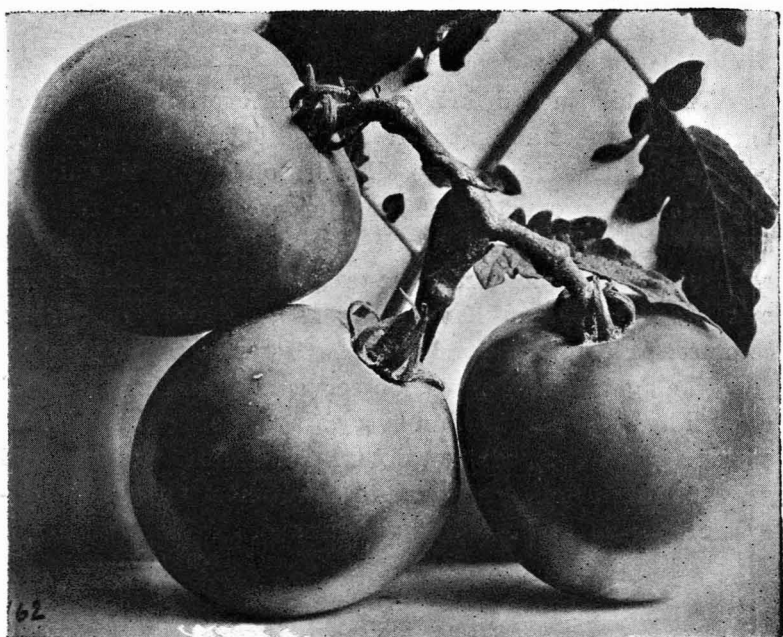


COMMERCIAL VEGETABLE PRODUCTION IN HAWAII



Hawaii grown "Globe" tomatoes $\frac{3}{4}$ natural size.

Plants per acre 1742, yield 17,420 lbs.

Gross income per acre \$500-\$1000.

Agricultural Extension Service
University of Hawaii, Honolulu T. H.

FREDERICK G. KRAUSS, DIRECTOR

This bulletin is dedicated to the enterprising and intelligent landowners and planters throughout Hawaii who may be able to appreciate the possibilities offered in Hawaii for the extensive production of truck crops, for which there is a potential market of at least ten million dollars within and without Hawaii's borders. The present imports of her home markets exceed a million dollars as this first treatise on commercial vegetable production in Hawaii goes to press.

The agricultural extension service of the University of Hawaii has pledged to aid in every way possible the upbuilding of a prosperous commercial truck farming industry, and growers in Hawaii are urged to avail themselves of whatever resources we have at our command.

F. G. K.

COMMERCIAL VEGETABLE PRODUCTION IN HAWAII

By F. G. Krauss

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Commercial Vegetable Production in Hawaii

By F. G. KRAUSS

INTRODUCTION

The people of Hawaii are awakening to the opportunities offered agriculturalists to supply the food wants of the territory and to build up an export trade in farm produce which will supplement the trade in sugar and pineapple.

One of these opportunities appears to be in truck crops. Of these, at the present moment, the Irish potato seems the most promising. Not only does Hawaii import more than \$350,000 worth of Irish potatoes annually, most of which might well be produced at home, but there now seems a great market on the mainland for early Hawaiian grown potatoes. Although no Irish potatoes have been exported from Hawaii since the '50's, when annual shipments exceeded 50,000 barrels, there has recently been forwarded to California a trial shipment in competition with Florida and Texas stocks. This shipment has met with a favorable reception.

Although, in more recent years, sweet potatoes, shell beans, onions, taro, and some other vegetable products have been shipped to the Pacific Coast more or less successfully, Hawaii has been too prosperous under a limited cropping system to concern herself seriously with greater crop diversification. However, changing world conditions have caused all thinking men to consider the possibilities of greater diversification than has in the past seemed feasible. This bulletin on commercial vegetable growing in Hawaii is an attempt to show how a greater variety of garden truck may be produced more successfully than has been the case in the past.

Hawaii consumes annually fresh vegetables worth more than a million dollars. Of this large total, vegetables worth \$691,669 were imported from abroad in 1930. In addition to fresh produce, dried, canned, and preserved vegetables valued at \$2,237,579 were imported in 1930. In other

words, Hawaii now imports vegetable produce worth annually in excess of $2\frac{3}{4}$ million dollars. There is reason to believe that Hawaii can produce profitably at least one-half of the vegetables which are now imported.

Prophecies concerning the quantity of vegetables Hawaii may be able to export in the fresh and canned state can be made more safely after we have learned to supply more of our own needs. In the case of early Irish and sweet potatoes, the possibilities seem almost unlimited. In any event, Hawaii has amply demonstrated at her agricultural fairs and in actual trade for many years that she is capable of producing all the classes of vegetables which she now imports. Only the enterprise applied to our great stable industries is lacking to add these new laurels to our agricultural accomplishments.

In the following pages will be found cultural directions and other data gleaned from many sources that are believed reliable and applicable to Hawaiian conditions. On subjects in which the writer has needed assistance, he has called upon his colleagues for their aid. The chapters on irrigation and chemical fertilizers have been checked over by Professor Harold A. Wadsworth, of the Soil Physics Department of the University of Hawaii, and by Dr. Oscar C. Magistad, Chemist, Experiment Station, A.H.P.C., respectively. The chapter on the preparation of vegetables for market and tables II and III in the appendix were prepared by Mr. A. S. T. Lund, Extension Economist and Marketing Agent. The illustrations not accredited to others are from the Extension Service of the University of Hawaii. To the analytically minded producer, the statistical matter contained in tables II and III of the appendix should be especially interesting and suggestive in connection with the general text.

ESTABLISHING A COMMERCIAL TRUCK FARM

Wickson has well said: "No matter how skillful and successful a man may be in his particular locality, his experience can only be a safe guide to those who happen to work under similar conditions. Therefore a suggestive treatise must analyze the local conditions and practice and translate them into terms of wide applicability."¹

To do this necessitates keen discernment and good judgment based on wide experience and training. Hawaii's vegetable industry is as yet too limited to give us all the guidance needed at this time, but we have drawn upon the experience of many individuals, to which has been added our own observations and experiences.

The first requisite for the establishment of a successful commercial truck farm in Hawaii is that the individual who is to undertake the enterprise should combine the qualities of both a good farmer and a good business man. He should know as thoroughly as possible the soil, climate, cultural conditions, and the general community in which he establishes his enterprise. Secondly, he should locate where he has access to markets, where there is available an inherently productive soil, and where there are facilities for ample irrigation. Above all, either his land must be sheltered from destructive winds or he must have the means for providing necessary shelter. He should especially guard against soil infestation by the commonly called Japanese nut grass and other tenacious, noxious weeds and plant diseases. Every serious handicap should be avoided beforehand through foresight and prevention.

There is no better safeguard and guide for the prospective truck farmer than to have lived in the community and farmed the land for a year or two before he undertakes his truck farming enterprise. If he has profitably and intensively grown corn, potatoes, and other tilled crops under irrigation and fertilization over a series of years, if he has maintained a thrifty home vegetable garden by controlling pests and plant diseases, and has satisfactorily determined that there is a demand for vegetables, either locally or within reach of convenient transportation facilities,

¹"California Vegetables" by Edward J. Wickson, 5th edition, 1923.

such a farmer has an excellent chance to succeed and may begin to produce staple vegetables on a field scale. These might include both early and main crop Irish potatoes, sweet potatoes, beans, tomatoes, peppers, onions, cabbage, sweet corn, cucumbers, and melons, depending on the condition of the soil, the climate, and the markets. These are all row crops which can be cultivated economically by the use of modern hand machines, horse-drawn implements, or garden tractors.

While the danger of over-production must be considered, this situation does not affect superior products nearly so much as it does poorly grown crops. In addition to striving for high quality, the market gardener and truck farmer in Hawaii, as elsewhere, must constantly strive to produce



Fig. 1.—Newly sown and transplanted beds illustrating intensive Oriental culture as practiced in Hawaii. Note straw mulch on beds in foreground. This kind of commercial vegetable growing is termed “market gardening” in contrast to the more extensive type of truck farming practiced in the Continental United States.

his crops more and more economically. A larger expense often results in a greater saving, as in the use of more fertilizer, more thorough tillage, and better seed. Concerning this point, Professor Falconer, agricultural economist of Ohio State University, has said: “Inefficiency in production is no cure for low prices. Experience and research

have shown that farmers with high yields usually make greater profits than their neighbors with low yields. On high-priced lands, high yields are more economical to produce than low yields. If a reduction in output of a particular crop seems desirable, it is better to reduce the acreage than to lower the efficiency on a larger area. The inefficient and poor farmer will have to drop out altogether when prices are low, while the good farmer will contrive new economies."

Before entering upon an extensive commercial truck gardening enterprise, the gardener should prepare a budget covering cost of his intended "set-up" and probable running expenses, together with an estimate of probable receipts and net returns. First, he must take careful account of his resources in land, equipment, labor, transporta-

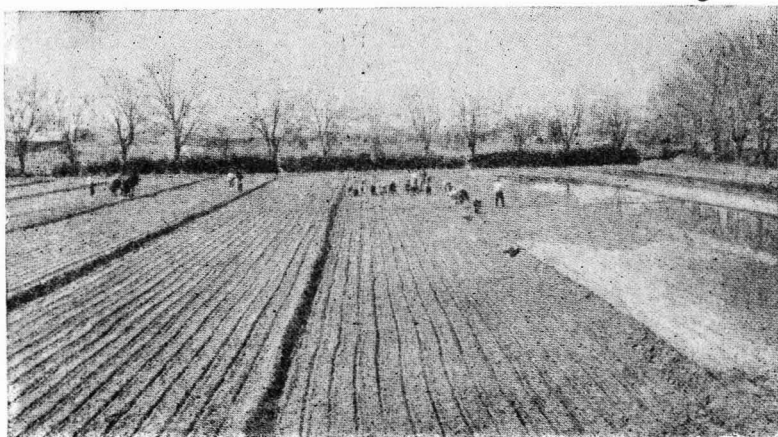


Fig. 2.—Showing preparation of the land, transplanting, and irrigation. This kind of commercial vegetable growing is termed "truck farming" in contrast to the more intensive type of market gardening, generally practiced in Hawaii. After Bulletin No. 193, Agri. Expt. Stat., New Mexico College of Agriculture.

tion facilities, and working capital. In order that he may make a fair appraisal of his fitness for the enterprise and thus determine his likelihood of success, he would do well to give due consideration to his farming ability and previous experience as a business man. If lacking in any of these essentials, he should associate himself with some capable co-worker from the start or join a well-established association of growers. Commercial vegetable production is one of the most highly specialized branches of agriculture and the most intensive type of farming and plant

utilization, and, when rightly conducted, it may become a highly profitable enterprise. Conversely, if undertaken without suitable preparation and resources, the enterprise is doomed to failure from the start.

Success in marketing fresh vegetables is dependent upon a number of well-defined factors, among which are: (1) harvesting the produce at the right time and in a proper manner, (2) grading to a definite standard, and (3) careful packing. Above all else, the product should be prime when harvested, neither slightly immature nor slightly over-ripe. Moreover, in order to prevent bruising and to retain the natural freshness of the product, it must be handled with care and dispatch. Stale and damaged vegetable produce will kill trade even when demand is brisk.

Vegetables of a dependable grade and pack inspire confidence in the trade, a confidence which is reflected in greater demand and higher prices. It will be better for all concerned when producers come to realize that the best marketing facilities cannot overcome the handicap of indifferent quality and careless handling methods. Poor markets, giving dissatisfaction to the grower, are more often caused by carelessness and ignorance in preparing the produce for market than by over-supply. Even in a glutted market the superior produce usually finds ready sale at a fair price.

Improvement in handling methods is best accomplished through systematic efforts of growers working in cooperation with high-minded and experienced dealers and backed by cooperative marketing organizations constantly improved as the industry grows.

No exhaustive treatise on methods of marketing vegetables can be given here; the most that can be done is to mention a few of the essential principles. Direct marketing, or retailing by the market gardener, may be accomplished by setting up a stall in a well-established public or municipal market, by peddling from house to house in the city or town, by the sales at the street curb or farmers' market, at roadside markets, or by parcel post or express shipments to an established clientele.

Such methods of marketing take the farmer's attention from the supervision of production. However, where there are large families, the grown children may often be given worthy and profitable employment by these means. It is believed that an exceptional opportunity is available to the small or medium scale market gardener and his

family if they will take advantage of the marketing facilities afforded by the parcel post and roadside stand. Here, as in all other marketing, quality of product, a suitable variety of produce, and attractiveness of display are of great importance. There are few better advertisements than an attractive booth stocked with attractive home hampers of choice "fresh from the farm to family" produce. Such hampers may be cheap but serviceable, thin wood baskets filled with attractive assortments of vegetables, reasonably priced. A somewhat stronger type of package could be utilized for parcel post or express shipments.

The indirect method of marketing, accomplished through wholesale and jobbers' agencies, requires less personal supervision than does direct marketing. This method of marketing is preferable for the extensive truck farmer operating at a distance from the market. The producer usually delivers the goods to the shipping point, although the transaction may be through wholesale buyers who buy on the ground. Commission merchants, brokers, receivers, jobbers, cooperative organizations, and produce auctioneers are a few of the wholesale agencies.

Selling service, whatever its nature, must be paid for as surely as must transportation and distribution. The largest part of the spread between the producer and the consumer usually goes to the retailer. The returns to the producer will be proportionately greater the nearer to the consumer that he carries his product. This is one of the great advantages the local market gardener has over his mainland competitor. The producer cannot ignore his marketing costs. In periods of high wages and high general costs, marketing costs are of necessity correspondingly high. At such times it may be to the advantage of the producer to perform as many of the marketing services and handle as much of the transportation as he possibly can.

