way. Buildings like those shown in figure 119 are especially constructed for this purpose and, while frost-proof, are well ventilated and so arranged that they can be held with but slight change in temperature throughout the season. The bulbs are kept at a temperature a few degrees above the freezing point and are never allowed to freeze.

Bulbs stored in frost-proof houses are either handled in ventilated slat crates or spread in layers upon slat shelves similar to those used for the storage of squashes. A precaution taken in such a house is to leave a passage between the crates and the outside wall. It is also an advantage if the crates can rest on either a concrete floor or supports in direct contact with the earth. The jar and vibration of elevated benches and floors seem to interfere with the perfect keeping of the bulbs. The room should be kept dark so as to prevent growth; and should be moist, rather than dry, to prevent shrinkage. For further details concerning the construction of onion storage houses, see page 88.

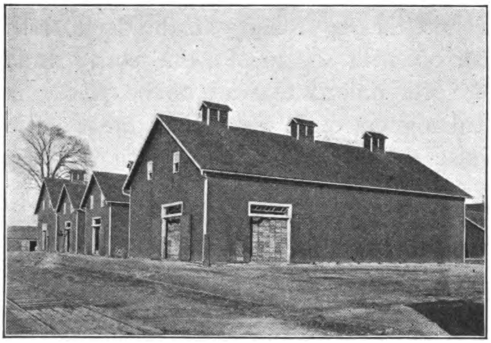


FIG. 119. Frost-proof onion storage houses

ONIONS AS A FIELD CROP AT THE SOUTH

Growing Bermuda onions. The Bermuda type of onion is now quite extensively cultivated in southern Texas. These onions require a somewhat longer season for developing than the hardier types grown at the North, and for this reason they have never found favor there except when grown by the hotbed method, known as the new onion culture. In subtropical regions of the South, however, this plant does well as a winter crop.

Seed of the Bermuda onion. The seed of this type of onion is not grown in the United States. Many attempts have been made to produce it here but without success thus far; that is, the seed grown here does not reproduce the same grade of bulbs as that produced by the seed grown in Tenerife. The seed crop of Texas is too uncertain and the yield too small to maintain the industry, and when produced in California the type is changed to such an extent as to render the resulting crop unsatisfactory.

This variety should be called Tenerife instead of Bermuda. The trade, however, recognizes this type under the name Bermuda, and it is likely that this designation will hold, regardless of the territory in which the seed or the mature bulbs are produced.

Soil for the Bermuda onion. Land which is naturally fertile, or which can be made rich by the addition of a sufficient quantity of stable manure or commercial fertilizer, should be chosen for this crop. Soils of a sandy, loamy nature are preferred, and if possible should be so situated that irrigation can be practiced; for, as a rule, the rainfall in this zone is not to be depended upon to make a satisfactory crop.

Cultivation of the Bermuda onion. Seed is seldom sown in the field where the crop is to mature, but in seed beds. These beds are from 12 to 15 feet wide, of any desired length, and very level, to permit of irrigation. The seeds are sown in drills from 3 to 4 inches apart, and the bed irrigated from time to time as is necessary to produce good strong plants. The seeds are usually sown about October 15, and the plants kept growing rapidly until the first of December, when they are transplanted to the field. In transplanting, the seedlings are drawn and set in exactly the same manner as described in connection with plants grown in hotbeds. The land on which the onions are to mature, if not perfectly level so as to admit of irrigation, is either laid off in beds or in contour lines to admit of applying water during the growing season. By the first of December well-grown seedling plants should have a thickness between that of a rye straw and that of a lead pencil. They are then dibbled out to stand 5 or 6 inches apart in the row, in rows 12 to 15 inches apart. Clean cultivation and sufficiently frequent watering to keep the plants constantly growing should be given until about the middle of March, when the water is withheld and the crop brought to maturity. The crop should, under favorable conditions, be ready to go into the market during the month of April or early in May. By intensive cultivation, supplemented by large quantities of stable manure or commercial fertilizer, as high as 40,000 pounds or 20 tons of onions have been produced on an acre. These onions, reaching the markets at a time when the stored crop grown at the North is nearly exhausted, meet with little competition.

Marketing the Bermuda onion. As Bermuda onions are somewhat milder in flavor than the Northern-grown stored product, the market will take a large quantity of these at good prices during the spring months. In other respects the crop is handled as described for the Northern-grown crop, but instead of being stored the onions are packed in slat crates containing 1 bushel and are immediately placed upon the market. This type of onion is very perishable and cannot be stored like the hardier onions grown at the North. It is therefore distinctively a truck crop, and one which must be handled quickly.

The Production of Onion Sets

The term "sets" is applied to seedling onions which have formed small bulbs (see figure 120) and have been brought to early maturity either by crowding or by insufficient nourishment. Several hundred thousand bushels of onion sets are grown annually in America. While sets can be produced in any region where mature bulbs for winter use are successful, the areas for their commercial production are at present confined chiefly to sections of Kentucky, Ohio, Illinois, and California. The Eastern product is chiefly used by market gardeners for growing early

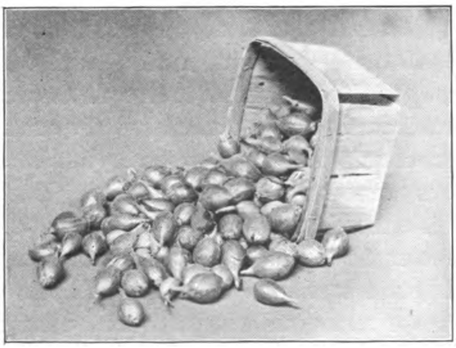


FIG. 120. Onion sets

bunch onions, and by amateurs for the production of early green onions or mature bulbs. The California crop is largely grown from pure strains of seed, large quantities of Silver Skin and White Bermuda being grown to ship to the Texas Bermuda-onion-growing section.

Soil and climate for onion sets. Onion sets can be produced in almost any locality where market onions can be grown. The soil should be only moderately rich and free from weeds. The character of the soil in different localities varies somewhat, but well-drained, sandy loam is best. In the vicinity of Chicago, sets are produced on prairie land the fertility of which is kept up by light dressings of stable manure. In California, sets are grown on alluvial land of a peaty character. The land should be prepared as early as possible in the spring and brought to a smooth, even surface, free from lumps or any refuse that will interfere with the work of drilling the seed.

Cultivation of onion sets. The principal requirement in the production of onion sets is to bring them to early maturity either by sowing thickly or by lack of plant food. As a rule, seed is sown in broad drills from 8 to 14 inches apart, the quantity of seed per acre varying from 40 to 100 pounds. Some growers use the ordinary hand seed drill which sows a single row; others use the same drill with a spreader on the shoe which scatters the seed over a space 2 or 3 inches in width, while in some sections a drill having 5 small points is employed. In California 6 or 8 drills like that shown in figure 151 are rigged to operate by horse power or other power. It seems to make little difference which method of sowing is followed so long as the seed is applied at a very heavy rate and a uniform stand is obtained. The single broad rows about 10 inches apart seem to be most satisfactory and economical. The seedlings generally appear within ten days after the seed is sown, and constant cultivation is required to keep the surface soil loose and the ground free from weeds. The tools generally employed are the wheel hoe and the ordinary hand hoe; occasionally small hand hoes or knives are required to keep weeds from spreading among the plants. No horse tools can be employed in the cultivation of sets because the plants are small and delicate and because of the narrow space between the rows.

Harvesting onion sets. About midsummer the sets "bottom," or form bulbs, and are ready for pulling as soon as the tops begin to die. As a rule, they should not be allowed to remain in the ground until thoroughly ripened, for the ripening process has a tendency to cause them to shoot to seed when planted the following spring. The most satisfactory plan is to remove them from the ground just a little before they are ripe, and thus suspend growth until they are replaced in the ground the following spring.

FIG. 121. Onion sets stacked in the field to cure

The sets are loosened by means of a fork or by a cutting blade attached to a wheel hoe frame. These cutting blades are usually in the form of the letter U, and are sharpened on the front edge so that they will lift the sets as the frames are pushed forward. After being loosened the sets are pulled by hand, and the tops are either twisted off immediately or are placed in small piles or in windrows to dry (see figure 121). When placed in windrows or stacks they are so arranged that the tops will protect the bulbs from the sunlight. From 8 to 12 rows are brought together and piled into a long, narrow windrow. If the tops are removed immediately, the bulbs are placed about 3 inches deep on slat-bottom trays, which are packed with air spaces between, in an open shed where they will dry as rapidly as possible. If the sets are dried with the tops adhering, they are cleaned in the field by being rubbed over a screen and then placed on trays or in shallow crates until required for market. Onion sets may be stored in any building where they will be protected from extreme freezing, but they require an abundant circulation of air. After they are thoroughly dried they should be passed through a fanning mill to clean out the particles of tops, shriveled bulbs, dirt, or other refuse.

Marketing onion sets. In placing sets upon the market they are packed either in ventilated barrels or in bushel crates. They are sometimes handled in bags, but in these they become injured in handling. In storage, the sets are kept as cool as possible to prevent their sprouting before time for their sale in the spring.

The Production of Green Bunch Onions

Early bunchers from potato onions. Market gardeners in the neighborhood of large towns and cities annually use large quantities of onions known as potato onions and set onions in order to produce the green bunch onions which are found in the markets early in the season. The potato onion is one that propagates itself by vegetative parts, by the division of the bulb. Large bulbs are planted in the spring or in the autumn, and the product is a large number of small bulblets. These are planted the succeeding autumn to produce bunch onions for the next spring market. The common practice is to select an area of well-enriched and well-drained sandy loam and, about October 15 in the latitude of New York but earlier farther north, to set the small potato onions in rows 15 inches apart and 2 or 3 inches apart in the row. As soon as the ground is frozen the planted area is mulched with strawy manure, which is allowed to remain until the succeeding spring. The onions will not be injured by remaining frozen during the winter, but the mulch should be thick enough to prevent alternate freezings and thawings. With the approach of spring, top growth will begin and the mulch should be removed, after which the onions will soon attain marketable size, for salable condition is determined more by the size of the tops than by the size of the bulbs.

Bunch onions from sets. The set onions may be tiny bulblets produced at the top of the stalk of a type of onions that reproduce themselves in this manner. Commercial onion sets are, however, more often produced by sowing ordinary seed of the onion very thickly in broad rows. Set onions of this type are usually planted in the spring rather than in the autumn and are used for the same purpose as are the potato onions.

Seed growing. For the selection of soil and the methods of preparing the ground, cultivating, fertilizing, and storing the bulbs from which the seed is to be grown, the directions already given are applicable. After the soil has been properly prepared, cover the onions in trenches 4 or 5 inches deep, allowing about 6 inches between the bulbs. The rows, if to be worked by hand, should be from 14 to 18 inches apart; but if horse power is to be used, they should be at least 2½ feet apart. In the East it is important to plant the onions as early as the spring weather will permit. In the seed-growing sections of California the winters are not severe, and it is the common practice to plant in the autumn.

After the seed stalks are well started, the soil should be thrown to the plants to give them the necessary support. This should be done several times during the season, finally leaving a ridge 7 or 8 inches high. Some growers prefer to support the plants by means of twine stretched on either side of the rows.

After the last cultivation the plants should be disturbed as little as possible until the time for harvesting. Promptness in harvesting is very important, for if delayed too long the seed receptacles burst open and a part of the crop will be lost in handling. When the tops assume a yellowish appearance, remove them with 5 or 6 inches of the stem and, if overripe, deposit in tight vessels or in cloth-lined baskets to prevent loss. The entire crop does not mature at the same time, and it is therefore necessary to make three or four cuttings in order to remove the seed at the proper state of ripeness. Until dry enough for threshing, the tops should be stored in well-ventilated rooms having a tight floor. Frequent turning of the tops will hasten their drying and shake out more than half the seed. The remaining seed may be removed by flailing. In California, where there is little danger from rain, the seed heads, as they are cut, are spread upon sheets and frequently turned until dry enough to thresh. Cleaning is done by repeated winnowing and by washing in buckets or tubs to separate the light seed and chaff that the winnowing fails to remove. The seed must be thoroughly dried and stored in a place free from excessive moisture.

Insects and diseases. *Onion maggot* (*Phorbia ceparum*). This is one of the most destructive insect enemies of this vegetable in both Europe and America. The eggs are deposited on the plants near the ground, and require about a week to hatch. After the eggs have hatched, the larvæ burrow into the bulbs and remain for about two weeks, when they emerge, pupate in the ground, and the adult insects which develop deposit their eggs for another generation. The larvæ cause the plants to turn yellow, wither, and finally die before the bulbs have matured.

Such preventive measures and remedies as the following have been suggested: the application of unleached wood ashes and charcoal spread over the beds; the use of gas lime between the rows; the sowing of potash salts; rolling the beds before sowing; growing the bulbs in trenches; drawing the earth about the plants as they grow. Planting in a new location each year is perhaps the most effective preventive.

Carbolic-acid emulsion has been found by the New York Cornell Experiment Station to be an effective remedy. The emulsion is made by dissolving 1 pound of hard soap or 1 quart of soft soap in 1 gallon of boiling water, to which 1 pint of crude carbolic acid is added, the whole being stirred into an emulsion. One pint of this added to 30 quarts of water and poured around the bases of the plants, about 4 ounces per plant at each application, beginning when the plants are set out and repeated every week or ten days until the last of May, will prove effective. To bring about the best results, some of the earth should be removed from about the plants before pouring on the emulsion. Such treatments, however, are out of the question in commercial practice.

Onion thrips. This is one of the insects that secure their nourishment by sucking the juices of the plants which they attack. The thrips is very troublesome to onions that have suffered a check to their growth. The insect attacks the leaves, causing them to assume a dull gray or dirty appearance, which afterwards turns to brownish yellow before the leaves die. It has been particularly troublesome in the Bermuda-onion growing sections of Texas and in some Northern fields. It is usually most abundant during dry periods, for an abundance of moisture is not congenial to the life or the reproduction of the insect.

There are no satisfactory methods of controlling this pest. Spraying the plants with kerosene emulsion made with resin whale-oil soap is one of the best applications. Spraying with standard Bordeaux mixture to which 2 ounces of resin whale-oil soap have been added will also be found a good preventive.

Onion smut (*Urocystis cepulæ*). This is a disease which attacks the young plants, causing the formation of dark spots or lines on the leaves and stem near the surface of the ground. As the onion seedling develops, these spots crack open, exposing a black, powdery mass, which is the spores of the fungus. The disease, if very severe, causes the tops to wither and die, and then often spreads to the bulbs. Onion smut is more or less prevalent in different parts of the country, the loss from it being very great in some years. As a preventive, all the refuse upon the onion field should be burned immediately after the crop is harvested, thus destroying most of the spores from which the disease rapidly spreads the following season. Adherence to a strict system of crop rotation, however, is the most practical preventive against the disease. Transplanting is also quite effective, as the smut does not attack sets or well-grown transplants as readily as young seedlings.

Experiments at the Connecticut and New York State Agricultural Experiment stations have demonstrated that treatment with a mixture of equal parts of sulphur and lime, or of sulphide of potassium and lime, increased the yield on land badly infected with smut in a ratio of about 5 to 1. The mixture is sown in the drill with the seed. At the Ohio station an effective remedy has been found in the use of a formaldehyde solution, made at the rate of 1 pound of 40 per cent formaldehyde to 25 to 33 gallons of water, applied to the seed and soil at the time of planting, by means of a drip attachment to the seed drill, using from 125 to 150 gallons of the solution to the acre.

Heart rot. This is a bacterial trouble which seems to attack all varieties of onions which have been carelessly or roughly handled in topping, particularly those topped by machinery. To prevent the losses which occur in storage from this disease, care should be exercised to use only clean implements for topping and to disinfect the topping machines carefully and frequently.

PARSLEY

Parsley and cress are the two plants most used for garnishing. While parsley cannot be classed as a crop of great commercial importance, it is very generally used, and is almost always grown by market gardeners and in the home garden although seldom grown on a scale extensive enough to class it as a truck crop.

Botany. Botanically, parsley is closely related to the parsnip and belongs to the family *Umbelliferæ*, but differs from it in that the delicately cut, aromatic leaves are the part chiefly used. Parsley, *Apium petroselinum*, is a biennial accredited to some part of the Mediterranean region. The first year it produces a dense whorl of radical leaves; the second it throws up its seed stalk. The seed, which under usual conditions retains its vitality from three to five years, is small, somewhat 3-sided, and of a brownish color. One ounce of seed is allowed for each 150 feet of drill.

In America, parsley is chiefly used for garnishing and for flavoring soups and stews. For these purposes those sorts with fibrous roots and abundant foliage are grown. In Europe a thick-rooted type which produces foliage similar to that of the common sorts, and roots not unlike those of the parsnip, is grown for the same uses. With these sorts the fleshy roots, instead of the leaves, furnish the part used in soups and stews.

Culture. Although the parsley plant is quite hardy and can be held in hotbeds and greenhouses for more than a year, it is usually treated as an annual. It is almost wholly propagated by seed, although it can be increased by division. The seeds are small and are slow to germinate. The crop is therefore seldom sown in the open, but in flats, hotbeds, or cold frames, where congenial conditions for the germination of the seed can be maintained. The young plants are delicate and grow slowly at first. For these reasons transplanting from the seed bed to the field is more satisfactory than sowing the seed in place.

The soil of the growing bed should be well drained but retentive of moisture, and should be thoroughly enriched with stable manure. The crop is usually matured in hotbeds, cold frames, or cool houses, for it is in greatest demand during the winter season. There is no season, however, when it is not in demand, and the wise gardener provides an all-the-year-round supply.

Parsley grown in the open should be planted in succession so as to have fresh tender leaves at all seasons. A March sowing, in the latitude of New York, will provide a spring supply, and an August planting should produce plants which, if properly protected, would give the autumn and winter supply. Strong roots from the spring-sown seed, if stripped of foliage so as to induce the formation of new tender leaves in August or early September and then carefully tended, will provide a satisfactory autumn and winter crop.

The plants in the open should be set 8 or 10 inches apart in rows 10 inches apart.

PARSNIPS

The parsnip is extensively grown in the kitchen gardens at the North. It is also grown to a limited extent by market gardeners of the same region, but has never found a place in the list of crops grown on an extensive scale by truck farmers. This is to be explained in two ways: (1) the parsnip is by nature adapted to Northern rather than to Southern conditions; (2) it is a plant requiring a long growing season and winter frosts to develop it to greatest perfection. The parsnip is one of the plants which will ever have a well-defined season. While its food value is said to be greater than that of the carrot or beet, its uses are not so varied and its consumption is as a result more restricted. It is used as a vegetable served with a cream dressing or fried, and as one of the ingredients of soups and stews.

Botany. Botanically, the parsnip belongs to the *Umbelliferæ*, or Parsnip family. Specifically it is known as *Pastinaca sativa*, and is a hardy biennial, native to Europe and Great Britain. It runs wild to a limited extent in parts of the United States. The root is the portion for which the plant is cultivated, and in its natural state is small and fibrous, but under cultivation has been developed to large proportions, sometimes 2 feet in length and 3 or 4 inches in diameter. It is of a general conical shape and attains its full size in one season. The flowers and seed are produced the second year. The yellow flowers are borne in large, spreading umbels, 5 or 6 inches in diameter, on flower stalks from 4 to 6 feet in height. The seeds, which normally ripen in July or August, are about $\frac{1}{4}$ inch in diameter, flat and thin, with a membranous winglike border, and either pale green or yellow.

Soil. The value of this root is determined by its quality, and since this depends largely upon the nature and preparation of the soil, more than usual attention should be given to this part of the culture of the crop. Because of the long root of the parsnip, the soil should be deep and rich. Land which has long been in use for garden purposes is better than recently broken turf, even though it be thoroughly subsoiled. A deep seed bed prepared by first disking, then plowing 8 or 10 inches and subsoiling the bottom of each furrow, will give best results. After the deep stirring of the soil is completed, the surface preparation should be continued by the use of the disk and Meeker harrows. Young parsnips are not fitted to compete with weeds, and therefore the seed bed should be such as to induce quick germination and a robust growth of plants. The deep seed bed, if rich and well supplied with organic matter, will foster the development of large, long, succulent, conical roots. Poor soils, shallow preparation, and inadequate cultivation tend to produce short-branched roots, woody in character.

Planting. The seeds, which are light, thin, and rather slow to germinate, should be sown at the rate of $\frac{1}{4}$ ounce to 100 feet of row, or about 6 pounds per acre. Rows are usually laid off 16 or 18 inches apart in the kitchen garden, and the seeds planted about 1 inch deep with the garden drill. In field culture the rows may be from 22 to 30 inches apart, according to the manner of cultivation to be practiced. The young plants should stand 3 or 4 inches apart in the row. Parsnips are hardy and should be sown as early in the season as the soil can be prepared and the planting accomplished.

Cultivation. During the growing season the plants should be kept free from weeds, and the earth stirred at frequent intervals so as to preserve a surface mulch of soil and thus induce rapid vegetative growth.

Harvesting. Young roots are sometimes marketed in September, but they are not fully developed nor as highly flavored then as they are later in the season. It is a popular notion that parsnips are greatly improved by the action of frost.

Unless the soil is too moist to permit harvesting the crop early in the spring, only so much of it as will be required for winter trade should be harvested in the autumn. The plants should be lifted without bruising or breaking the roots, and the tops should be closely cropped. The roots must be thoroughly washed before being sent to market. Those required for winter use should be packed away, in moist sand or leaf mold, in a cool pit or vegetable cellar to prevent drying out. Broken and scarred roots are not satisfactory for storage.

Any part of the crop which may have been left in the field over winter should be dug and prepared for market with the same care as that harvested in the autumn.

In European countries parsnips are often harvested when the roots are not more than ½ inch in diameter at the crown and used as a fresh vegetable the same as carrots.

PEAS

The pea has been cultivated for many generations and is undoubtedly of European or Asiatic origin, but no definite locality can be named as its home. It was found among the Greeks during the time of Theophrastus. The garden pea is probably the most important of all the species belonging to this genus. It cannot, however, be said to be the most important of the legumes, for in modern agriculture the garden bean and the cowpea undoubtedly outrank it from a commercial standpoint. The garden pea, however, has a great number of uses. The principal, and perhaps its most important, use is that of human food, either in the fresh green state or as a mature seed. It is also of value as a forage crop for stock, both in the green state and when dried for hay. Because of this variety of uses it is readily seen what an important part it may play in the economics of a civilized nation.

Botany. The garden pea is known to botanists by the name *Pisum sativum*, of Linnæus. It has a hollow stem, which in the

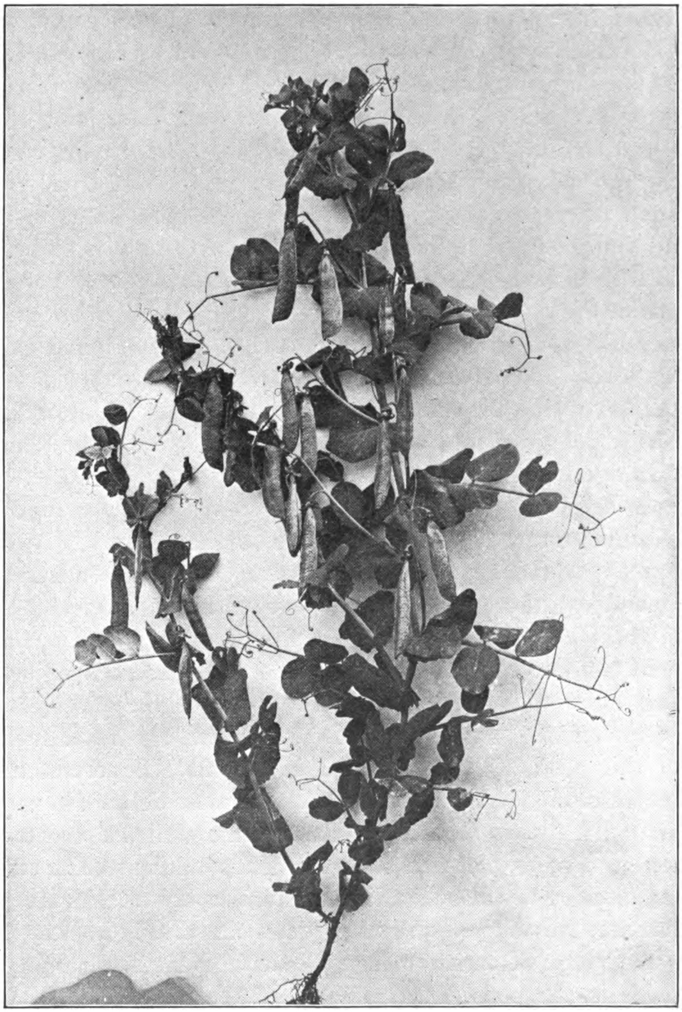


FIG. 122. Pea vine, showing branching, leaf-attachment, tendrils, and manner of bearing pods

tall growing sorts requires a support for best development. The dwarf sorts get along well without such support and can therefore be more economically grown. The pea has compound pinnate leaves, the odd leaflet being replaced by tendrils which are prehensile and enable the plant to climb by clinging to objects within their reach. The base of the leafstalk is surrounded by a broad, clasping stipule larger than any of the leaflets. The flowers are borne singly or in pairs on the axils of the leaves at each joint of the stem, and are either white or violet in color. Sorts having colored flowers can be distinguished by the small reddish circle about the stem where it is clasped by the stipule. The seeds of peas having violet-colored flowers are always more or less splashed or tinged with brown. These varieties are rejected for table purposes because of the unattractive grayish color of the peas when cooked and because of their less delicate flavor. They are found chiefly among sorts grown for stock food. Most of the table varieties of peas have white flowers, and the seed is either white or green when ripe. A good idea of the general character of the plant is given in figure 122.

Types of peas. Among the peas used by man for food are three distinct forms: (1) those with smooth, hard seeds; (2) those with green, convolute, or wrinkled seeds, which are never very hard; and (3) those with thick pods and comparatively small seeds, the pods carrying an abundance of sugar and starch and, when in a green condition, being edible like the pods of beans. Among the smooth-seeded peas are some of the most important commercial sorts. The field peas grown for stock feeding are of this class, as well as some of the most important early-market sorts. The wrinkled peas, which are more delicate in nature, less hardy, and less resistant to frost, while well adapted to the kitchen garden, are not well suited to field conditions. The edible-podded peas, of which only a limited number of varieties are now in existence, are adapted only to garden culture. Figure 123 illustrates the range of variation in pea pods and the arrangement of the seeds in the pods.

Soil. Peas are grown on a great variety of soils. In general, however, the growing of peas for canning and for stock food must be largely confined to high or Northern latitudes, the pea thriving best during the cool days of the spring and autumn months. The soil best adapted to the pea is a clayey loam, or a sandy loam carrying a large percentage of clay. In Southern latitudes, where peas are produced for early markets, a sandy loam is

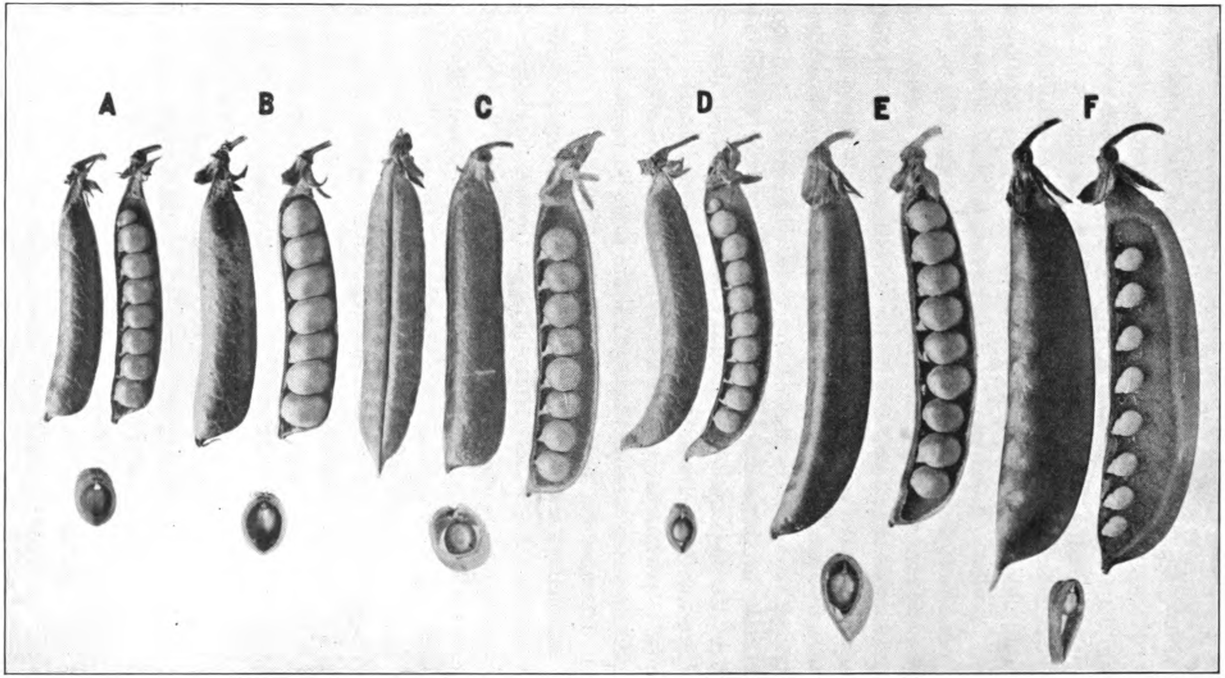


FIG. 123. Pea pods showing types and range of variation

A, Extra-early dwarf wrinkled pea, American Wonder; *B*, Medium-early wrinkled pea, Nott's Excelsior; *C*, Main-crop smooth pea, Marrowfat; *D*, French canning-type smooth pea, French Canner; *E*, Large-podded wrinkled pea, Pride of Market; *F*, Fleshy- or edible-podded pea, Melting Sugar the soil chiefly depended upon for this crop. At the North, however, where large quantities are produced for canning purposes, and by the market gardener for local consumption, the soil selected is usually a retentive clayey loam. This holds moisture well and is cooler than the sandy soils, and for this reason has a tendency to keep the plants growing longer, an advantage for the market or the family garden. The longer the vines can be maintained in a growing condition, the longer the fruiting season, particularly with the large-growing, wrinkled varieties. The smooth, hard-seeded sorts have a more determinate habit of growth, and soil influences are therefore less marked. The same soil conditions apply equally to the early dwarf sorts having wrinkled seeds, such as the American Wonder.

Preparation of the soil. The soil should be deeply stirred and enriched by the application of liberal quantities of stable manure and, if necessary, of commercial fertilizer. Deep cultivation, however, is the important factor, for in order to have peas stand for a considerable period, it is necessary that the seed be planted deep. Repeated experiments have been made along this line, and it is now an established fact that if peas can be planted 3, 4, or even 6 inches deep, a larger crop and a longer period of harvest will result than if the planting is shallow. It is therefore the practice of the best market and private gardeners to plant peas, especially the wrinkled sorts, comparatively deep, even if the trench in which they are planted is not entirely filled at the time of sowing the seed. Four inches is not an unusual depth for covering this crop, and in order to plant the seeds to this depth, it is necessary to have a seed bed 8 or 10 inches in depth. In preparing the soil for a crop which needs to be planted both early and deep, it is a good practice to run a disk harrow over it before it is plowed. This has a tendency to break up and loosen the surface soil, causing it to dry more quickly than if left undisturbed. It also leaves a layer of well-pulverized soil on the bottom of the furrow after plowing, so that when the disk harrow or other cultivator has been run through it, the whole thickness of the furrow slice becomes pulverized and accessible for the use of the roots of the plants. This system of cultivation is one of the most effective for deepening the seed bed known to the writer.

Planting. As has been suggested, the depth of planting largely predetermines the duration of the plantation and its yield. Because peas require deep planting, and because they are comparatively resistant to cold, they can be planted early in the season. In the latitude of Washington, D.C., seed can frequently be sown in February, although most of the planting is done in March. Farther south the season is correspondingly earlier.

In market and private gardens it is desirable that peas be available during a long period, and to bring this about it is necessary not only to select varieties which mature in succession but to make a succession of plantings. For the earliest planting some of the early, hard-seeded sorts which mature quickly should be employed, and these followed by the more delicate *high-quality* wrinkled sorts and edible pods. Plantings should be made at intervals of from six to ten days in order to secure this succession, and the varieties should be selected with reference to the length of time required for their maturity so as to fit into this succession. As the hard-seeded sorts are most robust and offer the quickest-maturing peas, they are naturally employed for the early plantings.

The method of planting in the market and private garden should be such as to admit of cultivation. A common practice is to make 2 drills about 6 inches apart with a space of 2 or 2½ feet between them, to allow for necessary cultivation. The tall-growing, late-maturing sorts with wrinkled seeds or edible pods when planted in this way will require trellis for support. Such a trellis can be provided by the use of brush, stuck between each two rows, as shown in figure 124, or it can be suspended from a wire running parallel with and above the rows, the pea vines attaching themselves to it. Where it is not practicable to use this crude method of supporting the vines, poultry netting can be placed upon stakes between two lines of peas. A modification of the poultry-netting trellis is made by the use of small square stakes about 2 inches in diameter, to which are fastened crosspieces about 1 foot or 15 inches long. Upon these crosspieces, and in a horizontal position, poultry netting 12 or 15 inches in width is stretched. The first wire should be about 10 or 12 inches from the ground, and above this there should be two more, making the trellis about 3 or 3½ feet high. The pea vines, as they grow, will pass through the meshes of the wire. This plan provides a satisfactory and well-ventilated trellis that can be used from year to year by taking care to preserve the wire from rust.

Peas as a field crop for canning. The field crop of peas, either for the farm or for the canner's use, is sown broadcast like oats, usually about a bushel to the acre, with an ordinary grain drill. The crop is allowed to mature with no special attention or cultivation other than thorough preparation of the soil. As soon as the peas are sufficiently developed for the use of the canner, they are harvested with a mowing machine, raked in the ordinary fashion, and

FIG. 124. Peas trained on brush

immediately hauled on hayracks to the canning factory, where they are passed through threshing machines specially prepared for this work, which shell the peas, separate them from the pods and vines, and deliver them in bulk. The peas then pass over screens which grade them into the various sizes used for canning purposes. There are usually three grades. The harvest is timed so as to give a maximum quantity of No. 1's, but there will always be a quantity of those which are too large and too much matured to go into this grade. These are placed in another, cheaper, grade of canned goods. The small immature peas are sometimes disposed of to hotels or to private individuals for immediate consumption, but are more often canned and put on the market as *petit pois*. Of late some canners are making a great point of putting up a brand of peas in which the *run of the pod* is used. This simply means that the crop as it comes from the huller is canned without grading. It really gives a product better than usually obtained in the No. 1 grade. After the peas are hulled in this manner by machinery and graded, they are carefully washed before being placed in the cans for cooking.

A few years ago the supply of peas for canneries was grown the same as are garden peas, and the pods were picked by hand in the same way. This was an expensive operation and made the price to the canners much higher than now, when the work is done by machinery as described above.

Strange as it may seem, the region around Baltimore, which for many years was the seat of the pea-canning industry, has lost its prestige, so far as the canning of this crop is concerned. The cultivation of peas for canning is now carried on most extensively in regions north of Maryland, where farm practices are followed in the production of the crop. Colorado, Illinois, Wisconsin, Michigan, and New York are the states now leading in the production of canned peas.

Harvesting. The harvesting of peas for culinary purposes must always be carried on by hand, because it is necessary to exercise judgment in the selection of the pods which are suitable for this purpose.

Peas do not ship well. They soon heat if packed in receptacles containing such small quantities as a bushel. When peas are to be shipped any considerable distance, the receptacle now in popular use is the half barrel or bushel basket, made after the fashion of the Delaware peach basket — a deep, narrow, or slim basket about the height of an ordinary flour barrel, and 10 inches in diameter at the bottom and about 18 inches at the top. Such a receptacle (see figure 125) gives good ventilation and is very cheap.

The manner of harvesting peas for canning purposes has already been mentioned, and its simplicity will at once appeal to the commercial planter who appreciates the importance of cheapened methods. The harvesting of peas for stock food or for seed is conducted practically the same as harvesting for canning purposes, except that, as a rule, the peas are allowed to mature longer.

Peas as forage. Besides the uses of peas already suggested, in some localities, especially in high altitudes, they are mixed with oats and planted as a forage crop for horses. When the oats are mature the whole crop is threshed and the seeds of the peas allowed to form a part of the ration of the animals to which the oats are fed. The addition of pea vines to the oat straw very materially increases its value as forage.

Peas are seldom or never grown as a forcing crop, except for special use in private establishments or for experimental purposes.

FIG. 125. Packing peas in Delaware-type baskets

Insects and diseases. The garden pea is subject to the attack of two destructive insects — the pea louse and the pea weevil.

Pea louse. This is one of the plant lice, or aphides, which frequently infest fruit and garden plants. These insects are particularly difficult to treat in the open on account of the manner in which they secure their food. They are sucking insects and cannot be killed by poisonous sprays. Contact insecticides are the only available means known for their destruction. On dense-growing, leafy plants like peas it is a very difficult matter to spray the plants effectively for the control of such a pest, and therefore an extensive visitation of the pea louse in any region is a serious matter. A few years ago such an outbreak occurred in the pea-growing section of Maryland, and the indications were that the entire pea industry would be driven from that region. Fortunately, however, the multiplication and continuance of an insect of this character is largely controlled by soil, crop, and climatic conditions, and the pea louse passed away from Maryland almost as completely and quickly as it appeared.

Pea weevil. This is a small snout beetle or weevil which gains entrance to the pea through the egg, which is deposited in the pod while the pea is in a green state, the larva as well as the adult insect deriving its nourishment from the pea. When the peas are in the green state the weevil cannot be detected, and no injury is caused by the deposition of the eggs. It is in the dry, stored peas that the harm is done. Without the exercise of proper care in the fumigation of stored peas and beans, the weevil may destroy a large percentage of the seed. By the use of bisulphide of carbon in closed rooms, boxes, or bins, the peas and beans can be effectively fumigated and the insects destroyed, after which the seeds can be kept with comparative safety. This method of treating the seed was suggested many years ago by Professor W. W. Tracy, Sr., and special houses which were built for this purpose are known as Tracy houses.

Mildew. The mildew of the pea is of considerable economic importance in some sections during certain seasons, as it renders the production of peas out of the question. During the hot weather, when there is considerable alteration in temperature between day and night and the air is charged with humidity, it becomes almost impossible to grow peas because of the mildew. This is more especially true of the fall than of the spring months. In localities where this disease prevails, the growing of peas is regulated to avoid seasons when the disease is most destructive.

Varieties. The varieties of garden peas are sufficiently numerous to meet the requirements of the most exacting taste. As has already been suggested, there is a group of varieties based on the character of the seed (whether hard or wrinkled) and the character of the pod (whether edible or nonedible). A second classification, based on the habit of growth of the plant, has three subdivisions: (1) dwarf plants, (2) medium-sized plants, and (3) tall plants. These are of course arbitrary subdivisions, but they are closely correlated with the other subdivisions of the Pea family. For instance, the earliest varieties are as a rule dwarf or medium-growing sorts, while the late sorts are usually tall-growing, and many of them have wrinkled green seeds. A still further subdivision is based on the season of ripening — early, medium, and late-maturing sorts. While no exact statement can be made in regard to these different characteristics, yet, in general, it may be said that the earliest peas must necessarily be the hardiest ones, and earliness and hardiness are as a rule correlated with smooth, round seed and a dwarf or half-dwarf habit of growth. But not all the extra-early varieties are smooth; some of them have wrinkled grains, as, for instance, the American Wonder and peas of that type. However, the general statement holds true that the earliest sorts have a smooth, round type of seed, and the tender, late-growing sorts usually have wrinkled green seeds. The farm or agricultural types of peas, such as the Canada field pea, all have hard, round seeds. These peas possess great hardiness and are as a rule somewhat more prolific seeders than are the wrinkled types, although for garden purposes the wrinkled types are to be preferred because they are of better quality, have a longer fruiting period, and their pods do not pass the edible condition as soon as do the sorts having hard, smooth seeds.

Among the earliest sorts suitable for garden uses may be mentioned First of All and Alaska. These are both round-seeded sorts. The Thomas Laxton, Gradus, and American Wonder are all early sorts of the wrinkled type. Among the medium-early peas may be mentioned McLean's Advancer, Horsford's Market Garden, and Pride of the Market, all of which are of the wrinkled sorts. And among the main or late crops are Stratagem, Telephone, Telegraph, and White Marrow Fat. Two of the sugar or edible-pod peas are Early Sugar and the Mammoth Great-Seeded Sugar.

PEPPERS

This group of plants presents a wide diversity of varietal characteristics. There are marked differences not only in the size and shape of the fruits but also in their quality. Some are exceedingly pungent, while others have no pungency, and still others have the pungency localized. The plants of this group vary greatly in size, form of leaf and fruit, as well as in their length of life. In temperate regions they are all classed as annuals, but under tropical conditions several varieties are perennials of a more or less woody character. These plants are all classed as *Capsicum annuum*.[1]

Importance of the pepper. Commercially the pepper is one of the minor crops. It is more important as a market-garden than as a truck crop, for all kinds find a place in the market garden, while only sweet peppers are extensively grown for shipment. The Tabasco pepper is, perhaps, the best-known representative of the group, for it is found on nearly every table in the land. The Paprika is a well-known sweet pepper, the cultivation of which has but recently been popularized in the United States.

Methods of cultivation. For best results the pepper should be planted on rich garden loam, but the plant thrives remarkably well on lands of moderate fertility if in good tilth.

Young pepper plants are quite tender and do best if treated the same as eggplants and tomatoes. It is best to plant the seeds about a quarter of an inch deep, in rows 2 or 2½ inches apart, in a well-prepared compost either in flats in the greenhouse or in a hotbed. After the first true leaves have developed, the young plants should either be transplanted to stand 2 by 2 inches apart or be placed separately in thumb pots.

As the plants are sensitive to frost they should not be placed in the open until the danger of frost is past. No advantage is gained by placing plants which, like the pepper, require a high temperature in the open before the temperature conditions are congenial. The pepper should be planted in the field at the same time as the tomato.

The individual plants should stand 15 to 18 inches apart in the row and the space between rows should be wide enough to allow cultivation with horse-power implements. Some of the very dwarf types of peppers may be planted as close as 8 or 10 inches apart in the row. The subsequent cultivation of the crop consists in keeping the soil well stirred and free from weeds.

[1] A comprehensive study of the varieties of the pepper is reported by Irish, of the Shaw Botanic Gardens.

Harvesting. As soon as they are fully grown, but before they begin to color, sweet peppers are cut with only a short stem adhering to each fruit and packed in small splint baskets like those used for peaches. These baskets fit into a carrier which usually holds six baskets. The cayenne pepper is seldom handled in this way. As a rule, the stem with its fruits is cut close to the ground and carried to market. These peppers are also dried and handled in bulk. The old-fashioned way is to put them on long strings for drying.

POTATOES

The potato is of great economic importance as a food for man; in addition it is valuable for starch, cattle food, and alcohol. It is grown extensively as an early market-garden and truck crop, and even more extensively as a field crop in the northern part of the United States. In some sections the same land can be made to produce two crops of potatoes in a single season, thus rendering it a very important and profitable industry.

Varieties have been developed which adapt it to the great range of climatic conditions. It has been found, however, that certain varieties are peculiarly fitted for certain climates. The repeated attempts which have been made to introduce European, and particularly English, varieties of potatoes into the United States have proved very discouraging, thus showing that varieties which are of great importance in one section or country may not be adapted to conditions in another. Some varieties are especially adapted to the sandy lands and short season of the Southern states, while others are preëminently adapted to the cool and retentive, heavy soils of the Northern states. Some require only a short season for maturity, while others demand the entire growing period to perfect their crop. With this great diversity of character it is evident that the potato can be modified to meet almost every condition of soil and climate which exists in the temperate zone. This is not saying, however, that every soil and climate can be made to produce a profitable yield of potatoes. There will always be certain regions possessing the peculiar soil and climatic conditions which will make them the leading commercial areas for the cultivation of this product.

Since the introduction of the potato into cultivation, it has played a very important part in sustaining the human race. It received its name, Irish potato, from the fact that it is one of the standard foods of the Irish people. Because of its enormous yields and its easy cultivation, it has grown to be an important economic factor in the maintenance of the dense population of that country.

Botany. The term "potato," when not modified by an adjective, suggests to the mind of the American the so-called Irish potato (*Solanum tuberosum*). When the name is modified by the word "sweet," reference is made to a different plant, belonging to the Morning-glory family and known botanically as *Ipomœa batatas*. In this section attention will be given only to the Irish potato.

Origin and distribution. This plant, which is now recognized as an important article of food, as well as an important commercial crop throughout the north-temperate regions of the earth, is of American origin. Among the New World plants which have been brought under cultivation since the discovery of America, it stands out as one of the most important, being second only to Indian corn. The world over, the potato is probably eaten by a greater proportion of the earth's inhabitants than any other crop except rice. The potato early found a wide use throughout Great Britain and the northern part of the continent of Europe. With the development of the New World it immediately became an important garden crop, and its cultivation has kept pace with the increase in population until now it is distributed over the entire area of North America occupied by civilized peoples. It is a commercial product in Mexico as well as in Alaska. The distribution of the potato has followed the progress of civilized man. Into every country which the white race has penetrated, the potato has been carried, sometimes with success, sometimes with failure, but an attempt to introduce it has always been made.

As before stated, this plant is of American origin, and De Candolle says: "It is proved beyond a doubt that at the time of the discovery of America the cultivation of the potato was practiced, with every appearance of ancient usage, in the temperate regions extending from Chile to New Granada, at altitudes varying with the latitude. This appears from the testimony of all the early travelers, among whom I shall name Acosta for Peru, and Pedro Cieca, quoted by de l'Écluse for Quito."[1] It appears from this statement that the potato had been cultivated for generations prior to the discovery of the plant by Europeans, so that, even when it came to the attention of continentals, it was by no means a wild plant. It is further evident that the potato was introduced into Europe between the middle and the last of the sixteenth century, probably about 1585 or 1586. It is possible, however, that it was carried to continental Europe at an earlier date than this, perhaps as early as 1535, although there is no conclusive evidence of this.

Besides *Solanum tuberosum*, the common type of the potato, another tuber-bearing species, indigenous to low, moist areas and subtropical climates, has, during late years, attracted considerable attention. This is *Solanum commersonii*, a native of Brazil and parts of the Andes north of Chile, from which region another solanaceous plant of great economic importance has come, namely, the tomato. The *Solanum commersonii*, so far as present knowledge goes, is a plant of comparatively little economic value. It has an advantage over *Solanum tuberosum* in that it is adapted to moist grounds and to higher temperatures.

De Candolle sums up his investigations into the history of the potato as follows:

1. The potato is wild in Chile, in a form which is still seen in our cultivated plants.
2. It is very doubtful whether its natural home extends to Peru and New Granada.
3. Its cultivation was diffused before the discovery of America from Chile to New Granada.
4. It was introduced probably in the latter half of the sixteenth century, into that part of the United States now known as Virginia and North Carolina.
5. It was imported into Europe between 1580 and 1585, first by the Spaniards and afterwards by the English, at the time of Raleigh's voyages to Virginia.[2]

The following discussion of potatoes will be made under three heads: (1) Potatoes as a Farm Crop at the North; (2) Potatoes as a Truck Crop at the South; and (3) Potatoes under Irrigation.

[1] De Candolle, "Origin of Cultivated Plants," p. 45.

[2] For a full account of the origin of the potato the reader is referred to De Candolle's "Origin of Cultivated Plants," pp. 45–53.

Potatoes as a Farm Crop at the North

Up to within comparatively recent years the chief center of production of the Irish potato in America was in the northern and eastern United States. There the cultivation of the crop took on two characteristic phases — the growing of early potatoes and of late, or winter, potatoes. These two crops were founded on varietal differences rather than on different methods of culture. There is sufficient difference in the time required for the growth and maturity of different varieties to enable growers to select those which, if planted early, will produce edible tubers in a comparatively short time, and others which, even if planted at the same time, will not produce edible tubers until the cool, mild weather of autumn comes on. This accounts for the two crops at the North.

Kind of soil. A glance at the map, figure 126, shows that the late-potato section of the country is almost completely included within the area covered by the great ice age. In other words, the area in which winter potatoes are most extensively grown falls within the limits of the glacial-drift formation of the United States. There are exceptions to this, particularly in the Pacific coast region, where the upheaval of the great mountain ranges has thrown the isothermal lines far to the south. The great potato fields of Colorado, while high, are considerably south of the territory in which this industry is chiefly found, the altitude compensating for the latitude, as is indicated both by the flora of the region and by the isothermal conditions. In general, it may be said that the soil best suited to the cultivation of the potato is a gravelly or sandy loam, not too light in character, and still not a stiff clay, although potatoes of good quality and a fair yield are produced upon somewhat retentive clay soils.

It is believed that the character of the soil has more influence on the quality of the potato than on the yield. The yield is more largely determined by the kind and amount of fertilizer and seed used, the cultivation given, and the climate than by the character of the soil. The heaviest yields of potatoes are obtained in the higher latitudes where the soil conditions are congenial, that is, where there is a moderately retentive loamy or gravelly soil. The lowest yields are usually obtained in the trucking regions where the soils are light, quick, and sandy and where the temperature becomes high early in the season. Another reason for the light yields in the trucking regions, notwithstanding that large quantities of fertilizers are used, is the immature condition of the greater part of the crop when harvested. The potatoes do not have an opportunity to attain their full growth before they are harvested and placed upon the market; they are dug as soon as large enough, regardless of the stage of development.

Preparation of the soil. The fact that the potato is a hoe crop makes it one of the best preparatory crops for grains, and is therefore chiefly planted upon land which has been in clover for at least one year. A rotation by which potatoes follow clover, after the second cutting, is considered almost ideal. The advantages of the clover sod are twofold: it supplies organic matter which renders the mechanical condition of the soil more suited to the development of the tubers, and supplies the soil with humus which renders it a better medium for carrying water to the plant. Clover is one of the most valuable plants in agriculture. It belongs to the great nitrogen-gathering group and gathers and stores up for future crops the most expensive element of plant food, nitrogen. By a judicious use of clovers with phosphoric acid and potash, the crop-producing capacity of most soils can be maintained without the purchase of nitrogen. Land which is in clover sod should be deeply and thoroughly plowed in the fall, or early in the spring, before the clover has made any considerable growth, so as not to have too much fermenting organic matter in the soil near the seed. The plowing should be done sufficiently in advance of the time of planting to allow the sod to become somewhat decayed before the tubers are planted. The implements used in the preparation of the soil should be such as will thoroughly pulverize and fine it, leaving the subsurface thoroughly compact while maintaining a good seed bed in the top three inches of the soil. Deep plowing and thorough pulverizing with a disk harrow, followed by the acme harrow prior to planting, should make a satisfactory seed bed.

Seed. The term "seed" as applied to the cultivation of potatoes has reference to the tubers which are used for the reproduction of the crop. Technically the word means the fruit of the plant which is borne in the seed balls formed after the blossoms fall; but with

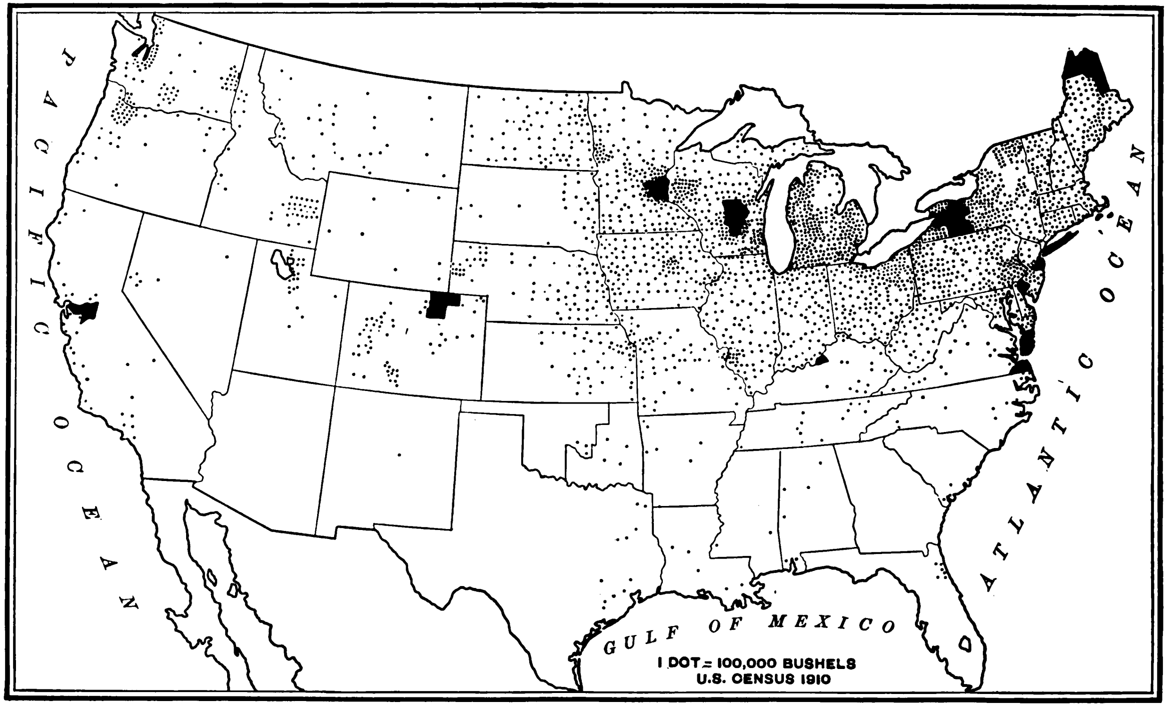


FIG. 126. Map showing distribution and intensity of the potato industry, census of 1910

potatoes the term is never confused, as it is universally applied to the tubers for planting, which are used either whole or cut.

There are many different methods of seed treatment followed by successful potato growers. Some plant small, whole potatoes, while others select medium-sized, perfectly formed tubers and cut them so that each piece shall contain one or two eyes. Some cut the potato in two, discarding the so-called stem end, and use for seed purposes only the portion which has the most eyes concentrated upon it. Whether or not there is any advantage in this peculiar practice cannot well be determined, but successful growers have their fads and follow them. A good safe practice is to select medium-sized potatoes, and cut them into pieces having at least two eyes each, to which a considerable portion of the stored starchy material adheres. It is believed that with the potato, as with other plants, the more food material that can be carried into the soil with the eyes, the stronger will be the growth that results. Some growers go so far as to cut the seed several weeks in advance of the time when it is to be planted, claiming that the healing and drying processes which come after cutting are a benefit, since the dry, warm soil in which the seed is placed does not draw moisture from the seed so treated but tends to contribute moisture to the seed, thus causing quick germination. This is a point which requires further evidence for proof. Many of the most successful European growers use only whole tubers for seed, and these not less than 4 ounces in weight. Recent developments in the irrigated potato-growing areas indicate the superiority of whole tubers for seed.

While there are grounds for differences of opinion regarding the size of seed pieces and between whole and cut seed, there can be no question that the seed should be selected from healthy plants and from vigorous productive hills. Seed selection is as effective in the improvement of the potato as in the improvement of corn.

Treatment of seed for scab. The treatment of seed for the early crop is believed to be as important at the South, where the potatoes are marketed immediately after harvesting, as at the North. The treatment of potatoes to control potato scab has become a regular practice among the most successful growers at the North. Either of two practices may be followed to accomplish this result:

the potatoes may be soaked in formaldehyde or a solution of bichloride of mercury; or, better still, where conditions will permit, they may be fumigated with formaldehyde gas while in the car or warehouse.

The corrosive sublimate (bichloride of mercury) treatment is as follows: soak the uncut seed one and one half to two hours in a solution made by dissolving 2 ounces of corrosive sublimate in 16 gallons of water. The solution is exceedingly poisonous and must be guarded to prevent stock from gaining access to it.

The most economical and effective method of disinfecting seed potatoes on a large scale is by the use of formaldehyde gas liberated by mixing the commercial solution with potassium permanganate. The following is a description of this method of disinfection:

To use it, an air-tight shed should be constructed of sufficient size to hold whatever quantity it may be desired to treat at one time. This may be made of rough lumber, lined with building paper, and provided with a tight door. The potatoes may be treated in sacks, but these sacks must be piled so as to allow a free circulation of air all around them. It is suggested that they be piled in tiers, with two 2 × 4 inch scantlings between the layers of sacks. Space should be left in the center of the building for placing the charge of formaldehyde, which should be set off in shallow pans, such as galvanized washtubs. For each 1000 cubic feet, 23 ounces of potassium permanganate and 3 pints of formaldehyde should be allowed. After the potatoes are properly stacked and everything is made ready, the permanganate should be spread in a thin layer on the bottom of the pan, the required quantity of formaldehyde poured in and stirred quickly, and the building vacated. The building should then be kept closed tight for twenty-four hours, when it may be opened and the potatoes taken out.

Formaldehyde is a nonpoisonous but highly irritant fluid which can be purchased in small lots at about 50 cents a pound, in carboy lots at 20 cents, or in barrel lots at about 12 cents. Potassium permanganate is a reddish-brown crystalline substance, purchasable at from 13 to 25 cents a pound.

The precaution should be taken not to pile any potatoes directly over the pans or within 3 feet laterally, as the gas there might be strong enough to injure the potatoes and destroy their germinating power. The formaldehyde works best in a humid atmosphere. It is therefore advised that the floor of the shed be wet down before the treatment is made. The potatoes, however, should not be wet, as the disinfection is more thorough if the surfaces are dry.

Small quantities of potatoes may be disinfected by soaking in a solution of 1 pint of formaldehyde to 30 gallons of water for two hours. Either the gas or the solution treatment may be applied some time previous to planting, provided the potatoes are not exposed to reinfection by being put into receptacles that have previously held scabby potatoes. The treatment should also be made before the potatoes are cut for seed.

The expense connected with the treatment of seed potatoes by the gas method will vary in different cases according to the amount of labor required in handling and whether a special building has to be erected for the purpose. The cost of labor and of the building will be the principal items. The cost of the materials need not amount to over 1 cent per sack. For example, a shed 12 by 24 feet and 7 feet high contains 2016 cubic feet and would require 3 pounds of potassium permanganate, costing 60 cents, and 6 pints of formaldehyde, costing $1.20; total $1.80. Two hundred sacks can easily be treated at once in such a shed. An entire day should be allowed for each treatment.[1]

As the potato scab is not only carried to the field by the seed, but remains in the soil from season to season, it is of the utmost importance that potatoes be used in rotation with other crops, so as to allow as long an interval as possible between successive potato crops. This will have a tendency to "starve out" the potato scab in the soil; then by the use of scab-free treated seed the prospect for a crop of smooth tubers is greatly enhanced.

Fertilizers. Because the potato tubers are formed in the soil and are subject to diseases which are increased by the use of stable manure and lime, the fertilization of potatoes in a commercial way resolves itself largely into the use of specially prepared commercial manures. If farmyard manure is used, it should be thoroughly decayed and applied so as to become thoroughly incorporated with the soil. A good way is to scatter it during the fall or early winter upon a clover sod which is to be turned under for potatoes the following year. It is not advisable, however, to apply the manure to the land immediately before plowing, nor to attempt to incorporate it with the soil at planting time, as is frequently done with many truck crops and with sweet potatoes. Farmyard manure, if applied at the time of planting, seems to have the effect of increasing the prevalence of scab, and for this reason its use has been discouraged. Properly prepared commercial fertilizers do not have this effect and, when composed of ingredients which are quickly available, produce very satisfactory results. Nearly every firm that manufactures commercial fertilizers on an extensive scale offers for sale a special potato mixture. In general it may be said that

[1] Adapted from *Bulletin No. 141* and *Bulletin No. 149* of the Maine Agricultural Experiment Station, by W. J. Morse.

such a fertilizer should contain a proportionately small amount of nitrogen, but should be very rich in potash. Whatever the soil, the potato crop seems to be benefited by a heavy application of potash. A fertilizer carrying 3 or 4 per cent of nitrogen, from 6 to 8 per cent of phosphoric acid, and from 8 to 10 per cent of potash is the usual combination; but, as suggested above, it should be the aim of the grower to obtain his nitrogen supply through the use of leguminous crops rather than by purchase in the form of a chemical. There may be an exception to this in localities with very short growing seasons, in which case quick-acting forms of nitrogen, such as nitrate of soda or sulphate of ammonia, would be preferable to the slower-acting organic forms. If it is desired to buy the ingredients separately and combine them at home, the following formulas will be found fairly satisfactory:

I. Nitrogen in the form of dried blood containing 13 per cent nitrogen	600 lb.
Phosphoric acid in the form of 16 per cent acid phosphate.	1000 lb.
Potash in the form of high-grade sulphate of potash containing 50 per cent potash	400 lb.

This mixture contains 3.9 per cent nitrogen, 8 per cent available phosphoric acid, and 10 per cent potash.

II. Nitrogen in the form of sulphate of ammonia containing 20 per cent nitrogen	200 lb.
Nitrogen and phosphoric acid in the form of dried fish scrap containing 8 per cent nitrogen and 8 per cent phosphoric acid	500 lb.
Phosphoric acid in the form of 16 per cent acid phosphate.	900 lb.
Potash in the form of high-grade sulphate of potash containing 50 per cent potash	400 lb.

This mixture contains 4 per cent nitrogen, 9.2 per cent available phosphoric acid, and 10 per cent potash.

III. Nitrogen in the form of nitrate of soda containing 16 per cent nitrogen	200 lb.
Nitrogen, phosphoric acid, and potash in the form of cottonseed meal containing 7 per cent nitrogen, 2 per cent phosphoric acid, and 2 per cent potash	600 lb.
Phosphoric acid in the form of 16 per cent acid phosphate .	850 lb.
Potash in the form of high-grade sulphate of potash containing 50 per cent potash	350 lb.

This mixture contains 3.7 per cent nitrogen, 7.4 per cent available phosphoric acid, and 9.4 per cent potash.

IV. Nitrogen in the form of nitrate of soda containing 16 per cent nitrogen	200 lb.
Nitrogen and phosphoric acid in the form of tankage containing 8 per cent nitrogen and 11 per cent phosphoric acid	600 lb.
Phosphoric acid in the form of 16 per cent acid phosphate	800 lb.
Potash in the form of high-grade sulphate of potash containing 50 per cent potash	400 lb.

This mixture contains 4 per cent nitrogen, 9.7 per cent available phosphoric acid, and 10 per cent potash.

In using commercial fertilizers it is the common practice to apply about half with a grain drill, and the other half in the row with the potato planter or some other distributor at the time the seed is covered. The quantity of high-grade fertilizer used depends upon the character of the soil and the preparatory crop; for the late, or winter, crop of potatoes from 500 to 1200 pounds to the acre are used, while from 1000 to 2000 pounds are frequently used on the spring crop in the trucking region. Where the quantity is as small as 500 pounds, it is not necessary to distribute it broadcast with a grain drill; it may be applied with the potato planter at the time the planting is done. Ordinarily it is best to distribute the fertilizer several days in advance of planting the seed in order that any free acid which may exist in the chemicals may become neutralized by the soil or dissipated through it. Large quantities of fertilizers placed immediately in contact with the seeds seem to have a detrimental effect, especially in dry seasons, and as the character of the season cannot be foretold it is advisable to observe the precautionary measures just noted.

Planting. As has been suggested, potatoes are commonly planted at intervals of from 9 to 15 inches in rows about 30 inches apart. Where labor is scarce, however, and it is desired to carry on the entire cultivation of the area by horse power, some growers have satisfied themselves that it is more economical to plant in hills 30 inches apart each way so as to admit of cultivation in both directions. This of course gives only half as many hills to the acre, but admits of the use of horse-power implements in the field cultivation of the crop. When grown in a small way potatoes are usually planted by hand, but when grown on an extensive scale a planter similar to the type shown in figure 127 is employed for distributing the seed. These machines usually require two men to operate them successfully. Some planters are supposed to be automatic, but to obtain a perfect stand it is desirable that the working of the machine be under constant observation so as to insure the dropping of a seed piece at each interval. When the machine is employed the seed pieces must be of a uniform size and each piece must have the desired number of eyes, for a single piece is dropped by the machine each time. The depth of planting should vary with the season and the character of the soil, and should range from 3 or 4 to 5 inches. On very heavy, retentive soils 3 inches will be sufficiently deep, while on light and looser soils 4 or even 5 inches is

FIG. 127. Planting potatoes with the two-man machine

not too deep. Early plantings should be deeper than those made later in the season, as it is desirable that the plants shall not appear above the ground until all danger of hard freezing is past. The depth of planting should also be considered in connection with the style of cultivation to be given. If the ridge system is to be followed, the seed may be planted shallower than when flat culture is to be practiced.