The farmer will find it profitable to give much thought to the marketing end of his enterprise. Prospective truck farmers should consult the specialist in marketing and farm management of the University of Hawaii Agricultural Extension Service. In this bulletin will be found a chapter on the "Preparation of Vegetables for Market," which has to do primarily with grading and determining standards. In the appendix are given statistical data concerning the monthly wholesale prices for 1931 of a long list of vegetable products. The market gardener and truck farmer would do well to study the monthly trend of these prices, which are likely to be fairly representative of any year.

SEED STOCKS AND SEEDAGE

One of the primary requisites for success in vegetable growing is the use of good seed. Good seed means seed stocks of suitable varieties and superior strains which are virile and true to type. Fortunately, good seed is not expensive, whereas cheap and unreliable seed may prove very costly in the end.

Buying Seeds. The market gardener's best safeguard in this matter is to deal only with reliable seedsmen who cater to the commercial vegetable grower. Whenever possible, certified seed should be bought. This means that purity of strain and high germination are vouched for. California is one of the foremost seed growing states in the Union and specializes in many varieties that are well suited to Hawaiian conditions. However, reliable seeds can be bought from seedsmen throughout the United States.

Seed orders should be carefully made up from the latest available catalogues and trade lists. The seed harvest on the mainland is usually over by November 1, and new stocks become available in December. It pays to order early and in sufficient quantity to last throughout the year. Whenever possible, the seed should be bought at wholesale, thus insuring a considerable saving to the large grower. It is best to avoid untried novelties and to stick to well-established standard varieties. Varieties should not be changed from year to year unless there is a good reason. Exceptionally promising new sorts offered by reliable seedsmen may be tested in trial grounds set apart for that special purpose.

Growing Seed Stocks. The experienced market gardener may be able to grow some of his own seed stocks. Certain vegetable seeds such as snap, shell, and lima beans, corn, okra, and the vine crops, and especially any superior "sport" or mutation found among any of the crops grown, may well be selected in the field and saved for seed to good advantage.

For seed purposes, only superior plants should be selected in the field. These should be staked and marked, and the seed should be permitted to mature fully before harvesting. Many of the new and superior varieties of vegetables that are announced in seedsmen's catalogues each year are the result of discoveries of wide-awake market gardeners. When such a "find" is made, it gives the gardener an ad-

vantage over his competitors and may lead to a profitable side line in seed growing. However, because seed growing is a highly specialized business quite apart from market gardening, only those equipped by experience and other advantages should aspire to make a business of vegetable-seed growing.

Storing Seed. Seeds must be carefully stored to retain their vitality and to protect them from insect injury. There are no better storage containers than well-made galvanized-iron garbage cans with snug fitting covers; 20 to 40 gallon sizes are most suitable.

To protect seed from weevils, the source of much damage to beans, there is probably no better method than fumigation by the use of carbon bisulphide. This liquid evaporates quickly, producing fumes which are heavier than air, thus causing downward permeation through the seed mass, whether the seeds are stored in bulk or in bags. If the containers are absolutely tight, the usual dosage is one pound (pint) of carbon bisulphide for each 100 cubic feet of space. If the bin is not very tight, it is better to double the dose.

The bisulphide is best applied by placing it in shallow vessels on the top of the seed. The container should be closed as tightly as possible. It should remain closed for from 24 to 48 hours before the cover is removed to give the seed a good airing.

Since carbon bisulphide is more volatile and inflammable than gasoline, fire and explosion must be guarded against. Flames must be kept away from treated bins. Users must guard against inhaling the deadly fumes. Reinfestation of seed should be avoided since repeated fumigations lower the vitality of the seed. All seed stocks should be carefully marked with tags describing the variety, source of supply, and age of crop.

Sowing Seeds; Using Seed Beds and Cold Frames. Many vegetables that are benefited by transplanting, such as cabbages and tomatoes, are best started in seed beds, either in the open or in cold frames. Seed beds and frames should be located in a sheltered place and as conveniently as possible, since the tender seedlings need frequent attention in ventilation and watering.

Seed beds should be 4 feet wide and as long as necessary to accommodate the number of seedlings needed.

It is usually best to excavate the soil to a depth of from 4 to 6 inches where the seed bed or cold frame is to be placed, and to refill the bed with new soil and compost.

Good drainage must be provided. The soil should be moderately rich loam, built up several inches above the surrounding ground. The surface should be levelled off, and then a thin layer of soil should be sifted through an 8-mesh sieve over the surface of the bed. If the soil is unusually dry, the bed should be watered thoroughly first. The seed



Fig. 3.—Outdoor seed propagating beds. See also methods of propagating seedlings in cold frames, Fig. 4.

bed is now ready for planting. The seed rows should be marked off from 6 to 8 inches apart and the seed sown thinly in shallow drills, covered lightly with fine soil, and made firm with a smooth flat board. Frames should be protected with glass or with a muslin-covered sash. Unframed seed beds in the open should be protected with a covering of thin muslin stretched on frames 2 feet above the surface, unless all weather conditions are favorable.

Most seeds will germinate within 8 days. The soil should be kept moderately moist. Undue crowding and shading of the young seedlings must be guarded against. Everything possible should be done to produce strong, stocky, well-formed plants by thinning out and transplanting at the proper time and by providing light and ventilation.

A practice known as “blocking off” is advisable about 10 days before the plants are removed from the seed bed.

This operation consists of running a long, strong-bladed knife along the plant row to cut the lateral roots about 2 inches from both sides of the plant row. This causes the

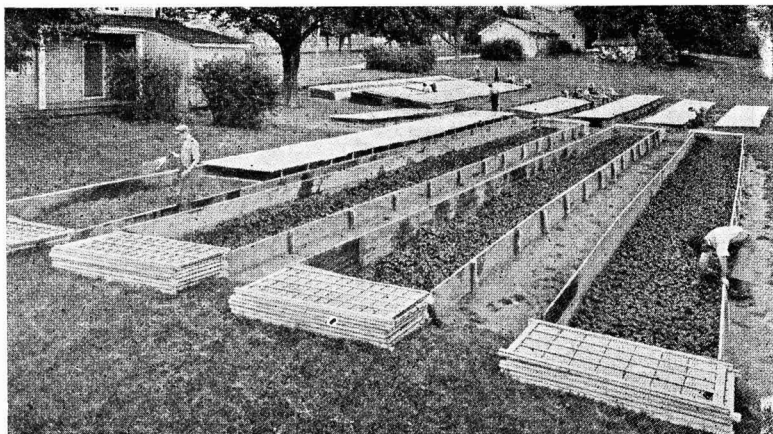


Fig. 4.—Cold frames for propagating seedlings for transplanting. See also methods of propagating seedlings in outdoor seed propagating beds, Fig. 3.

seedlings to establish new roots before they are transplanted, and it greatly facilitates removal of the plants from the seed bed.

The roots on one side of the plants should be cut several days before those on the other side, to lessen the shock.

It is usually profitable to transplant some of the seedlings, especially of tomato plants, from the seed bed to paper pots, of which the type called "locked paper band" are cheap and serviceable. The 3 x 3 x 3-inch size costs approximately \$4 per 1,000 and is the best all-around size. In transplanting to the field after the plants have re-established themselves in the pots, the plant and pot should be set directly in the ground where they are to remain permanently. To some extent, these paper pots for the plant act as cut-worm guards.

Seedlings may also be transplanted from the seed bed to "flats," as the shallow transplanting boxes or trays are termed. A convenient size for flats is 4 x 16 x 24 inches. A smaller size, 4 x 12 x 18 inches, is preferred by many. Plants handled in this manner will have well-developed root systems and can be readily transplanted. The plants may be "hardened" by exposure to the full sunlight and by gradually lessening their supply of moisture before they are transplanted to the field.

The seedlings should be set out either on top or on the side of the ridge if the season is wet, or in the bottom of the furrow if the season is dry or if irrigation water is limited. A trowel or dibble may be used for transplanting seedlings, and the soil should be pressed down around the roots, which must not be jumbled in a close mass when the



Fig. 5.—Crop planted in check-rowed hills. By this method the soil can be cross cultivated, thus greatly economizing in hand labor.

plants are set out. It is advisable to water thoroughly seedlings a short time before they are lifted for transplanting, so that the soil may settle and adhere to the roots when they are taken up. Watering also softens the soil and consequently there is less damage to rootlets and less wilting of the plants. The seedlings should be watered thoroughly again when they are set out in the open ground. Whenever possible, transplanting should be done on a cloudy day. If done on bright sunny days, care should be taken to protect the roots from drying.

Seeding Directly in the Ground. Most vegetables will be sown directly in the open ground where the plants are to remain permanently. Though beans are usually planted in "hills," most seeds are sown in continuous rows termed "drills." Most progressive market gardeners and certainly

all extensive truck farmers will want to take advantage of the modern combined hill- and drill-seeders, for they are economical in both time and labor. These may be had as wheeled, man-pushed, or horse-drawn implements. The last may be equipped with a fertilizer attachment.

The man-driven seeders can be equipped with a small



Fig. 6.—Crops planted in continuous rows and spaced for horse cultivation. Nearly all truck crops can be grown by this method most economically.

plow for opening furrows 3 inches in depth, and with hoes, cultivator teeth, and sweeps, all of which are interchangeable with the seeder attachments. These drills may be regulated to handle all kinds of seeds from lettuce to beans, distributing the seeds accurately and economically. In hill planting, the machine spacings may range from 4 to 24 inches apart. The seed hopper of the man-pushed seeders has a capacity of from 3 to 5 quarts of seed. Equipped with marker rod, furrower, seed covering device, and roller wheel, the total weight of such a seeder is 35 pounds. Even in close-spaced row planting, a man can sow an acre a day with one of these machines. Large horse-drawn seeders will sow at least 5 acres a day.

Depths to Sow Seeds and to Set Transplanted Seedlings.

It is important that seed be covered to a proper and uniform depth. Although the depth of planting will vary with

soil and season, it is a good general rule to plant most seeds in the open field to a depth equal to about 5 times the seed's smallest diameter. Thus a bean measuring $\frac{1}{4}$ inch in thickness would be planted $1\frac{1}{2}$ inches deep while a lettuce seed

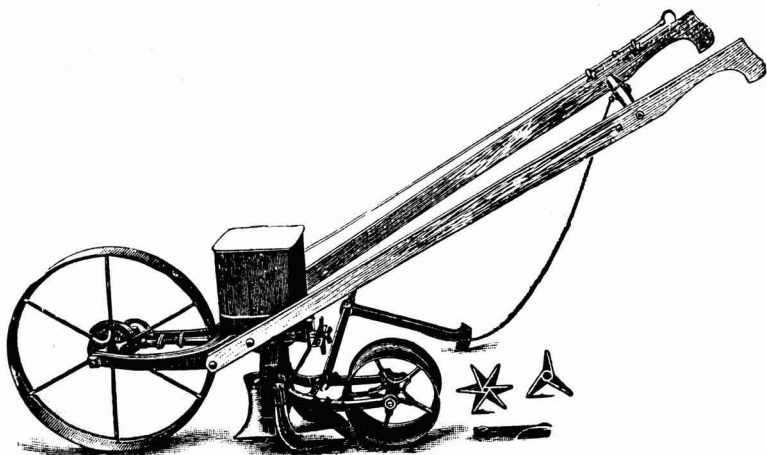


Fig. 7.—Hill and drill seeders.
15-inch steel driving wheel. Holds 3 quarts.
16½-inch steel driving wheel. Holds 5 quarts.

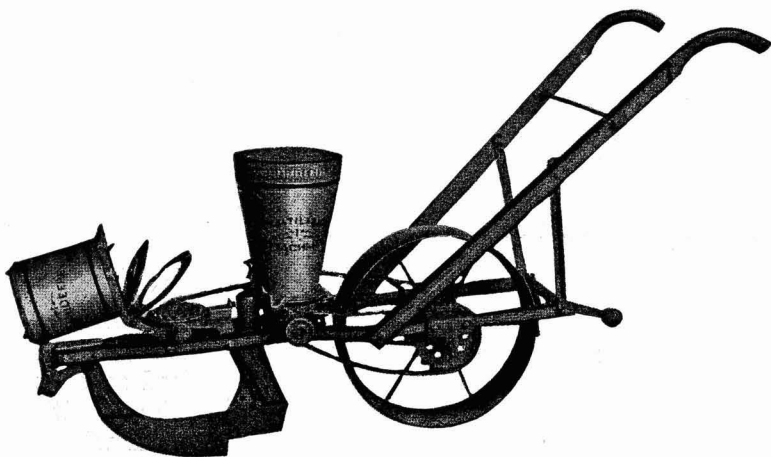


Fig. 8.—One-horse planter for large seeds such as pop and sweet corn, beans, peanuts, etc. Equipped with fertilizer attachment.

$\frac{1}{32}$ inch thick would be planted at a depth of about $\frac{1}{8}$ inch. In heavy and wet soils, the seeds should be sown to a lesser depth than indicated above and in dry sandy soils to a greater depth.

Transplanted seedlings should be set in the open ground at the same depth they stood in the seed bed or pots unless the soil is light and dry, in which case they should be set slightly deeper. If the seedlings are spindly and lank, they should be set deeper than they stood in the seed bed.

Testing Seed. Since only viable seed can germinate and bring forth a crop, any doubtful lot of seed should be tested for germination before it is sown. This is best done by counting out 100 seeds picked at random and placing them on a moist blotting paper which is covered with another sheet of blotting paper. These should be placed on a dinner plate, covered with an inverted plate, and set in a warm place, care being taken to keep the blotting paper moist. The test should be completed in from 5 to 10 days. The number of seeds that give good germination represent the percentage of good seed. If 50 seeds thus tested germinate, then twice the usual amount of seed should be planted in the field.

TILLAGE AND SOIL MANAGEMENT

The productiveness of soils depends largely upon how they are tilled and managed. Obviously, differences in soil types necessitate different methods of management. The objective in any case is to bring about and to maintain to the highest degree possible good soil tilth and available fertility. This may necessitate good plowing, fertilization, and artificial drainage.

Open drainage ditches are best suited for carrying off excess water under most Hawaii conditions. Tile drainage is thought to be unsatisfactory, because of its high cost and because of the tendency of our fine silts to clog the tile.

Plowing. When these conditions have been met, the tillage necessary to provide a good seed bed is in order. The

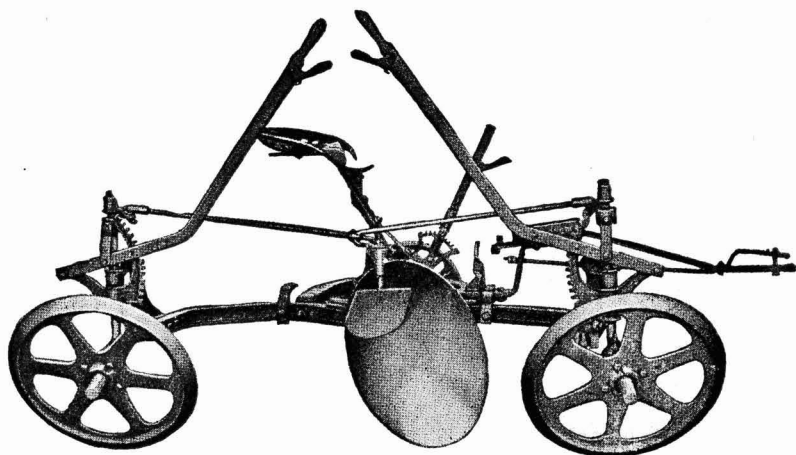


Fig. 9.—The reversible disc plow is doubtless the best all round plow-tool for the extensive market gardener or the limited truck farmer. The disc-harrow, not illustrated, is an invaluable implement to follow the plow. It is especially useful for working into the surface soil, manures, composts and fertilizers that have been broadcast.

first operation for producing a good seed bed is plowing. Care must be taken not to plow heavy soils when they are wet, a condition which causes “puddling” and cloddiness that no amount of after tillage can correct within a season. Nor should any of our shallow Hawaiian soils be plowed too deeply. To bring uncongenial subsoil to the surface in any but the smallest amounts is sure to invite trouble later on.

There are many types of mold-board plows and several of the disc type. For most soils excepting those that are stony, the disc type of plow is preferable. Because of their

rotary motion, the discs scour well and turn a perfect furrow. Mold-board plows usually do not scour well in any of our Hawaiian soils. If the soil needs further pulverizing at

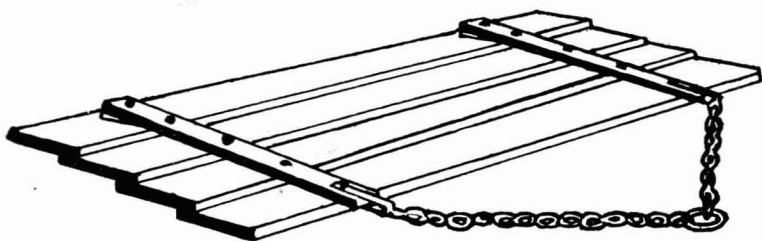


Fig. 10.—A cheap and effective home-made plank drag or “clod masher.”

this time, it should be harrowed. If the ground is stony, a spring-tooth harrow should be used. Otherwise, a disc harrow is preferable. Often a planker (clod-masher) will do effective work in assisting to break up the soil. If the soil is too loose, a heavy log or iron roller can be used to good advantage in packing it. One of the best implements for pre-planting tillage is a culti-packer made of a series of cast-iron wheels with sharp edges shaped in a compound



Fig. 11.—A combination roller, pulverizer, cultivator and packer.

curve. These wheels crush the clods and pack the soil at the same time. After due lapse of time, the land can be cross-plowed and again harrowed and culti-packed.

At least 3 thorough plowings and harrowings, in any

but the most tractable soils, constitute the least preparatory tillage that should be considered. Many pineapple growers find it profitable to plow and harrow their land from 5 to 8 times. Only the good seed bed will produce good crops. A noted truck farmer states: "To secure the ideal seed bed that will insure the best seed germination and plant growth, the soil tilth should not be too deep and loose, but the soil should be mellow and well pulverized above the depth at which the seed is planted. Below this

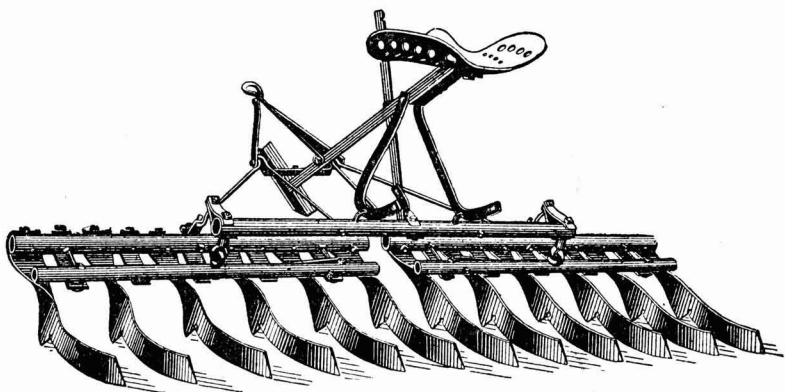


Fig. 12.—Harrow for smoothing and leveling the soil behind the plow. point, it should be firm and well settled." Thus it will make a good connection with the subsoil, so that the water stored therein may be drawn up into the surface soil to supply moisture for the seed. The loose deep seed bed is almost wholly dependent upon rains and surface irrigation to supply the plant with moisture.

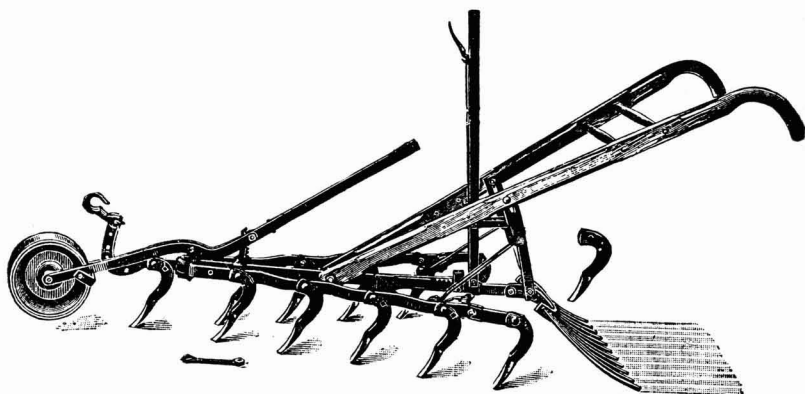


Fig. 13.—Twelve-tooth cultivator and harrow-rake. A most useful implement for the vegetable grower who has facilities for horse cultivation.

Cultivation. Cultivators are of as many types as are plows and harrows. For horse cultivation, the best type is the horse-drawn 5 or 7 tooth combination hoe and cultivator, with a front wheel to regulate depth and to facilitate handling. In addition, the use of a 12 tooth harrow, cultivator, and pulverizer, equipped with a front wheel, is recommended. For bedding, wide furrowing, and hilling, a double celery hiller will be found of greatest value. The foregoing tools are 1-horse implements without a seat for

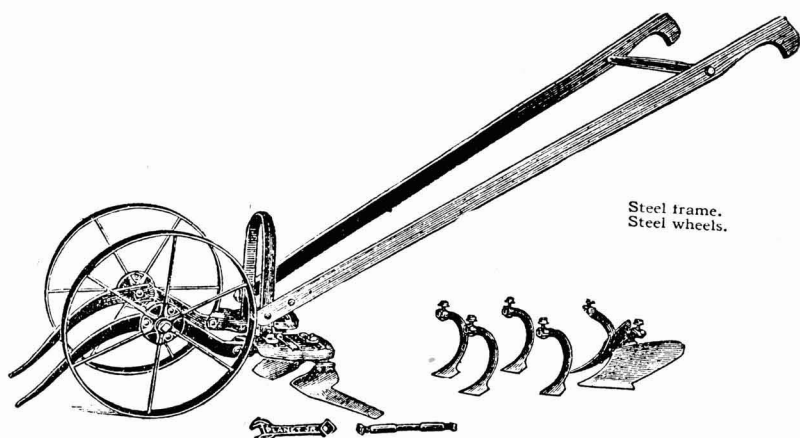


Fig. 14.—The combined double and single wheel-hoe. A labor saving implement for the market gardener.

the operator. For extensive truck farming, there are available the 2-horse or garden tractor sulky type of 2 or 3 row cultivators, furrowers, and ridgers, which permit the operator to ride.

For the small market gardener, there is available a light single and double wheel plow, hoe, and cultivator, which can also be equipped with combined hill- and drill-seeder. These seeder attachments are admirably suited for planting areas up to 5 acres in size.

An admirable little hand tillage implement recently placed on the market is termed the weeder-mulcher-cultivator. In general appearance, it resembles an ordinary lawn mower, and its principle of operation is much the same. It has 8 reel blades, set in reel heads which revolve against a stationary knife. The knife, which is slightly behind the revolving blades, follows just below the surface, cutting the weeds at their roots. The resultant horizontal slice of surface soil is then pulverized by the revolving reel blades,

leaving a fine earth mulch. Three cultivator teeth may be attached to the rear of the bladed reel when deeper cultivation is desired. These little hand implements are made to cultivate strips from 6 to 14 inches in width and sell for from \$10 to \$20, according to size.

Every market gardener will need a number of hand tools, such as field hoes of the type used on sugar and pineapple plantations, some so-called Italian grape or grading

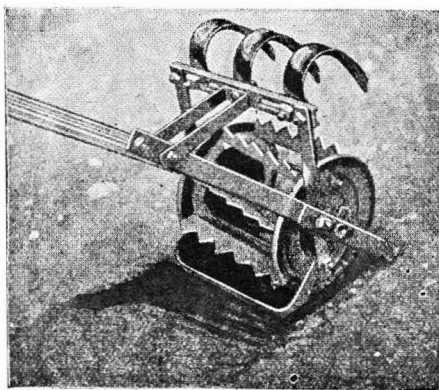


Fig. 15.—A very useful new type of cultivator and “mulcher” suitable for the market gardener and truck farmer spacing rows too close for the use of horse implements.

hoes which are especially useful in digging water courses, some goose-neck pattern potato-hooks for digging potatoes and working over compost heaps, and some forks and spades for digging odd corners which cannot be reached with a plow. (A complete series of these tools are described in Extension Bulletin No. 4, “The Home Vegetable Garden,” which may give the truck farmer other useful information on gardening.)

Tractors. The truck farmer producing potatoes and onions on a large scale can probably use a tractor to advantage. The average market gardener, however, must content himself with a span of mules or possibly a garden tractor. The latter machines have been found economical on 10 acre farms. These implements are beginning to attract much attention in Hawaii at the present time. A recent bulletin of one of the mainland experiment stations reports the following advantages and disadvantages of the modern garden tractor.

The advantages:—(1) The overhead cost of a garden tractor when not in use is low as compared with that of

other forms of power. (2) The operation cost is low. (3) When properly handled it does not destroy plants. (4) It is a labor and time saver. (5) It may be adapted to belt work. (6) The small sizes are especially adapted to narrow row crops.

The disadvantages:—(1) Lacks traction in sandy soils. (2) Difficult turning at end of rows in some cases. (3) May have poor service on repairs. (4) High initial cost.

The average cost of a medium-sized garden tractor, in-



Fig. 16.—Land bedding for pineapples suitable for large scale truck farming. In the center of such beds may be planted single rows of such annual crops as cucumbers, cantaloupes, squash, and melons. Or double or treble rows of such perennial crops as artichokes, asparagus, cabbage, lettuce, egg plants, peppers, and tomatoes, although of the last only two rows had best be planted if staked and pruned and only one row when unsupported. This would also apply to pole beans.

cluding the necessary tools ranges from \$275 to \$400. When used with care and not to excess, such a tractor should last at least 5 years. This would give a yearly depreciation of 20 per cent on the investment, or \$60 plus interest on the

average investment, plus repairs and incidentals which would total around \$100 for yearly fixed cost.²

The yearly operation costs based on 400 hours of work (40 days' work a year) on a 5 acre market garden follow:

Fuel cost, (3 gal. for each 10 hour day)	
120 gal. @ 20c	\$24
Oil cost, 5 gal. @ 80c	\$ 4
Total fuel and oil cost	\$28

The total yearly fixed and operating cost, not including labor, would be \$28; the total daily cost, not including labor, would be \$3.20.

The cost of mule labor, including cost of total equipment, would probably equal or exceed the garden tractor cost, because the animals would have to be fed when idle. Before investing in traction power, a careful comparison of costs, advantages, and disadvantages should be made.

Care of Tools. A tool house and work shop is a valuable adjunct to every market garden and truck farm. The conservative truck farmer will make his purchases of tools and implements with thought and care. While it is uneconomical to do without tools that are needed, it is likewise needless extravagance to overload with a lot of expensive implements that can be done without. Having provided himself with all necessary tools, he should use them skillfully and take good care of them. It has been truly said that more good tools are permitted to rust through neglect than are worn out by intelligent use.

²The average investment may be determined as follows:
$$\text{Average investment} = \frac{\text{first cost} \times \text{years of service} \times 1}{\text{years of service} \times 2}$$

PLANT FOODS: ROTATION, MANURING AND FERTILIZATION

Successful market gardening depends upon the truck farmer's ability to obtain maximum growth and quick maturity at the least cost. This is possible only when the soil is kept in the condition best suited to the crop. Two ways of maintaining the soil in good condition are recommended: (1) rotation of main crops with cover and green-manuring crops or with other marketable crops and (2) the intelligent use of manures, composts, and commercial fertilizers.