Method of cultivation. Notwithstanding the fact that repeated experiments made by experiment stations and by practical growers have demonstrated that flat or level cultivation is the ideal method for potatoes, many growers still adhere to the plan of growing potatoes in hills or ridges. The flat method of cultivation exposes less soil surface to the action of the sun and wind, and therefore conserves moisture; the ridge or hill system throws the earth up in ridges, and while it keeps the tubers more perfectly covered with soil and prevents sun scald, there is more liability to injury from drought.

With the early crop, where there is practically no danger of serious drought, the question of level cultivation is not of so great importance as it is with the late crop, which must pass through the most trying period of the year. The implements best suited to the level method of cultivation are the 5-tooth cultivator of the Planet Jr. or Iron Age type, or the 2-horse corn cultivator fitted with narrow blades. In any case, the teeth or blades which are used should not be more than 1½ or 2 inches wide, so that the ground may be left as nearly level as possible. If, however, the ridge or hill system is followed, a narrow shovel plow will be needed in order to throw earth over the tubers and to produce the ridges desired.

In the cultivation of potatoes, as with other hoe crops, the chief object is to conserve soil moisture and to set free plant food. The old idea that cultivation had for its object the killing of weeds only has long since been exploded. Growers have learned that tillage to prevent the formation of a crust and to preserve soil moisture is the really important factor in cultivation. The most advantageous method of preserving this soil mulch is to cultivate with an implement that cuts the soil about 2½ or 3 inches deep and leaves it fine and loose and nearly level rather than in ridges.

Insects and diseases. The potato is subject to two enemies that are more or less serious according to the season and locality — the Colorado potato beetle and the flea beetle.

Colorado potato beetle. This is familiar to every potato grower and needs no description. It is, perhaps, the most serious insect enemy of the potato. The adult beetles do comparatively little harm, but the young beetles, called slugs, are voracious eaters and quickly defoliate the vines unless proper restrictive measures are taken. A common treatment is to spray the plants with Paris green at the rate of 1½ pounds to 50 gallons of water. In some instances this combination has been known to burn and slightly injure the foliage, but this is of minor importance in comparison with the destruction caused by the beetles. There are other insecticides, such as London purple and arsenate of lead, which are used to a considerable extent.

Flea beetles. These frequently invade potato fields in vast numbers, attacking the leaves and causing innumerable tiny holes to appear. In infested regions, when systematic spraying for the control of blight by the use of Bordeaux mixture is carried out, it is a well-known fact that injury from flea beetles is decidedly less. It is fortunate that the treatment for the control of the blight is also a satisfactory and economical treatment for this form of insect pest. Probably the most economical method of treatment is to combine the spray for the insect pests with the treatment for the blight, which is one of the most injurious potato diseases with which we have to contend.

Blights. There are different diseases called blight. The early blight, which causes the foliage to turn yellow and assume an abnormal condition, results in the death of the plant before its proper season of ripening. There is another blight, known as the late blight, or rot, which affects the leaves and, if not prevented, causes the tubers to rot very quickly after the plants have become infested. These different forms are not common to all potato-growing sections; the early blight is more serious in the North, while the late blight is more serious in the early-potato-growing regions at the South.

The treatment which has proved most effective in the control of the potato blights consists of frequent applications of Bordeaux mixture. The early application may be combined with Paris green or London purple for the destruction of the Colorado beetle. Even after the necessity for the use of the poison has ceased, the plants should be sprayed at intervals of a week or ten days throughout the growing period, depending upon the weather. In some sections five treatments seem to suffice, while in others as many as seven are found profitable, and even necessary, for the production of a successful crop. Both Paris green and Bordeaux mixture are now applied with power sprayers arranged to spray both the top and lower sides of the leaves at the same time, the pump being worked by gear driven from the wheels of the spray cart. There are various forms of such devices, some spraying as many as eight rows at one trip across the field.

Potato scab. The next most serious enemy of the potato is the potato scab, which is shown on the tubers in figure 128. Scab, which appears as rough, somewhat corky spots upon the surface of the tubers, is the result of a fungus which lives from year to year in the soil and on stored tubers, and is communicated to the new potato from the seed or soil, as the case may be. The common method of dealing with this disease is to treat the seed previous to planting it, but do not mistake the small, corky lenticels which are characteristic

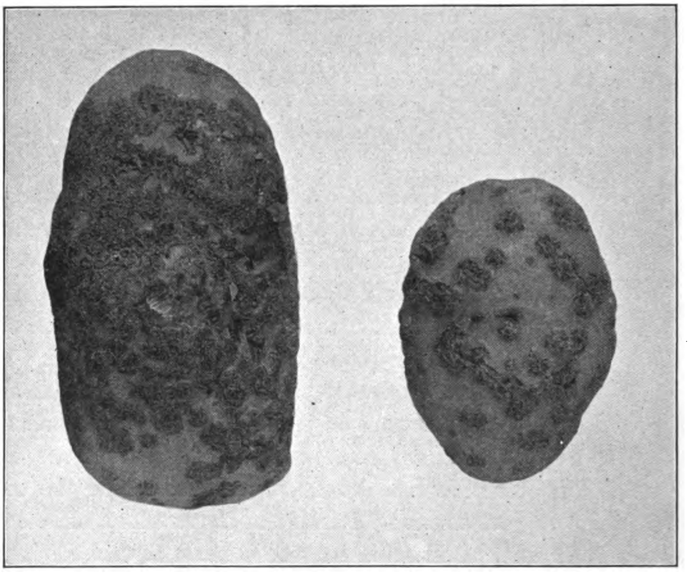


FIG. 128. Scabby tubers

of some varieties for the irregular rough, scabby spots which are characteristic of this disease. The common method of handling the seed is to soak it for two hours, prior to cutting or planting, in a solution of 1 pint of formaldehyde (or formalin) to 30 gallons of water, or to soak the seed for 1½ hours in a solution of bichloride of mercury, 2 ounces to 16 gallons of water. The bichloride of mercury, while undoubtedly quite as effective as the formaldehyde, is less easily handled and is not sufficiently less expensive to justify the substitution of one for the other. The bichloride of mercury, or corrosive sublimate, is a deadly poison and more dangerous to handle than formaldehyde, although it, too, is a deadly poison. Both solutions must be used with the utmost care.

Spraying. The fact that the early varieties of potatoes used by truck farmers and market gardeners are as a rule dug before full maturity renders the necessity for spraying somewhat less imperative than in the more northern sections, where large yields depend upon maintaining growth as late in the fall as possible.

Spraying with arsenicals for the beetle is necessary except in the extreme South, and injuries from arsenical poisoning, tipburn, and the early-blight fungus are so general that spraying with Bordeaux mixture and an arsenical combined should become the established farm practice. The poison may be either Paris green or arsenate of lead, from 2 to 4 pounds to 50 gallons of water. The former burns the leaves when used alone and in large quantities, but not when applied with Bordeaux mixture. The Bordeaux mixture is not a poison to the beetle, but acts as a partial deterrent. It also diminishes the tipburn, probably by protecting the plants against excessive loss of water and by direct stimulation.

Preparation of Bordeaux mixture. To make the Bordeaux mixture on a small scale take two half-barrel tubs, one for the copper-sulphate solution and the other for the milk-of-lime solution. Place 5 pounds of lime in one tub and slake this with sufficient water to break up thoroughly the lime without allowing it to burn. After the lime is thoroughly slaked dilute it to 25 gallons. Into the other tub pour 25 gallons of water and suspend in it 5 pounds of copper sulphate in a gunny sack or other porous sack from 24 to 48 hours before the solution is required. Bordeaux mixture is then made by pouring these two solutions through a wire-cloth sieve which has about 18 or 20 meshes to the inch, equal quantities of the two solutions being poured at the same time through the strainer, which should be suspended over a barrel or other receptacle sufficiently large to hold 50 gallons of the mixture. In making this combination it is best to have two men dipping simultaneously from the two receptacles and pouring the two solutions together into the strainer. The milk-of-lime and the copper solutions should at all times be kept thoroughly stirred.

When large quantities of Bordeaux mixture are required, stock solutions are made in 50-gallon casks, the concentration of the copper-sulphate solution being 1 pound of copper sulphate for each gallon of water; that is, 50 pounds of copper sulphate to 50 gallons of water. The lime solution carries 1 pound of lime for each gallon of water; that is, 50 pounds of lime to 50 gallons of water. Five

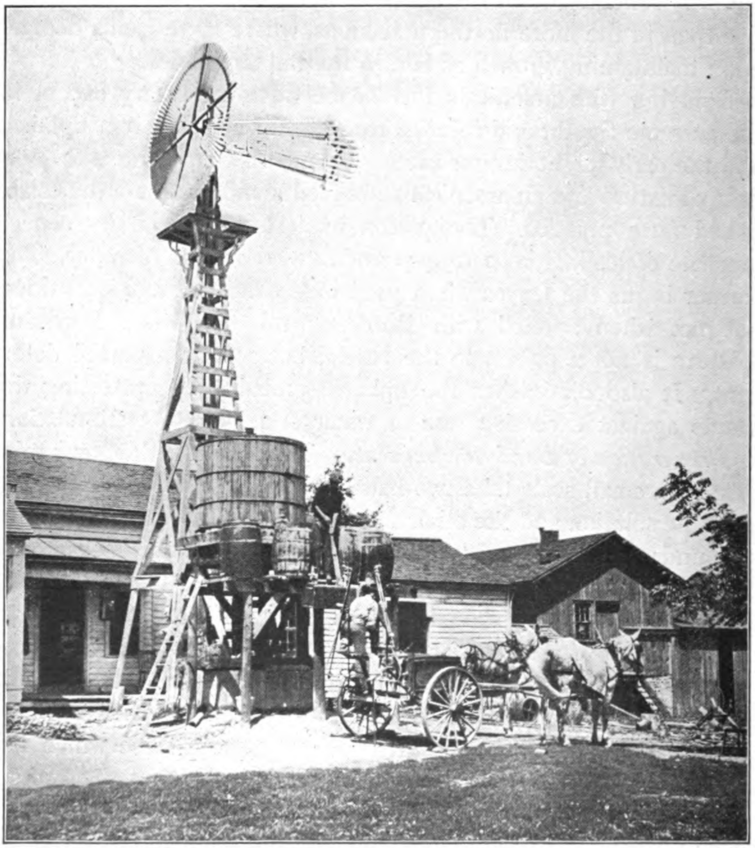


FIG. 129. Equipment for making Bordeaux mixture — tank, stock solution and dilution barrels, and power sprayer

gallons of the copper-sulphate stock solution are placed in one dilution barrel and 5 gallons of the stock solution of lime in a second dilution barrel; each dilution barrel is then supplied with sufficient water to make 25 gallons in each receptacle. To make Bordeaux mixture these diluted solutions are then drawn or poured together, as above described. An arrangement for preparing Bordeaux mixture on a larger scale is shown in figure 129.

The mixture should be applied by means of nozzles producing a mistlike spray. On a large scale automatic horse-power machines, such as shown in figures 130 and 131, will be required to do the work economically, but on a small scale the work can be done with a knapsack or other hand-power sprayer. The sprayings must begin early in the season and be frequent and thorough to be effective.

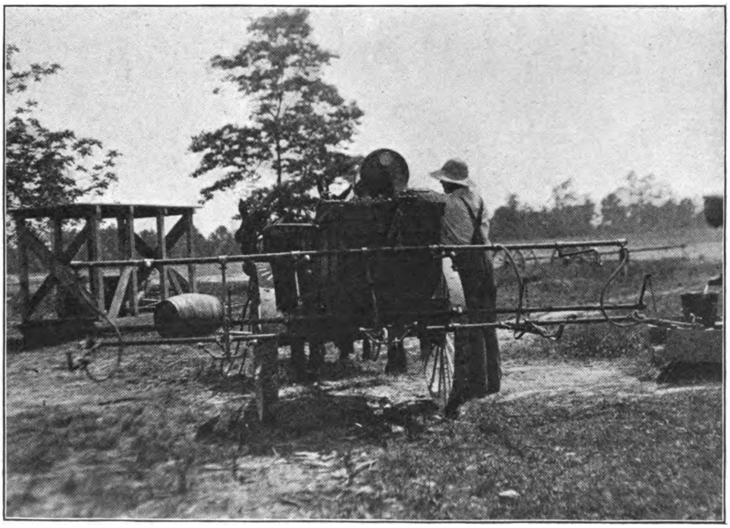


FIG. 130. Spraying rig designed to spray from below up and on top

Harvesting. When potatoes are grown upon a comparatively small scale, the harvest will have to be carried on with hand implements, for it would not be profitable to invest in modern harvesting machines.

In harvesting by hand, two types of implements are used: the spading fork, or potato fork, as it is sometimes called, which carries four or five broad tines; or a strongly made, round-tined fork, carrying tines closely set. If the round-tined fork could be made as strong and durable as the broad-tined pattern, it would be a more desirable implement, as there is less injury to the tuber if punctured by a round tine than if punctured by the broad tine of the spading fork. The other instrument for the hand digging of potatoes is the potato hook, which is made after the fashion of a fork with the tines turned at right angles to the handle, so that it is used in the same way as a hoe. This implement usually carries four or five round tines; in some instances the tines are made flat, as in the spading fork, but the round-tined type is most desirable. This hook can be used to advantage on light, sandy soils, and where there is only a comparatively small crop to be harvested. With

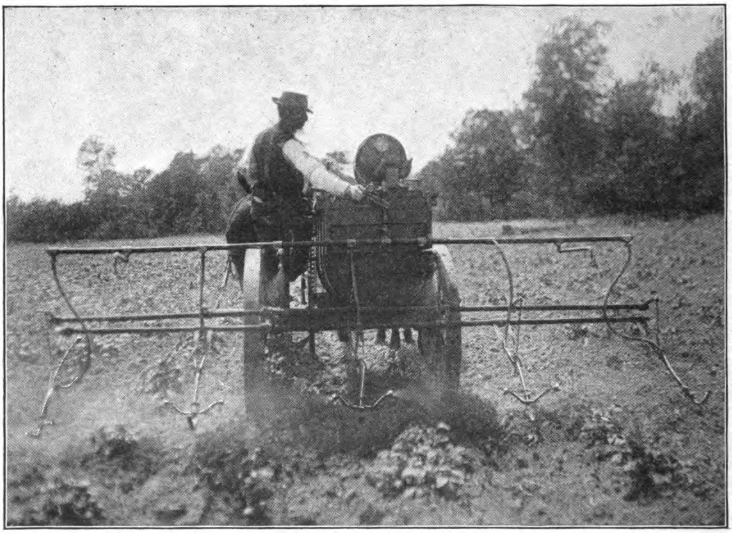


FIG. 131. Power sprayer in action — two sets of nozzles, one set to spray down and one to spray up

both these implements the potatoes are turned out of the ground as shown in figure 132, and the ground is left in almost the same condition as before the crop was harvested.

Between the hand implements and the horse-power potato diggers comes the ordinary turning plow. This is used to a great extent for harvesting potatoes. An ordinary plow used for turning stubble land is run under the hills of potatoes so as to throw the tubers out as the soil is turned by the moldboard. The plow is not a good digger, as it cuts and bruises some tubers while it leaves others hidden in the soil.

In extensive operations, where men are employed to pick up potatoes by the bushel, one person usually goes ahead of the pickers and loosens and exposes the tubers either with a hook or by hand. In many Southern localities this work is done with the fingers, in which case none of the tubers are bruised or injured except those which may have been cut or scarred by the plow. The plows used for this purpose are usually of moderate size and are hauled by one or two horses or mules, as shown in figure 143, page 378.

FIG. 132. Digging potatoes by hand with forks

There are a number of different mechanical devices designed for gathering potatoes. Most of them are made after the fashion of a plow, except that they are not provided with a moldboard; or if they have one, it is made of bars of steel so as to allow the earth to rattle through and throw the potatoes out on the surface, as shown in figure 133. Another type is one in which the point of the digger runs under the hills and lifts the tubers and tops, allowing the earth to fall through a screen which is made of steel bars, the potatoes being rolled out on the surface of the bars, from which they are carried by an endless chain to an arrangement at the rear of the machine and are deposited on the ground. Such a digger is shown in figure 134. Where potatoes are extensively grown in New York, Michigan, Wisconsin, and Colorado, a potato digger is generally employed. Figure 135 shows diggers at work. Along the Atlantic coast where early potatoes are grown by truckers these implements have not yet made their appearance, and the work is done almost entirely by hand, the tubers being turned out by the plow and picked up by hand. That the digger can be successfully

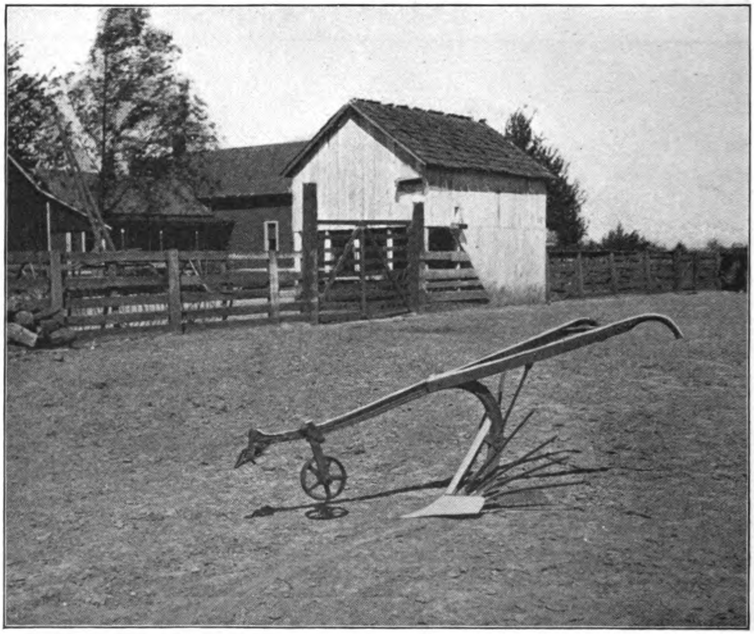


FIG. 133. Potato digger with steel finger bars instead of moldboards

employed in harvesting the early crop is proved by the fact that it is extensively used in the early potato-growing regions of Texas and Louisiana.

The practices followed in gathering potatoes in the field are local in character. In some sections nesting slat crates holding one bushel each are the receptacles employed for gathering the tubers and carrying them to the car or to the storehouse. In other sections the tubers are gathered into half-bushel splint baskets, which are emptied into gunny sacks and in these are hauled to the car or to

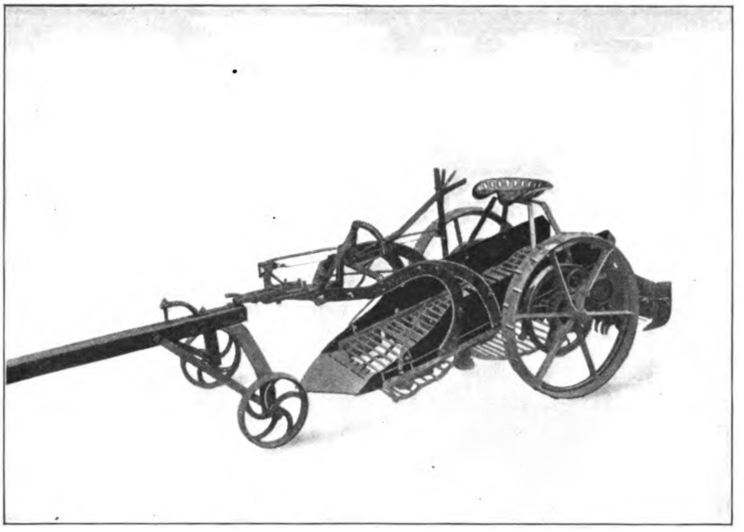


FIG. 134. A modern potato digger

FIG. 135. Digging scene on an extensive potato ranch

the storeroom. Potatoes are marketed in ventilated barrels, in gunny sacks holding 165 pounds, or more often in bulk in carload lots. In some places the receptacles are half-bushel wire baskets, which have the advantage of being light but strong and at the same time act as a screen. The practice to be adopted will be determined by the grower after a study of local conditions.

Sorting and grading. In general, potatoes are graded by the pickers in the field. This of course requires some skill and judgment on the part of those gathering them. In localities where the crop is very extensively handled, however, mechanical devices fashioned somewhat after the pattern of the pea graders are used for sorting and grading. In some cases a rotary cylinder is used, which allows the potatoes of different sizes to pass through the screen at different points, thus depositing different grades in separate receptacles. Many different machines have been designed for this work. Those built with two inclined swinging screens so arranged that the potatoes roll off into sacks, the larger ones from the topmost screen and the small potatoes from the lower screen, while the dirt falls through both, are very satisfactory. This type of grader is extensively used in the Colorado region. It is mounted on slides and hauled through the field to receive the tubers from the pickers.

Marketing. The marketing of winter, or late, crops of potatoes is on quite a different basis from that necessary in the trucking region. The late crop is, in general, less perishable, especially if the vines have been carefully sprayed and the tubers have ripened before digging. Ordinarily, however, if the market is at all good, it is more economical to ship the potatoes directly from the field than to attempt to store them. There are several reasons for this. The first is the expense of handling. Potatoes are a bulky, heavy product, and to haul them from the field to storage pits or cellars is as much work, and almost as great an expense, as to haul them directly to the car for shipment. The additional cost of storage equipment and the rehandling of the potatoes from storage to the cars at shipping time adds a considerable item to the expense of the crop. A second important consideration is the loss consequent upon storage. This loss usually consists of two items — shrinkage in the potatoes themselves, which amounts to about 10 per cent, and loss from decay, which may range anywhere from 1 to 15 per cent, depending upon the condition of the tubers when stored and upon storage facilities. There is also a possibility of loss from freezing or from uncongenial storage conditions. Then, too, if the price of potatoes at digging time is in the neighborhood of 40 cents or 50 cents per bushel, it is usually more profitable to sell at that time than from January to April at 75 cents a bushel, because the loss sustained from shrinkage and rot, or other storage conditions, is usually sufficient to offset the difference in price. Some growers, however, insist that it is best to store potatoes. This is undoubtedly true if the price at digging time is below 40 cents a bushel, but no arbitrary rule can be laid down. All factors that may have a direct bearing upon the future price of the product should be carefully considered, provided the decision to hold or to sell the crop is entirely within one's own control.

The grower should keep thoroughly informed concerning the prospective crop in the various sections with which his product competes in the market — the acreage planted and the conditions of the crop as compared with those of former years. There are reliable statistical reports and periodicals from which such information can be obtained. A careful study of these reports should clearly indicate the status of the crop and give a reliable basis for a judgment as to what the price of potatoes will be in any season.

Shipment and marketing. Potatoes are frequently gathered from the field, carried directly to the shipping point and marketed in bulk in carload lots. In some cases the potatoes as they are picked up are dumped into wagons, from which they are shoveled with wooden or wire scoops into the cars. More frequently, however, picking crates are loaded directly into wagons, and the potatoes are not rehandled until they are dumped into the car. This is a common practice among the Northern growers of late potatoes.

The truck growers along the Atlantic coast market their potatoes almost exclusively in ventilated barrels or gunny sacks. Barrels of the ordinary type, which hold 3 bushels, are made of laths, staves, or splints and have one solid end, the other end being covered with a gunny sack. In other localities a common receptacle for marketing potatoes is a sack which holds either 90 or 165 pounds. The 90-pound sack is the receptacle most commonly used in northern and eastern Texas and adjacent sections. Many of the late-crop potatoes grown at the North are also marketed in this manner, while on the Pacific coast 100-pound sacks are almost universally used.

It is a good plan for the growers to fill the sacks well so that there is a slight excess in weight in each. There is always more or less shrinkage during shipment, and it is desirable that the potatoes overrun slightly in weight when they reach the market.

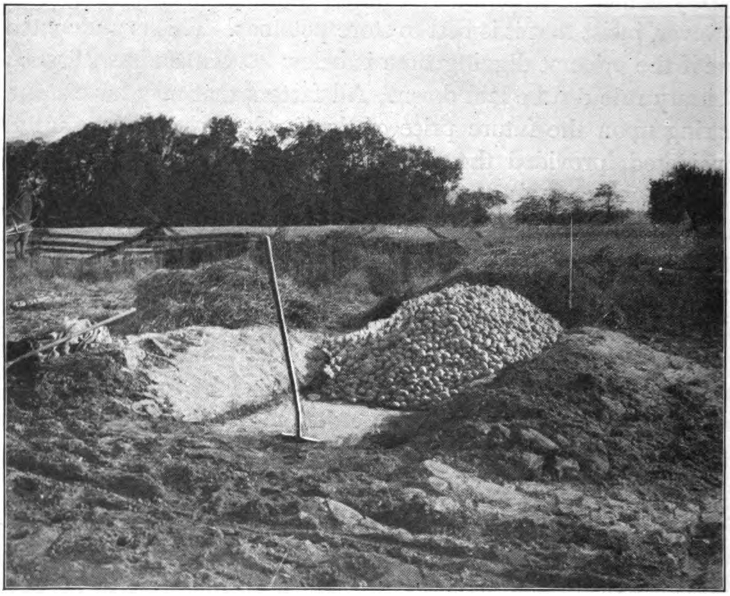


FIG. 136. Pitting or burying potatoes in the field

There is always better sale for sacks containing a little excess than for those short in weight. The higher price is sufficient to warrant the growers in providing this slight excess.

Storage. The storing of the crop may be done in temporary pits in the field, as shown in figure 136, which is usually termed "burying the potatoes," in barn cellars, or in specially constructed root cellars, as shown in figure 137. When the tubers are buried in the field the pits are constructed on a well-drained, somewhat elevated piece of ground. An excavation about 6 or 8 inches deep and about 4 feet wide is made to receive the tubers. The potatoes are then placed in a conical heap of any desired length, usually about a carload capacity, and heaped as long as they will remain in position. After the conical heap, or a section of it, has been completed the tubers are covered with clean straw, preferably rye or wheat, and this in turn is covered with a layer of earth which at first may be only 3 or 4 inches thick, but which should be increased in thickness as the cold weather of winter comes on. If the covering of

FIG. 137. Potato storage pit

earth is not deemed sufficient during extremely cold weather, an additional protection may be afforded by the use of coarse stable litter or bundles of corn fodder placed over the pit. A trench, deep enough to prevent surface water reaching the interior of the pit, should be dug completely around the pit and should be provided with an adequate outlet for the water.

Root cellars and barn cellars. Many growers who are engaged in the extensive production of potatoes, either for market or for seed purposes, make provision for the storage of their crops, either in regular root cellars (see figure 28, page 84) or in barn cellars. The latter are made frost proof, but are provided with sufficient ventilation to maintain a low temperature, and sufficient humidity to prevent excessive evaporation from the tubers. This type of storage equipment is more desirable for persons engaged in the production of seed potatoes than for those who grow potatoes for consumption, unless they are within easy reach of the market at all seasons. Seed growers of the extreme North generally plan to move their crop in the fall to warehouses at distributing points,

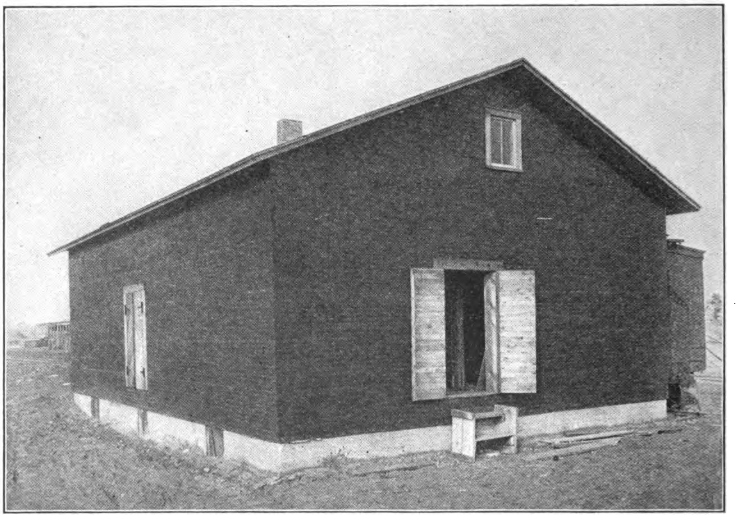


FIG. 138. Frost-proof potato storage house at shipping point

or to place it as near as possible to the points at which it is to be used for seed purposes. In fact, dealers who handle seed potatoes make it a point to purchase their stock and have it in storage the previous fall before danger of loss from cold weather occurs.

Carriage houses and barns are frequently constructed with basements or cellar rooms for potato or cabbage storage, the chief requisite being a frost-proof room, free from moisture and provided with ventilation for the purpose of controlling the temperature of the room. The same principles hold in the construction of root cellars, although such cellars are usually independent structures built either into a hill or only partly below ground.

In barn cellars and root cellars the tubers are usually stored in bulk, for there is less shrinkage and greater economy of space and storage equipment when the crop is so stored. Storage warehouses are constructed at distributing points either in the city or at an important railroad point in the growing region. These buildings are of varying capacity but are usually built entirely above ground, either beside the railroad, as shown in figure 138, or with a track running into the building. In construction these houses are modeled after the refrigerator in order that the rooms may be made as nearly frost proof as possible. This can be most economically accomplished in frame construction by the use of sheathing, building felt, and dead-air spaces, as suggested in figure 139. The tubers stored in these houses are carefully assorted and sacked, and the sacks piled in ricks of convenient height and width. As an added precaution, however, a walk should be left between the outside wall of the building and the outermost rick of sacks.

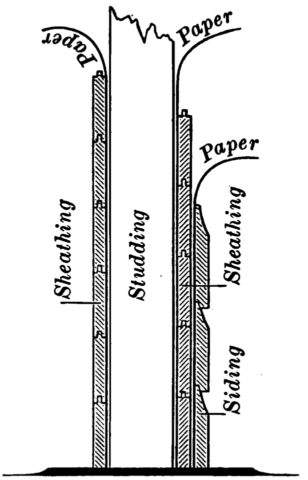


FIG. 139. Wall construction for a frost-proof building

Temperature of storage rooms. The temperature of the storage pit, cellar, or warehouse is important for two reasons. Too low a temperature may destroy the life of the tuber, rendering it unfit for seed and undesirable for food, even if it does not rot it. Tubers which have been held at too low a temperature for a long time become sweet and unpalatable. This sometimes occurs without causing the potato to break down and rot. On the other hand, too high a temperature causes heavy shrinkage, through excessive loss of moisture, premature sprouting, and consequent lowering of vitality and quality. Ideal storage conditions for cellars or pits are moisture conditions which will prevent excessive shrinkage, good ventilation, provisions for excluding light, and facilities for maintaining a temperature between 34° F. as a minimum and 45° F. as a maximum throughout the entire storage period.

Transportation. The bulk of the commercial potato crop of the country is shipped to market by boat or by rail. Only a few of the important potato-growing sections are favored with water transportation facilities, and as a result the greater part of the crop is annually moved by rail. The shipment of potatoes by rail is a simple matter in the early part of the harvest season, but as the season advances and cold snaps become more frequent, the risk increases correspondingly. Early in the season ordinary freight cars are satisfactory and safe, but as the cold becomes uncertain, either

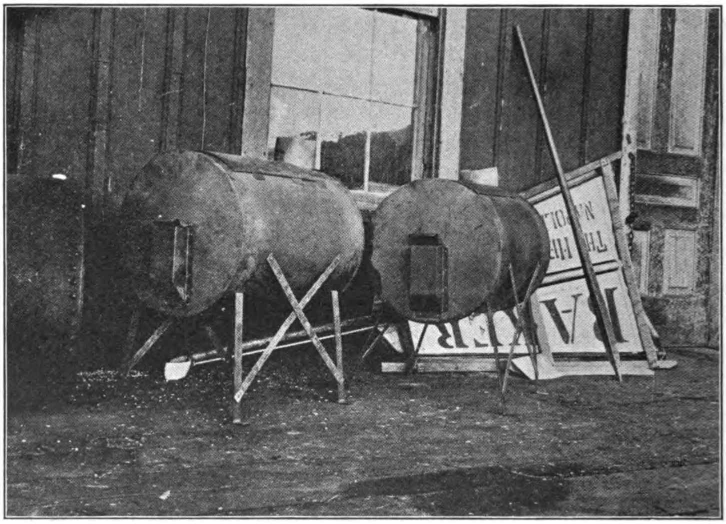


FIG. 140. Sheet-iron stoves used for heating cars in cold weather, Michigan

lined cars or refrigerator cars are a necessity. In some Northern localities the cars are provided with the means of heating by the installation of an "air-tight," sheet-iron stove such as is shown in figure 140. While such stoves, or even lanterns suspended in the closed car, will prevent the interior temperature from reaching the freezing point, the chief danger and the most frequent source of loss is frost, which penetrates the wall of the car and freezes the potatoes lying against the floor or outside walls. False floors and sides which prevent the tubers from coming in contact with the outer walls of the car are a great safeguard.