Cover and Green-Manuring Crops. Green manuring as a means to soil amendment has, perhaps, less application to the more restricted market gardening than to extensive truck farming. Only where the truck farmer can afford to permit part of his land to lie unproductive is it feasible to practice green manuring. However, wherever green manuring is feasible, advantage should be taken of this means by which valuable organic matter may be added to the soil.

In general, a leguminous green-manuring crop is to be preferred to a non-leguminous crop, because the former will add more nitrogen to the soil than will the latter. Although the main object of green manuring is to add vegetable matter or humus to the soil for the direct improvement of its texture, its general physical condition, and its store of plant food, green manuring insures other benefits. During the growing season, green-manuring crops furnish a valuable protective cover against drying wind and scorching sun. Equally important, such crops greatly reduce soil erosion and the leaching of plant food. A dense cover crop smothers many noxious weeds.

The only safeguards to be considered in planning for green-manuring and cover crops are guarding against the undue introduction of nematodes, insect pests, and plant diseases. The intelligent gardener will instinctively guard against these dangers.

The crops used in green manuring and cover cropping, rightly applied, are almost certain to increase the subsequent crops with which they enter into rotation. For heavy soils, the green crop should be fully mature before it is turned under. On open, sandy soils, the vegetation should be turned under when it is most succulent, to reap the benefit of its binding effect on the loose soil particles.

In general, it pays to fertilize leguminous green-manuring crops with some form of phosphate. To get the great-

est benefit from them, they should be grown during that season of the year when their protective covering is needed most, and then turned under a month before the succeeding money crop is planted. Thorough disintegration of the vegetable matter furnished by the cover crop is desirable before the succeeding crop is planted.

The following leguminous crops are well adapted to green manuring in both the lowlands and uplands up to 3000 feet elevation. Cow peas: *Brabham*, *Whip-o-will*, and *Large Blackeye*. Jack beans: *Canavalia ensiformis*. Soy beans: *O-too-tan*, *Laredo*, *Biloxi*. Pigeon peas, for long cropping periods. Mung beans: *Hastings*. Velvet beans: *Brazilian*, *Lyon*, *Black Mauritius*, and *Extra Early Bush*. All but the Early Bush variety send out long trailers and need watching to prevent interfering unduly with the melon tribe.

In altitudes above 3000 feet, vetch, lupines, and horse beans thrive better than the legumes recommended for the lowlands.

All of these crops may be planted in drills or broadcast. If planted in the dry season, the farmer should usually "list" the seed; that is, plant it in the bottom of the furrow where it can best secure the available moisture.

When the plants have attained their maximum growth, they should be turned under with the other crop residue. If the green-manuring crops are in seed at the time of plowing under, many of the seeds will germinate and produce a valuable volunteer crop, which may again be turned under, thus providing additional organic matter at small cost.

The yields of vegetable matter from green-manuring crops will vary with the variety of crop and with the season. A small amount of fertilizer, especially phosphorus, less than 500 pounds for each acre, applied at the time of planting, will often double or treble the yield of green manure at a low cost. Under favorable conditions, a good green-manuring crop will produce, in from 3 to 5 months, vegetable matter equal in value to 10 tons of manure. The cost of producing a green-manuring crop will range from \$20 to \$40 an acre. Its direct value to the succeeding crop should fully equal its cost.

The far-sighted truck farmer may, by rotating his crops, reap a golden harvest, decrease insect pest dangers, improve the condition of his soil, and economize on fertilizer costs. For instance, in a rotation of potatoes with beans, a combination which is highly recommended, the potato crop

should be treated with a liberal amount of complete fertilizer rich in phosphoric acid and potash, supplemented with "side dressings" of nitrate of soda or sulphate of ammonia as the crop develops. The succeeding bean crop, which would obtain all the potash and nitrogen needed from the residual fertilizer left by the potato crop, should require fertilization with phosphorus only.

In most rotations, it is recommended that especially heavy applications of phosphoric acid be applied to the legume crops. No leguminous crop will thrive unless phosphorus is present in adequate supply. In an experiment with Maui Red Kidney beans, a type which will probably be extensively grown, the best cultivation and an almost virgin soil yielded only 395 pounds of shelled beans to the acre. An application of only 333 pounds of half super-phosphate and half reverted phosphate to the acre in the furrow at time of planting gave the extraordinary yield of 2,100 pounds per acre, or an increase of over 500 per cent. While this may be an exceptional case, the market gardener and truck farmer may well take cognizance of this example.

The successful and economic production of vegetables is very dependent upon high soil fertility and favorable soil texture. Soils deficient in these essential qualities are certain to give scant yields of unprofitable produce low in quality. Most highly productive soils are rich in humus. Soils lacking in this substance may be enriched by green-manuring crops and crop residues, as we have seen, or by liberal applications of stable or barnyard manures, and other forms of organic matter, such as rice straw and hulls, land muck, leaf mold, marsh mulch, and peat moss. Organic matter in the soil stimulates bacterial action, especially if the soil is fortified with lime or lime-phosphate, and gives "life" and "pep" to the soil.

A soil, to be fertile and productive, must not only be rich in the constituents of plant food but must also have favorable soil texture. Soils must not be too loose and light, as is said of extremely sandy soils, nor too heavy and stiff, as are adobe and clay soils. A fertile soil is one which is well-drained and which does not retain excessive moisture, since only in such soils can roots develop fully. Furthermore, a fertile soil is neither too acid nor too alkaline.

While specific directions are given for the fertilization of each of the major vegetable crops under their respective headings, it is desirable that certain basic principles be understood before attempting any extensive market garden-

ing or truck farming enterprise. Nearly all soils may be greatly improved by intelligent application of manure and fertilizer at or before the time of planting, but intensive vegetable growing demands that the growing crop be given supplementary feeding throughout its development. In other words, no other class of farming requires so much consideration for the soil's enrichment previous to planting the crop, nor such well balanced supplementary feeding of the growing crop as does the production of large crops of choice vegetables.

Stable Manure. Where large supplies of stable and barnyard manures are available, the market gardener has a distinct advantage and should make the most of this asset. However, animal manures differ greatly in quality and should be used accordingly. Well-rotted manures, if rightly handled, have more available plant food than fresh undecomposed manures, especially when they contain much straw litter. Coarse, strawy manures are valuable primarily for improving the texture of stiff, compact, clay soils, but they contain comparatively little plant food. However, as they become disintegrated, they form a favorable medium for beneficial soil bacteria.

Thoroughly rotted and disintegrated manures contain a considerable amount of plant food, unless they have been excessively leached through exposure to rains in the barnyard. From the physical standpoint, such manures are favorable for binding loose, sandy soils, making them more retentive of moisture and plant food, as well as for providing a better all-around medium for the growth of the plant. In addition to plant food, manures furnish the humus and valuable bacterial life so important for maintaining fertility. Although 35 tons of well rotted manure to the acre is a fairly liberal application, as much as 100 tons often may be used to advantage. For most market garden crops, it is best to spread the manure after the last plowing, harrowing it into the soil until it is thoroughly incorporated.

Composts. Most manures harbor weed seed and lack uniformity, balanced plant food constituents, and desirable texture. Especially is this true of mixed manures and those that have been accumulated over a long period. For these reasons, manures should be reinforced with supplementary mineral matter, composted, "aged" or "ripened," and thoroughly mixed. This is best done by piling the manure in tidy ricks designated as compost heaps. If the mass is too dry when first piled, it should be wetted to hasten decay and

to prevent the heating to which horse manure is especially subject. Horse manure is usually spoken of as "hot" manure and cow manure as "cold" manure. If swine and poultry manures are available, as well as horse and cow manure, they are best stacked in foot deep layers, one on top of the other. Layers of soil and mineral fertilizers may be interspersed throughout the heap. Liquid excrements, when available, should be poured over the manure pile and allowed to soak in.

If the manure heap is kept moist, favorable organic acids are formed by the processes of decomposition of the organic matter. The nitrogen combines with hydrogen, forming ammonia, and the ammonia unites with the organic acids, forming humates and other salts of ammonia which are soluble in water and quickly available for plant food.

In preparing composts, it is important to fork over the manure pile several times to make as uniform a mixture as possible and to prevent overheating. The temperature of fermentation should not be allowed to rise above 150° F., lest some of the valuable ammonia be lost by volatilization.

Since farm manures are especially deficient in phosphorus, it usually pays to fortify most manures with phosphoric acid in some form. When the composting process is to last for 6 months or longer, finely ground phosphate rock containing approximately 32 per cent of the active plant food element is recommended; otherwise, the more soluble super-phosphate or reverted phosphates would be preferable. As much as 100 pounds of rock phosphate to each ton of manure is recommended in these mixtures. This should be uniformly incorporated with the mass by working over the manure pile several times. Approximately 25 pounds of sulphate or muriate of potash may be added to each ton of manure.

Composts, other than those in which animal manures form the major part, are made up of a great variety of waste products, the basis of which are usually plant residues, such as lawn grass clippings, weeds, straw, garden refuse, road sweepings, dead leaves, peat-moss, marsh mulch, and, possibly, night-soils. To such a mass is often added fish scraps, garbage, crushed bone, wood ashes, and any other material that will decompose and make plant food. It is surprising how much refuse suitable for composting can be accumulated through systematic search and conservation.

The best method of composting manures and other waste organic materials is to select a protected strip of

land and to plow and scrape a trench 10 feet wide, 2 feet deep, and as long as is needed. A heap of compost 10 x 10 x 6 feet represents from 20 to 30 tons of compost. A 100 foot trench 10 feet wide will, therefore, hold from 300 to 500 tons of compost. Such a pile of compost should be sufficient for fertilizing between 20 and 25 acres of truck garden land. In constructing the compost heap, a side wall of earth several feet high should be built on each side of the trench. The material to be composted should be deposited in alternate layers until the bed is from 4 to 6 feet deep. If properly located, all the materials can be hauled onto the pile, saving much handling.

Because of the scarcity and the high price of stable manure, there has come into more common use a manure substitute termed "peat moss" or "mull." This is a natural product composed of the partly decayed remains of mosses and various aquatic plants that grew along the shores of fresh-water lakes in ancient times. Peat decays slowly, is highly absorbent and retentive of moisture, free from weed seeds, and, in its virgin state, usually free from fungus. It is especially useful in building up the humus in soils. The two constituents which peat might be expected to add to soils when used as manure or as a soil amendment are its organic matter and a small amount of nitrogen. Like stable manure, it contains little phosphoric acid and potash.

Peat moss is an excellent base for composts. It is rather expensive, the present price in Honolulu being about \$20 per ton. It is a good rule not to use more peat than will ferment in the compost, unless it is to be used to improve the physical condition of a stiff, clay soil.

The cost of stable manures and compost will range from \$1 to \$5 per ton. Their value, on the other hand, is dependent upon the content of their fertilizer constituents, plus whatever value their organic matter may have in improving the physical condition of the soil. This latter supplementary factor is often important and cannot be supplied by chemical fertilizers alone. An average ton of mixed stable or barnyard manure is considered to contain approximately 10 pounds of nitrogen, 5 pounds of phosphoric acid (equivalent to 2.2 pounds of phosphorus) and 10 pounds of potash (equivalent to 8.3 pounds potassium). These constituents at market fertilizer rates could be bought in high grade fertilizers at about the following prices: nitrogen at 25 cents per pound, phosphorus at 7½ cents per pound, and potassium at 7½ cents per pound. On this basis, the ton

of manure would be worth \$3.90. The market gardener and truck farmer can probably afford to pay as much as \$5 per ton for his manures and composts when applying 20 tons or less to the acre. When larger amounts of manure are required, much greater value is likely to be derived from the purchase of a high grade complete vegetable fertilizer costing approximately \$60 per ton. Such a fertilizer should contain about 8 per cent nitrogen, 12 per cent phosphoric acid and 6 per cent potash compounded from high quality, quickly-available elements. On this basis, the ton of commercial fertilizer should contain 15 times as much nitrogen, 100 times as much phosphorus, and about 15 times as much potash as an average ton of manure. The complete fertilizer would be better balanced and much more uniform than any manure could possibly be.

Synthetic Manure. The possibilities of making synthetic or artificial barnyard manure may well attract the attention of market gardeners having access to a lot of cheap rice straw or sugar cane bagasse. Synthetic manure is prepared by stacking and wetting straw or other vegetable waste, such as sugar cane bagasse, layer by layer, and treating the mass with certain chemicals. As developed at the Rothamsted Experiment Station in England, the vegetable mass was impregnated with the bacteria capable of decomposing straw. It has since been found that these organisms are usually present in sufficient amount to start fermentation of the material without artificial introduction. The following directions for composting straw and like material are gleaned from the Agriculture News Letter, University of Nevada Agricultural Extension Service:

“A good chemical mixture consists of 45 parts by weight of ammonium sulphate, 15 parts of super-phosphate, and 40 parts of finely ground limestone. About 150 pounds of such a mixture is used for each ton of straw.

“A layer of dry, well-trodden straw 10 feet square and about a foot deep is first put down, and water added until the layer is wet through. Over the moistened straw are then sprinkled about 25 pounds of the chemical mixture. Then another layer of straw is tramped on and similarly treated, and the process continued until the pile consists of 6 layers. This will use up a ton of straw and the 150 pounds of chemicals.

“The top of the stack is left flat, and water is applied every 2 or 3 days to control the temperature, as long as much heating continues. However, after the heat dies down,

just enough water is necessary to keep the mass moist. When it is well rotted down, the material is ready for use.

"By this method about 3 tons of manure are produced from each ton of dry straw."

This process is recommended for trial by all who may be favorably situated for obtaining the raw materials.

Commercial Fertilizers. Because of the growing scarcity of natural manures, the market gardener has had to resort to the use of chemical commercial fertilizers and packing house refuse. The value of these products has been proved, and no commercial gardener can farm successfully without their use. Some of the advantages of concentrated commercial fertilizers are their freedom from noxious weed seeds, plant diseases, and insect pests, and the ease with which they may be handled. Complete fertilizers are mixtures containing the so-called essential elements, such as nitrogen, in the form of nitrate or ammonia; phosphorus, in the form of acid phosphate; potassium, in the form of potash, and occasionally calcium, in the form of lime. No one fertilizer formula can be best for all conditions, but many successful vegetable growers use mixtures containing from 5 per cent to 10 per cent nitrogen, from 8 per cent to 12 per cent available phosphoric acid, and from 5 per cent to 10 per cent potash. Such ready-mixed fertilizers cost from \$45 to \$65 per ton.

In the case of lettuce, spinach, and other leaf crops, the general formula should be reinforced with secondary applications of a top-dressing fertilizer, which is specially prepared for forcing the crop. The top dressing should consist of nitrate of soda or sulphate of ammonia used alone in amounts not exceeding 300 pounds an acre at a single application. An excellent top dressing for leaf crops may be composed of 10 per cent nitrogen, 6 per cent available phosphoric acid, and 3 per cent potash. This secondary application often stimulates growth greatly.

On root, tuber, and bulbous crops, such as carrots, potatoes, and onions, top-dressing fertilizers rich in nitrogen should not be applied. These crops should be "top-dressed" with the basic fertilizer used at the time they are planted, if supplementary fertilization appears necessary.

With an abundance of humus, such as is provided by green manure, stable manure, or compost, in the soil, from 1,000 to 2,000 pounds of a high grade fertilizer may often be profitably applied on each acre. For closely planted crops, it is best to broadcast the fertilizer. For crops planted in widely spaced rows or hills, it is usually more

profitable to apply the fertilizer where the seed is sown. In any case, the fertilizer should be well mixed with the soil and the application made a short time before or at the time of planting.

The successful truck farmer watches his crops carefully and governs his fertilization according to the crops' development. He does not apply too much fertilizer and he

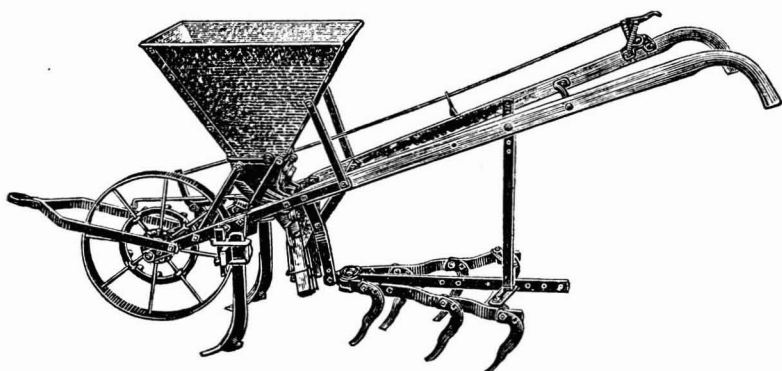


Fig. 17.—A row and side-dressing fertilizer distributor saves labor and material. Supplementary fertilization for the growing crop sometimes doubles the yield.

does not apply fertilizer at the wrong time. After cabbages and similar crops have started to head, the application of an excess of nitrogen is likely to cause splitting of the heads and to ruin the crop. The same care must be used with tomatoes and similar crops after they begin to set fruit.

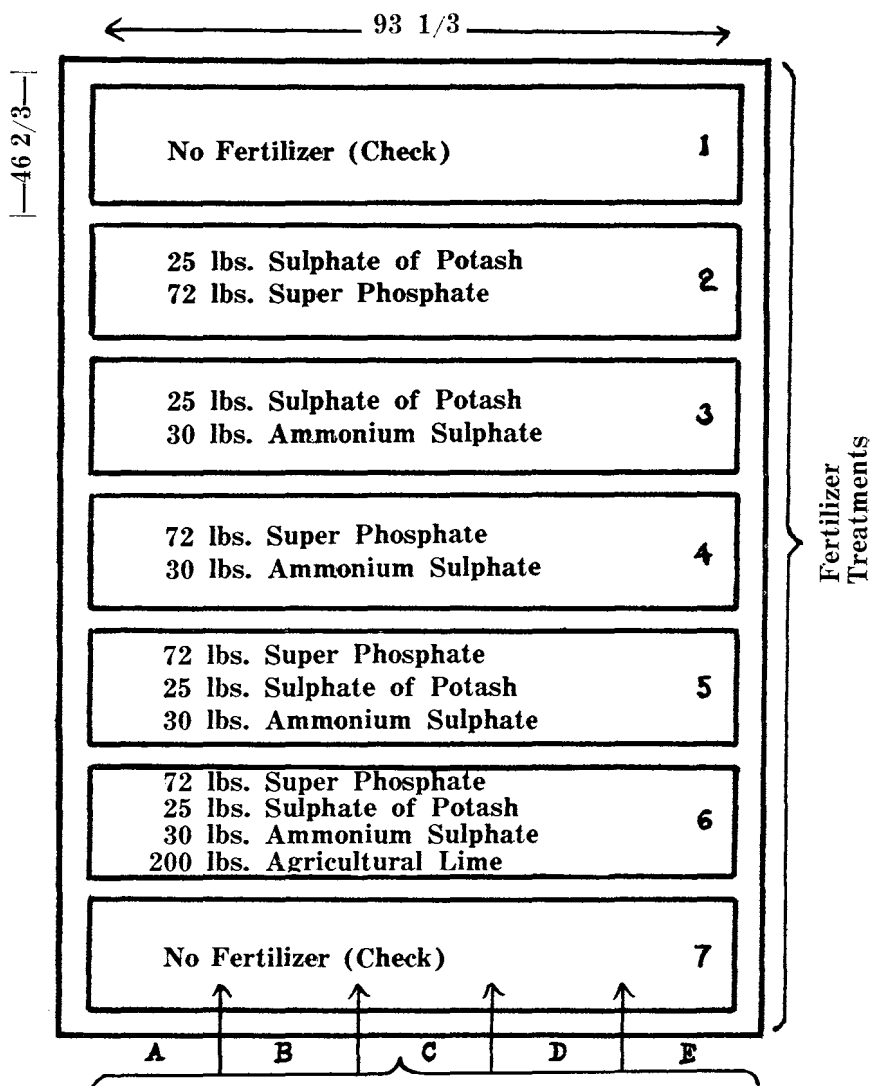
Lime. There is usually little danger of over-liming very acid Hawaiian soils. Lime is a soil corrective, neutralizing the excess free acids of the soil. Most leguminous crops, such as beans, are benefited by moderate liming. Although as much as 15 tons of lime have been applied to some soils, it is best to make plot tests before liming. The county extension agent will determine the comparative acidity of market garden and truck farm soils upon request.

Testing. Haphazard fertilizer practice is sure to lead to disappointment and loss. It will pay the extensive user of commercial fertilizers to conduct some simple field tests to determine at first hand the best treatments for his soil.

The following plan can be carried out by any intelligent truck farmer, and it will enable him to discover the kind and amount of plant food his soil and crops need most. On poor soils, the amounts of fertilizers given in the plan may well be doubled, and part of each plot may be "side-dressed" in addition.

VEGETABLE FERTILIZER TEST PLAN

Seven plots, each $\frac{1}{10}$ acre in size ($93 \frac{1}{3} \times 46 \frac{2}{3}$ feet). Five varieties of vegetables may be tested for their fertilizer requirements in the plan given below. Run all variety rows across the fertilizer plots. If 5 varieties of vegetables are tested, each subdivision would be approximately 18×46 feet.



Arrows and letters designate vegetable variety plots

In addition to the above fertilizer treatments applied just before planting the crops, subsequent applications of nitrate of soda or ammonium sulphate may be made in fractional dose several times during the growing season.

This plan requires the use of 7 plots of $1/10$ acre each, $93 \frac{1}{3}$ by $46 \frac{2}{3}$ feet. Each plot should be separated from the other by intervals of at least 2 feet, to prevent the fertilizers from getting on adjacent plots. All plots must be treated alike in every respect, except in the amount and kind of fertilizer applied. If several crops are to be tested, they should be planted in long rows, either in hills or drills, across the entire 7 plots. It is important that each plot be plowed, manured, cultivated, and irrigated in a like manner, and that all be planted to their respective crops at the same time. A full and uniform plant stand is of great importance in gauging the results of this test.

The results from such a test should show:

Plot No. 1—What the land will produce without any fertilizer.

Plot No. 2—The effect of phosphoric acid and potash or the need of nitrogen in addition.

Plot No. 3—The effect of potash and nitrogen or the need of phosphorus in addition.

Plot No. 4—The effects of acid phosphate and nitrogen or the need of potash in addition.

Plot No. 5—The effect of a "complete fertilizer": one containing nitrogen, phosphoric acid and potash, the total so-called essential elements of plant food.

Plot No. 6—The effect of lime in addition to a complete fertilizer.

Plot No. 7—A check on Plot No. 1 to indicate whether the land is uniform in composition. If the soil under test is known to be uniform, check plot No. 7 might be treated with the fertilizer practice previously in use for the sake of comparison with the new.

More plots can be added to test other standard ready-made mixed fertilizers or lime, manures, composts, and such materials as mud-press, coffee pumice and other available refuse. The yields of each separate unit should be carefully gathered and weighed, and the quality as well as quantity should be noted. If there are 6 rows of each variety of vegetable under test, 3 of the rows might be "side"

or "top-dressed" with fractional doses of quick acting nitrogenous fertilizers such as nitrate of soda, sulphate of ammonia, or liquid manure to test this more modern practice. One or more "side dressings" in applications of from 100 to 200 pounds to the acre may well be tested in these experiments.

Truck farmers should study well their fertilizer problems and consult freely with their county agricultural extension agent concerning this complex subject.

MULCHING

Mulching the soil in vegetable growing may well be given consideration by the market gardener and truck farmer in Hawaii, especially when and where the water supply is limited. The practice consists of covering the cultivated soil with some protective material. Its main objectives are: (1) to conserve the soil moisture by checking evaporation; (2) to keep the surface soil loose and mellow; (3) to protect the vegetables from earth spattered up by rain, especially such vegetables as bush beans, which are readily infected with soil borne disease spores, and such cultures as strawberries which grow especially near the ground, and (4) to keep down weeds. In Hawaiian pineapple culture, it has been definitely proved that nitrogen and other plant food constituents are greatly conserved and the drying out of soils greatly lessened when the soil is overlaid with mulching paper. On the other hand, paper mulching, unless rationally done, may not compensate for its cost.

Contrary to much of the recent propaganda against the use of the so-called earth or dust mulch, the writer advocates the application of this age-old practice wherever and whenever practicable. When it is impractical to maintain a surface soil mulch by means of tillage, it is recommended that experiments be conducted in the use of straw, rice hulls, dry grasses which are free from seeds, baggasse, peat moss, and any other suitable mulching material that may be available. At the University Farm in Manoa Valley, tomato plants mulched with pineapple mulching paper, yielded 80 per cent more fruit than did those not mulched. There was a saving of approximately 50 per cent in the amount of water necessary when plants were not mulched.

The mulched plants began to ripen their fruit at least ten days earlier than unmulched plants. Irish potatoes mulched with rice straw or similar material respond favorably.

All tillage and fertilization must be applied before the mulch is spread. Thus a saving is made in subsequent cultivation. Soil remains much more mellow under mulch than without such covering, even under a high state of tillage.

Paper Mulch. Mulching paper should be unrolled and exposed to the sun for several hours before it is finally stretched over the ground. Paper so exposed will lie much more smoothly than paper spread when cold. The ordinary mulching paper comes in strips 18 and 36 inches wide and in lengths ranging up to 300 feet. Mulching paper can be re-used for several seasons.

The seed may be drilled either before the mulch is applied or after the paper is laid. In the former case, the plants may be left to develop to any extent desired before the paper is applied to permit earlier cultivation, if that seems necessary. On the other hand, the paper can be laid before planting, if care is taken to leave sufficient and uniform spaces between the strips of paper to permit drilling the seed. The spaces between the strips of paper may vary from 2 to 6 inches. If seed is planted in hills, the intervening space between the strips of paper can be utilized as in ordinary field culture, or the paper strips can be punctured at regular intervals by cross-cuts. When cross-cuts are made in the paper, the resultant four flaps of paper should be turned back, leaving an opening of from 4 to 8 inches square. The seed should be sown or seedlings transplanted in the opening thus formed.

Since mulching cannot take the place of irrigation entirely, furrows for irrigation must be provided. With paper-mulched beds, narrow V-shaped or broad U-shaped furrows should be plowed at the 3 foot intervals separating the paper-mulched beds. These furrows may be plowed in multiples of 2 or 3 furrows at a time by the use of a suitable gang of listers, a team of horses, or a tractor, before laying the paper, or after the paper is laid by the use of a middle-breaker plow drawn by a single horse or two horses tandem. In the latter case, the operation of furrowing may be made to serve the additional purpose of covering the edge of the paper with soil to hold it down.

The best information concerning the use of paper mulch that we have been able to gather would indicate that beans, cucumbers, cabbage, tomatoes, and peppers are most bene-

fited, and of these cucumbers responded best and corn least to such treatment. Lettuce, beets, and carrots fail to show marked improvement. Against whatever advantages there are in the use of mulching paper, must be reckoned the initial high cost of the material, more than \$50 an acre, the cost of applying, and the difficulty of anchoring the paper during windy weather.

When the soils are mulched with straw or rice hulls, the irrigation water must be made to flow slowly to prevent the washing away of the mulching material. Some earth mulch is destroyed after each irrigation, and the land must be reconditioned as soon as the soil is dry enough to make it friable.

The best final disposition to make of vegetable mulch, such as straw and materials that will decay, is to turn them under at the end of the crop season.