The greater part of the late potato crop is shipped in carload lots in bulk or in gunny sacks; if in sacks, 165 or 180 pounds, according to the demands of the market in which they are to be sold, are placed in each sack.

Varieties. The difference in the length of time for potatoes to mature has already been recognized in discussing the distinction made at the North between early and late potatoes. Besides these differences there are marked contrasts in the adaptation of different sorts to different soils; not only do some sorts yield better upon a certain kind of soil, but the quality of the tuber varies with the character of the soil.

Since the discovery that certain plants are more resistant to diseases than others, this fact has been taken as the basis for evolving varieties which possess the ability to resist blight or rot. At present we have several so-called resistant varieties that have some merit. Many breeders are giving this point special consideration, and it is probable that within a few years resistant varieties will be as well marked as are early and late sorts at the present time.

The production of new varieties of potatoes is a matter of more than ordinary interest because it is so different from the method of commercial reproduction. Commercially, the potato is reproduced from vegetative parts, that is, by the tubers without the intervention of true seed, but the development of new sorts is based on reproduction from seed produced by the seed balls. The seed ball is of rare occurrence in many varieties, the universal reproduction of the plant by vegetative parts seeming to have had the effect of discouraging the production of seed balls by most varieties. Sorts show a great difference in this respect; some produce few or no seed balls, while others produce them in comparative profusion. The element of chance, which is such a large factor in the production of new varieties, renders the potato a particularly attractive subject to work with.

For early crop use Early Rose, Beauty of Hebron, Early Ohio at the North, and Bliss's Triumph (Red Bliss, or Triumph), Early Ohio, and Irish Cobbler at the South. For late crop use Green Mountain, Carman, Rural New Yorker, White Giant, and Burbank for the North, and McCormick for Maryland and Virginia.

Potatoes as a Truck Crop at the South

Distribution of the crop. The growing of Irish potatoes as a truck crop at the South has assumed large proportions. Thousands of acres are annually planted to early varieties of potatoes, which are harvested as soon as they have reached suitable size regardless of their maturity (as suggested by figure 141), and immediately transported to Northern cities for distribution and consumption. This

FIG. 141. A good stand in the trucking district

industry extends along the Atlantic seaboard, from the southernmost terminals of railway transportation to the vicinity of the great centers of consumption. Florida produces a large annual crop of early potatoes, followed by Georgia, South Carolina, North Carolina, Virginia, Maryland, and New Jersey in turn. The great early-potato-producing sections of Florida are centered around Hastings; in Georgia the sections are largely confined to the vicinity of Savannah; in South Carolina a large acreage is cultivated in the trucking region about Charleston; in North Carolina a very extensive crop is planted in the vicinity of Wilmington; while Norfolk, Virginia, probably outclasses all other regions along the Atlantic coast so far as acreage and yield are concerned. This vicinity is one of the oldest and largest early-potato-producing sections of North America. Besides this belt of country devoted to this industry, there are isolated regions along the Gulf coast and in northern Texas, Kentucky, and Missouri where potato growing has been established and has proved quite profitable.

Variations of the crops. It is impossible to give accurate statistics in regard to this crop, for it changes annually according to the markets of the preceding year, those who engage in the industry being greatly influenced by the previous year's return. This is an exceedingly unfortunate condition, as the growers should determine their planting, not by their previous year's experience, but by the condition of the crop at the North. The crop of so-called winter potatoes produced at the North has more influence upon the price that will be received for the early crop than any other single factor. The truck farmer should therefore keep a careful record of the crop at the North the year preceding his planting. The quantity, quality, and price of the held-over Northern crop are factors which influence decidedly the price of the new crop when it reaches the market. A market which is well stocked with old potatoes that have been kept in fairly good condition means a very low price for the early crop when it comes in competition with such stock. As this new crop cannot be retained long in the soil at the extreme South without rapid deterioration, neglect on the part of the grower to determine the quantity of old potatoes in sight at planting season, as compared with a normal supply, may mean a very meager profit, if any, or a very heavy loss if the crop cannot be moved at the proper season and at a satisfactory price.

Soil. The character of soil best adapted to the production of early potatoes is a light, sandy loam (what the truck growers call a quick soil) rather than a heavy, retentive one — one that is thoroughly well drained and comes into condition very quickly in the season. Late, retentive soils are not desirable for potato growing, particularly for early markets. It is considered more advantageous to add heavy dressings of fertilizer to the soil than to use heavy, rich, and retentive soils. Earliness of the crop is of more importance than rich soil. In order to produce early potatoes it is necessary to make use of every factor that will stimulate rapid growth and quick maturity. Light, rather dry, warm soils are nearest to the ideal for this purpose.

Preparation of the soil. Thorough, deep preparation of the soil is essential for success with potatoes. The soil should be prepared by growing a hoed crop upon it the previous year, one of the legumes if possible, and should be cleared of all débris and rubbish during the fall or winter. As soon as conditions are favorable in the early spring or late winter, the ground should be deeply and

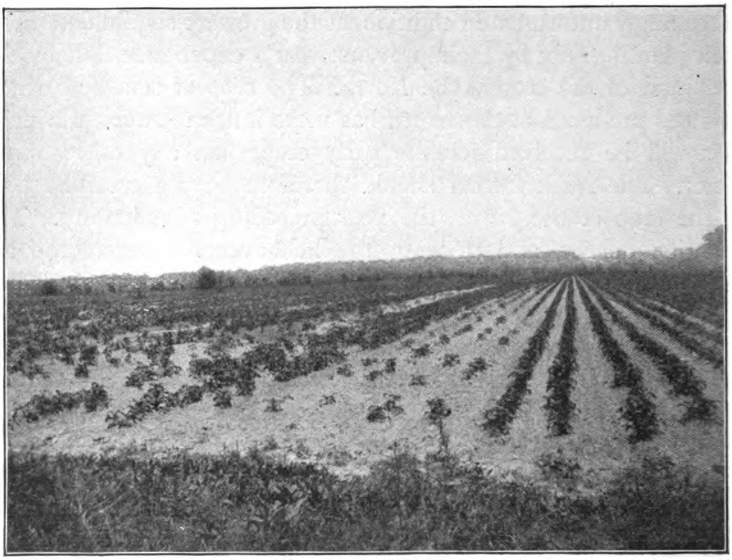


FIG. 142. Good and poor stands of potatoes due to seed

thoroughly plowed either with a disk plow or a good turning plow. After plowing, if the ground shows a tendency to bake, it should be thoroughly fined and moderately well compacted by the use of a harrow and clod crusher. Soils slow to come into condition in the spring are greatly benefited by disking before plowing.

The depth of plowing should not be greater for potatoes than for other truck crops. As a general rule the seed bed should be deep and mellow, but it is not safe to turn up too much subsoil at any one time. It is well to deepen the soil gradually, an inch a year, until the desired depth has been attained.

Source of seed. In growing early potatoes, perhaps more than any other single crop, the sources from which the seed is obtained influence the resulting crop. The practice which is almost universally followed is to plant tubers of early varieties which have been grown for several seasons at the North. The demand by truck farmers for Northern-grown seed has developed a considerable industry in some of the potato-producing regions, notably Maine, Michigan, and Wisconsin. Early varieties which are especially adapted to truck work at the South are extensively cultivated in these Northern regions, for the purpose of producing seed to be used in the South. The crop is harvested and placed in storage houses either at the North or at the South, where it can be made available to meet the demand for seed for early planting at the South. In a majority of instances it is found that second-crop home-grown seed is slower to germinate, as shown in figure 142, and is later in maturing than Northern-grown seed. As quick development is an important element in the crop at the South, growers are urged to consider this point carefully.

Quantity of seed. The quantity of seed used to the acre depends largely upon the manner in which it is planted; that is, the distance between the rows, the distance between the hills in the rows, and whether the seed is used whole or cut. It may be stated in general terms, however, that from 8 to 12 bushels of seed as ordinarily grown are required to plant an acre. If the potatoes are cut to two eyes and are small, 8 bushels will plant an acre; but if the potatoes are large, 8 bushels will not plant a measured acre. Some successful growers use small or medium-sized whole potatoes, others cut the potatoes in half, while still others cut to one or two eyes. If the potatoes are sound and have not sprouted to any considerable extent previous to planting and have not been subjected to unreasonably low or high temperatures, one-eye or two-eye pieces from a medium-sized potato will give good results. When seed potatoes are scarce and high in price, growers will endeavor to make the seed go as far as possible by cutting it to one-eye or two-eye pieces.

Tests conducted to determine the best character of seed to use indicate that a potato weighing about 3 ounces, when cut in half and planted one piece in a place, gives the best results so far as yield is concerned. In some localities, however, particularly where excessively wet or excessively dry planting periods occur, it has been determined that whole potatoes are safer for the early crop than cut seed.

Rapid germination of second-crop seed. A novel practice for securing quick growth from second-crop seed has been adopted by a successful potato grower in Texas. Mr. Morrell has developed an idea which is closely akin to the practices of the potato growers of the Channel Islands. The method consists in storing the tubers of the second crop in a tight building, which by the use of artificial heat can be kept frost proof. At harvest time the tubers are stored in slatted crates and the temperature of the storage house held as low as practicable without freezing until within four or six weeks before planting time, when the temperature is raised to 68° or 70° F. This temperature is maintained until the eyes of the potatoes show activity. The sprouts should not be allowed to develop to any considerable length before planting the tubers, on account of the danger of breaking them in the necessary handling at planting time. If the sprouts are one-eighth inch or less in length there should be little loss from handling. If the house can be well lighted at the time the temperature is raised, the sprouts will be much stouter than those developed in the dark. This plan provides a congenial temperature for the germination of the tubers and makes it possible to delay planting until outside conditions are generally favorable for the rapid growth of the plants, and to use for seed only those tubers which are actually viable. With good preparation and cultivation this method should give a perfect stand, a decidedly increased yield, and early maturing of the crop.

This plan has been used for Northern-grown seed, but it is found that this seed when mature responds more quickly to a given heat stimulus and consequently does not need to be placed in a warm room more than ten days or two weeks before planting.

The practice of the Channel Islands accomplishes the same results in a slightly different manner. The tubers are placed one layer deep on germinating trays, which are arranged on racks or are provided with corner posts a few inches long so as to admit air and light. The tubers are induced to germinate in the trays, and at planting time only those with well-developed sprouts are used.

As the work is all done by hand there is little danger of injury to the seed from breaking off the sprouts. In all sections of the South where hand planting is practiced, this method of procedure is perfectly practicable and would entirely obviate losses from uncongenial conditions due to cold, damp spring weather and inferior seed. Planting could be delayed until conditions were favorable, and poor seed would be detected before it was planted.

Held-over seed. The consensus of opinion is that in Southern localities it is impracticable to keep early potatoes from harvest time to the next season's planting period. The conclusions of those who have given this problem careful study are that the exposure of the tubers to the sun at harvest time is the chief factor in determining their keeping qualities. In other words, it is possible to keep potatoes in the extreme South from season to season, provided the tubers are not exposed to the sun after being dug. They should be immediately carried to a protected place where there is ample ventilation and where they will receive only diffused light, such as a cyclone cellar, or the basement of a house, or even where brush potection will prevent the sun's shining directly upon them. It is, of course, necessary that the tubers be well-matured before being dug and that they be the product of disease-free plants. Plants killed by blight yield tubers which seldom keep well even under the most favorable conditions.

Varieties. The varieties that are grown in the Southern states are quite distinct. The Red Bliss, or Bliss's Triumph, which is of comparatively little value in the North, is popular in the South, and is perhaps more extensively cultivated than any other single sort. Next comes the Irish Cobbler, XX Early, Early Ohio, and Bovee. There is a difference in the varieties used in different localities. In eastern and northern Texas, perhaps nine tenths of the early crop of potatoes is of the Bliss's Triumph variety. Along the Atlantic coast the percentage of this variety is much lower, although it as well as Early Rose is popular in Florida. The Irish Cobbler, at present, leads all other sorts in the Atlantic coast section from Florida to New Jersey. These sorts are the best now known for this use, but they are far from ideal. The ideal sort for the truck grower is one which sets five or six tubers early and develops them to market size quickly.

Harvesting. The question of maturity in the potato is not considered in harvesting the early crop for Northern markets; as soon as the tubers are of sufficient size to be salable, they are harvested.

As has already been noted, potato blight is prevalent in Southern localities, and for this reason as soon as the vines become in the slightest degree affected with this disease, the whole crop should be removed as quickly as possible. Otherwise there will be great danger of heavy loss from the rotting of the tubers.

FIG. 143. Digging truck-crop potatoes with a plow

While the harvesting of early Irish potatoes grown for home consumption is largely carried on by hand, in some localities improved implements, such as potato diggers and potato sorters, are brought into service. The truck farmers along the Atlantic coast, however, adhere largely to the simpler methods of handling the crop, as suggested in figures 143 and 144. This is undoubtedly accounted for by the fact that labor is more abundant and not so well trained in the use of improved machinery as in the more northern and western districts. In digging early potatoes in the Atlantic coast district ordinary turning plows are used. Laborers follow the plows and gather the potatoes from the soil and throw them, four or six rows together, in piles, after which they are sorted and put into barrels for shipment. In the potato regions of Louisiana and Texas, where early potatoes form a crop of considerable importance, improved machinery is largely depended upon for harvesting.

Packages. The packages for early potatoes are determined partly by custom and the demands of the market, but largely by the local timber supply. In regions where timber is plentiful and barrels and crates figure largely in the shipment of other truck crops,

FIG. 144. Harvesting truck-crop potatoes; "grabbling," or seeking out the tubers by hand

potatoes are chiefly shipped in barrels, as shown in figure 145. In other localities burlap sacks are employed, as is the case in most regions growing late potatoes.

Up to the present time no standard measure, barrel, or bag for the handling of potatoes has been adopted. Recently certain states have passed laws requiring these packages to come up to a given standard, usually 170 pounds net for a barrel, and all short-measure packages entering their markets to be so marked. The barrel used by the trucker of the Atlantic coast region during past years holds about 11 pecks and weighs from 155 to 165 pounds net. These barrels cost the grower about 22 cents each, including the burlap cover. The bags used for the handling of the crop grown in the Southwestern region cost the grower in lots of 1000 or more about 7 cents each. These packages are used but once and are not returned to the grower.

Grading. The grading of early potatoes is quite as important as the grading of fruits. Large and small tubers should not be mixed in the same barrel. The pickers should be taught to gather the large and merchantable tubers in one basket and the small, or seed, potatoes in another, and these if placed upon the market should

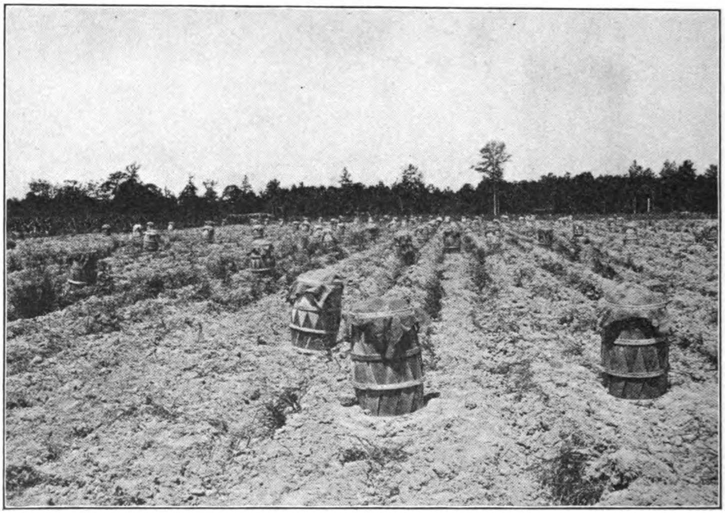


FIG. 145. Truck-crop potatoes barreled ready for shipment

go in separate receptacles and be clearly marked so as to represent the grade. If a mechanical sorter is used, this work will be more effectively accomplished than if left to the pickers.

A common type of potato grader is a rotary screen which separates the earth from the tubers and allows the small ones to fall through the large meshes of the screen before reaching the general outlet for those of merchantable size. The objection to a mechanical grader of this type is that it bruises the immature tubers and renders them somewhat less attractive, and shortens the time they can be held on the market. Immature potatoes harvested in hot weather are highly perishable and should be handled carefully.

Marketing. The early potatoes which are produced upon these lands are usually shipped to the Northern markets in ventilated barrels or sacks, the practice depending upon the timber supply and the proximity to barrel factories. In Texas, sacks of 90-pounds or 95-pounds capacity are almost universally used. The perishable nature of the immature potato makes it necessary to place it upon the market in such quantities only as will admit of immediate consumption. Producers in regions where the growing of early potatoes has been extensively developed appreciate this and have provided for it by organizing shippers' associations, through which the crop is graded, often trade-marked, and distributed chiefly in carload lots. The officers of the association being in constant telegraphic communication with the various markets are thus informed regarding the most satisfactory destination for every consignment. It is the purpose of these associations, however, to conduct their business in such a way that the product can be sold f. o. b. (free on board) shipping point instead of by consignment, and the best-organized associations are usually able to do this. Some of the best-managed truck exchanges are able to dispose of over 90 per cent of the total product handled on an f. o. b. shipping-point basis.

The great advantage of such a system of selling is that it enables the brokers in a small city or town to buy direct from the producer instead of through another city broker. It enables the consumer to obtain fresh products, as they are shipped direct from the point of production to the place of consumption. The plan carries other benefits which are of great moment to the producer. He is enabled to sell in carload lots at the shipping point, thus saving himself the cost of transportation, which ranges from 7 to 15 per cent of the gross selling price. The exchange secures a much wider distribution of the crop, with the result that overstocked markets are much less likely than under the consignment system. The transportation companies provide better service, and claims are more promptly settled through the exchange than in the case of individuals. This plan enables the producer to be his own salesman. It transfers the distributing point from the city to the field, where it should be. It brings the market to the field instead of the product to the market. The exchange becomes the farmer's commission house through which he secures information and over which he exercises control.

The association, by purchasing consumable supplies in quantity, can secure satisfactory prices and insure quick delivery and uniformity in quality and style of packages.

The price of potatoes varies from year to year, depending upon the amount and quality of the old crop held over and the skill of the grower in getting his product into the early market. Early potatoes of good size and appearance usually command a very satisfactory price, sometimes as much as $5.00 or $6.00 a barrel, but the average price ranges from $1.50 to $3.00 a barrel.

Potatoes under Irrigation

An extensive industry, based on the cultivation of potatoes under irrigation, has developed in several localities in the Great Plains and Pacific coast regions, where the precipitation is too small to permit agricultural operations to be conducted without irrigation. There is a great diversity of soil and contour of the land in these areas.

Preparing the soil. The preparation of the soil for potatoes to be grown under irrigation is, without doubt, the most important part of the cultivation of the crop. New lands produce a high grade of potatoes, but of somewhat smaller yields than lands which have been cropped with alfalfa or other legumes for a series of years. The plowing of the land should be deep and thorough, for, under the extensive plan of growing potatoes, it is necessary to have the soil in a fine state of tilth so that the work of planting, cultivating, irrigating, and harvesting, which is all done by machinery, may be carried on with the least possible difficulty.

The rotation of crops in the irrigated regions is of as great importance as in the humid regions. The practice of growing potatoes after potatoes is not a good one and leads to soil troubles as well as to diseases in the crop. The common rotation practiced in the irrigated region is to plant potatoes on soil on which alfalfa has been grown for two or three years. Potatoes follow the alfalfa one or two years, and the rotation is completed by planting the land to small grains for two years. In some localities, where nitrification takes place and alfalfa is used in the rotation, the lands gradually become too rich in nitrogen. This leads to difficulties which it is believed can best be overcome by substituting grains or hoe crops, such as beets or corn, in the rotation to precede the potato crop rather than to plant the potatoes after alfalfa.

Planting. On irrigated lands, after the plowing has been completed and the first harrowing has been given, it is necessary to level the earth so as to fill in slight depressions which may occur, and to take down ridges so that it will be possible to carry the water and distribute it evenly over the field. The amount of leveling required to fit the land for planting will depend upon the contour of the area. After leveling, the ground should be thoroughly disked. The details of planting on irrigated areas do not differ from those of planting in humid localities except that, where the contour of the land will permit, the rows should be laid out in such a way as to obtain a gradual, uniform slope lengthwise of the field, unless the rows exceed a quarter of a mile in length, in which case cross ditches must be provided. If the surface is uneven, ditches must be provided along the crown of the ridge, and the planting done on contour lines so as to lead the water at a uniform speed through the irrigating furrows. The accuracy and care with which the rows are laid out determines, to a great extent, the ease and success of the irrigation.

Planting on extensive areas is almost always done by machinery. The same type of planters shown in figure 127 is used in the irrigated district.

Cultivation. As soon as the planting is completed, cultivation is begun. In some instances this is simply harrowing in order to loosen the surface soil which has been compacted by the trampling of the teams and implements during the process of preparing for and planting the crop. In other cases the first cultivating is done with a four-horse cultivator having narrow blades which set very deep, so as to loosen the soil thoroughly and to increase slightly the ridges thrown by the planter over the seed. This cultivation is usually followed at once by the harrow. The number of cultivations necessary depends upon weather conditions and the rapidity of growth of the vines and weeds.

The second cultivation is given when the plants are large enough to make it easy to follow the rows. At that time the shovels are not run so close to the row as in the first cultivation, but the depth is not decreased. As the plants increase in size, the shovels next to the row are raised so that the roots of the plants will not be disturbed or injured. Sometimes two cultivations will suffice, but the ordinary practice is to cultivate three times. At each cultivation a little additional soil is thrown toward the plants.

The opening of the furrows for irrigation can be very successfully done with narrow, double-moldboard plows attached to a two-horse cultivator so that one plow follows through the middle of each row. These are so arranged that they make a deep, narrow channel for the water, the depth being practically that to which the cultivation has been carried, a furrow of from six to eight inches.

Irrigation. After the furrows have been opened, a canvas dam is thrown across the lateral which supplies the water, and the water is turned into every other row. The head of water used depends upon the contour of the land and the length of the row. If the rows are long, with a slight grade, a larger head of water is used than for short rows with a steep grade. Short rows with a steep grade will get too little water if a large flow is used. The idea of irrigation should be to wet the soil below the line of tuber formation and to allow the water to rise by capillarity through the ridge upon which the potatoes are growing. It is not considered the best practice to use enough water to saturate the soil; only so much should be used as will rise slowly by capillarity to meet the needs of the plants.

The successive irrigations should be carried on in alternate rows; that is, the second irrigation should be in the rows not included by the first, and the third irrigation should be in the rows used the first time. Cultivation should follow irrigation as soon as the condition of the soil will permit. Ordinarily it is not necessary to irrigate to put the land in order for planting or to cause the tubers to germinate. The first irrigation, under normal conditions, is given after the plants are several inches high, but no set rule can be made. The rainfall, the condition of the land, the temperature of the air, and the intensity of the wind during the spring months should be taken into consideration in determining the time for the first irrigation. In some seasons it will be necessary to irrigate early and to repeat the irrigations at frequent intervals, while at other times it may not be necessary to irrigate until the plants are about to come into bloom. One of the common errors is to attempt to make the water serve the purpose of supplying moisture and cultivation at the same time. Water should not be expected to perform this double duty; it should be relied upon only to furnish moisture, and the proper mechanical condition of the soil should be maintained by cultivation.

Harvesting. Potatoes are harvested by the use of diggers. Machines are put to work as soon as the vines have been cut by frost. As rapidly as the tubers are thrown out by the machines, pickers, usually equipped with wire baskets holding a half bushel,

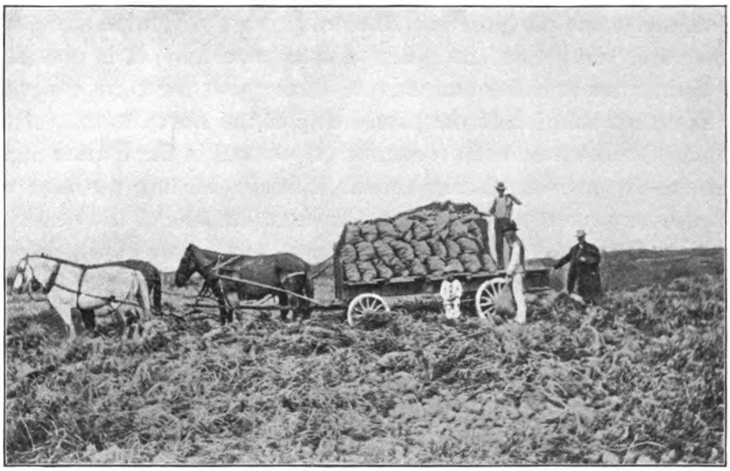


FIG. 146. Hauling potatoes from field to storage pit, Colorado

follow and transfer the tubers, if they are to be marketed immediately, to a grader similar to that described on page 364, which is hauled across the field. As the potatoes are gathered they are sorted and packed in sacks holding from 100 to 120 pounds. If the potatoes are to be stored, they are placed in sacks filled about half full, after which they are loaded onto platform wagons similar to that shown in figure 146, and hauled to the storage houses.

Storage houses. The dugout, or storage cellar, which is common throughout the potato-growing regions of Colorado, affords a cheap and efficient storage for potatoes in the dry climates, but is distinctively a dry-region structure. It is not adapted to humid regions. The dugout is simply an excavation made of the required dimensions to hold the crop to be stored, and is roofed over with poles, straw and earth, or concrete. Sometimes the side walls consist only of posts set in the excavation to carry the roof timbers, while in other cases both the side walls and the roof are constructed of concrete. An idea of the appearance of one of these cellars is given in figure 28, page 84. These storage pits are frequently filled at digging time and the crop held until the approach of mild weather in the spring. It is necessary in selecting a location for these pits to make sure that a draft of air may be secured through them so that the temperature may be lowered as required. After the contents of the pit have been lowered to a safe temperature, the doors and ventilators are closed, and opened only as is necessary to maintain a uniform temperature throughout the storage period.

Economic relation of the potato crop of the North to that of the South. The commercial production of potatoes in the United States presents a most interesting economic study, because we have two large areas producing this crop at different seasons of the year. At the North there is an immense autumn crop, a part of which goes into storage each year, both in the hands of growers and of dealers. The quantity of this hold-over crop determines to a great extent the prices which may be obtained for the early truck crop grown in the South Atlantic States, which comes into the Northern markets during April, May, and June. When these Northern potatoes are abundant and have been well kept, they are usually offered in Northern markets during the months of May and June at very low prices. The truck-crop potatoes, which naturally come into competition with these at this season of the year, suffer in consequence. In seasons when the late crop is normal or slightly below the normal, prices for the truck crop will then be better.

The following table, which is a comparison of the potato crops of 1908 and 1909, presents some very interesting information.

Crop of 1908	In hands of growers January 1, 1909	In hands of dealers January 1, 1909	Total available January 1, 1909
278,985,000 bushels	93,459,975 bushels	31,525,305 bushels	124,985,280 bushels

Average price to grower (old crop), January 1, 1909, 72 cents per bushel.
Price of new crop (truck), June 1, 1909, $3.25–$4.00 per barrel.

Crop of 1909	In hands of growers January 1, 1910	In hands of dealers January 1, 1910	Total available January 1, 1910
376,537,000 bushels	151,367,874 bushels	36,524,089 bushels	187,891,963 bushels

Average price to grower (old crop), January 1, 1910, 56 cents per bushel.
Price of new crop (truck), June 1, 1910, $1.50–$1.75 per barrel.

It will be noted that the crop of 1908 was 278,985,000 bushels; the quantity of potatoes in the hands of growers on January 1, 1909, was 93,459,975 bushels, while the quantity in the hands of dealers January 1, 1909, was 31,525,305 bushels, making the total available supply of potatoes at that date 124,985,280 bushels. At that time the price of potatoes to the grower was 72 cents; and on June 1, 1909, truck-crop potatoes were selling for from $3.25 to $4.00 per barrel. Compare this with the conditions which prevailed during the year 1909, when 376,537,000 bushels were produced. On January 1, 1910, there were 151,367,874 bushels of potatoes in the hands of growers and 36,524,089 bushels in the hands of dealers, making the total available supply 187,891,963 bushels. At this time growers were receiving 56 cents per bushel for their potatoes, and on June 1, 1910, truck-crop potatoes were selling for from $1.50 to $1.75 per barrel.

The range of prices received by the growers of truck-crop potatoes during the seasons of 1909 and 1910 clearly illustrates the influence of the hold-over crop at the North on the prices received by the growers at the South. The growers at the South should make it their business to learn the quantity of potatoes in the hands of growers and dealers not later than January 1 preceding their planting season, and determine their acreage accordingly. If there is a heavy hold-over crop, the acreage to be planted should be small; but if there is a light hold-over crop the acreage can be increased with the probability of satisfactory returns.

Development of new sorts. The number of varieties of potatoes now available in the trade would appear to be sufficient to fill the demands of all uses, soils, and climatic conditions. Varieties are constantly changing in character, and new uses and fields of culture are continually arising. To meet these conditions, and to satisfy the demand for new sorts for their own sake, there is constant work for the breeder. Just now the idea of securing sorts resistant to disease is uppermost in the mind of the potato grower. Sorts, both old and new, home-grown and foreign, are being subjected to the tests for disease resistance, which is the all-important factor.

The work of plant breeding has so advanced during the last decade that the task of securing plants with definite desirable qualities is much more certain at the present time than ever before. In fact, plant breeding has acquired somewhat the same certainty as animal breeding. The plant breeder, like the stock breeder, should have a well-defined ideal in mind before undertaking his task. The next step is an inventory of the existing sorts for the purpose of determining the degree to which they meet the new ideal and their prepotency and vigor when used as breeding stock. Among the potatoes none seem to have greater ability to adapt themselves to new conditions or to develop desired characteristics and qualities than the Early Rose and its numerous progeny.

New varieties of potatoes may arise in three ways: (1) as a result of seed reproduction through chance seedlings or through direct cross-fertilization; (2) through bud variation or sporting, not unknown but not usual; (3) by selection and line breeding, a very important means of increasing the commercial value of a variety without resorting to the intervention of the seed. By selecting tubers of a desired type from the most productive hills the yield and general character of the variety can be maintained at a high standard. If the work be still more restricted, and the start made from a single tuber selected from the most productive hill, and a line of selection followed in which the seed used is chosen each year only from the most ideal hills in the progeny, a strain of superlative merit will be built up. For the commercial grower this method is thoroughly practicable and will be found to repay well the time and effort expended. In fact, the advantages from such care in handling potatoes are quite as marked as in the case of corn.

Seed reproduction. The development of new sorts of potatoes by means of seed production is fascinating work. There is a sufficient element of chance connected with it to lend it the charm which makes it worth while. Chance seedlings are, however, less interesting than those which are the result of close pollination or of a definite cross. In chance seedlings none of the factors are known save, possibly, the characteristics of the parent bearing the seed. When the seed is the result of definite crossing, two elements are known, and if the origin of the two parents used is known, a still greater interest attaches to the work, for the progeny will give a clew to the relative strength of the two parents and their prepotency. Such knowledge is of the greatest value to the breeder in securing the combinations necessary to produce the desired results. The more extensive the information at hand as to the behavior of the progeny of definite crosses, the more exact will become the work of the breeder.

In the work of cross-pollination the mere transfer of pollen is not sufficient. The flower to be used as the seed parent must be emasculated before its pollen has developed; that is, the stamens must be removed, and the flower protected by means of a small manila bag until the stigma has reached maturity, at which time it will be ready to receive the pollen of the flower with which it is to be crossed. This flower, also, should be carefully covered to exclude insects and thus insure it against pollen from other flowers. After the emasculated flower has been pollinated, it should again be covered to protect it as before, the cover being allowed to remain until the seed balls have ripened so as to protect them against loss. Careful records of the plants used should be made so that the character of the progeny can be determined. The behavior of the second-generation cross of the potato is not known. It is possible that it may hold as much of interest and value as the second-generation hybrids of other plants, which has proved to be the generation in which the splitting up — the result of the influence of the two parents — takes place, thus explaining the greater achievements met with in recent years by hybridization.

Growing the plants. After having secured a satisfactory seed supply, the next step is the growing of the seedlings. This is the point at which many propagators fail. In order to attain satisfactory results the seed of the potato should be planted at the same time and treated in the same way as the seed of early tomatoes.

In the latitude of New York City the seed should be sown in a greenhouse or hotbed not later than March 15. As soon as large enough the young seedlings should be pricked out in flats or boxes and, if possible, shifted to pots before being placed in the open.