DOUBLE CROPPING

Succession Crops. The market gardener or truck farmer should aim to keep his land continuously occupied in producing the greatest possible yield on every acre throughout the year. In Hawaii, he can keep his land producing almost constantly. In the winter or early spring, he can plant the cool weather crops, following them with warm weather crops, and in the fall, he may plant cover and green-manuring crops which will conserve the soil humus, minimize erosion, and aid in the suppression of noxious weeds. When their other objectives have been attained, the cover crops may be turned under as green manure. In planning such intensive succession-rotation cropping, he should select crops as unlike as possible, both in their food requirements and in their susceptibility to insect pests and diseases. Otherwise, the continual rotation of crops may do more harm than benefit.

Companion Crops. The most intensive market gardening possible should be practiced in companion cropping or inter-cropping. All available space must be utilized to best advantage. By this system, at least 2 kinds of crops may be grown on the land at the same time. Radishes may be grown between rows of lettuce, spinach between rows of cabbage, or corn between rows of vine crops.

Companion cropping differs from succession cropping

in that under the former crops are grown in association throughout the season, while with the latter system one crop follows the other in rapid succession. As already indicated in the selection of both succession and companion crops, plants of the same family should be avoided when possible. Obviously, the vegetables inter-cropped should respond to the same general cultural methods, including fertilization, and pest control.

IRRIGATION

For most intensively grown market garden crops and for some of the extensive truck farming, regular irrigation must be practiced if the best results are to be obtained. When all other conditions are favorable, water may be the



Fig. 18.—Carrots to left; watercress to right, with irrigation ditch running through center. A common market gardening scene in Hawaii.

limiting factor between success and failure in a truck farming enterprise. Few inexperienced truck farmers seem to realize that the annual fresh vegetable product of an acre totaling from 40 to 80 tons of green vegetable matter contains from 80 to 90 per cent moisture, an amount equivalent to from 10,000 to 18,000 gallons of water. Yet this large quantity of moisture is small compared to the total

amount of water required by the crop during its growing period. Carefully conducted experiments show that from 400 to 500 pounds of water are required to produce 1 pound of dry vegetable matter. In other words, such crops as those mentioned above would actually consume more than 4,000,000 pounds of water, an amount equivalent to more than 500,000 gallons an acre every year.

Amount of Irrigation Required. Whatever the source of water supply, it is important to know the approximate amounts that must be provided by irrigation in order to meet the needs of the crop. This is a difficult problem. Ordinarily, an average retentive loamy soil with a fairly impervious subsoil, which is cropped continuously and intensively, will require during the dry season from 2 to 3 acre-inches, an amount equivalent to from 50,000 to 80,000 gallons of water an acre every time the plot is irrigated. Such irrigations may be required every 7 or 10 days throughout the rainless season.³

Such an application of water would probably be the maximum unit irrigation required for most vegetable crops under most Hawaiian conditions. How frequently irrigations will be necessary will depend on a number of factors, such as the water-holding capacity of the soil, the cultural methods used, the kind of crop grown, the state of the crop's maturity and the season of the year. In general, a thorough irrigation every week or 10 days during the dry season should be sufficient for most field-grown crops, if the land is properly cultivated. Mulching the soil with straw or paper will help to conserve the moisture.

Methods of Irrigation. Not only is an ample water sup-

³The following data will be useful for calculating the simpler units of water measurement: An acre-inch is the amount of water that will cover 1 acre 1 inch deep, and 10 acre-inches of water is enough to cover 1 acre 10 inches deep, or 10 acres 1 inch deep. As an acre contains 43,560 square feet, 12 acre-inches is equal to 43,560 cubic feet of water, and 1 acre-inch equals 1/12 of this amount, or 3,630 cubic feet. As there are 1,728 cubic inches in 1 cubic foot, and 231 cubic inches in a gallon, 1 cubic foot equals 7.48 gallons and 1 acre-inch equals 27,150 gallons.

Another measure frequently used in the gauging of streams and also used as an irrigation unit, is the second-foot, which is the discharge or flow of water equal in volume to 1 cubic foot a second. Therefore a stream or spring or any other flow of water having a discharge of 1 cubic foot a second would supply 1 acre-inch in 1 hour and 30 seconds. In 24 hours, a stream of 1 second-foot would supply approximately 24 acre-inches and would cover 8 acres of land with water 3 inches deep.

ply of greatest importance, but thoroughness in irrigation is a necessity. The system of irrigation used at the time of planting will depend on the climate and soil conditions. Irrigation by flooding will prove best where the soil dries out slowly and does not bake. Where evaporation is high, as in Hawaii, ditch irrigation will be found preferable. This will necessitate planting the crop on ridges or in raised beds. With crops grown in raised beds, the entire bed should be wetted, either before or immediately following planting, permitting the water to "sub" through. The number of furrows which should be watered at one time will depend upon the method of irrigation and upon the head of water available. If the furrows are to be filled quickly, there must be ample head of water. With heads of water of 90 gallons a minute from 3 to 9 furrows may be watered at one time, and the amount turned into each furrow will range from 10 to 30 gallons a minute.

Under most local conditions, the method of running the water for long periods of time in small furrows will probably be the most practicable. With a stream of 30 gallons a minute, more than 26 furrows may be watered at one time, with about 1 gallon a minute in each furrow. The same ratio is true for smaller heads. The water required to reach the end of the furrow without waste in a given length of time should be gauged as accurately as possible, and this quantity should be permitted to run for the length of time found necessary. In leeward Hawaii, especially in the environment of Honolulu, the irrigation season may extend throughout the year. In any event, the water must be available when most needed. It is a good rule to irrigate the crop sparingly while the plants are small. Excessive watering may cause shallow rooting and is wasteful. Less water is required when the weather is cool and the sky is overcast. Irrigation is most necessary in windy weather. The truck farmer should consider all factors before irrigating.

In recent years, irrigation by overhead sprinkling has come into prominence in some market gardening sections on the mainland. Several of the standard systems used on the mainland have been installed in Hawaii for irrigating alfalfa and vegetables, and, on the whole, they have proved fairly successful. However, we would advise that only a limited installation be tried out by the farmer before he invests in an extensive system. Professor H. A. Wadsworth, of the University of Hawaii, in summarizing irrigation by overhead sprinkling, states:

"1. Irrigation by overhead sprinkling is costly. At present, this method of irrigating is limited to the production of high-priced crops on land of high value.

"2. Intensive soil-moisture sampling during the irrigation season of 1925 indicated that adequate soil-moisture penetration can be secured by the sprinkling of decomposed granite and sandy loam soils, if the sprinkling equipment is wisely selected and intelligently operated. Experimental evidence as to the adaptability of sprinkling to heavy soils is not as conclusive.

"3. The type of installation to be adopted for a particular location depends upon the crops to be irrigated, the money available for investment in such equipment, and the labor available during the irrigation.

"4. The detailed design of a sprinkler layout requires considerable skill and care.

"5. Except in favored localities where natural pressure is available, pumps must be installed to create pressure for the operation of the system.

"6. Sprinkler systems, if used, should be installed because of their ability to distribute irrigation water uniformly and effectively, and not because of claims for other advantages.

"7. Judgment and care are essential in the intelligent operation of a sprinkler system. There is no substitute for a soil auger in determining the effectiveness of an irrigation."

Two good references on irrigation are, "Irrigation by Overhead Sprinkling" by H. A. Wadsworth, Circular 4, California Agricultural Extension Service, University of California, 1926, and "Practical Information for Beginners in Irrigation" by Samuel Fortier, Farmers Bulletin No. 864.

Drainage. Closely related to irrigation is drainage. Excess or stagnant water is very detrimental to plant growth. Ample drainage ditches must be provided to carry off all excess water as rapidly as possible. Under most Hawaii conditions, open ditches are to be preferred to those which are covered. Much will depend on the farmer's ingenuity in planning an adequate drainage system for his field. The truck farmer will find useful information concerning this subject in Agricultural Extension Bulletin No. 11, "The Problem of Soil Saving in the Hawaiian Islands" by Theodore C. Zschokke.

SHELTER AGAINST WIND

Heavy winds are very detrimental to all but the most hardy vegetables, and even these will suffer if too freely exposed. It is important that this factor be given adequate consideration in locating the market garden and truck farm. Failure is sure to result eventually unless careful consideration is given to providing adequate shelter to the growing vegetable crops.



Fig. 19.—Unirrigated truck farm on windward Oahu devoted to tomatoes and vine crops. Crops protected against the wind by single rows of Sorghum spaced 50 feet apart and set at right angle to the prevailing trade wind.

While a naturally protected area, such as some of our sheltered valleys or the lee of a hill or a cliff, is to be preferred, much protection may be obtained by planting permanent belts of trees and hedges. When more immediate and only temporary protection is demanded, 2 or 3 rows of the stiff, erect Uba cane, Merkier, Napier (Elephant) grass, or pigeon peas will give excellent temporary protection. Because all plant windbreaks sap much fertility and moisture from the ground, it is well to have the field headlands, 12 feet in width, bordering the windbreak. Beyond such a strip the soil should not be much affected. Ditches may be dug along rows of shelter trees to prevent their roots from

invading the planted areas. Windbreaks 10 feet high will not usually protect crops more than 50 feet beyond them, so it is necessary to plant these temporary low-growing hedges in parallel rows not more than 50 feet apart.

The practice of planting taller and hardier trees to the windward of truck areas is to be encouraged.⁴ As the permanent shelter plants develop, the temporary shelter plants may be removed.

Temporary and limited protection may be afforded young plants started in deep furrows. To be effective, such rows must be run at right angles to the prevailing winds. Plants of the melon tribe grown in level culture are easily damaged by wind. To prevent this, Mr. David Fleming, who has been exceptionally successful in growing melons as a side issue at Baldwin Packers, Honolua, Maui, keeps the vines in place by spreading on the ground pigeon peas and other brush to which the tendrils may attach themselves. The success of the crop may largely be measured by the extent to which the farmer has been able to overcome the handicap of destructive winds.

PLANT DISEASE AND INSECT PEST CONTROL

Crop rotation, rational fertilization, clean culture, and resistant varieties are the most efficient factors in controlling plant diseases and insect pests. If a plant disease or an insect pest becomes a serious menace to a particular crop, that crop and its nearest relatives should be entirely discontinued for at least 2 years, or planted at as great a distance from the infested area as possible. Many market gardeners and truck farmers have been put out of business because this warning was disregarded. Fall plowing, liming the acid soils, fertilizing heavily with phosphates in the higher elevations where available phosphorus is usually deficient, and planting suitable leguminous cover crops in the fall. These practices will do much to put the soil and the

⁴See Agricultural Extension Notes No. 20, "Windbreaks for the Farm and for the Home Garden," and Extension Bulletin No. 5, "A Manual for Tree Planters in the Hawaiian Islands," by Theodore C. Zschokke, Extension Forester.

crops that follow in the spring in condition to resist disease and attack by insects. Vigorous and rapid growth of the crop is the best safeguard against these enemies of the garden, and the intelligent gardener will soon learn that "an ounce of prevention is worth a pound of cure."

During the crop's development and after the harvest, diseased and insect-infested plant material should be destroyed by burning. No seriously infested material should be plowed under or added to the compost heap to spread its contagion. Soils infested with cutworms, wireworms, or the so-called Japanese beetle should be left in bare fallow to starve out the pests, or, better still, to facilitate poisoning by means of poisoned bait.

Methods of Control. An excellent way to poison large numbers of insect pests is to gather a sufficient quantity of slabs of the common prickly pear to sparsely cover the area to be treated. These slabs should be chopped into cubes the size of lump sugar and then soaked for at least 10 hours in an equal volume of 2 per cent sodium fluoride solution. When thoroughly soaked, the cubes should be distributed over the infested area at the rate of from 500 to 1000 pounds to each acre. In South Africa this method has been found much more efficient than our white arsenic and Paris green poisoned bran bait.

Many fungus diseases of plants may be transmitted through infested seed or sets. These maladies may be prevented in part by soaking the seed for from 30 minutes to 2 hours in a solution made by mixing 1 pint of formaldehyde (40 per cent formaline) with 30 gallons of water. The corrosive sublimate treatment is now in common use and appears to be the preferable method for treating diseases that attack the potato with the virulence of rhizoctonia. The writer has had good results from the use of "semesan" and similar standard disinfectants.

After the plants are growing, the most effective methods for controlling diseases and insect pests are by spraying or dusting with fungicides and insecticides. Bordeaux mixture is the most successful "all around remedy" that can be applied without specific knowledge of the malady. Powdered sulphur is the best known specific for the common mildews, but the cantaloupe and some other plants are not tolerant of sulphur dusting. In the use of any spray or dusting material, it is always best to make a preliminary test application before covering the whole field. Weather conditions may influence the effect of such control methods.

For the leaf-eating insects, such as cabbage worms and caterpillars, beetles, including the so-called Japanese beetle, crickets, grasshoppers, slugs, snails, and cutworms, arsenate of lead has become a universally standard treatment. Arsenate of lead can be used either as a spray or as a dusting powder.

Sucking insects, such as aphids, scale, thrip, red spider, mite, and mealy bugs, are best kept in check by spraying with nicotine sulphate solution or dusting with hydrated lime impregnated with the nicotine sulphate, the usual proportions being 1 part Black Leaf 40 to 4 parts lime. Finely powdered home grown tobacco also makes an excellent insecticide for dusting. Nicotine sulphate solution may be mixed with arsenate of lead solution to perform the two-fold object of destroying both sucking and chewing insects at one operation. The addition of from 3 to 5 pounds of soap to each 100 gallons of nicotine spray acts as a "spreader" when the spray is applied.

Fungus Diseases. As already stated, such diseases as rusts, blights, mildew and wilts, leaf curl, and scab are more easily prevented than cured. At the first sign of disease, plants should be sprayed with Bordeaux mixture. If aphids are present, nicotine sulphate should be added to the Bordeaux mixture. If the disease is associated with insect injury, arsenate of lead should be added. Soap should not be added to Bordeaux mixtures. It is well to remember that the most effective way to spray is by means of a medium fine mist under high pressure. Too heavy applications of liquid spray cause "run off" and are less efficient than a moderate amount thoroughly applied.

A knapsack sprayer for areas as large as 5 acres in extent is the most practical machine to use. This is less likely to get out of order than is the compressed air type of sprayer. For large scale operations, a power sprayer with high pressure will be essential. Between 100 and 300 gallons of liquid spray should cover an acre, depending on the size of plants and care of the operator.

The Agricultural Extension Service has in preparation a comprehensive manual on the control of insect pests and plant diseases which will be mailed to applicants when it is published.

SELLING THE CROP

No phase of the market gardening business requires more constant attention or more thorough study than the problem of marketing the various crops.

Almost all the important vegetables are perishable and, although some crops such as potatoes, sweet potatoes, onions, and cabbages may be stored for a few months, no vegetable crops can be held from year to year, as can the cereal grains and some other staple crops. The commercial gardener's profit depends largely on his ability to get a good price for his produce and to avoid damage or loss due to delays in shipment. Many market gardeners who are located near small cities find it profitable to sell their produce at retail. Several have their own stalls or stores from which the produce is sold directly to the consumer. Others peddle their produce from house to house, while another group, in part at least, distributes by parcel post to an established trade. This is an expensive method of distribution, and, while such producers secure all the profit, they should not lose sight of the fact that few men can do such different things well at the same time. There may be an exception to this general rule in the case of some of our Oriental farmers, many of whom appear to be good traders as well as good farmers. As a matter of general policy, the market gardener must either trust the growing of his crops or his marketing to some additional agency, for he cannot personally supervise all the work.

It is of utmost importance that the grower establish a reliable outlet for his produce. This is perhaps most easily done when the crops are grown for canneries. In this case, contracts are customarily placed in the spring, and the grower knows the price which he will receive for his produce. Although the unit prices paid by canneries are much lower than those paid by jobbers, the net returns to the thrifty large-scale producer from sales to canneries are as great as he would receive from other markets.

If possible, the market gardener should create new markets by such means as encouraging the establishment of canning industries or export markets. Both these enterprises offer splendid opportunities. If no other avenue for the outlet of his goods is at hand, the producer should make connections with a responsible commission house, with retail stores, or with other distributing agencies to handle his produce. Whatever arrangements are made should be defi-

nite in regard to grades and the quantities which can be handled.

Many market gardeners and truck farmers fail to get satisfactory prices because they do not grade and pack their products as they should. When poor stocks are mixed with good, the lowest price is almost invariably realized. It is this kind of truck that goes begging and gluts the market to the disadvantage of all concerned.

It is estimated that the producer does not receive more than a third of the dollar paid by the ultimate consumer. The balance of the dollar is divided between transportation and selling agencies. How fair this apparent discrepancy may be has never been fully settled. The fact remains that these middlemen have not been displaced by any radically better system for distribution.

The producer should associate himself cooperatively with his fellow producers instead of acting independently in marketing his crops. Many neighboring farmers work so independently and to such cross purposes that they share in only the inevitable thing, a disastrous market situation which they, in their ignorance or stubbornness, have brought about. The truck farmer must cooperate with other farmers, with selling agencies, and with the consumers.

Standard Marketing Units. Most vegetables are sold in standard units, consisting of bunches, dozens of crates, volumes, and weights. Different markets have different units. The truck farmer should familiarize himself with these standards. Whatever the grade or standard accepted, the commodity should be distinctly tagged according to that standard. Where trade-marks are once established, their significance should never be forgotten. Nor should sight be lost of the practices of unscrupulous dealers who may use trade-marked containers fraudulently by refilling them with inferior stocks. Many a good market gardener has had his reputation damaged by this fraudulent practice, fortunately unheard of in Hawaii.

The so-called head vegetables, such as cabbage, cauliflower, and lettuce, are usually sold by the head, although in the wholesale market the unit is the dozen, the crate, barrel, hundred, or, in late bulked cabbage, the ton weight.

If Hawaii becomes extensively engaged in truck farming, the "dry measure" will probably be adopted. Thus in many mainland wholesale markets the bushel basket is the unit of measure for such crops as peas and beans in pod, onions, tomatoes, and sweet potatoes. The half-bushel bas-

ket is particularly popular for tomatoes, egg-plants, early potatoes, and sweet potatoes in some sections. Hampers and baskets containing from 5 to 25 pounds of Brussels sprouts or early peas are much used. Potatoes and sweet potatoes are best packed in 100 pound burlap sacks. For an excellent treatise on this subject read Farmers' Bulletin No. 1196, copies of which may be obtained from the Agricultural Extension Service.

THE PREPARATION OF VEGETABLES FOR MARKET⁵

Standardizing and Grading. The necessity for standardization and grading of vegetables for market is no longer a question for debate. The large number of agricultural commodities being sold in the market makes it mandatory that vegetables be properly standardized and graded in order to meet the demands of the consumer and to return the greatest income to the producer.

By standardization is meant the fixing or the adoption of rules to guide in sorting commodities into groups of uniform kind, quality, and size. In other words, a certain standard is set up for a commodity which indicates the quality of the product. These standards may be based on chemical content, color, strength, size, ripeness, sweetness, shape, specific gravity, amount of moisture, freedom from foreign matter, and freedom from disease or injury. For vegetables, the standards usually used are color, size, ripeness, sweetness, shape, freedom from foreign matter, and freedom from disease and injury.

By grading is meant the actual dividing or sorting of a commodity in accordance with the rules of standardization. A grade is a unit of quality and is said to be standardized when it is generally known and used by buyers and sellers. If grades are to serve this purpose, both the buyers and sellers must have confidence in them.

Why Grading is Necessary. Grading is necessary because goods are not produced in uniform lots. From the same field several sizes and qualities of commodities may be taken. Grades are based on the demands of consumers. Experienced produce merchants all agree that vegetables of a desirable variety, well grown, carefully harvested, properly graded, packed and shipped, are more than half sold, while products poorly grown and carelessly prepared for market are always difficult to sell.

The Advantages of Grading. Perhaps the most important advantage of grading is that standard grades constitute a common language between producer and buyer. Grading decreases market costs, a fact which often means higher prices to the producer and lower prices to the consumer.

⁵This chapter has been prepared by Mr. A. S. T. Lund, Extension Economist and Marketing Agent, to whom the county agricultural extension agents refer all problems on the subject here treated.

It reduces the risk in handling, reduces the costs of transportation, decreases the work of trying to create or to increase the demand for home grown vegetables, and saves time for both purchaser and producer in making purchases and sales. An important benefit is the good will which grading creates. Standardized goods have a much wider market than non-standardized goods.

Where Grades Can be Obtained. The Bureau of Agricultural Economics of the United States Department of Agriculture, Washington, D. C., is charged with the responsibility of setting up grades and standards for agricultural commodities. These grades are known as U. S. grades and standards, and in the trade they are listed as U. S. No. 1, U. S. No. 2, U. S. No. 3, etc. Information on these grades and instructions as to how to use them can be obtained by calling on the county extension agents located in Lihue, Kauai; Wailuku, Maui; Hilo and Captain Cook, Hawaii, and Honolulu, Oahu.

Packing. Many vegetables must be packaged so that the marketing processes may be carried out efficiently.

The advantages of packages are that they (1) maintain the grade, (2) make handling easier, (3) prevent injury to products, (4) reduce transportation costs, (5) make storage easier, (6) reduce waste, (7) make the commodity appear more attractive, (8) make selling easier, (9) keep the products in a sanitary condition, and (10) make the use of home brands possible.

How Grading and Packing Affect Price. As has been pointed out in the previous paragraphs, grading and packing have a tendency to increase the price received for a product. Anything that makes a product more desirable to the consumer means more dollars to the producer. Conversely, no market practice can be considered desirable if it is detrimental to the consumer.

Where no grading standard is followed, buyers are inclined to pay a flat price based on the average value or on something a little less than the average value.

Many local shippers frequently complain of unjustifiable rejection of shipments on account of a declining market or for other causes. Buyers claim that they are often forced to accept poorly graded and packed products. The solution to the whole problem is definite, practical grading. Let the motto of the Hawaiian farmer be: "Grade and be Saved."

GLOBE ARTICHOKE

The artichoke is an important crop in California, where 10,000 acres are being planted to it. In the 1930-31 season, California markets used approximately 613 carloads of artichokes. At least 826 additional carloads were shipped to various parts of the United States and Canada.

Because the globe artichoke is an unknown commodity to many persons, the artichoke growers' associations in California have, at various times, undertaken advertising campaigns, with the result that the demand has been greatly

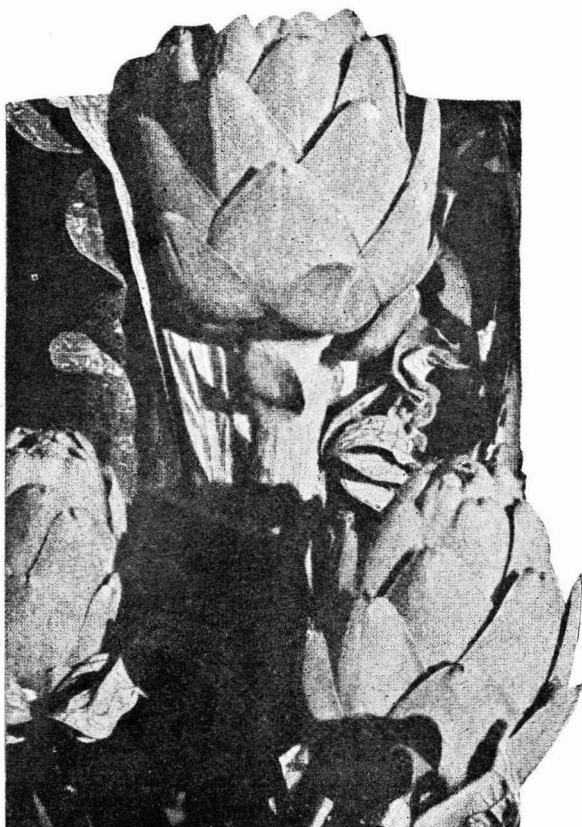


Fig. 20.—Green Globe Artichokes.

stimulated. Similar propaganda in Hawaii might easily increase the local demand for artichokes.

Cultural Methods. The globe artichoke is a perennial plant belonging to the thistle family. The large, immature,

globe-shaped flower-buds, which are borne terminally on both the center stem and its lateral branches, are the portions that are cooked and eaten. The most extensively grown variety is the *Large Green Globe*. The most suitable climate for the cultivation of artichokes is that of the cool, humid coastal regions. Under these conditions, the bracts which form the outer covering of the heads or buds become fleshy and succulent. With warm, bright weather the bracts spread outward, the buds develop too rapidly and soon get beyond the edible stage.

The plants thrive on any fertile, well-cultivated soil. Because it does not come true from seed, the artichoke is best propagated by suckers or offshoots selected from choice plants. Suckers, at the time of transplanting, should have some of the parent stock attached, from which new roots should have started. The plants should be cut back to within 6 inches of the crown, when planting.

Because the plants become large and spreading, they should be set out in the field from 4 to 6 feet apart, in rows from 8 to 10 feet apart. If all conditions are favorable, a small crop may be harvested in the spring following transplanting. When a plant is 5 years old, it should produce 50 buds in a season. In April or May, at the close of the harvest season, the plants should be allowed to dry, or they should be cut back and allowed to lie dormant until the succeeding rainy season, when the new growth will start.

Harvesting and Packing. The yields should be harvested once a week, by cutting the buds just before the bracts begin to spread. A short, clean-cut stem should be left attached to the bud, which is dropped into a sack for carting to the packing shed.

The buds should then be graded into different sizes. All damaged buds should be discarded. From 45 to 200 buds may be packed into a crate, according to their size. The usual shipping box measures $9\frac{3}{4}$ inches x 11 x $20\frac{5}{8}$ inches on the inside. The interior of these containers should be lined with wax paper.

Pests. Aphids are one of the few pests that attack this hardy plant. These are best controlled by spraying with a nicotine sulphate solution made of 1 pint of 10 per cent nicotine to 100 gallons water. The so-called plum moth does much damage to artichoke crops in California, by infesting the young buds. Field sanitation is said to be the best method of control.

ASPARAGUS

Asparagus has been grown successfully by a few progressive home gardeners in Hawaii for more than 30 years. Later, an enterprising rice-land owner near Pearl City developed the crop on a small commercial scale. Recently, an enterprising homesteader in the Pupukea uplands of Oahu has established a fine, thrifty 2 acre patch of this crop, as a sideline. This venture is perhaps the most outstanding demonstration of the commercial possibilities of asparagus made in Hawaii. The total annual production of asparagus in Hawaii at this time does not exceed 3 tons, and consequently, the price has been excellent.

While the imports of fresh asparagus from the main-

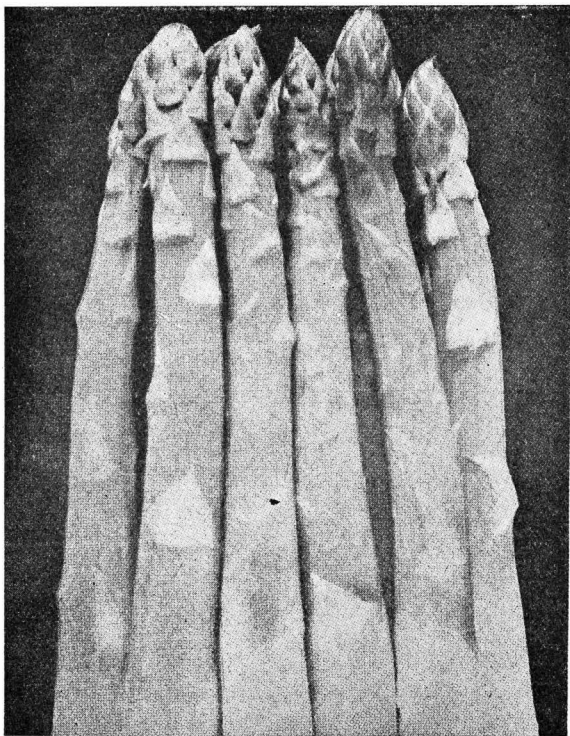


Fig 21.—Mary Washington Asparagus.

land in 1930 amounted to only 9,576 pounds, valued at \$1,149, approximately 585,364 pounds, valued at \$55,137, of the canned product was imported. This places asparagus second only to canned peas, the imports of which amounted

to \$74,908 in 1930. Of canned tomatoes, Hawaii imported 731,237 pounds, worth \$53,848. To Hawaii's humiliation if not disgrace, in 1930 we imported 665,850 pounds of fresh tomatoes valued at \$74,909!