It will prove best not to place them in the nursery until about June 1, when the soil and weather conditions should be such as to stimulate rapid growth, particularly if the soil is rich and well prepared. Under these conditions it should be possible to grow tubers of normal size the first year. With this treatment the writer has produced individual tubers from seed which attained the weight of one pound the first season, while with the usual method of sowing the seed in the open and allowing the plants to grow at will, it usually requires two or three years to accomplish the same results.

PUMPKINS

In America the term "pumpkin" is almost universally applied to that part of the Gourd family included in the varieties of *Cucurbita pepo* which are of running habit. From an economic standpoint the pumpkin is not of so great value as the squash. During recent years, however, the demand for pumpkin as a filling for pies has led to the canning of this product on an extensive scale.

Botany. Botanically, the true pumpkin is known as *Cucurbita pepo*, and is characterized by its hard-shelled fruit, rather slender, angular stem, which is but slightly swollen near the fruit, its deeply cut leaves, and stiff spines on the leafstalks. The plants may be bushy or trailing. This species includes not only the field pumpkins but the so-called summer squashes. The foliage, flowers, and fruit stems of the pumpkin and the summer squash are alike, but the habits of the plants and the characteristics of the fruit are very distinct. The pumpkin plant is a robust vine with long, trailing branches, upon which the pistillate flowers are produced. The summer squashes are distinguished by lack of runners and a bush habit of growth. While these two groups are considered identical from a botanical standpoint, they are horticulturally distinct and their uses are different.

The three species of cucurbits which are represented in the garden list are interesting because they do not intercross and because they do not cross with melons and cucumbers as is popularly supposed.

Cultivation. In New York state and in New England, pumpkins are often grown as a companion crop to corn. When so grown the fruits are generally used as a stock food, being greatly relished by both cattle and hogs; when grown as a separate crop, they are handled the same as winter squashes. Rich, well-drained land of a loamy nature suits them well. Since they are tender to frost, planting should be deferred until the danger from killing frosts is past. As a rule, the time for planting field corn is safe for pumpkins also. After thorough preparation the land is laid off in checks 8 feet apart each way. At the intersections the seeds are planted, from 4 to 10 in a place, preferably on a level with the general surface, although in some sections this must be modified to conform to climatic conditions. If rainfall is scanty the hills should be depressed, but if it is superabundant the hills should be slightly elevated above the general level of the soil surface. For superior fruits the practice adopted in squash culture, of manuring in the hill, should be followed.

Enemies. The pumpkin is subject to the same insect enemies as the squash, that is, the striped cucumber beetle, the squash bug, and the squash borer. The treatment for these pests is described on pages 235–237.

Harvesting and marketing. As soon as fully grown and colored, the pumpkin is ready for use, although the vine may not be ripe. The fruit of the pumpkin has a strong, hard shell, or rind, which does not readily decay. This characteristic, together with the firmness of the flesh, makes it possible to keep the pumpkin in warm, dry storage for several weeks. While the pumpkin is less subject to decay than the *maxima* squashes, fruits intended for storage should be carefully harvested with their stems adhering before frost kills the vines.

The crop is usually marketed in the autumn for canning or is shipped direct to the cities about Thanksgiving time. Large quantities of pumpkin are now annually canned, the demand of the canneries furnishing the chief market for the crop. The texture of the flesh of this fruit adapts it to desiccation, and although this means of preservation has long been practiced as a household art, it has never been made the basis of an extensive commercial enterprise.

Varieties. The varieties of pumpkin worthy of special mention are Connecticut Field, Mammoth, Cheese, and Winter Luxury.

RADISHES

The spring radish is a universal favorite. When it is well grown it possesses a crispness of flesh and a sprightliness of flavor which are most acceptable after a protracted diet of more concentrated, carbonaceous foods. Its crisp, acrid flavor makes it a decided appetizer, and for this reason it is very generally used upon the tables of all classes. As a market-garden crop the radish holds a subordinate position, but in the home garden it is one of the first crops to receive attention, because of its hardiness and quick return.

Botany. The radish, *Raphanus sativus,* belongs to the same family as mustard and cabbage, although it does not belong to the same genus. Two classes or types of radish are recognized, each having a wide diversity of forms with a varietal name. The early or spring sorts are all annual plants, but the later sorts — the so-called winter radishes — are usually treated as biennials, the roots being produced one season and the seeds the next. Some interesting investigations have been carried on to determine the origin of this much-prized vegetable. Notwithstanding the work of Carrière, who was able to take a wild form of an allied plant known as charlock, and from this in the course of five years develop a type of root corresponding in every respect to our highly improved garden sorts, some of our foremost horticultural botanists do not consider this as conclusive proof that the cultivated radish is a direct offshoot of the wild charlock. In fact, the origin of the radish is generally accredited to tropical India, where there are many forms of this plant in cultivation, and where the wild charlock is not known. Since the normal movement of plants has been from the orient toward the occident, it is not believed that the wild charlock made its way eastward in early times and became the parent of the present forms of radishes found in India. The true history of the plant will probably remain unknown, but for our purpose it is sufficient that the cultivated radish is now found in a great variety of forms adapted to a wide diversity of climates and seasons.

The discussion of the radish naturally falls under two heads: (1) The Radish as a Field Crop; and (2) The Radish as a Forcing Crop.

The Radish as a Field Crop

As a companion and succession crop. As a field crop the radish is seldom given the entire use of the ground. It is nearly always made a partner with some other crop which is to develop later and which requires a longer season. Seeds of the radish are sometimes used to mark the rows of a slow-germinating crop which grows with corresponding slowness after appearing above the ground, so that the occupation of the land by the radish for a comparatively short time does not materially interfere with the growth of the main crop. In the most intensive trucking areas of the United States, in the vicinity of New York City, particularly on Long Island, the radish is made to occupy the ground between rows of plants which later are to give a return. Under these conditions as many as five or six different crops, each maturing at a different date, are grown in contiguous rows; and as soon as one matures the ground is cleared to give more space to the remaining crops. Such a combination as the following may be employed. A row of radishes may be grown between two rows of lettuce, and on each side of these three rows two rows of peas, cabbage, or potatoes, the three crops coming off in the following order: first, the radishes; second, the lettuce; and finally the crop which occupies the rows farthest apart (see figure 1, page 6).

Kind of soil. A soil suitable for growing crops of this sort in combination must, of necessity, be exceedingly fertile, easily worked, and in condition to permit cultivation early in the season; it must be what is known as a "quick" soil. Such soils are usually composed of a combination of sand, clay, and humus, with sometimes a small mixture of gravel. They warm up readily, are usually of a dark color, do not retain an excessive amount of water, can be cultivated soon after heavy rains, and yet contain organic matter enough to guard against severe droughts. Soils having all these qualities are seldom found.

Preparation of the soil. If a soil contains the two primary ingredients, sand and clay, humus can be added by the use of stable manure or by turning under green crops, such as clover, Canada peas, cowpeas, rye, and other strong-growing plants. Corn is sometimes sown and plowed under early in its development for the purpose of supplying the soil with humus. Stable manure is the main reliance of the truck grower for his supply of humus. His crops are grown in succession and cannot well be arranged in rotations which admit of the use of green manuring crops. In fact, no successful truck grower would think of attempting to produce remunerative crops on his soil without the use of from 25 to 75 cubic yards of manure per acre each season. For such crops as the radish, coarse, strong manure should be avoided. Only fine, well-rotted manure is safe for use with this crop. Strong manures, which are going through the process of fermentation and decay, are too highly charged with nitrogen and induce a leaf development out of proportion to the development of the root, which usually results in an unsatisfactory and unmarketable product. Well-decomposed manure, at the rate of from 40 to 60 cubic yards per acre, will not be too much upon soils of the texture above described.

At the North such soils should be cultivated deeply by plowing late in the fall, leaving the ground in ridges or lists during the winter and, as soon as condition will permit in the spring, breaking down and cultivating the rough surface with a harrow, at that time incorporating with the surface the well-decomposed stable manure. This will leave the manure in the first 3 or 4 inches of the soil, instead of deeper, as would be the case if it were plowed under. The ground should be thoroughly worked to make it as fine as possible and to get the manure as thoroughly incorporated with the surface of the soil as can be done with the best soil-stirring implements. After such a preparation the surface should be made smooth and comparatively compact by the use of an implement like the Meeker disk harrow, which will accomplish practically the same work as the garden rake. The ground should then be marked off for seed sowing. It can be laid off in rows, or, if the area is to be devoted exclusively to radishes, it may be bedded and the rows run crosswise of the beds from 6 to 15 inches apart, the distance depending upon the method of cultivation. If the crop is planted in beds with narrow walks between, it will be convenient to have the beds from 6 to 10 feet wide and the rows from 6 to 8 inches apart. If a more extensive system is to be used, the rows should be from 12 to 18 inches apart to admit of cultivation.

Seed. For use either in the field or in the forcing house, none but the largest and heaviest radish seed should be used. Seeds which are less than 2 mm. ($\frac{2}{25}$ inch) in diameter should be rejected. In commercial seed about one third of the total bulk is below this size. The separation of the large from the small seed can be accomplished by a screen, with perforations of the desired size, or, on a large scale, by a shaking device which will determine the specific gravity of the seeds by the motion given the apparatus, the large and heavy seeds being sent in one direction and the light ones in another, and the two sizes being caught in different receptacles. The advantage of the large seed is that it gives the strongest and quickest maturing plants. It is especially desirable in forcing radishes to have the entire crop mature at one time, and this is also of considerable importance in field culture. Strong plants from large seeds will mature in from 21 to 35 days, while plants from smaller seeds will require from 8 to 15 days longer to come to maturity, and plants from very small seeds will never reach commercial sizes. It is therefore economical both in time and space to separate the large seed from the small.

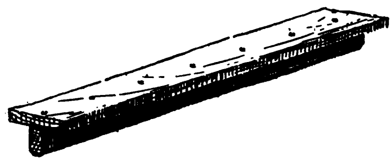


FIG. 147. Marker for sowing seeds in greenhouse

Seed sowing. Seed sowing can be accomplished in the open, either by the hand drill or by scattering the seed from the hand along the row. Ordinarily, in the field the seed should be planted about $\frac{3}{4}$ inch deep at the rate of from 30 to 40 seeds to the foot. In order to insure quick germination the earth covering the seed should be firmed so as to bring it into close contact with the seed. Modern seed drills are provided with rollers or press wheels, as shown in figure 117, which follow the drills and accomplish this work quite satisfactorily. Where the work is done by hand, as in a greenhouse or hotbed, the drill can be made by a marker shaped like a T, as shown in figure 147, by taking an ordinary lath, planing it down to $\frac{3}{4}$ inch in width and nailing it to a cleat 2 inches wide. Such a marker may vary from a few inches in length to the width of the bench or bed. After the seed is scattered and the earth placed over it, the work of compacting the soil above the seed can be accomplished by the use of a float about 4 × 8 inches, provided with a handle, or by placing a narrow board over the row and walking from end to end of it.

The radish is one of the common garden crops that are seldom or never transplanted. In a very few instances, where a close succession of crops is required in the forcing house, the radish is transplanted, but ordinarily, both in field and house cultivation, seeds are sown where the crop is to mature. The rapid germination and quick development of the crop, together with the cheapness of the seed, make it unnecessary to grow the seedlings in a specially prepared seed bed and transplant them.

Cultivation. The cultivation of the radish in the field is a comparatively simple operation. Its quick growth and the thorough preparation of the land necessary for success do not give opportunity for the growth and development of weeds. A wheel hoe or hand weeder is the only implement necessary.

Thinning. Whether the radish is used as a main crop or as a catch crop, the seedlings should be carefully thinned to stand from $1\frac{1}{2}$ to 2 inches apart in the row. This will allow sufficient space for the development of the roots, and when used as a marker will not seriously interfere with the development of the other crops.

Harvesting. Radishes are usually harvested as soon as they reach edible size. The plants are tied in bunches of from 5 to 10, according to the time of year. After being tied with a soft twine or band of raffia, they are thoroughly washed so that when they reach the market they will be in a bright, crisp condition. After washing, the bunches are packed in ventilated half-barrel baskets, of the Delaware type, but much deeper, although the diameter is not much greater. The bunches are packed in layers, with the roots toward the outside, until the basket is entirely filled. This leaves a rim of bright roots exposed about the green center as the lid of the basket is removed. In some instances larger receptacles are used for marketing the product, but the barrel is the maximum package, and when it is employed it is either of the ventilating type, used for the shipment of sweet potatoes, or of the lattice type, used for the shipment of kale and spinach.

The price received for radishes varies according to the season and the quality of the product, from 50 cents to $4.00 or $5.00 per 100 bunches.

The Radish as a Forcing Crop

Construction of frames and hotbeds. In trucking regions south of the District of Columbia, where small vegetables like lettuce, radishes, and early peas are grown, radishes are sometimes handled in frames like those shown in figure 16, page 60, which are made somewhat as follows: Inch boards 12 inches wide are used to construct a frame varying in width from 12 to 14 feet, and in length from 25 to 150 feet, which is placed upon the surface of the ground or upon slightly raised beds. The ends of the frame are usually made semicircular in outline and are constructed of matched lumber. A line of stakes is driven through the middle from end to end, and a ridge board is nailed to the top, at the height of the semicircular ends. At intervals of about 6 feet, strips $\frac{7}{8} \times 3$ inches wide and 16 or 18 feet long, depending upon the width of the bed, are sprung over the ridgepole and nailed at each end to the side boards. These serve as a support to the protecting muslin cover, which consists simply of a heavy grade of unbleached muslin, sewed together to form a large tent covering. This is made in sections and sometimes provided with a pole at the edge so that it can be rolled up and placed under a cap on top of, and in the center of, the structure. More frequently, however, the muslin is entirely removed and placed on a drying support at the side, so that when it becomes wet from rain or dew it can be spread out and dried before it is rolled. This is the ordinary construction for a frame used at the South for forcing lettuce and radishes.

At the North, where the climatic conditions will not permit the use of a simple device of this character, the cloth covering is replaced by glazed sash. Standard hotbed sash are usually employed, and the frame carrying them may be made as described on pages 55 and 56, or two of these frames may be placed back to back so as to give a double width. By the use of sash upon frames of this description, and the additional protection of mat or shutter-covering during severe weather, radishes can be started much earlier than in the open ground. Where a special market will justify additional expense in the cultivation of this crop, hotbeds, with about 12 or 14 inches of manure under them, are constructed for forcing purposes.

Soil for the cold frame and hotbed. In the case of the cold frame or hotbed the soil used should be of the nature described for field culture, and the precaution of using only soil enriched by the use of thoroughly decomposed stable manure should be strictly observed. A soil containing from 7 to 10 per cent of clay, and about one third its bulk of well-decomposed stable manure, will be found satisfactory. The soil in the frames should be sufficiently deep to prevent the roots of the radish from reaching either the hardpan underneath the cold frame or the manure that is used as the base of the hotbed. This will require a soil from 4 to 8 inches deep, according to the type of radishes grown. Soil for the hotbed or cold frame should be prepared in a compost before it is needed. The manure should be thoroughly composted for at least a year. A most satisfactory soil may be found in sods from an old pasture which have been piled with manure for at least six months before the soil is to be used in the hotbed or cold frame.

Seed for the cold frame and hotbed. The same precautions as to the selection of seed should be observed in planting the hotbed and cold frame as in field culture, for the even maturity of the crop is of greater importance here than in field culture.

Seed sowing in the cold frame and hotbed. In protected areas, like hotbeds and cold frames, seed need not be planted as deep as in the open, because the variations in soil moisture are less. A covering of ½ inch will be sufficient. In growing radishes for local market it will undoubtedly be best to treat them as a main crop, but even under these conditions they can be used as a catch crop between lettuce. Rigid care in thinning should be observed in field, hotbeds, and cold frames. The preparation of the forced product for market does not differ from the methods followed in handling the field-grown crop.

Requirements of the greenhouse. While the radish is very easily, and usually very successfully, cultivated in the open during the cooler portions of spring and autumn, it is somewhat exacting under greenhouse conditions. It is a cool-season crop, and the soil and atmospheric conditions of the early spring months should be imitated as far as possible in the houses devoted to its cultivation. A temperature ranging from 45° to 55° F. at night, and from 60° to 65° F. during the day, should be maintained.

The soil should be similar to that necessary for hotbeds and cold frames, and the house equipment should be the "solid bed" rather than the raised bench, as the radish does not require bottom heat; in fact, the soil should be slightly cooler than the atmosphere. If, however, drain tile can be run through the solid bed and thus provide a free circulation of warm air through the soil, better results will follow than when solid beds alone are depended upon. Raised beds, unless the soil exceeds 6 inches in depth, are not advisable, particularly if the crop is to be grown as a main crop. When lettuce is grown upon raised beds, radishes may be used to advantage as a catch crop. Radishes are exceedingly impatient of shade, and for this reason greenhouses of as light construction as possible should be employed. The glass should be of good size, and the framework of the house as light in construction as is consistent with strength and durability.

Seed sowing in the greenhouse. Prior to the seed sowing in the greenhouse the soil should be thoroughly moistened, so that at planting time it may be loose, friable, and yet contain sufficient water to insure the rapid germination of the seed. The seed should be planted in rows not more than 4 inches apart, and where the radish is the main crop the rows may be 3 inches apart. If the seed is carefully selected and tested and shows a high percentage of germination, it may be sown at intervals of ½ inch and covered with about ½ inch of good soil, which should be thoroughly firmed over the seeds. After the seed is sown, the bed should receive a good watering, but the watering should not be repeated until the plants have appeared above the surface of the ground.

Ventilation of the greenhouse. Keep the temperature of the house at all times within the ranges above noted, particularly during the early life of the plants. Provide a liberal quantity of fresh air by opening the ventilators, and keep the conditions as nearly ideal as possible. As soon as the plants show the first true leaves they should be thinned to stand from 1½ to 2 inches apart in the row, and from this time on careful tillage and the removal of all weeds that may appear are all that is necessary. Careful attention, however, should be given to maintain a proper degree of heat and a sufficient amount of moisture to insure rapid development so that the plants will not become drawn or in any way weakened from too high a temperature or too small an amount of moisture in the soil. With careful attention to the details of the cultivation of this crop, a skillful grower should be able to harvest a crop in from twenty-one to thirty days after the seed is sown.

Marketing the forced crop. Forced radishes should not reach the market before Thanksgiving time, as there is little demand for them earlier than this. Plantings should, therefore, be made during the last days of October or the first of November, so that the crop will not mature until the last of November or the first of December. Forced radishes should be tied in small bunches containing 3 to 5 plants and arranged in the most attractive manner possible.

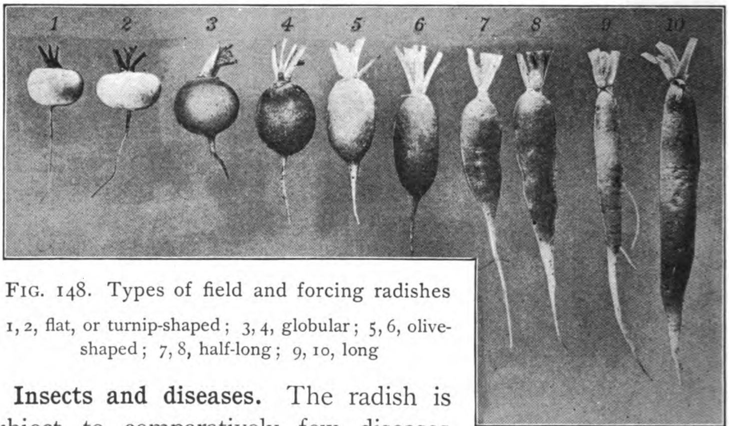


FIG. 148. Types of field and forcing radishes

1, 2, flat, or turnip-shaped; 3, 4, globular; 5, 6, olive-shaped; 7, 8, half-long; 9, 10, long

Insects and diseases. The radish is subject to comparatively few diseases that are of any importance. It suffers slightly during the development of its seed pods from a rust, but to the commercial grower of radishes for market this is of no significance except in so far as it affects the vitality of the seed. The chief drawback to the cultivation of radishes in the open is the cabbage maggot, which frequently infests both radish and cabbage roots, injuring them so that the product is seriously damaged, and in extreme cases totally destroyed. The radish is also frequently attacked by a flea beetle just as it appears above the surface of the ground. This little beetle defoliates the plant by sucking the juice from the leaves, causing them to wither and die. This enemy is most successfully combated by the use of tobacco dust or wood ashes scattered over the plant, and the maggot is best dealt with by incorporating a considerable quantity of wood ashes with the surface of the soil at the time of sowing the seeds. Tobacco dust is considered a specific for the maggot when used in the same way as recommended for the wood ashes.

Profits. When grown as a field crop the gross receipts from radishes range from $200 to $300 per acre, and the net receipt from $75 to $150 per acre; as a forced crop in hotbeds as high a return as $3.50 per sash for a single crop has been reported by one of the market gardeners in central New York.

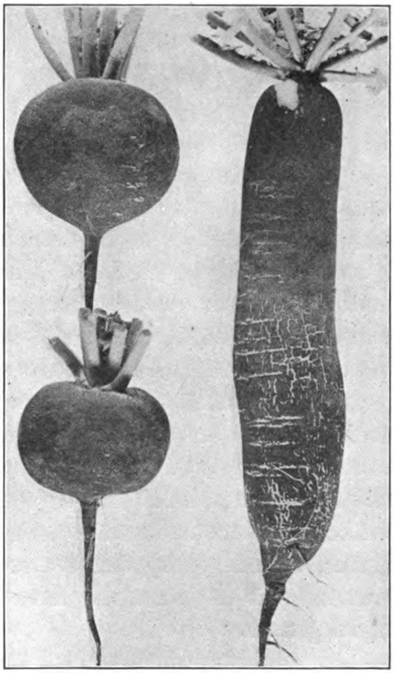


FIG. 149. Types of winter radishes

Varieties. There are three general groups of radishes in cultivation: the early varieties used for field cultivation and for forcing in cold frames, hotbeds, and greenhouses, to which belong the French Breakfast, the Early Scarlet Short Top, and the Long Scarlet types; the early, or summer group, which is represented by the Long Scarlet, Chartier, and the Stuttgart; and the class known as winter radishes. All root forms as well as color patterns represented in the cultivated varieties of the radish are found in each of the three groups. The variation in form is illustrated in figure 148, while the color range is from white through the shades of pink and purple to a dark mottled or solid black, each group possessing a complete range of colors.

The winter radishes are comparatively unknown in the United States, being only sparingly cultivated in a few localities. They are of slow growth, have firm flesh, and can be held in good condition as readily as the turnip, if given the same treatment. Seed of this group is usually sown about the last of July, or from that time on to the middle of August, and at the approach of severe weather the roots are lifted and packed in sandy soil, either in the vegetable cellar or in a bank or pit on the outside, in the manner in which potatoes and beets are sometimes buried. Otherwise, they require the same cultivation as turnips or the early group of radishes. They are not quite so exacting as to soil requirements as the early groups, but in other respects their cultivation is much the same. The general form of two good winter radishes is shown in figure 149.

RAPE

Rape is grown as both a spring and a fall crop, and while it is not generally used as a salad plant, for greens it is considered by many to be superior to mustard or kale. Not only is it valuable as a table plant, but it is an important stock food in European countries, and is now attracting considerable attention in this country as fodder for cattle and hogs. Rape is succulent, stands cold weather well, and during the winter season will furnish a considerable amount of food at a comparatively small cost. If handled carefully it can be used for dairy cattle as well as for stock cattle, sheep, and hogs. As a salad plant, rape should be treated practically the same as kale (see pages 265–268).

The chief enemy of rape is the cabbage louse, which is very destructive during dry, hot weather. Seeding should therefore be timed so that the plant will have the cooler and moister seasons for its growth.

RHUBARB

Rhubarb is one of the few perennial plants always found in the home vegetable garden. Because of its ability to store up a reserve of food in its large fleshy roots, it responds quickly to the touch of spring and, like asparagus, is one of the earliest products of the garden. The succulent, acid, thickened leafstalks afford a refreshing pie filler and sauce when stewed. The stalks cut in cubes or dice are sometimes canned in cold water for use as occasion requires.

Rhubarb is a popular home- and market-garden plant, but has formed a small part of the truck-farm products. It is naturally a Northern crop and is therefore not well suited to truck farming. Large, well-grown rhubarb stalks are heavy and deteriorate rapidly, and as a result are not well adapted for long-distance shipments. Within recent years forcing the crop has grown to be an important industry in the vicinity of some of the older cities of the North.

Botany. Botanically, rhubarb is known as *Rheum* (*hybridum*) *rhaponticum*, and is a native of Mongolia. The docks, to which the pie plant is most closely related, are among our worst weeds. In fact, none of its close kin are "desirable citizens." Buckwheat belongs to the same family but to a different genus and species. Rhubarb, therefore, stands alone as a useful representative of the genus to which it belongs.

Propagation. Rhubarb is easily propagated from seed, but the seedlings show a diversity in habits in growth — some producing many large leafstalks, while others have only a few slender ones. The value of a plantation depends upon the uniformity and the character of the product. The best plants are secured from the vegetative reproduction of the most desirable seedlings. There are a few so-called varieties, but in order to keep them true, propagation by root cuttings or by division is essential. In fact, the best market growers of rhubarb practice division rather than seed propagation.

Preparation of the soil. Strong roots are necessary to success either for a garden or a forcing crop, but to produce such roots requires the most careful and thorough preparation of the soil. The cuttings should be placed in soil which has been trenched to the depth of 18 or 20 inches and thoroughly enriched by the use of composted stable manure. The soil cannot be made too rich for the greatest success with this plant. If the roots are to remain as a permanent plantation, they should be planted deep, but the crowns should not be covered with more than 2 or 3 inches of soil. A slight depression over the crowns is often necessary to bury the roots as deep as desired without covering the crown too much. The rows should be from 4 to 6 feet apart, and the individual plants 2 or 3 feet apart in the row. For forcing roots the heavy enriching of the soil is essential, but the rows may be as close as 3 feet and the plants from 15 to 18 inches apart in the row.

Cultivation. Rhubarb should be liberally fertilized and carefully cultivated while in the nursery row or garden row before it has developed crowns strong enough to stand pulling. This cultivation should continue throughout the season to discourage weed growth, but should not be deep enough to interfere with or injure the roots of the plant. After the plants have reached bearing age and size, cultivation should be delayed until after the harvest period in the spring. At the close of the harvest, fertilize heavily with well-rotted manure, give frequent shallow cultivation, and never, under any circumstances, allow a blossom stalk to develop either in the nursery or field plantation. Seed production is a heavy drain on the vitality of the roots, and plants which produce seed never give a satisfactory crop the following season.

The earlier the crop the more valuable it is. As a result, many devices and practices have been resorted to in order to secure an early crop. Some of the simplest schemes are the use of inverted tubs, boxes, or flowerpots to stimulate top growth. Hotbed sash are often placed over the crowns, but few of these schemes produce marked effects or are adapted for use on an extensive scale.

Forcing. Forcing has taken the place of all the makeshifts in the production of this crop for the early market. Roots grown from the earliest robust plants by the intensive system described above are lifted from the nursery in the autumn and closely packed in a forcing house specially designed for the purpose. These houses may be of the lean-to type, with a northern or eastern exposure. Standard hotbed sash takes the place of the regular sash bar for six feet from the gutter. The remainder of the roof is constructed in the ordinary way. In some cases the rhubarb houses are built entirely of sash, an inexpensive post-and-rafter construction being used to carry the sash. The roots from the nursery are closely packed in the houses, all vacancies filled with soil, and the sash left off until the roots have been thoroughly frozen or until a short time before the actual forcing of the plants begins. If several houses are available, the length of the exposure of the roots depends upon the time it is desired to have the crop come on. The earliest houses are open only long enough to freeze the roots, while the last house to be started may be allowed to remain frozen for several weeks.

Rhubarb houses are always piped for overhead or side heat, bottom heat not being practicable, since the plants are set on the ground. From five to six weeks are necessary to bring the crop to marketable condition, depending upon the temperature maintained in the house. Another plan of forcing rhubarb is often employed. Strong one-year-old seedlings or nursery-grown cuttings are allowed to freeze after having been plowed out in the fall, or the roots are placed in the freezing chamber of a refrigeration plant for a few days and frozen. If these frozen roots are stored in a common cellar or basement room having a temperature of 40° or 45° F., strong leafstalks will develop with a minimum leaf blade. This plan requires less equipment than the first, and while it does not give as desirable a product as the forcing-house method, a large part of the first rhubarb to be offered on the market during the winter is grown in this way. Light is not essential to the production of leafstalks and small blades, but only strong, vigorous roots will give satisfactory results without light. Leafstalks grown in the dark are long and slender in comparison with those grown in the light, either in the open or in the forcing house.

Harvesting. The part of the rhubarb plant used commercially is the thick leafstalk, which carries a broad blade at its summit. In marketing the crop it is customary to pull rather than cut the leaves from the plant. By a slight lateral motion and, at the same time, a sharp pull, the leaves will be separated from the crown of the plant without much injury to it, and in this way no portion of the base of the leafstalk is left to decay over the crown. A smooth wound, which readily heals, is left. The greater part of the leaf blade is usually removed before sending the leafstalk to market. This is a good practice in that it lessens evaporation, and the leafstalks remain in a tense condition much longer than they would if the whole blade of the leaf were left intact. The leafstalks are usually tied in bundles of from four to ten, depending upon the season of the year and the size and length of the stalks.

Marketing. Rhubarb is always marketed in bunches, which are sometimes disposed of by weight but more often by the bunch or by the dozen stalks, markets varying considerably in such customs. Three stalks usually constitute a bunch of early rhubarb.

SALSIFY

Salsify is a hardy plant which lives through the winter to provide an early spring relish. The flavor of its cooked roots resembles that of the oyster, and for this reason it is known by the popular name "oyster plant."

Botany. The leaves of salsify resemble those of the leek. The roots are long and slightly tapering and, when grown in rich, well-prepared soil, frequently attain a length of 10 or 12 inches. Salsify is a hardy biennial belonging to the *Compositæ* and is known by the name *Tragopogon porrifolius.*

Culture. Salsify is a deep-rooted plant and thrives best on a rich, deeply tilled garden loam. The seed should be sown at the same time as early radishes, parsnips, and onions, for germination is better when the soil is moist and cool. If the seed is sown in drills from 12 to 15 inches apart, and the young plants thinned to 2 or 3 inches apart in the row, ample room for growth will be provided. With frequent surface cultivation to destroy weed growth and preserve a surface mulch, the crop should attain its full development by the last of September or the first of October, at which time it will be ready for use.

Harvesting and marketing. As salsify is perfectly hardy it can be harvested throughout the winter whenever frost will permit. In order to insure a continuous supply throughout the season it is best to harvest a portion of the crop in the autumn and store it, packed in sand, in a root cellar.

The roots are prepared for market by removing them from the soil, cutting away all but 2 or 3 inches of the leaves, washing the roots, and tying them in bunches of from 6 to 12 each.

SEA KALE

This salad plant, which, so far as its season and uses are concerned, closely resembles asparagus, is little cultivated in the United States, although extensively grown in its native country, England.

Botany. Sea kale is a hardy perennial belonging to the Mustard family and is known to botanists as *Crambe maritima.* It can be propagated from seed, from cuttings of the roots, or by division. The seeds, or pods, of which there are about 600 in an ounce, retain their vitality for three years.

Cultivation. The seed bed should be well enriched and deeply tilled. If the seed is sown where the plants are to mature, the rows must be laid off at least 3 feet apart, and the young plants thinned to stand 18 inches apart in the row. The first year the plants may be grown in the seed bed, and the following spring transplanted to the permanent field. The season for seed sowing in the latitude of New York is April. The seed bed as well as the permanent plantation should be given clean cultivation, all seed stalks should be nipped off as they appear, and the plants induced to make a robust growth. At the close of the season the dead leaves are cleared away, and the crowns of the plants covered with a good mulch of compost or stable manure. Before growth begins in the spring the winter cover is removed, and the earth is raked, care being taken not to injure the crowns. The crowns are covered with sand or compost for blanching unless the blanching is to be accomplished by the use of a regular sea-kale pot. A large flowerpot, with the hole in the bottom plugged, will serve the purpose of the regular kale pot.

Harvesting. The young shoots are cut when from 3 to 4 inches tall and used in much the same manner as asparagus. The season depends upon the climate and varies in length from three to six weeks.

SPINACH

Distribution. Spinach, while an important truck and market-garden crop in certain sections of this country, is too often missing from the kitchen garden. It is far superior to any other salad plant grown for boiling. As a truck crop its zone is limited by shipping facilities and freight rates. Spinach is bulky and seldom sells for a high price per barrel, and for these reasons growers beyond the range of low freight rates cannot afford to grow it. Norfolk, Virginia, with its mild winter conditions and reasonable freight rates has come to be the great center for the production of both spinach and kale. Other localities with favorable climatic and market conditions also produce these crops, but less extensively.

Botany. Spinach is known as *Spinacia oleracea* L. It belongs to the Goosefoot family, the most familiar representatives of which are the pigweeds. There are two well-marked types of spinach recognized by gardeners: one has a spiny or prickly seed and was for a time the only sort planted for winter use; the other type has smooth seeds and was formerly considered less hardy than the prickly type. The varieties now used for winter planting are of the smooth-seeded type and appear to be as hardy as the prickly-seeded form.

Under cultivation spinach has been greatly modified and improved. There are forms which are long standing, that is, do not run to seed quickly; others have savoyed leaves with thickened parenchyma; while the wild forms have arrow-shaped, pointed leaves. The leaves are borne upon a low crown and form a rosette, as shown in figure 150. The staminate and pistillate flowers are, as a rule, borne upon different plants.

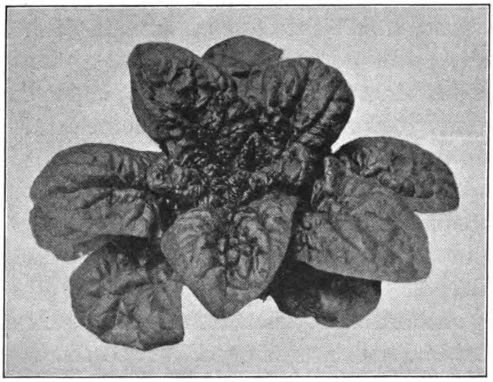


FIG. 150. A spinach plant, showing habit of growth

Planting. Spinach is one of those plants which thrive best during the cool, moist season of the year; as a result it is planted very early in the spring for immediate use or, in the milder climates, in August or September to be harvested during the autumn and winter. Even as far north as central New York it is sown in August for early spring use and heavily mulched to protect it through the winter.

Preparation and cultivation of the soil. The soil best suited to spinach is a well-drained, well-enriched, sandy or gravelly loam — a warm, early soil. This should be deeply tilled and thrown up into broad beds or bands that will carry from 5 to 8 rows when the rows are 8 or 10 inches apart. A space of from 18 to 24 inches is left between the beds for the convenience of the workers. For the

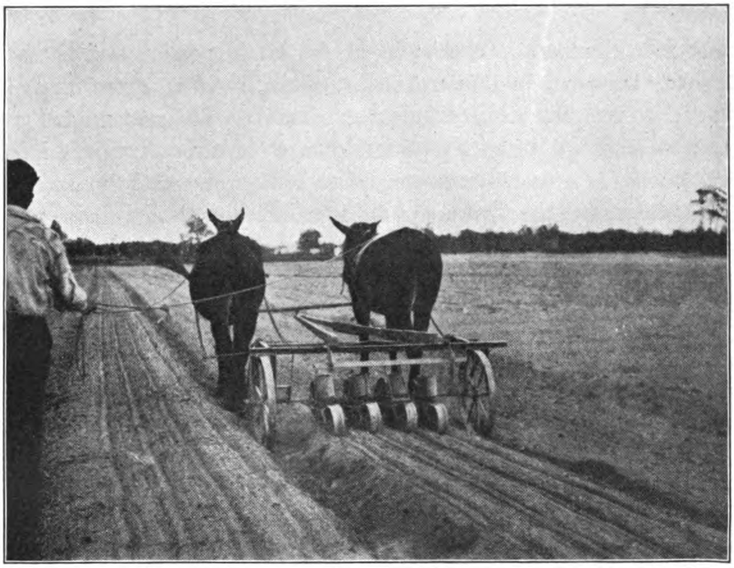


FIG. 151. Spinach drill for working on beds

FIG. 152. Fertilizer distributor used for spinach

most part the beds are thrown up by horse power, and the seed is sown by specially constructed seed drills (see figure 151) arranged to sow the desired number of rows. The quantity of seed used varies from 15 to 25 pounds per acre. The fertilizer is also distributed by a machine arranged to scatter it either broadcast or along the rows (see figure 152). The quantity varies from 500 to 1500 pounds with the condition of the soil, and applications are made from time to time as the condition of the crop requires.

FIG. 153. Thinning, or "spooning out," spinach

Thinning. After the young plants are well up and have the first pair of true leaves, the beds are gone over and thinned the same as are beets. This operation is accomplished by the use of a large iron spoon, as shown in figure 153, and is called spooning out. The work is chiefly done by women and children on a piecework basis charging a given amount per 100 yards of bed.

Cultivation. Cultivation is accomplished either by horse power, as shown in figure 154, or by the use of the hand hoe. The crop is carefully studied and is cultivated or fertilized according as its behavior demands.

Spinach requires a good supply of humus in the soil and will not tolerate highly acid conditions. The use of lime on spinach is very beneficial when the soils are acid or have been long and heavily treated with commercial fertilizers. Besides lime, spinach responds to potash and nitrogen; but stable manure or green manures, such as cowpeas or crimson clover, should be a feature in the rotation for this crop.

Enemies and diseases. The green fly is the worst pest of the spinach grower. If for any reason the plants become severely

FIG. 154. A novel arrangement for cultivating spinach

retarded in their growth, they are almost certain to become infested with the aphis. Great care should be exercised to keep the plants growing thriftily, as in such condition they are much less likely to be attacked. Once thoroughly infested, it is a very difficult matter to rid the plants of the insects. Much can be done with kerosene emulsion, but frequent rains and cool weather are more effective than sprays. Spinach is apt to suffer in some localities where it has long been under cultivation on light soils and where commercial fertilizers have been used in an excessive way. It frequently looks yellow, makes an indifferent growth, and is tough and stunted. This pathologists term malnutrition. The plant is starved in the presence of an abundant food supply because the plant food is not presented in an available form. The soil is as a rule lacking in organic matter. The beneficial bacteria which are able to transform crude materials into available form are not present in sufficient number.

The absence of these low forms is in great measure due to the lack of a sufficient amount of decaying organic matter in the soil. Soils may be charged with crude mineral elements and yet provide an uncongenial environment for certain plants. In order that crude materials may be made available for plants, the soil conditions must be favorable to the growth of the right kind of organisms in large numbers. The use of stable manure or cowpeas plowed under, followed by an application of lime, is one of the surest and quickest ways of correcting the conditions which cause malnutrition.

Rust. The disease popularly known as spinach rust has been found to be the result of the fungus *Heterosporium variabile*. It is a trouble associated with conditions which in any way interfere with the normal growth of the plant, such as severe winter cold, late planting, and conditions which bring about malnutrition. Its presence is indicated by stunted growth and yellow spots, and the affected area often extends for many yards. Only weakened leaves seem to be infected, and the attacks usually follow unfavorable conditions in late December or January. The plants are seldom killed by this rust, but the extra expense required to trim affected plants materially increases the cost of production. No remedy is suggested, but since the parasite is a weak one, it is inferred that the disease is of minor consequence. All that is necessary is to see that the soil is in suitable condition to stimulate vigorous growth.

Harvesting. Spinach is harvested with a sharp scuffle hoe by cutting the taproot of the plant just below the surface of the soil. As the plants are gathered, all dead or discolored leaves are removed, and the plants are then packed in splint or ventilated barrels or barrel-high Delaware baskets. If shipped in barrels, burlap is used for covering, but the baskets are provided with slatted heads. A good stand of spinach on 8-row beds should yield from 200 to 250 barrels per acre.

SQUASHES

The squash is one of the garden products the value and merits of which few people know or appreciate. The types of squash which are in cultivation are sufficiently varied to provide a continuous supply of this vegetable from early summer to late winter.

Botany. The important varieties of garden squashes belong to three species, which are known as *Cucurbita maxima*, *Cucurbita pepo*, and *Cucurbita moschata*. Of these, the first, *Cucurbita maxima*, is perhaps the most important. To this belong the "long-keeping" varieties, which are richest and finest in flavor. Next to it in importance from the market gardener's standpoint is *Cucurbita pepo;* to this species belong the scallop, bush, or summer squash, the field pumpkin of the North, and the cymling of the South. Of the so-called summer squash, or *Cucurbita pepo*, there are a number of types, the most important of which are the summer crookneck and the scallop and pattypan squashes, also called cymlings.

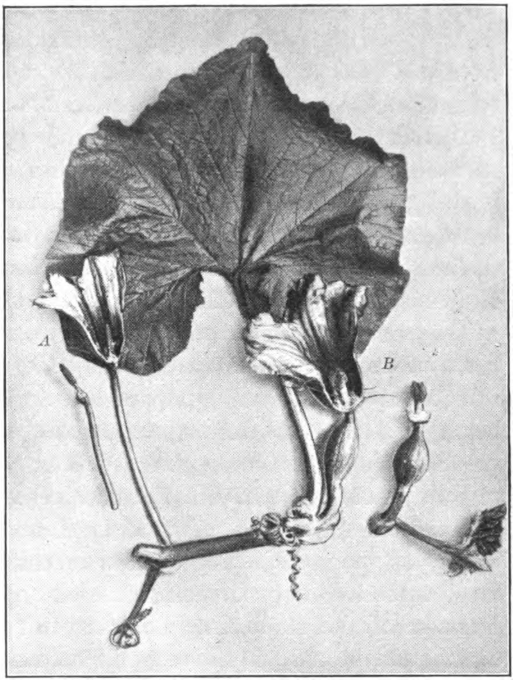


FIG. 155. A *maxima* squash leaf and flowers
A, staminate; *B*, pistillate

The third type is the Canada Crookneck, *Cucurbita moschata*. The *moschata* group is chiefly valuable for its use as a pie filling. It is also known as the pie pumpkin. In some sections it is extensively grown for cattle food the same as the field pumpkin.

Squashes are exceedingly interesting botanically from the fact that they bear two classes of flowers — staminate and pistillate, as shown at *A* and *B* in figure 155 — on different parts of the plants. The summer squash, with its bush-like habit of growth, bears its staminate flowers on long stalks, while the pistillate flowers are borne upon comparatively short stalks close to the base of the plant. The running sorts, which include the *moschata*, the *maxima*, and the so-called pumpkin, bear their pistillate flowers at some distance from the roots of the plant, while the staminate flowers are, as a rule, borne near the root on flower stalks of considerable length.

Distribution. The adaptation of the types of squashes to the various parts of the United States forms an interesting chapter in the geographical distribution of cultivated plants. The varieties belonging to the *maxima* group are almost entirely confined to the northern half of the United States and chiefly to the New England and Middle states, but are found to a limited extent in Michigan, Wisconsin, Minnesota, and the Dakotas. The *moschata* has a wider distribution, although not so generally and extensively used as is the *maxima* group in the region to which it properly belongs. The *moschata*, or pie pumpkin, is widely distributed over the South and Southwest, but is not so extensively cultivated in regions where the *maxima* has become well known.

The summer squash, or cymling, although it is not of so high quality as the *maxima* or *moschata*, has a distinct use and the most extended range of cultivation of any of the Squash family. Because of the short time necessary for it to reach edible condition, and because it thrives well both at the North and at the South, it is generally cultivated in the gardens of all sections of the United States. The summer squash is never used by pastry cooks, as are both the other forms.

The pumpkin and the squash. The true pumpkin, as known in the United States, is a member of the same species as the summer squash (*Cucurbita pepo*). It is perhaps more extensively used in the manufacture of pies than either the *maxima* or *moschata* squashes. The use of the terms "squash" and "pumpkin" in literature is somewhat confusing. So far as the *moschata* and *maxima* groups are concerned, there is little need for confusion, for all the varieties of these species are generally spoken of as squashes, the only exception being the Canada Crookneck. The greatest confusion arises from calling the bush squashes (including the summer crooknecks, scallops, and cymlings) "squashes" and the large running varieties of the same species "pumpkins." Botanists recognize both types in the species *pepo*, but the trade calls the bush form a "squash" and the trailing form a "pumpkin." In Europe all species are called pumpkins, which avoids confusion but affords no means of distinguishing the groups save through specific or varietal names.

Cultivation. From what has been said, it will at once be seen that the squash lends itself to a diversity of soils and a wide range of climate. The winter squashes of the *maxima* group thrive best upon a rather retentive or clayey soil — one that is well drained but capable of retaining moisture and fertilizers. A clayey loam is the ideal soil for squashes of this type. The rapid growth of the plant demands an abundant supply of available food, and to provide this it is the common practice to use stable manure under the hill or place where the seeds are planted. The soil is plowed early in the season, and by successive cultivations a fine compact seed bed is prepared. At planting time the rows are laid off in checks 8 feet apart each way, and at the intersection of the check marks an excavation is made which will hold a peck or more of well-rotted stable manure. The manure is placed in the excavation and 3 or 4 inches of earth drawn over it. The seed is then planted, the common practice being to plant from 6 to 10 seeds 1 inch or 1½ inches deep in the layer of soil over the manure. As the squash is native to tropical regions, seed planting in the open must be deferred until all danger from frost has passed and the soil is warm. The normal season for planting corn is usually satisfactory for the squash.

After the seedlings appear aboveground and the plants have become thoroughly established and show a tendency to run, they are thinned to 2 or 3 plants to the hill. Thinning, however, should not be done until all danger of destruction by insects has passed. Thorough cultivation should follow so that weeds will not interfere with the growth of the plants nor with their development when they begin to run and occupy the land. After the vines become strong and are running rapidly they will require only sufficient cultivation to prevent an extraordinary weed growth. The scallop, or bush, squashes produce a dense growth of leaves covering a restricted area about the hill, and the fruits are produced near the roots of the plant, while in the *moschata* and the *maxima* types the fruits are produced upon the vines at some distance from the roots of the plants.

The cultivation of the bush squash differs somewhat from that of the running types, because less space is necessary to accommodate the vines. The bush form can be cultivated throughout the season and requires less thorough preparation of the soil previous to planting. The common practice is to plant the bush squash in hills 4 or 6 feet apart each way, the distance depending upon the amount of ground available. The same number of seeds are used, and the same preparation of the hills is made as with the vining sorts. It is customary in localities subject to heavy rainfall to raise the hill or seed bed somewhat above the general level of the ground. Ordinarily, however, it is safest to arrange the hill or seed bed so as to be on a level with the general surface of the field.

The aim in cultivation should be to prevent weed growth, and to keep a loose soil mulch about the roots to conserve moisture and to induce rapid growth.

Insect enemies. All types of squashes are attacked by the squash bug, *Anasa tristis* DeG. This enemy, like all true bugs, obtains its nourishment by sucking the juices of the plant, and is therefore difficult to control with insecticides. The arsenical poisons have little effect, but contact insecticides (such as kerosene emulsion) and repellents (such as tobacco dust and air-slaked lime) are the chief means of control.

The striped squash or cucumber beetle, *Diabrotica vittata* Fab., is not at all discriminating in its menu, but attacks any and all vine plants. This pest is also difficult to control, and since it usually appears suddenly in great numbers there is little time to apply remedies after it makes its appearance. Preventive means are safest and most effective. On a small scale plants can be protected with hand boxes covered with cloth or wire gauze. Squares of mosquito netting dropped over the plants and the edges covered with earth are effective and satisfactory. Tobacco dust mulch is as good as any preventive, but thorough spraying with Bordeaux mixture, to which have been added 3 pounds of arsenate of lead to each 50 gallons, should be kept up as long as the insects are troublesome. It is possible that the lime-sulphur spray so extensively used as an insecticide on fruit trees may be of service for this pest.

The squash-vine borer is less troublesome than either of the others just mentioned, but it usually appears in large numbers each year, and as its injuries are felt later in the season they are seemingly more important than those that destroy the young plants. This insect (*Melittia satyriniformis* Hbn.) attacks the plant near the root, causing it to enlarge and assume a rough, corky appearance. The presence of the characteristic borings will be detected. Tobacco dust is a good preventive for this insect; a knife with a thin, narrow, sharp blade can, however, usually be used to split the stem and at the same time destroy the borer without injury to the plant. A safe practice is to mound earth over the main stalk of the plant as soon as runners are formed. The roots will then form along the buried portion of the stem, and if the main stalk of the plant is destroyed the independently rooted runners will preserve the plant.

Harvesting. The bush type of squash is harvested as soon as the fruits are of edible size and before the shell begins to harden. As soon as the shell hardens, the fruits are past the desirable edible stage. As long as it is possible to make a cut through the skin with a very light pressure of the thumb-nail the summer squash is in fit condition for use. As soon as the shell becomes somewhat resistant to such a test, it is too far advanced to be placed upon the market. Not so, however, with the *maxima* and the *moschata* types. The harder and the more resistant the shell, the better; but as the fruits of these types are seldom used before they are thoroughly mature, this is a matter of small importance because they normally produce the hard, resistant shell desired.

The utmost care should be exercised in harvesting the *maxima* and *moschata* types of squashes to prevent breaking off the stems or bruising the shells. As soon as the hard, brittle shell is injured or broken, decay is apt to set in and the loss of the squash is the result.

The *maxima* type is stored in large quantities, and it is therefore essential that from the time the vines are killed by frost great care be taken to protect the squashes in every possible way.

Careful handling is the keynote to the successful storing of the winter squash, for no matter how fully equipped the house may be for maintaining the proper temperature, if the squash has been injured by frost or through rough handling, it will not keep.

Storing. The extremely hard, resistant shell characteristic of most varieties of the *maxima* group makes it possible, by proper storage facilities, to keep them from harvest time until as late as the following March or April. For family use and in a small way,

FIG. 156. Interior of squash storage house, showing method of placing the fruits

this type of squash keeps fairly well in a dry, comparatively dark cellar, the temperature of which ranges from 38° to 45° F. Where this squash is grown on a large scale for market purposes, specially designed storage houses are constructed. Such houses are usually built entirely aboveground, of dimensions adequate for storing the acreage grown. The walls of the house should be constructed so as to give good insulation, that is, so as to prevent rapid changes of temperature between the inside and outside. The houses are often built with double walls of paper and matched lumber, with an air space between them. The inside construction is such as to provide slatted racks arranged one above the other, on which a single layer of squashes can be placed, as shown in figure 156. The racks should not be attached to the outside wall but should be built so that there will be a narrow passage between them and the outside wall. A convenient width for the racks which have a passageway on each side is from 5 to 6 feet; those which have a passageway on one side only should not be over 3½ feet wide. The slats can be made of 1 × 3 inch material placed 2 or 3 inches apart. As the squashes are brought from the field they are carefully laid on these slats. As soon as one tier of racks is filled, the one next above is loaded, and so on until the house is filled.

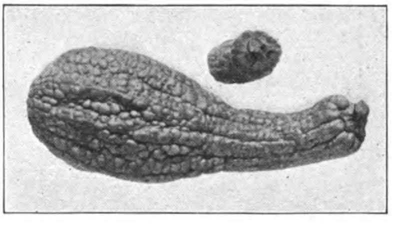


FIG. 157. Summer crookneck

Squashes intended for storage should be allowed to lie in the field as long as possible, but should not be exposed to severe frosts or freezing. At harvest time the fruits should be carefully removed from the vines with the stems attached and placed in wagons on straw or leaves. If the wagons have springs, so much the better. The most careful handling possible should characterize every operation connected with the storage of the squash. The ventilation of the storage house should be adjusted to maintain a temperature of from 40° to 45° F. To meet the severe conditions of midwinter, the house should be provided with artificial heat in addition to tight-fitting ventilators, so that the temperature of the building will never fall below 38° F. A moist, close atmosphere is detrimental to the fruits.

Marketing. The summer squash is usually marketed in baskets similar to those used in the shipment of lettuce. Tall baskets holding about a half barrel and made like the Delaware peach basket are the common receptacles. The pie pumpkin, or Canada Crookneck squash, is chiefly a fruit for local consumption and is seldom transported long distances. The winter squash of the *maxima* type, represented by the Hubbard, Boston Marrow, etc., is, however, a commodity which will bear and justify long-distance shipments. These squashes are usually packed in ventilated barrels covered with burlap.

Varieties. The standard of excellence among the bush or summer squashes is the Summer Crookneck, shown in figure 157. This, for some reason, is not so extensively cultivated by shippers as the White Bush, Scallop, Pattypan, or Cymling. The standard of excellence for the winter squash is the Hubbard, shown in figure 158, of which the Large Warted Hubbard and the Golden Hubbard are the two leading varieties. The Golden Hubbard is not so large as the Large Warted Hubbard, but is more prolific and

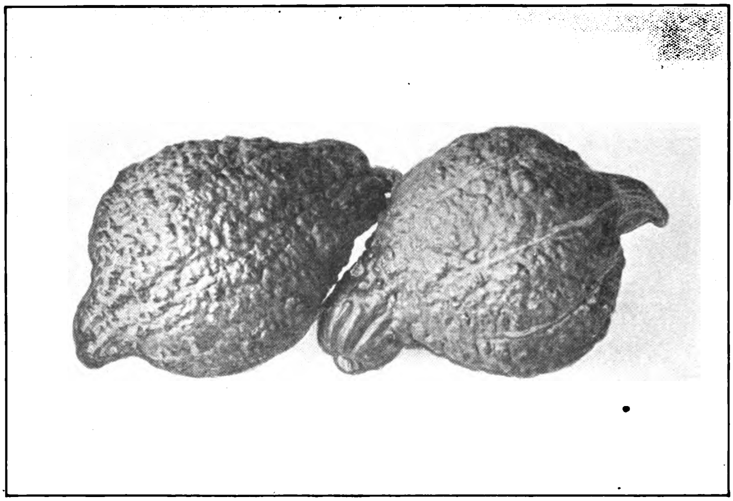


FIG. 158. Hubbard squash (*Cucurbita maxima*)

ranks well with it in quality. The Boston Marrow is a very popular second early or autumn squash, but not so well adapted to long keeping as the Hubbarb varieties. In addition to these, there are many other varieties of more or less commercial importance.

Under good treatment the squash yields abundantly and sells at a fairly remunerative price. Winter squashes of the *maxima* type sell for from $1.25 to $1.50 per barrel. The earliest summer squashes which come on the market sell for a little more, but as they are perishable and must be sold quickly they are therefore more uncertain than the long-keeping winter types. Notwithstanding this, they are extensively grown and shipped from the Southern trucking regions early in the season.

SWEET POTATOES

Botany. It is an unfortunate circumstance that two such different plants as the Irish potato (*Solanum tuberosum*), of the Nightshade family, and the sweet potato (*Ipomœa batatas*), which belongs to the Morning-Glory family, should both be named *potato*, but such are the conditions which confront and confuse us in the English language.

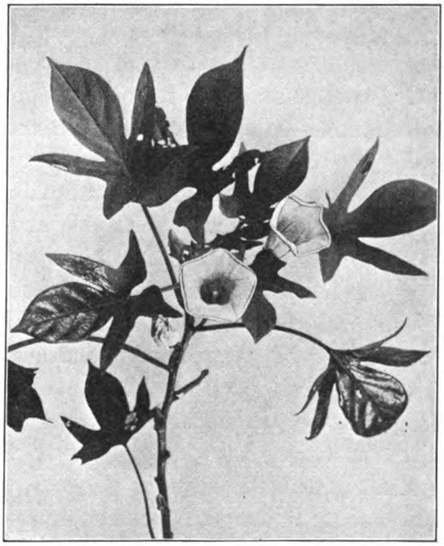


FIG. 159. Sweet-potato foliage and flowers

The origin of the sweet potato is more obscure than that of many other garden vegetables which have been cultivated longer. De Candolle gives two probable places of origin for it — America and Asia, with the balance of evidence in favor of America. We shall not attempt to settle this controversy, but leave it an open question for future investigation.

The sweet-potato plant is like the morning-glory in many respects, but has in addition the power to produce a large number of thick roots, a characteristic not common to all the members of the Morning-Glory family. The sweet potato is very widely distributed throughout the latitudes where it thrives without special attention. Under favorable climatic conditions it is able to perpetuate itself from year to year without special cultivation. This, in addition to the fact that it is a valuable food plant for both man and beast, makes it an important commercial and culinary vegetable.

Uses. The root of the sweet potato is a valuable article of food, for, although composed chiefly of starch, it contains more of the muscle-forming elements than does the Irish potato. It is used in a fresh state for boiling and baking, and is dried and converted into flour, or desiccated and handled the same as dried fruits. It is also extensively canned.

As a stock food the sweet potato is very valuable. The vines have some food value for pigs and cattle, and the roots are a desirable food for swine, sheep, and cows. When planted for hogs, sweet potatoes are usually left in the ground to be harvested by the animals at will. When intended as food for cows or sheep, the roots, to be safe for consumption, must be harvested and passed through a root cutter. This feature of sweet-potato cultivation, because of the limited stock industry in the regions in which these potatoes thrive best, has not, up to the present time, become a factor of any considerable importance. Within the next decade, however, the sweet potato is destined to become of great importance as a food for stockers or for fattening animals, and will, to a considerable extent, take the place of the more expensive grains now used. The roots can be cheaply dried in kilns similar to those used for curing hops, and when so cured a product is obtained which, according to chemical analysis, has about the same composition as corn meal. An average of 750 pounds of dried material can be made from 1 ton of fresh potatoes. The roots are prepared for drying by being passed through a root cutter, which cuts them into thin slices or chips.

Kind of soil. The sweet potato is a gross feeder and revels in a rich soil. It demands perfect drainage and a soil that warms up to a high degree and dries out rapidly after heavy rains. For this reason a sandy soil or a sandy loam is best suited to the crop. While the sweet potato will thrive upon heavy soils, the yield is much less and the character of the roots is different. Heavy, retentive soils have a tendency to produce roots which are abnormally long and watery as compared with the same varieties grown upon light, sandy soils. Varieties differ widely in relative dryness of their flesh, so that the differences which may be noted in the product found in the open market may be either varietal or due to the character of soil on which they have been grown.

Preparation of the soil. The preparation of the soil for sweet potatoes should be as follows: the first choice of land for planting is a crimson clover sod, and the second, stubble land. Plowing should be done early — in the latitude of New Jersey during the early part of April. After the land has been deeply plowed and thoroughly pulverized, a disk harrow should be used at intervals of six or eight days until the season for planting arrives. A week or ten days previous to planting, the commercial fertilizer which is to be used should be distributed broadcast with a grain drill. The drilling should be done with a common hoe or disk drill and will take the place of one cultivation with the disk harrow. The fertilizer should be of a high grade, carrying about 3 per cent of nitrogen, 6 per cent of phosphoric acid, and 10 or 12 per cent of potash. The quantity per acre for highest commercial results should range between 600 and 1500 pounds to the acre, 1000 pounds usually being a satisfactory amount.

After broadcasting the fertilizer, the rows are laid off about 4 feet apart. The first step in this operation is to open a furrow about 4 inches deep with a one-horse turning plow. A liberal dressing of well-rotted stable manure is then scattered in the furrow, after which a back furrow should be run to throw the earth from each side upon the manure, thus forming a low, comparatively flat ridge, which can be struck off with a board, garden rake, or weeder. In this way a suitable bed for planting the potato sets is prepared. In some instances the land is left flat, but when manure or fertilizer is used in the furrow the bed is considered an advantage, and in localities where the land is liable to wash and where heavy rains prevail during the growing season a list or ridge is necessary.

Propagation. The success of the sweet-potato crop is dependent on the quality of the seed and the sets produced from it, as well as on the stand of plants in the field.

While the sweet potato is propagated from vegetative parts like the white potato, the method of procedure is different. The seed of the sweet potato consists of small-sized roots selected and stored in separate bins at harvest time. It is seldom planted in place as is the seed of white potatoes. In the northern part of the sweet-potato region the sets are grown by bedding the seed in either manure or fire-heated hotbeds. Extensive growers maintain their own propagating beds, but small planters often purchase the sets they need. The hotbeds are prepared late in March or early in April, and in the latitude of Washington, D.C., the potatoes are bedded between April 1 and April 15 as shown in figure 160.

The manure hotbeds are prepared in the usual way, as illustrated in figure 15, page 59, except that clean sand or sterilized sandy loam is used in place of the usual compost. Farther south, sash-protected cold frames serve the purpose of the hotbed.

When the crop is extensively grown a special kind of fire-heated hotbed is employed for starting the sets. A bed of this sort is shown in figure 10, page 44, and is constructed as follows: a sloping area is selected, and at the lowest side a brick furnace large enough to burn 2-foot or 4-foot wood is built. A brick or

FIG. 160. Bedding seed — sweet potatoes

terra-cotta flue leads from the furnace a distance of 30 feet or more and opens into the general chamber underneath the floor of the hotbed. At the end opposite the furnace a plank chimney, provided with a slide damper and of sufficient height to create a satisfactory draft, is erected. In reality the hotbed consists of a platform or box, one end of which is on a level with the earth, while the other is over the furnace, a considerable air space being left between the furnace and the bottom of the bed. The sides are planked up so as to prevent the escape of heat which comes from the furnace. The bottom of the bed can be made of slabs or cheap lumber, and the soil, which must be very sandy, should be placed 3 or 4 inches deep over the bottom. The potatoes are placed on this and covered to the depth of 1½ or 2 inches with clean sand which is free from earth or decaying organic matter. The soil should be moistened at the time of placing the tubers in position, and the hotbed should be kept at a temperature of from 80° to 85° F. for a number of days. The bed so constructed can be covered with either sash or cloth, duck or muslin being often used. Beds constructed in this fashion can be from 80 to 200 feet

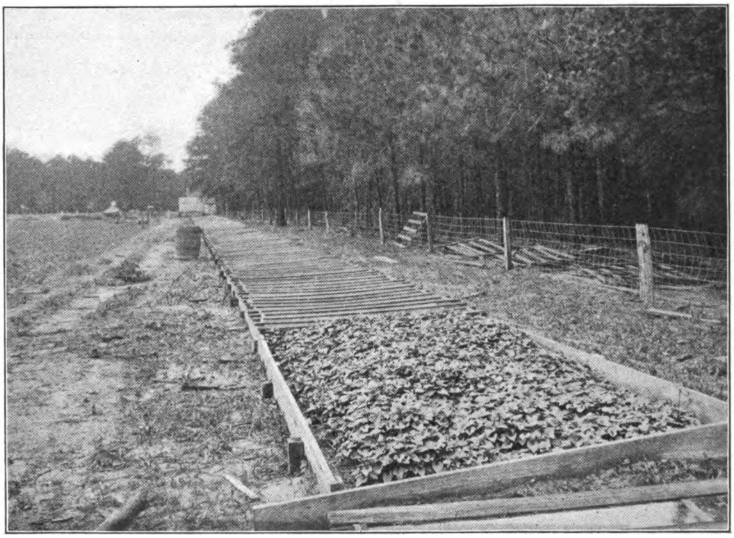


FIG. 161. Sweet-potato propagating bed

in length and from 16 to 30 feet in width. Sixteen feet is a convenient width, wider beds being less satisfactory because of the difficulty of watering and pulling the sets.[1]

In latitudes south of Washington, where the winters are not sufficiently severe to destroy the roots if left in the ground, a practice sometimes followed is to leave a sufficient quantity of sweet potatoes in the field where they grew, to furnish sets for the next season's plantation. Or, where this is not practicable, the seed potatoes may be placed in a temporary seed bed, which should be

[1] See pages 43 and 44 for further description.

prepared in much the same way as seed beds for tobacco. This area can be made the site of a large brush heap, and after burning the brush to kill weed seeds and warm the soil, the tubers can be bedded in the area in the regular manner.

If fire hotbeds are not used, the tubers may be bedded in ordinary hotbeds or cold frames, such as illustrated in figure 161, or in a greenhouse if one is available. After the slips have grown to a height of 6 inches or more they are separated from the mother root by grasping the sprouts with one hand, the mother root with the other, and pulling. It is desirable to retain as many roots as possible at the

FIG. 162. Setting sweet-potato plants by hand

base of the slips, and disturb the roots as little as possible in breaking off the slips. Other shoots will develop immediately, and it is possible to get two or three drawings from the same bed during the season. In those climates where it is not necessary to make special preparations for bedding the plants or for the construction of hotbeds for the production of sets, the cultivation of the sweet potato becomes a very simple and inexpensive operation, and it is in those latitudes that its greatest use as a stock food may be expected.

Planting. The preparation of the ridges for planting has already been described. The sets are usually placed at intervals of about 15 inches. If the work is done by hand, as shown in figure 162, a small trowel, similar to that used by brick masons, will be a help. With this a man can become so proficient that he can plant from 5000 to 8000 sets in a day of ten hours. The usual method, however, is to use the planter shown in figure 11, page 46, which opens the furrow, waters the plant, and packs the soil around it. Boys or men riding on the machine place the slips in position. Transplanters are expensive, but for large areas they are in reality an economy.

Thorough cultivation to prevent the growth of weeds must be given these young plants as soon as they have taken root, for after they begin to run it is impossible to use horse-power cultivators. The ridges should be kept in as good form as possible to provide for the protection of the roots and to keep the land well drained.

Insects and diseases. The sweet potato is not troubled by many enemies. Very few insects work upon the vines, and these do comparatively little damage. The diseases which are most destructive are the rots of the roots, of which there are two forms — the soft rot, which affects the roots while in storage, and the black rot, which does most injury to the crop while still in the field. In the Southern states the black rot is quite prevalent and does much damage, destroying the roots and interfering with the growth of the plants. Wherever this disease is prevalent it is necessary to select soil which has not been used for sweet-potato culture for several years, and to grow seed from slips which are not affected. Vine cuttings planted on clean soil is the surest way of securing disease-free seed.

The treatment of the soft rot consists chiefly in carefully sorting and handling the tubers at harvest time and placing them in a storeroom, heated to 80° or 90° F. while the work of storing is in progress and for ten days thereafter, gradually lowering the temperature to between 50° and 60° F. for the general storage period. Treating the seed roots before bedding with the standard formalin solution used for potato scab (see page 348) has proved very effective.[1]

[1] For further information on this subject see *Bulletin No. 30*, 2d Series, Louisiana Experiment Station; *Bulletin No. 76*, New Jersey Experiment Station; *Bulletin No. 36*, Texas Experiment Station; and *Farmers' Bulletin, No. 324*, United States Department of Agriculture.

Harvesting. The gathering of sweet potatoes, like that of Irish potatoes, is a laborious operation because of the large quantity and the great weight of the roots, but the harvest period is longer than that for Irish potatoes. If it is desired to place the potatoes on the market at once, the work of harvesting should begin as soon as the roots are large enough. In the latitude of Baltimore this means early in September, continuing until the last of October. Where the potatoes are intended for storage purposes, however, harvesting should be delayed as long as possible so as to give the roots the full benefit of the growing season. In the latitude of Washington, D.C., such harvesting begins about October 10 and extends until the first of November. The roots are plowed out with a plow of special design equipped with two rolling colters, as shown in figure 163, for cutting the vines on either side of the row. After the roots are turned out they are allowed to lie in the sun for two or three hours before being picked up.

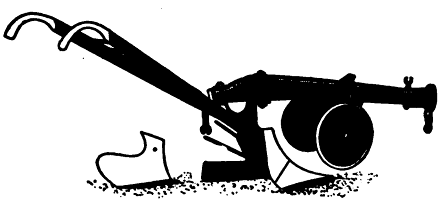


FIG. 163. Plow with double rolling colter for harvesting sweet potatoes

Small baskets, such as shown in figure 164, should be used for gathering the roots. Five-eighths bushel splint baskets of the Delaware type are convenient. As soon as the roots are dry on the surface, they should be hauled on a *spring* wagon to the storage house. Every operation incident to the harvesting of the roots should be conducted so as to injure them as little as possible. Bruised and injured roots are not suitable for storage.

The yield of sweet potatoes varies from 200 up to 500 or 600 bushels to the acre when such a variety as the Big Stem Jersey is grown. Other varieties, of weaker growth, do not yield so much.

The price usually ranges from 50 cents to 75 cents per bushel, or from $2.50 to $3.00 per barrel, depending on the season and the supply.

Storing. Sweet potatoes can be stored and held for delivery during the winter months the same as apples and other products of a semiperishable character. The usual method is to place them in large bins in buildings which are partly or entirely aboveground. Some growers, however, use banked buildings or cellars with good results. The bins should be so arranged that there is a distance of from 15 to 18 inches between the slats forming the sides of the bin and the outside wall of the building. The outside wall should be made as nearly frost proof as possible. The construction sometimes employed for the walls is that of the ice house at the North. Any precaution of this kind tends to lessen the danger of loss and the necessity for artificial heating. When the building is made of

FIG. 164. Harvesting sweet potatoes

matched or batten lumber with paper inside, it is customary to use a heater of some kind to maintain an even temperature. During the time the potatoes are being carried from the field to the storage house it is the custom to keep the interior at a high temperature so as to drive as much moisture as possible out of the potatoes. If the house can be held at from 85° to 90° F. at this period it is considered very desirable. After the lapse of ten days or two weeks the temperature is gradually lowered to about 55° F. If properly treated, sweet potatoes can be held from the harvest in October until it is time to dispose of them in the market or until bedding time in April.

At harvest time the roots are separated into two grades, the large and commercial roots forming one grade and the seed and strings the other. It is the common practice to store the two grades in separate bins, and sometimes in separate buildings. After being placed in storage they should not be disturbed until they are taken out for the market or for planting. Sweet potatoes will not stand stirring or handling as do Irish potatoes. If they are rehandled or disturbed after being placed in bins, they are almost sure to decay. The common practice is to store several hundred or even several

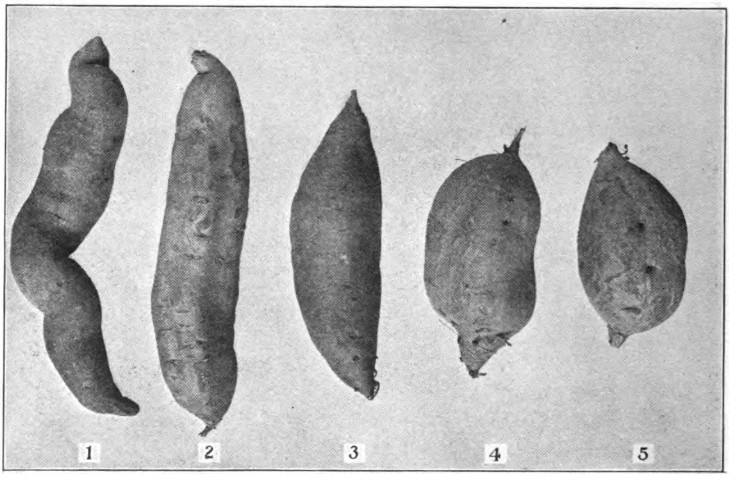


FIG. 165. Varieties of sweet potatoes

1, Black Spanish; 2, Shanghai; 3, Big Stem Jersey; 4, Red Bermuda; 5, Southern Queen

thousand bushels in a single bin. Some growers, however, place the roots in crates as they are gathered, and set the crates in the storehouse. The most economical way is to place them in bulk in the house.

It is a good plan to make the storage bins on a unit basis so that the contents of one, two, or three bins will be required for a carload. To remove all the roots from one or more units does not necessitate disturbing the roots in the others.

Marketing. The common method of marketing sweet potatoes is to grade them as they are taken from the bins or from the field and place them in ventilated barrels with a gunny-sack covering.

Some shippers divide the potatoes into three grades exclusive of the seed, which might be counted as a fourth grade. The grade called selects is comprised of tubers of uniform medium sizes which are well formed. The large potatoes go as No. 2's, and in the Washington market are known as pie potatoes. The small tubers go into a class which may be called No. 1's.

In cold weather the roots should be packed in tight, double-headed barrels or in lined boxes and shipped in lined freight or refrigerator cars.

Varieties. The so-called varieties of sweet potatoes are numerous, but a careful test of nearly one hundred of these has revealed the fact that there are not more than twenty or twenty-five distinct sorts worthy of the name and of being kept separate. In the different sections a wide range of types of potatoes is grown for the different markets, as indicated in figure 165. The Northern and Northeastern markets, including Baltimore, Philadelphia, New York, and Boston, all demand a dry, mealy potato, while the Southern growers and the Southern market prefer a watery sweet potato — one containing a very high percentage of sugar and having a soft, gelatinous flesh when cooked. The Yellow Jersey and the Big Stem Jersey are two of the leading sorts for cultivation in Maryland, Delaware, and New Jersey, while soft-fleshed sorts such as Nancy Hall, Dooley Yam, and Triumph are the popular potatoes of the South.

The difference between the two types of sweet potatoes is so marked that the dry-fleshed sorts are popularly called sweet potatoes, while those with watery flesh are called yams. This distinction is a false and improper one. Both types are true sweet potatoes. The true yam belongs to a different family of plants, *Dioscorea*, and is not commercially cultivated in the United States.

TOMATOES

Origin. While few important commercial fruits or vegetables can be attributed to America, the tomato is a vegetable of American origin which compares favorably in commercial importance with its old-world rivals both in this and in Mediterranean countries. This plant, because of its relation to the Nightshade family, was for a long time held in disrepute by gardeners and people generally. For at least a century after it was known to botanists and gardeners, it was very sparingly cultivated, and then chiefly as an ornamental. As a commercial product, therefore, it was greatly delayed, and it was not until the feeling that the tomato was poisonous was changed that its cultivation began to attract attention and its use became general.

Its cultivation in England and the United States came much later than in the countries bordering the Mediterranean. Climatic conditions undoubtedly had much to do with this. In the warm climate and otherwise congenial atmosphere of the Mediterranean countries, the tomato flourished; in England, however, because of the comparatively short season and small amount of heat during the growing period, its cultivation spread slowly. Even now, four centuries after its discovery, the growing of the tomato in Great Britain is confined chiefly to houses and protected walls. In the United States, after the plant was once introduced and its poisonous effects discredited, its cultivation spread rapidly, and now we find it among the most universally cultivated of our garden vegetables.

The original habitat of the tomato is not known, but historical evidence seems to show that the plant was first carried to Europe from Peru.

Botany. The genus *Lycopersicum*, to which the tomato belongs, contains several species besides the three which are more or less commonly met with in our gardens and which are later on referred to as the parents of the three types. The currant tomato is known as *Lycopersicum pimpimellifolium*, the cherry tomato as *Lycopersicum cerasiforme*, and the common garden tomato as *Lycopersicum esculentum*.

Types. There are now a number of distinct types of the tomato in cultivation, three of which are worthy of mention; namely, the currant type, the cherry type, and the common commercial type, of which there are many varieties.

The currant type. The currant tomato is a weak-growing, small-leaved, small-fruited plant, bearing its fruit in large currantlike clusters, the individual fruits being about $\frac{1}{4}$ inch in diameter and usually red in color.

The cherry type. The cherry tomato is somewhat similar to the currant type in habit of growth, though it is more robust and has larger foliage. The individual fruits of the large clusters are much larger than the currant variety, having a diameter of from $\frac{1}{2}$ to $\frac{5}{8}$ inch, and in some extreme cases, $\frac{3}{4}$ inch. The smooth, spherical fruits of these two classes are usually two-celled and very regular in size and shape.

The commercial type. The plant of the commercial tomato is more robust in growth than either the currant or the cherry type. The most characteristic and probably the normal habit of the plant is spreading, with large open, compound leaves and comparatively small, flat, or somewhat rolled, leaflets. It may, however, be upright in habit with large, much-wrinkled leaves, giving it a very compact and sturdy appearance, as in the Dwarf Champion group. In another group, known as the potato leaf, the leaflets are large and flat, but quite pubescent, giving the plant a luxuriant appearance. The normal and most characteristic form of the tomato has a decumbent habit of growth and open compound leaves with comparatively small leaflets or subdivisions.

From these facts it is evident there is more than one species, and that within the species there is marked variation. The variations are carried out in the form and color of the fruit and leaves as well as in the habit of the plant. The different types vary in color from the deep red of the Cherry through various shades to the purple of the Beauty and the yellow of the Golden Queen. The form of the fruit varies from the spherical type of the Currant and Cherry to pyriform and turbinated, and from the broad, flat Beefsteak type to the globular, regularly formed fruits of the Stone, Beauty, and Perfection.

Cultivation. Because of the tropical origin of the tomato, it requires a long season for growth and development, and, in the Northern states, to secure paying crops it is necessary to resort to schemes for lengthening the growing season. It is much easier for the gardener to control the growth of the plant while it is small than when it is large and established in the field; therefore, the season is lengthened at the beginning rather than at the end. Moreover, early fruits are, as a rule, more valuable than late ones, and it is of advantage to the gardener to secure his crop as early in the season as possible. This is accomplished by sowing the seeds in hotbeds[1] or greenhouses several weeks in advance of the time when they could be safely planted in the open. In the latitude of New York City, seed is sown about March 15. Farther south, it is customary to plant somewhat earlier, from February 10 to February 15, and as the more southern latitudes are approached, the dates of planting are even earlier. In Florida and southern Texas plantings are made in November, so that the fruits come into the market several weeks in advance of the earliest Northern-grown fruits. It is evident that the tomato has no fixed period of growth. In fact, in climates where its growth is not interrupted by frosts it has practically become a perennial plant, but in temperate regions where the seasons are distinct it has been forced to acquire an annual habit and is treated as an annual plant.

With the breaking down of the prejudice against it, and since the advent of improved canning processes, the tomato has come to be a very important commercial field and garden crop. It is a fruit that is relished at all periods of the year in a fresh state, and is equally welcome on the table, when properly cooked, whether it has just been taken from the vines or has been preserved in cans. As a result of this extensive use, the tomato is now cultivated both as a field and as a forced crop.

The Tomato as a Field Crop at the North

Planting. East of the Mississippi River and north of the latitude of Washington, D.C., the tomato is handled as an annual, the seeds being sown in hotbeds about the middle of March (see figure 166). As soon as the young plants have developed their first true leaves they are transplanted so as to stand about 2 inches apart each way and are allowed to develop in these quarters until they have attained the height of from 4 to 6 inches and the leaves have begun to crowd considerably. They are then transplanted to pots 3 or 4 inches in diameter, similar to those used by florists, or if these are not available, to strawberry boxes or tin rims. The latter are made by melting the tops and bottoms from ordinary tin

[1] The construction of hotbeds for bringing on tomatoes is described on pages 57–60.

cans such as are used by canners for vegetables. The heat necessary to unsolder the tops and bottoms of the cans will also unsolder the seam at the side, which will leave a rim of tin about 5 inches in height and from about 3 to 4 inches in diameter. After tying a string around the rim so as to prevent its spreading open, each can is filled with soil and used as a receptacle for a young plant. By slipping a shingle under each can it may easily be shifted to the place where the plant is to grow until field-planting time arrives. If seed is sown in March, it will frequently happen that plants handled as described above will be in bloom

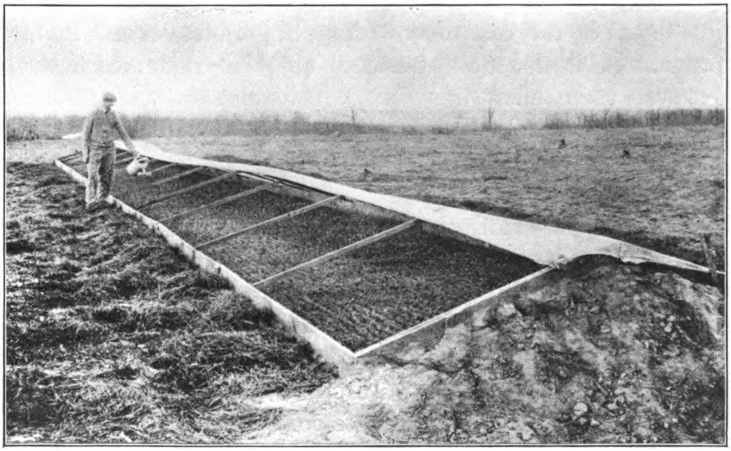


FIG. 166. Hotbed for starting tomato plants

or will have formed small fruits the size of a marble before it is time to transplant to the field. With careful handling at the time of transplanting, these blossoms and fruits can be saved and will come to maturity and produce an early and profitable crop.

Training. For earliest returns it is desirable to train these forced plants to a single stem by tying them to a stake 4 or 5 feet in height. A good stake for this purpose is made from small saplings such as are used for training beans, or from a mill edge $\frac{7}{8}$ or 1 inch square. These stakes should be driven firmly into the ground beside the plants, and the plants carefully tied to them to prevent whipping and to keep the fruits off the ground. All side shoots should be kept pinched out, and only the central leading stem allowed to develop. If the plants are to be trained in this way, they can be set from 18 inches to 2 feet apart in the row, and from 3½ to 4 feet between the rows.

Another style of training frequently used is to place a flaring frame about 18 inches square at the base and 24 inches square at the top over the plants before they begin to spread. As the fruits become heavy they fall against the sides of the rack and are thus prevented from coming in contact with the earth. For a kitchen garden where but few plants are to be grown this is a very satisfactory plan. The plants can be set somewhat closer than is the case where no supports are provided. For commercial plantations, however, the cost of the frame is prohibitive, and the common practice is to set the plants about 4 feet apart each way in checks so as to allow them to be cultivated in both directions. Under intensive cultivation the first method will be found very satisfactory.

Where tomatoes are grown on a large scale and where the product brings only a small price per bushel, this expensive method of handling cannot be indulged in. The common practice of growing tomatoes for the general market and for canning purposes is to sow the seed very thinly in a hotbed about March 15, allowing the plants to grow slowly until they can be transplanted to the field between May 15 and June 1. In spite of the most careful attention, plants when grown under these conditions will have long, thin stems and a small tuft of leaves at the top. Plants over a foot high, which have been grown under these conditions, should be treated as follows: Instead of attempting to set the plants deep and maintain them in an upright position, remove all except three or four of the topmost leaves about the growing point. Dig a trench 3 or 4 inches deep along the row, with a slight slope from a deep point at one end to the surface of the ground at the other. Place the bare stems of the tomatoes and the roots in this trench, with the roots in the deepest part; fill the trench throughout its length with fresh soil, and pack it firmly. Under these conditions the plant will take root throughout the length of the buried stem, and in a short time this added root system will force the plant into vigorous growth. When plants of this kind are to be grown on an extensive scale they are never trained. They are allowed to grow at will, and the fruits are gathered as they ripen without special attention to keeping them off the ground or to otherwise caring for them.

Distribution of the crop. The soil for the tomato varies as much as the different localities in which the plant is grown. Judging from the extent of the tomato industry in Maryland, and the fact that the greatest quantity of canned tomatoes is grown and packed in that state, one would naturally expect to find that the soil conditions of Maryland are ideal for the tomato. While it is undoubtedly true that the tomato can be more economically grown in Maryland than in any locality north of that point, it does not necessarily follow that the largest yield per acre is obtained in this locality. The largest yields of tomatoes are undoubtedly obtained in latitudes north of Maryland as the result of careful handling of the plants and attention to fertilization and cultivation. Carefully measured yields from areas of $\frac{1}{4}$ acre and upwards in Michigan have indicated a return of 1200 bushels per acre, which is probably far in excess of the yields ordinarily obtained by even the best growers in localities where tomatoes are extensively produced for canning purposes.

The season for fruit production is longer in the higher latitudes than it is in the lower ones. This is a rather interesting and unexpected condition. One would expect the tomato to mature its fruit earlier and continue bearing longer in the latitude of Washington than in that of Boston, but this is not the case. Tomatoes in the latitude of Washington and south of this point come into bearing quickly, produce a heavy flush of fruit, and then refuse to do more. In order to have a continuous supply throughout the season it is necessary for market gardeners and truckers to plant seeds in succession. In fact, the common practice among truck growers is to make two sowings — an early sowing about the first of February, which will give fruits early in July; a second sowing from April 15 to May 1, which will give a crop of fruit from September to November. In the latitude of Boston, however, upon the clay or gravelly loam soils of the terminal moraines, plants from seed sown March 15 and transferred to the field about June 1 will grow and ripen fruits continuously until the vines are killed by the frosts. For this reason the large yields above mentioned become possible.

Fertilizers. Since the tomato is grown exclusively for its fruit those fertilizers which induce a large growth of plant and foliage are not desirable. Soils vary greatly in regard to the amount of available plant food they contain. The use of a fertilizer is determined largely by the character, mechanical condition, and composition of the soil. If a soil is deficient in all the essential elements of plant food, — namely, nitrogen, potash, and phosphoric acid, — the application of any one or even two of these elements will not materially influence the yield of the crop. In such cases a complete fertilizer must be used; one containing a small percentage of nitrogen (1 or 2 per cent) with a large percentage of potash (from 4 to 6 per cent) and phosphoric acid (from 8 to 12 per cent) is considered most desirable. On soils deficient in potash or phosphoric acid or in both, little would be gained by adding nitrogen. Economy of operation, as well as the general effect upon the soil, must also be considered. This may be influenced by the character of the season, but should be based on the increased yield and the increased net receipts from the crop.

The best and most economical fertilizers to be applied upon any given soil must be determined by the grower by actual test. Fortunately in most states where tomato culture is an important industry, the state experiment stations have conducted tests of great value in this connection. A very simple test of different fertilizers may be made by setting aside a section in one corner of the field or in some place where the soil is uniform and representative of the entire field.

A plan for a fertilizer test. Use some good standard variety and divide the planting area into plots of 10 plants each, and treat somewhat as follows:

Plot 1. Nitrate of soda, ½ lb. to 10 plants.
Plot 2. Muriate of potash, ½ lb. to 10 plants.
Plot 3. Phosphate, 2 lb. to 10 plants.
Plot 4. Nitrate of soda, ½ lb.; muriate of potash, ½ lb. to 10 plants.
Plot 5. Phosphate, 2 lb.; muriate of potash, ½ lb. to 10 plants.
Plot 6. Nitrate of soda, ½ lb.; phosphate, 2 lb. to 10 plants.
Plot 7. Nitrate of soda, ½ lb.; phosphate, 2 lb.; muriate of potash, ½ lb. to 10 plants.
Plot 8. Barnyard manure, 1 shovelful to each plant.
Plot 9. No fertilizer or manure.

Keep an accurate, separate record of each plot, giving the date and amount of each picking, together with the green fruit on the plants when killed by frost. From such a record one can easily determine the influence of the various mixtures on the period of ripening and the yield of fruit, and these results, in turn, will indicate the relative value of each mixture. This test may be modified by increasing or decreasing the amount of the various ingredients and comparing the results. If plants are spaced 4 feet apart each way, 2722 will be required for an acre, and each plot of 10 plants will represent about $\frac{1}{272}$ of an acre. Then by multiplying the amount of fertilizer applied to one plot and the yield of fruit produced by one plot, by 272, the corresponding amount of fertilizer and yield per acre of fruit will be obtained.

As a rule readily soluble, "quick" fertilizers which produce an early growth and early ripening of the crop are most desirable. Nitrate of soda is undoubtedly the best form in which to apply nitrogen. It acts quickly, but only for a short time, and for that reason is very desirable where short-season crops are concerned. In many cases it has been found an advantage to apply the nitrate in two installments rather than all at once, one application being made when the plants are set in the field, and a second about the time the fruits begin to color. Fertilizers containing nitrogen in a slowly available form, as cottonseed meal or coarse, undecomposed stable manure, which do not stimulate an active growth until late in the season, are too slow for a short-season crop like the tomato, which needs something to stimulate it at the time it is transplanted to the field. These nitrogenous fertilizers tend to stimulate late growth of the vine at the expense of maturity of the fruit. Potash and phosphoric acid are more conducive to the development of fruits than is nitrogen, unless it is in the form of nitrate of soda. Heavy dressings of stable manure tend to produce too much vine and are seldom employed. If stable manure is used, it is at a moderate rate, not more than one small shovelful to a plant. This, if well-decomposed and thoroughly incorporated with the soil, is very stimulating to the young plant, and therefore very beneficial. Whatever the fertilizer, it should be applied, in part at least, at the time the plants are transplanted. The readily soluble fertilizers such as nitrate of soda, in localities where there is excessive rainfall, are best applied in two light dressings.[1]

Cultivation. As soon as the young seedlings from the hotbed or greenhouse are transferred to the field they should be given clean cultivation with implements which stir the surface of the soil but do not produce ridges or furrows. The spring-tooth cultivator, or the Planet Jr. type of horse hoe with narrow shovels, makes an ideal implement for cultivating this crop. When the plants are set in check rows 4 feet apart each way, it is possible in field culture to keep the plantation almost perfectly free from weeds by the use of horse hoes alone. If, however, the plants are set so that cultivation can be carried on only in one direction, hand hoeing will be necessary to keep down the weeds between the plants in the row. Where land is not expensive and where hand labor is an item, the cost of producing a crop of tomatoes can be decidedly lessened by planting them in check rows and carrying on the cultivation by horse power. A man with a modern cultivator and a well-trained horse can easily do the work of several men working with hand tools. And since the cost of production determines the percentage of profit, every legitimate means which does not check the growth or fruitfulness of the plants should be taken advantage of to reduce this item.

The grower should bear in mind, however, that the object of cultivation is not merely to kill weeds. Destruction of weeds is an important factor and in itself sufficient to justify clean cultivation, but the preservation of a soil mulch for the purpose of husbanding the moisture during periods of drought is of even greater importance. With care in the choice of implements both results can be obtained with the same expenditure of labor.

Harvesting and marketing. The fruits should be gathered two or three times a week if the tomato is grown as a truck crop, but when grown for canning purposes the harvesting periods need not be so frequent. When the fruits are to be shipped some distance they should be gathered as soon as fully developed and partially colored. Tomatoes are a velvet green up to the time the ripening process begins, but when they are fully grown their color

[1] See *New York State Station Bulletin No. 32;* and *New Jersey Bulletin No. 79.*

begins to change from a deep green to a light green or white, and at this stage, if they are to be shipped long distances, the fruits should be harvested. For home markets, however, the fruits should be allowed to ripen upon the plant. In harvesting, none except sound fruits of the same stage of maturity should be harvested and packed in any one receptacle. Leaky fruits and deformed fruits should be rejected.

In packing for market, tomatoes that are symmetrical in form, uniform in size, and of a like degree of ripeness should be selected for filling any one receptacle. Where the fruits are to be shipped long distances and have been picked in an immature state, the individual fruits should be wrapped in thin, pliable brown or white paper, similar in grade to tea paper. When so wrapped and packed in small receptacles they may be shipped several hundred miles and go upon the market in good condition. For long-distance shipments it is the common practice to employ the six-basket carrier now so universally used for peaches. As in the shipment of peaches, the wrapped fruits are carefully placed in the carrier baskets and the baskets in turn packed in a carrier. A flat box from 18 to 20 inches square and about 5 inches deep, which will carry two layers of wrapped fruit, is now quite extensively used in some sections of the country. The preference in packages, however, seems to be in favor of the six-basket carrier.

Formerly tomatoes which were grown and shipped less than a hundred miles were packed in flat, handled baskets. A shallow basket made of splints with a folding handle or with one upright handle was employed. These baskets held a little less than a half bushel. Fruits were gathered as soon as partially colored, carefully arranged in the baskets, and the baskets covered with tinted mosquito bar. This style of shipment is not now very generally practiced, except where the fruits are to be carried short distances. Fruits intended for the canning factory are allowed to mature upon the vines, are packed in the short, flat, handled baskets described above, or in Delaware baskets, or in bushel boxes, and are carried directly to the factory. The bushel box or slatted crate is probably more generally employed for this purpose than any other form of receptacle. The riper the tomato the more easily it can be injured and the more carefully it should be prepared for market.

Varieties. There are a large number of sorts of tomatoes, each one possessing some points of merit which distinguish it from all others. These distinguishing characteristics enable the intelligent cultivator to select sorts for special purposes and for special soils and climates. The varying demands of the markets, and the different soil and climatic conditions of the various sections of the United States where the tomato is grown, can only be satisfied by a list as variable as are the conditions. It is fortunate that domesticated plants present so many different forms, otherwise the cultivation of many crops would be restricted to a few favored localities.

Important differences in the varieties of tomato are manifested chiefly in the fruit. Early ripening sorts are frequently irregular in shape, have comparatively thin walls, large seed cavities, and numerous seeds. The fruit is apt to color and ripen unevenly, remaining green around the stem or containing a hard green core. Later ripening sorts, while not all superior to the above, have as a rule thicker and firmer walls, smaller seed cavities, and few seeds. The most highly developed varieties now make few seeds and ripen evenly. These characteristics of the fruit are important factors in determining their fitness for special purposes. Medium-sized, smooth, spherical fruits, which ripen evenly and have small seed cavities and thick walls, are especially suited to long-distance shipment. These qualities should enter into every variety to the greatest possible degree consistent with earliness, lateness, heavy yield, or any other special quality which gives the variety a marked commercial advantage.

The following list of varieties is made up of sorts possessing some markedly distinct characteristic, such as early maturity; great size; purple, red, or yellow color; dwarf habit; etc.

1. Early ripening: Sparks's Earliana, Atlantic Prize, Early Freedom.
2. Large fruited: Ponderosa (or Beefsteak).
3. Purple fruits: Beauty, Acme, Imperial.
4. Red fruits: Favorite (late), Honor Bright, Matchless, Stone, Trophy, Royal Red, New Jersey.
5. Yellow fruited: Golden Queen, Lemon Blush.
6. Dwarf (or tree) type: Dwarf Champion, Station Upright tree, Aristocrat.
7. Potato-leaf type: Livingston's Potato Leaf, Mikado, Turner's Hybrid.

The Tomato as a Field Crop at the South

Commercial tomato growing in the Southern states is almost wholly confined to the production of tomatoes at a season when they cannot be grown at the North except in greenhouses. On this account the commercial production of the crop is restricted to areas where there is very little, if any, freezing during the winter months. Florida, Texas, and Mississippi lead all the other Southern states

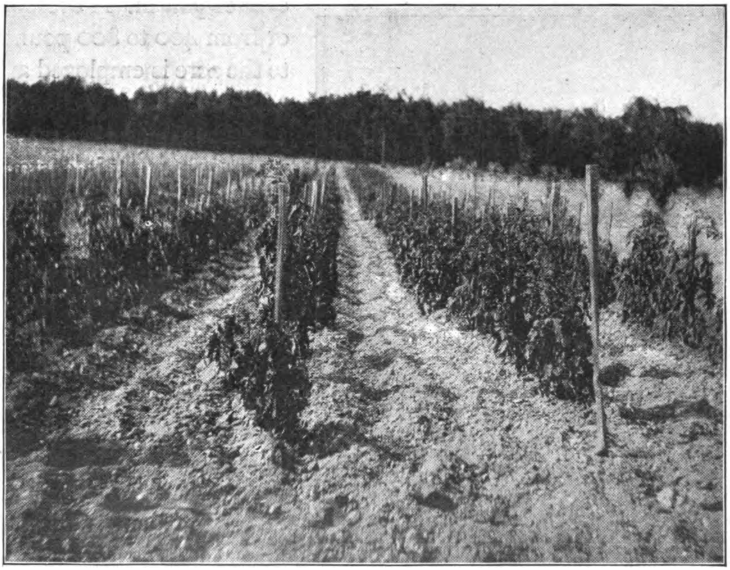


FIG. 167. Tomatoes trained to stakes

in the production of this crop. At the extreme southern limit of tomato cultivation in Florida the plants are grown so as to be ready for setting in the field about December 1. The date of seed sowing advances as one proceeds northward, so that in northern Florida the seeds are sown early in January and the young plants placed in the field in March. Where frost conditions do not form barriers to the production of seedling plants in the open, the seed beds are made in some sheltered spot where partial shade can be given and where frequent watering will be possible. As soon as the young plants are from 6 to 10 inches in height, they are transferred to the field in practically the same manner as are the hotbed-grown plants produced for general field culture at the North, and, unless for a specially early crop, they are not transplanted or potted. The plants are set in rows from 3 to 4 feet apart, and the plants are spaced from 18 inches to 3 feet apart in the row. The ground is fertilized with commercial fertilizers containing from 1 to 2 per cent of nitrogen in the form of nitrate of soda, from 8 to 10 per cent of phosphoric acid, and from 4 to 6 and even 8 per cent of potash. A dressing of from 400 to 800 pounds to the acre is employed and with clean cultivation the plants make a quick return.

FIG. 168. Wrapping and packing tomatoes for distant markets

Training. It is customary in this latitude to train the plants to stakes from 2 to $2\frac{1}{2}$ feet in height. The stalks, usually reduced to two or three, are tied to the stakes in order to keep the fruits and the foliage off the ground, and to expose the plants to the action of sun and air for the purpose of bringing the fruits to early maturity. A field of plants so trained is shown in figure 167.

Yield. The difficulties of producing a satisfactory crop of tomatoes in these southern latitudes are much greater than at the North. In some localities the Southern blight, which produces a dry, darkened area, usually around the blow end of the tomato, frequently causes the loss of a considerable percentage of the crop. The fact that no effective remedy is now known for this disease renders the cultivation of the tomato at the South more precarious than it would otherwise be. Tomato worms, too, are more abundant and more annoying in the Southern fields than at the North. The yield of fruit under these conditions is much less than in regions having the long growing-periods characteristic of higher latitudes; it varies from 75 to 200 bushels to the acre. The smallness of the yield is not a result of the methods of culture or training practiced, but is, without doubt, to be attributed to the uncongenial climatic conditions and the harmful soil organisms.

Soil. The best soil for the production of this crop is one which contains a comparatively large percentage of sand. At the South, sandy loam or a sandy soil is preferred to bottom land.

Harvesting and marketing. The same precautions in handling the fruits should be observed at the South as at the North. For the long-distance shipments necessary to place the Florida- and Texas-grown tomatoes on the market, the fruits are picked as soon as they have reached full development and show the slightest change in color. The individual fruits are wrapped in a soft brown or white tea paper and packed in two-layer boxes or in the six-basket peach carrier already mentioned and shown in figure 168. Fruits packed in this way and shipped by express or by fast freight under refrigeration are successfully carried from Miami, Florida, to New York City, and from Corpus Christi, Texas, to Chicago. The four-basket carrier shown in figure 169 is used by Texas growers with satisfaction. The prices obtained for the fruits grown in these latitudes at the season when the Northern markets are bare of fresh tomatoes, except those from greenhouses, net satisfactory returns to the growers.

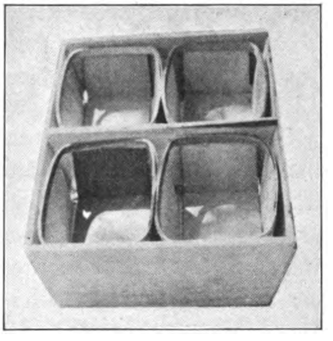


FIG. 169. Four-basket carrier for tomatoes

Late crop for the South. At the present time the tomato growers of the South place their main dependence on the early crop which matures in advance of the tomatoes grown at the North, and which comes in competition only with the hothouse-grown product. There is, however, another very promising field for a limited number of truck growers in the Southern states in the production of a second or later crop of tomatoes, which shall ripen during the months of September and October. The Southern markets, which are each year becoming more and more important, are practically bare of tomatoes from early in July throughout the rest of the season, and some local growers have taken advantage of the opportunity to grow a second or late crop, and are now reaping a satisfactory harvest from such plantations. The varieties adapted to this purpose are not well understood, and each locality engaging in this work will, of necessity, be compelled to work out its own variety list. When this shall have been determined, the question of producing a late crop to supply the Southern market will be much simplified, and a large number of gardeners will find it a paying crop. At the present time the Success seems to be the only variety which is well adapted to this purpose in the state of Texas.

The Forcing of Tomatoes

Construction of the greenhouse. In the forcing of plants in an artificial environment, the first requirement for success is a properly constructed greenhouse. Because of the tropical nature of the tomato, extraordinary provisions must be made to meet the demands of the crop. In the forcing of most vegetables a low temperature and benches without bottom heat are satisfactory, but with the tomato the house must be piped so as to maintain a minimum temperature of 65° F. and the benches are most satisfactory if constructed to admit of applying bottom heat. The common type of house is the even-span or three-quarter-span house. For the even-span house the ridge should, preferably, run north and south; for the three-quarter-span house it is best to have the long side sloping toward the south. Because of its long fruiting season and the fact that its clusters of fruit are borne one above the other, the tomato requires a considerable amount of head room. Low houses are therefore not desirable. The side walls of the house should be at least 4 feet in height, and the distance from the top of the middle bench to the ridge should be at least 10 feet. The depth of soil necessary is at least 6 or 8 inches, which is considerably more than that required by roses. The temperature and other requirements of the forced tomato are much like those of the greenhouse rose. The night temperature should be maintained at 60° to 65° F. and the day temperature from 70° to 80° F.

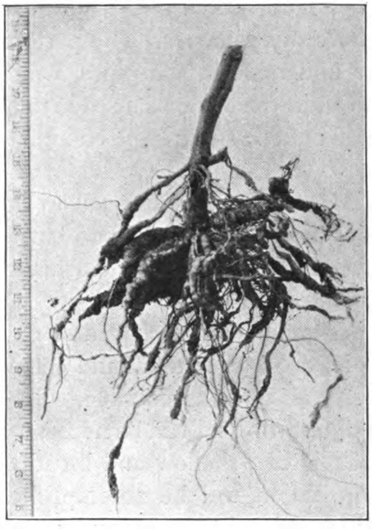


FIG. 170. Tomato root infested with nematodes

Soil. The soil for the cultivation of this crop should be well-decomposed loam made, if possible, from the sods of an old pasture the soil of which is a rather light, clayey loam or a heavy, sandy loam. With this should be incorporated about one fourth its bulk of well-rotted stable manure, preferably cow manure. By composting these two materials together for from four to six months before they are required for use, a satisfactory soil will be obtained. The soil that is used for forcing tomatoes should be frozen each year, and it is consequently unwise to allow it to remain in the greenhouse longer than a single season. It becomes somewhat exhausted and is liable to become infested with injurious forms of life, particularly nematodes, which cause root knots upon the plants, defeating the work of the gardener. Figure 170 shows a tomato root infested with nematodes, while figure 171 illustrates a healthy tomato root-system. This trouble, however, can be easily overcome by subjecting the soil to freezing or to steam sterilization. In localities where the winter temperature will not permit renovating the soil by freezing, steam may be used to accomplish the same end.

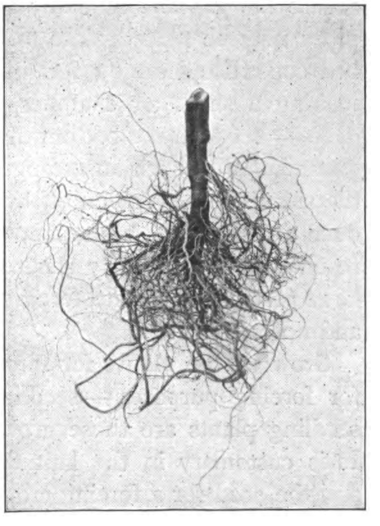


FIG. 171. Healthy tomato root

Soil sterilization. Sterilization can be carried on in boxes from about 12 to 18 inches deep, in the bottom of which are steam pipes with perforations $\frac{1}{16}$ inch in diameter every 2 inches. The perforations are arranged to come on the underside of the pipes, which are in coils and far enough apart to allow the blade of a spade to be operated between them. The boxes should be made large enough to hold one or two cartloads of compost, and should have lids which are carefully fitted to the boxes. After subjecting the soil to the action of the steam a sufficiently long time to cook a potato buried in it, it will be thoroughly sterilized. If a more permanent structure than the box is desired, a brick pit 18 or 20 inches in depth can be arranged for the purpose. The bottom should be paved or concreted, and the side walls made at least 9 inches thick and coated with cement to make them as nearly air-tight as possible. Good drainage should be provided, and a tight-fitting lid will be necessary. Better than this type of pit, however, is one shallow and broad or long rather than deep, as the sterilization will be accomplished sooner in a comparatively shallow layer of soil than in a very deep one.[1] After the soil has been sterilized or after the compost has been made as first described, it should be spread upon benches so constructed as to admit of placing steam or hot-water pipes beneath them in order to produce the desired amount of bottom heat. To secure the greatest economy of both labor and space, the heating pipes may be placed close to the surface of the ground, and the bed constructed only a few inches above the heating pipes, thus making a small air chamber — not more than 10 or 12 inches deep — between the bottom of the bed and the top of the floor or ground. With such an arrangement and adequate openings along the sides, the heat given off by the pipes beneath the bed will produce a sufficiently high temperature for the tomato. While best results are undoubtedly secured from the use of bottom heat, a large part of the tomato forcing houses are built with solid benches and no bottom heat.

Growing the plants for forcing. Two types of plants are used for forcing purposes — seedling plants and cutting plants. The seedling plants are those grown specially for greenhouse culture. It is customary in the latitude of New York and northward to sow the seed for a forcing crop between August 1 and August 15.

[1] See also the description of the Shamel sterilizer, page 25.

As soon as the young seedling plants develop the first true leaves, they are transplanted to small pots, preferably 3-inch pots. They are planted deep at this time and are kept growing vigorously but not fast enough to produce a soft, succulent growth. As soon as the pots are filled with roots, the plants are shifted to larger (4-inch) pots; and when they have attained a height of 12 or 15 inches and have developed their first blossoms, they are then set from 15 to 18 inches apart each way in the benches of the greenhouse where they are to produce their crop. A well-grown plant suitable for either field or greenhouse use is shown in figure 172.

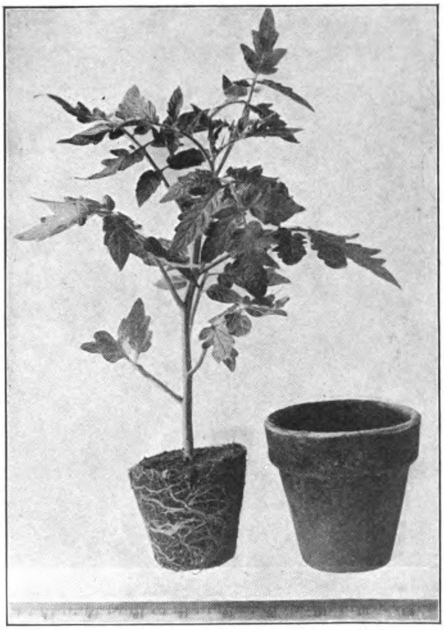


FIG. 172. Tomato plant suitable for forcing house or early field use

Cuttings should be taken off from strong, vigorous, growing plants in the field and placed in the bed about the last of August. They will quickly take root, and as soon as the roots have developed to the length of from ½ to 1 inch, the young plants are shifted to 3-inch or 4-inch pots, where they remain until the blossom buds are well formed, or until the blossoms have expanded, when they should be transplanted to the benches on which they are to mature. Cutting plants are somewhat shorter-jointed and come into blossom more quickly than do the seedling plants, and for this reason may be started somewhat later.

Training. In forcing houses it is usual to grow tomato plants with a single stem or, at most, with two or three stems. The houses are provided with wires which are fastened by screw eyes or staples to the sash bars and which run parallel with the rows and directly over the plants. Wires are also fastened to the top of the benches and pass close to the base of the stems of the plants. Strong twine is used between the two wires to serve as the support to which the stems of the tomatoes are tied. Plants trained to a single stem are shown in figure 173. The tomatoes should be carefully tied with raffia, which is passed around the supporting strings two or three times so that when a loop is passed under a fruit cluster or leaf the plant will be held to the supporting string and still have sufficient room for the growth and thickening of the stem.

FIG. 173. Tomato plants trained to single stems

If the stalk of the plant is tied tightly to the supporting string or wire, it is liable to be girdled. As the fruit clusters develop, it will be necessary to pass a band of raffia under one of the subdivisions of each cluster and around the stem of the plant, or around the supporting string, so that the clusters will not be broken off by the weight of the fruit. When broken, the nourishment for the developing fruit is cut off and its growth from that time on is unsatisfactory.

Pollination. In the field, where the plants are exposed to the action of wind and the visits of insects, no special care is necessary to insure the pollination of the flowers and the setting of the fruits. Under the abnormal conditions existing in the greenhouse, however, the flowers must be artificially pollinated, otherwise a very small percentage of fruits will set. To pollinate in the greenhouse, let the temperature of the house become quite high in the middle of bright, sunshiny days while the plants are in bloom, and then with a light stick, 18 inches or 2 feet in length, strike the supporting strings or wires so as to jar the plants and thus liberate the pollen. A more satisfactory way, however, is to use a watch glass $1\frac{1}{4}$ or $1\frac{1}{2}$ inches in diameter, embedded in putty, at the end of a handle 12 or 18 inches long, made of a light wood. Grasp this spatula in the left hand and with a light stick of equal length pass through the house. Tap each open flower lightly with the wand and at the same time hold the watch glass under the flower to catch the pollen; before removing the watch glass from this position, lift it sufficiently to cause the stigma of the flower to dip into the pollen contained in the watch glass. By going through the house carefully every day during the blooming period, 90 per cent or more of the blossoms which develop can be induced to set. During dark, cloudy, or stormy weather, however, a smaller percentage of flowers can be successfully fertilized than during bright weather, for it is impossible to modify conditions in the greenhouse so as to overcome entirely the adverse outside conditions.

Manuring. It is desirable that tomato plants which are being forced should be kept growing at a moderately rapid rate through the whole period. Growth should be strong and robust at all times, yet slow enough to produce close-jointed plants which bear fruit clusters near together. There is considerable difference in varieties in this particular, and those plants which naturally bear their clusters close together should be selected for forcing purposes, provided they possess the other desirable qualities. The manuring of the plants should take a form which will be conducive to this strong, vigorous growth, yet not sufficiently heavy to produce plants which run to wood at the expense of fruit. If a nitrogenous fertilizer is to be used, nitrate of soda in solution is preferable to the slower-acting forms commonly employed in greenhouse operations, such as bone meal, cottonseed meal, and sheep manure. An artificial fertilizer is better than stable manure for producing strong growth in the plants. Nitrate of soda, sulphate of potash, and acid phosphate can be combined to give the desired proportions of nitrogen, phosphoric acid, and potash. A good fertilizer for this purpose consists of the following: $1\frac{1}{2}$ parts of nitrate of soda, 1 part of sulphate of potash, 2 parts of acid phosphate. Apply this at the rate of 2 ounces per plant as soon as the plants have become well established, and when the first fruits begin to color, make a second application, using the same amount of the mixture per plant.

Insects and diseases. Forced tomatoes, as a rule, are not seriously injured by the common insect pests of the greenhouse. The mealy bug and the white fly are the most annoying pests to the tomato. The mealy bug can be destroyed by spraying the plants with fir-tree oil or with a solution of ivory soap in water. The white fly, *Aleyrodes vaparorum*, is easily held in check by fumigation with tobacco or with one of the modern tobacco smudges.

Nematodes, or eelworms, are minute organisms which frequently infest soil in subtropical climates and under greenhouse conditions, and are sometimes very destructive to the tomato. This organism attacks the roots of the plant, causing abnormal swellings, or galls, which interfere with the development of the roots and prevent them from performing their normal functions. Infested plants are weakened through lack of nourishment, the growth is abnormal, and fruit production ceases. An examination of the roots reveals the deformed, knotty condition shown in figure 170, which is characteristic of this trouble. The only remedy is to root out and destroy the plants, discard the soil for greenhouse purposes, and after disinfecting the benches refill them with clean soil or sterilized soil, as described on pages 24–25.

The one disease which is a menace to the forcing of tomatoes is the mildew, *Cladosporium fulvum*. The first indications of this disease are slight yellow discolorations on the surface of the leaf and velvety brown patches of the fungus on the underside. This stage is rapidly followed by the distortion and drying of the leaflets. The spores of this disease ripen quickly and spread from leaf to leaf. It usually appears first on the lower and older leaves, which have partly lost their vitality. The plants should therefore be carefully watched for the appearance of this mildew, and when its presence is detected *immediate steps* should be taken to eradicate it. One of the best methods is to spray the plants at intervals of a week or ten days with a solution of ammoniacal carbonate of copper. This is made by dissolving 1 ounce of copper carbonate in 3 pints of strong ammonia to form a stock solution, which should be diluted with 25 gallons of water. If applied with a fine Vermorell nozzle and a strong force pump, this solution will prove effective.

Ventilation and watering. Careful attention should be given to ventilation and watering. Ample ventilation without cold drafts, together with careful watering, will go far toward the control of mildew. The plants should not be weakened by too much or too little water. If they are to be syringed, this should be done once every week or ten days, and then only in the morning of bright days. Ordinarily, however, the atmosphere of the house should be kept dry rather than moist, for a very moist atmosphere is apt to produce a soft, succulent growth which brings on a disease known to gardeners as œdema. This is only a physiological condition, however, and can be prevented by keeping the house dry. Extreme variations in the temperature of the house should not be allowed; the night temperature should range between 65° and 68° F., and the day temperature between 70° and 80° F.

Gathering the fruits. The individual fruits as they ripen should be cut from the clusters, with a portion of the stem adhering, in such a way as not to disturb the remaining fruits. Tomatoes gathered in this way present a pleasing appearance and are not apt to be leaky. For special markets close at hand it is not necessary to wrap them, for they are usually sold by the pound. For long-distance shipment, however, it is better to wrap the fruits in tea paper, either white or brown, and pack them in carrier baskets similar to those used by peach growers for the shipment of peaches. The yield of a plant grown as described above should range between 4 and 10 pounds, the average being about 5 or 6 pounds.

TURNIPS

The name "turnip" is applied indiscriminately to both the rutabaga and the common flat Dutch type of turnip. Common turnips and rutabagas are both grown chiefly for their roots, and while they hold a lowly position in the scale of garden vegetables, yet in some sections they are extensively grown for stock food and as a market-garden crop.

Botany. Botanically, the turnip belongs to the Mustard family, which includes, among common garden plants, mustard, rape, cabbage, and radish. They are known specifically as follows: the rutabaga as *Brassica campestris;* the common strap-leaf, flat-top turnip as *Brassica rapa;* rape as *Brassica napus.* One would naturally expect to find the specific name *rapa* used for the true rape, but for some reason unknown to the writer the botanists confused these names at an early day, and we now have *Brassica napus* as the specific name of rape. The two types of mustard, white and black, are known specifically as *Brassica alba* and *Brassica nigra,* which are true explanatory titles. Besides these groups of plants there is the Chinese cabbage, of which there are many types, and which is considered under the true cabbage; but the writer believes that, botanically and horticulturally, it is more closely related to rape and kale than to the cabbage proper.

Soil. The soil best suited to these plants is well-enriched, sandy or clayey loam. Like all members of the Mustard family, they make their growth quickly and must therefore have a liberal supply of available food. The use of from thirty to forty loads of well-rotted stable manure is not an excessive amount of fertilizer. Because of the small return per acre received from the turnip, it would be impracticable to apply this large amount of manure if the land were to be used only for a single crop of turnips. The usual practice, however, is to grow the common turnip as a catch crop, or as a crop to follow early potatoes, early beets, peas, beans, or some other standard vegetable which has yielded a large profit. As a rule, no special fertilizer is applied to turnips, but in rare cases a readily available nitrogenous fertilizer is used to stimulate rapid growth and insure a firm, brittle texture.

Seed sowing. The fall crop of the common flat-top turnip is usually sown from July 15 to August 15 in latitudes north of Washington, and usually upon land that has previously produced an important crop. One method is to sow the seed broadcast and slightly rake or harrow it in, after thoroughly plowing and harrowing the land to make it as smooth as possible. Rutabagas require a longer period for development and are usually sown in the month of May in the latitude of New York City. It is customary to plant this crop $\frac{3}{4}$ inch deep in rows like those for beets. After the young plants appear and have become well established, they are thinned to stand from 4 to 6 inches apart in the row, to make room for the development of their thickened roots.

The common turnip may also be used as a spring crop. Market gardeners at the North often grow turnips early in the season, to be followed by later vegetables on the same land. This crop is sown about the same time that radishes and beets are planted, frequently in the month of March or April. All the members of this group of plants are comparatively hardy and capable of withstanding low temperatures. The turnip, therefore, may be cultivated either as a spring or fall crop. Mustards are as hardy as the common turnip and can be grown as both a spring and a fall crop.

Harvesting. The crop from seed sown early is usually bunched and sold the same as beets. That sown in the autumn is handled the same as beets — the roots are pulled, the tops cut off, and the product sold by the bushel.

Rutabagas, which require the whole season for development, are treated the same as the fall crop of turnips; the tops are cut off and only the thickened roots sold on the market.

WATERMELONS

From an economic standpoint the watermelon is undoubtedly the most valuable of any of the plants belonging to the cucurbits. It is of subtropical origin and in southern and southwestern United States is extensively grown. It is not unusual to find fields of from 100 to 400 acres in extent devoted exclusively to the cultivation of this crop.

Distribution. While the watermelon may be said to be more cosmopolitan than the squash, it is not so generally distributed over the United States as cymlings, cucumbers, or muskmelons. The two states which lead all the others in the production of the watermelon are Georgia and Texas. In the census year of 1900, Georgia grew 27,874 acres, Texas 26,276 acres, South Carolina 10,511 acres, North Carolina stood fourth with 9814 acres, and Virginia ranked next with 9297 acres. Under careful cultivation watermelons can be grown in every state in the Union, but the chief center of production is from Virginia southward along the

Atlantic coast, and through the Gulf States to Texas, the area coinciding very nearly with that over which the long-leaf pine is naturally distributed. The acreages mentioned give some idea of the extent of this industry in the United States. It is not an uncommon sight during the watermelon season to see a train of from 30 to 40 cars loaded with watermelons pass through the gateway of the South to the North.

Uses. The use of the watermelon is confined almost exclusively to human consumption as it has no by-products. It has some value, however, as a food for hogs, but because of the limited number of these animals reared in the region where watermelons are extensively grown, the crop is of minor importance as a stock food. The commercial value of the crop is great. A carload to the acre is considered a normal crop on land well suited to its cultivation, and a carload consists of 1200 melons each weighing about 20 pounds, which is considered the ideal weight for market. Most plants when grown toward the Northern limit of their successful cultivation become earlier and more fruitful in proportion to their vegetative growth. This does not hold with the watermelon; the best results both at the North and the South invariably come from using seeds grown at the South.

Varieties often change in varietal characters under different environments. Georgia Rattlesnake, grown in the sandy soils in the vicinity of Augusta, Georgia, has no superior either for home use or market; but 150 miles north of Augusta it does not maintain its good qualities.[1]

Botany. The watermelon, a native of Africa, is undoubtedly more extensively cultivated in the United States than in any other country. This plant is known to botanists as *Citrullus vulgaris*, a member of the great group *Cucurbitaceæ*. It is a tender annual, which, under the care of the horticulturist, has developed a variety of forms differing in size, shape, and markings, and in the color of the seeds and flesh. There are two well-defined classes of watermelons — the common watermelon of commerce shown in figure 174, with its sweet, brittle flesh, and a small, hard-fleshed melon used for preserving, which is " long keeping " in comparison with the perishable nature of the table melon. This small melon

[1] J. S. Newman, " Southern Gardeners' Practical Manual."

is seldom spoken of as a watermelon, but because it is preserved and sometimes used for the same purposes as the true citron of commerce it is called a citron or citron melon.

Soil. The soil for the watermelon is necessarily of a warm, sandy nature, and the climate to which it is best adapted is warm and inclined to be dry rather than moist. While the plant requires considerable moisture, it thrives well in regions where the rainfall is comparatively scanty. Warm, sandy, quick soils, a moderate precipitation, and a high temperature during the growing season

FIG. 174. Watermelon fruits and foliage

are essential for the highest commercial success of this crop. Many growers, especially through certain sections of Virginia, prefer the sandy lands bordering streams, but the crop is successfully and extensively grown in sections of northern Texas where there is little rain. In fact, watermelons are successfully grown in the dry regions of Kansas, Nebraska, and South Dakota, where the annual rainfall does not exceed 15 or 16 inches.

Preparation of the soil. The soil should be plowed moderately deep and well prepared. A crop of cowpeas, soy beans, or velvet beans should be turned under as a preparation for the melon crop. Such a practice improves the mechanical condition of the soil and increases its supply of nitrogen. The watermelon, like all other cucurbitaceous plants, is a gross feeder and requires an abundance of available plant food. To meet this requirement it is well to use manure or a commercial fertilizer in the hill. For this purpose there is no better material than hog manure, but as a rule this is not available in sufficient quantities for extensive operations, and any well-decomposed manure may be substituted. When stable manure is scarce, a substitute can be made by composting 1000 pounds of cottonseed, 1000 pounds of high-grade acid phosphate, 1000 pounds of fresh stable manure, and 300 pounds of kainite. These materials should be thoroughly mixed and thrown into a heap to ferment for at least six weeks before needed in the field. The composting destroys weed seeds and renders the plant food in the mixture more available. Such a compost can be safely used at the rate of 5 pounds to the hill or 2 tons to the acre in drills. Place the hills from 8 to 12 feet apart each way in check rows, and make an excavation sufficiently deep to hold a good shovelful of the manure. Over this place a layer of 3 or 4 inches of soil. If the hills are slightly raised, so much the better in localities where there is danger of excessive moisture; but in regions where there is lack of precipitation, it is better to maintain the surface of the hill upon a level with the surrounding soil. A complete fertilizer carrying 3 per cent of nitrogen, 8 per cent of potash in the form of muriate or sulphate of potash, and 8 per cent of phosphoric acid, mixed with the soil at the rate of about a half pound to each hill, makes a very good substitute for the stable manure if the humus content of the soil is kept up by the use of green manures. Such a fertilizer is approached in the following combination:

Nitrate of soda, 500 lb.; nitrogen, 3.3 per cent.
High-grade superphosphate, 1200 lb.; phosphoric acid, 8.4 per cent.
Sulphate of potash, 300 lb.; potash, 7.5 per cent.

This may be used at the rate of 400 or 500 pounds per acre, in the drill opened preparatory to plowing in the bed for planting.

In most localities where watermelons are grown on an extensive scale they are not planted in hills in check rows. A furrow is opened along the line of the row, and the compost manure or fertilizer is scattered in the furrow at the rate of from 400 to 500 pounds per acre. It is incorporated with the soil by running a scooter plow once or twice along the row, and then bedding on this by turning two or four furrows upon this line of fertilizer. The seeds are planted, sometimes in drills to be thinned to the desired distance after the plants are established, but more often in hills 3, 4, 6, or 8 feet apart.

Planting. At planting time an abundance of seed should be used so that there may be a sufficient number of plants to withstand the attacks of insect enemies which are more or less troublesome. Fifteen and even twenty seeds are often used to a hill, and if these are separately placed at intervals of an inch or more apart it will prove an advantage. Another plan is to plant about half the seed at one time and from six to ten days later to plant again, so as to have two sets in the same hill. About the time the plants begin to form the third leaf and to show a tendency to run, they should be thinned to 3 or 4 plants to the hill. At this time, if they are not growing rapidly and the plantation is in a region where there are frequent showers, it is well to stimulate growth by a light side dressing of nitrate of soda, at the rate of 100 pounds per acre, or of a high-grade fertilizer, using 250 pounds to the acre. This treatment can be repeated to advantage after each cultivation.

At planting time the seeds should be covered with soil to the depth of 1 inch or 1½ inches. Deep planting is not advisable because the plants are slow in reaching the surface of the ground and a great deal of the stored strength of the plant is used up in reaching the light if it is planted too deep.

Cultivation. The habit of growth of the plant makes it imperative that the selection and preparation of the land before planting be most carefully and thoroughly done. The preparatory crop should be one which will enrich the soil and at the same time smother weed growth. Plowing should be done early, to give an opportunity to kill one crop of weeds by harrowing before planting. All this is made necessary because the crop cannot be cultivated with horse-power implements after the plants begin to vine.

After planting, which should be planned so that a two-horse spring harrow can be used between the rows, cultivation should be regular as long as the vines will permit. The aim is to anticipate later cultivation by a thorough destruction of the weeds and the maintenance of a good soil mulch during the early growing season. At the last cultivation cowpeas are often scattered thinly to act as a windbreak to vines and to serve as a partial shade to the fruits later in the season.

Insects and diseases. Fortunately the watermelon is not troubled to any great extent by diseases, except in certain localities where it has been under cultivation on the same soil for a number of years. In such cases it is frequently affected with the wilt disease, which destroys the vines. The remedy for this trouble is to rotate the crop, placing it on soil which has not previously been used for watermelon production for at least four or five years.

The one insect to whose attacks the watermelon is subject is the striped beetle, known as the striped cucumber beetle, which, soon after the plants appear above the ground, is very annoying and quite destructive. One reason for using a large number of seeds to the hill is to guard against total loss by the ravages of this insect. Large numbers of plants are better able to withstand their onslaughts than are a few plants, and for this reason planters usually anticipate trouble by using a large quantity of seed.

In cases where it is not considered too expensive, the same remedy suggested in the case of the squash may be resorted to; that is, the use of frames 18 inches square and about 4 inches deep, covered with cloth or with thin goods of some kind, such as mosquito netting or wire netting, for the protection of the young plants. These give satisfactory protection, but are too expensive and cumbersome for extensive commercial use. Perhaps the cheapest and most easily handled guard is the square of mosquito netting suggested in the chapter on the squash. By placing a small stake 6 or 8 inches high in the center of a hill and dropping the cloth over the top of this so as to form a miniature tent and fastening the edges with earth, the plants can be cheaply and successfully protected from insects.

Where it is desirable to use insecticides rather than preventive means for the treatment of such pests, nothing is better than tobacco dust or tobacco fertilizer. Tobacco dust is the sweepings from cigar factories, and the tobacco fertilizer is a commercial product which consists of ground stems of the leaves. This is a comparatively cheap insecticide and is at the same time a fertilizer of no mean value, as it contains a high percentage of potash.

Varieties. The varieties of watermelons are classed according to color and form. The color patterns are of two general styles: those uniformly light or dark green over the entire surface exposed to the sun, and those striped or mottled with two shades of green. The shape of the melon varies from the globular type of the citron and the Kolb Gem to the long, cylindrical type of the Rattlesnake.

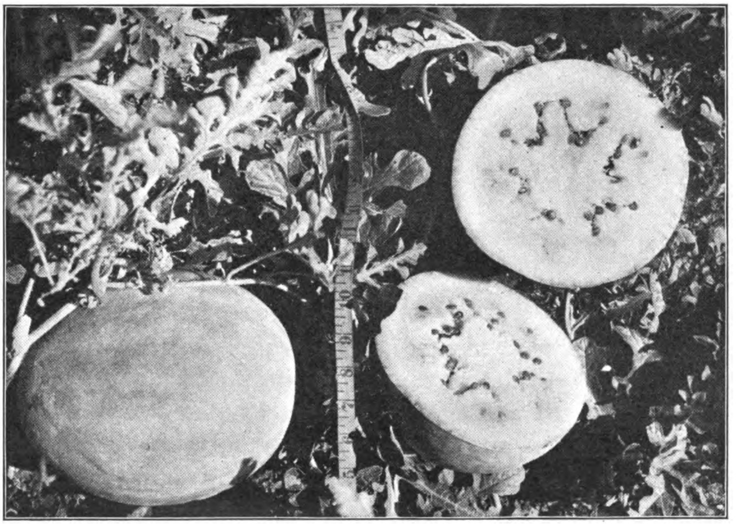


FIG. 175. Form and cross section of a good table melon

Besides these divisions according to color and form, there are two divisions of the watermelon family based on use. The table melons are by far the most numerous and important, but the preserving melons are grown to a considerable extent under the name of citron. While these are not edible in a fresh state, they make a rich preserve relished by many. The table melons are selected for two purposes—home use and shipment. The varieties suited only for home use have thin, brittle rinds, tender, fine-grained flesh, and are too fragile for shipment. Some of the best for home use are McIver, Florida Favorite, Kleckley's Sweet, Bradford, Long White Icing, and Sugar Loaf. For shipment, Kolb Gem, Duke Jones, Pride of Georgia, or Jones, Mammoth Iron Clad, and Dixie are the best. Among the recent introductions worthy of note is a Spanish type called Pasadena. Its particular merit is its good quality and the attractive color of its flesh, which is a very deep, bright red. Figure 175 shows the form and cross section of a good type of table melon.

Experience has demonstrated that the highest quality melons, which have brittle flesh, few fibers, and a thin rind, are not well adapted for shipping purposes. Professor Starnes gives the points of excellence in a market melon as follows:

Shipping capacity	35
Size	25
Productiveness	15
Quality	10
Earliness	8
Shape	4
Color of flesh	2
Color of rind and markings	1
Total	100

The most desirable market melons weigh from 20 to 30 pounds, and have bright red flesh of fair texture and good shipping qualities.

Harvesting and marketing. Watermelons are a comparatively cheap product and are therefore handled in the least expensive manner possible. Shipments do not begin to any great extent until the melons can be handled in carload lots. A few of the earliest melons are shipped in ventilated barrels like squashes, but the great bulk of the product is shipped in carloads or in cargo lots by small sailing or motor crafts. They are too bulky and too heavy to be transported profitably by express or by local freight.

At harvest time it is necessary that mature, well-developed melons be selected and that they be handled in the most careful manner possible. Melons are very brittle and easily broken. The wagons in which they are hauled to the car are usually provided with litter of some kind on which to lay the fruits, and as they are placed in the car, they are handled carefully to prevent bruising. It is a wise precaution to place the smaller melons in the bottom of the car, for they will carry a greater weight proportionately than the large ones.

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