Asparagus is characterized as a perennial crop and may last in production for many years. Its young shoots, which are termed asparagus tips by the housewife and "spears" by the grower, if left to grow, produce the stiff, erect stems and foliage so much admired both in mid-season and in the fall, when they bear innumerable red berries which contain the seed. In the early months or following the first rains after maturity, the new "tips," or aerial stems, emerge from the surface of the soil like some beautiful ivory carving, but soon acquires green and purplish tinge under the influence of light.

Varieties. The variety most extensively grown in California is the *Mary Washington*, a variety which succeeds in Hawaii. Other varieties which may be obtained from Pacific Coast nurseries and seedsmen are *Argenteuil*, *Palmetto*, *Conover's Colossal*, and *West*. Year-old plants cost about \$10 per 1,000 plants when bought in quantity. Roots become available in January and should be ordered as early in the season as possible. While we recommend the *Mary Washington* variety because of its good qualities in size, shape, color, and uniformity, as well as for its productiveness and rust resistance, the beginner in asparagus culture may well test several varieties before he plants extensively.

Soil and climatic requirements of asparagus are well defined in that the plant will tolerate high temperature and some drouth when once established. However, it is in the cool moist seasons of late winter and early spring that the plants are productive of choice and profitable crops. Few good tips can be expected after the end of April, except in unusually favorable locations, such as the cool, moist uplands. Any good, deep, rich soil with a firm retentive substrata can be made suitable for the crop, although very light, sandy soils with gravelly subsoils are not conducive to long life of this crop. Whereas light soils produce early crops which bring high prices, heavy soils produce crops that are later but larger. Heavy soils tend to produce crooked spears. The Delta region in California, where the best asparagus is grown, has a soil which is a mixture of muck and silt. This is considered an ideal asparagus soil, for it is extremely fertile, loose, and friable in texture, permitting perfect development of the spears. Because aspara-

gus has a high tolerance for sodium chloride (common salt), the crop may well be considered suitable for soils too saline for other crops—other conditions being favorable. Undoubtedly a large percentage of our more tractable rice lands would be well suited to this crop.

Cultural Methods. Asparagus is a greedy feeder, and it would be difficult to overmanure and fertilize the plant beds. The better the cultivation and the more the fertility provided, the greater will be the quality and quantity of the produce. In California, it is not unusual to apply a ton of high-grade fertilizer in a year. With such treatment, the asparagus bed should produce profitable crops over a period from 10 to 15 years.

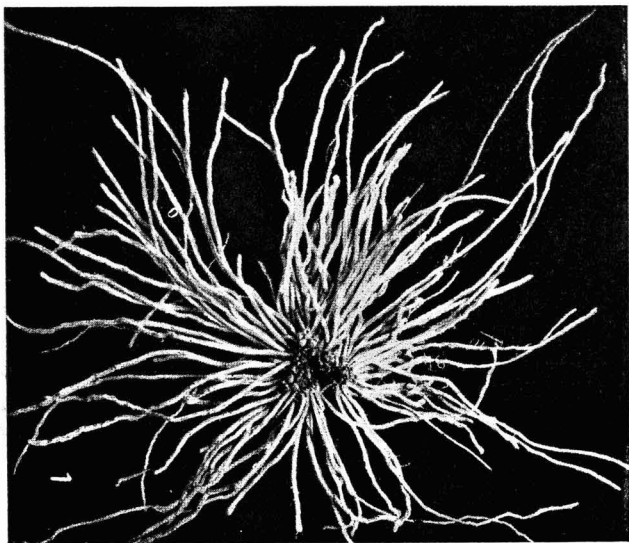


Fig. 22.—One-year old asparagus crown. These are dug from the nursery and planted in permanent beds spaced 18 to 24 inches apart in rows 5 to 7 feet apart. Such roots may be grown from seed or bought at about \$10.00 per 1000. After Calif. Agri. Expt. Stat. Bulletin No. 446.

Before the beds are laid out, the land should be prepared as thoroughly as possible. After a good, deep tilth has been provided by repeated plowings and harrowings, the field should be staked off for rows 5 feet apart if green asparagus is to be grown, and 7 feet apart if white shoots are to be grown. The wider distance gives more soil for hilling and covering the spears for a longer period than would be available if the rows were closer together.

Deep furrows should be opened by running a mold-board or "middle buster" plow 3 or 4 times where each row is to be planted. It is a good plan to apply more than 20 tons of well-rotted manure to each acre in the bottom of the furrows and to reinforce the manure with at least 1000 pounds of 6-12-6 fertilizer. A furrow slice of earth should be plowed from each side over the manure and fertilizer, and the soil, manure, and fertilizer should be mixed thoroughly by use of a potato hoe. Another furrow should be plowed from each side, and then the bed should be rounded off to an oval shape. Next, a trench should be dug a foot wide and to such a depth that the crown of the plants, when set, will be 6 inches below the surface of the bed when the trench is filled with soil.

The roots should be placed from 18 to 24 inches apart in the row, and each set on top of a slight mound of loose soil, with the roots spread naturally about the crown. They should be covered with mellow soil to a depth of 2 inches at the time of planting. Several additional inches of soil should be filled in at subsequent cultivations. One-year-old roots may be planted, but never any older stocks. Cultivation should begin immediately after planting to keep the soil mellow. If irrigation is necessary, water should be applied immediately after planting, and the plants should be cultivated as soon as the soil is dry enough.

If the soil is very fertile, cash crops may be grown between the rows of asparagus during the first year. Weeds must not be allowed to gain a foothold in the asparagus patch. Many failures may be attributed to lack of cultivation and weeding of the patch.

No "tips" should be harvested the first year. Just before the winter or spring rains begin after the first year, all surface vegetation should be cut away to permit the new growth. A light crop may be expected the second year. Cultivation should begin as early in the spring as the soil will permit. Shallow harrowing over the plants, if done with care, will not injure the plants at this time. During these early cultivations, 1000 pounds of the complete fertilizer may be applied to the surface of the bed and harrowed in. As soon as the spears appear, cultivation should be confined to the area between the rows and should continue until the plants completely cover the intervening space. The fall treatment consists of applying 20 tons or more of manure after the dead tops have been removed. This treatment, supplemented by the applications of com-

mercial fertilizer, should be repeated each year during the life of the field.

In the third spring, if all conditions have been favorable, spears may be cut for 3 or 4 weeks, but longer cutting may seriously weaken the plants. Each succeeding year, the cutting season may be lengthened, until in the fifth or sixth year the cutting period may extend until June. At the end of the cutting season, fertilizer should be applied, as in the second year. The plants being dormant, a disc harrow with



Fig. 23.—Asparagus plant showing top growth, crown, and mass of fleshy roots. Crown set in field, 1919; photo taken July 25, 1924. After Calif. Agri. Expt. Stat. Bul. 446.

the discs set at a slight angle may be used to disc in the fertilizer to a depth of several inches. This disking will destroy weeds and leave the surface soil mellow. For the production of green asparagus shoots, a very low ridge will suffice, but when long white shoots are desired the plant bed must be ridged much higher. This may be done by the use of an improvised A-shaped scraper between the plant

rows. The young shoots will have to pass through an additional layer of soil before emerging to the light which causes greening.

Harvesting and Marketing. As the crop develops, the field should be cut over early each morning, and the spears should be immediately taken to the packing shed to keep them fresh. Green asparagus should be cut just beneath the surface of the soil after the shoots have emerged sufficiently from the ground. Great care must be exercised not to injure the unseen buds beneath the surface. No stalks must be allowed to remain during the cutting season. Unmarketable shoots should be cut and discarded.



Fig 24.—Knife for cutting asparagus.
Another type has a V-shaped end.

Asparagus deteriorates rapidly and should be marketed daily. Bunches should be prepared to meet the market demands. Bunching devices for holding the spears in a cluster while they are trimmed and tied may be bought for about \$5 or can be made on the farm.

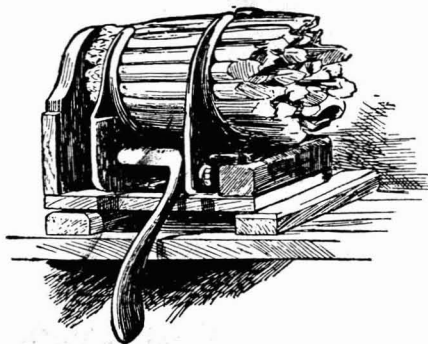


Fig. 25.—Asparagus buncher and bunch of spears ready to be tied.

The price that asparagus commands depends largely upon the care with which it is graded and bunched. Clean asparagus should not be washed. The bunches should be tied with clean raffia, and the butts should be cut off square and even. Shipment should be made in crates. For long distance shipments, it is advisable to pack the bunches upright with the butts resting on a layer of moist moss.

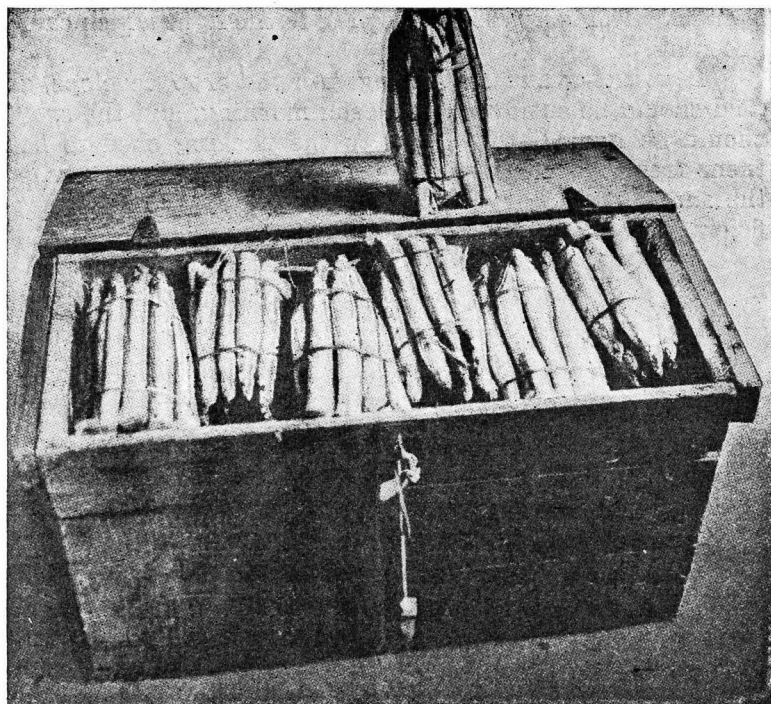


Fig. 26.—An asparagus box of the strawberry-crate type, with two dozen bunches of asparagus placed on the side. Such a crate would bring about \$5.00 wholesale in the Honolulu market at the best of the year. An acre should produce 80 to 100 crates per annum under favorable conditions. After Farmers' Bulletin No. 829, entitled "Asparagus."

The average yield of asparagus in the best California areas is as follows:

Year	Pounds per acre
First (year planted)	0
Second	500
Third	1000
Fourth	2000
Fifth	4000
Sixth	4000
Seventh	4000
Eighth	5000
Ninth	4500
Tenth	4000

When manure or other organic matter is difficult to obtain, the asparagus patch may be green-manured, by planting a row of cow peas or velvet beans between the rows immediately following the harvest. In about 3 months, the resultant rank growth may be cultivated into the soil.

Insects and Other Pests. Asparagus is subject to a number of pests. In the United States and Europe, the common asparagus beetle is prevalent, but it has not been reported on asparagus grown in Hawaii. The larvae and adult stages feed upon the marketable spears and the foliage. This pest is held in check by natural enemies, including several species of lady bird beetles which feed on the eggs. Numerous soldier-bugs and small dragon flies prey on the larvae. A parasitic wasp-like fly also helps control the pest. The asparagus miner is reported in Florida, Texas, Washington, and California, but has apparently not been noticed on Hawaiian-grown asparagus. As a means of controlling this pest, Fink recommends the addition of syrup to arsenical sprays. The asparagus or garden centipede, wire worms, army worms, and cutworms do some damage locally. The only control known for these is poisoned bait.

Asparagus rust, a disease which once seriously threatened to impair the California industry, must be guarded against. This malady attacks the green foliage and eventually kills the tops, which are needed to store up food and strength in the roots for the following year's crop. Good cultivation and the application of powdered sulphur appear to be the best methods of control. The sulphur should be applied as soon as the tops "feather out" and before the plants bloom. They should be dusted frequently and thoroughly if the disease seems imminent.

BEANS

Beans are of many classes and varieties. This variation is the result of cross-breeding and selection, as well as of natural mutations. The common field, or garden bean, also known as the kidney or haricot bean, is by far the most important, for this type includes varieties of dry, snap, and green shell beans, the Limas, teparies, and flowering beans.

The usual horticultural classification of this genus is,
(1) according to habit of growth, as bush or climbing,
(2) according to culinary uses, as green shell, snap shorts,

or dry shell beans, (3) according to the color of the pod in the edible stage, as the green podded or the yellow-podded wax, and (4) as field, or garden, hardy and adaptable types. There is, naturally, much over-lapping in this classification. Most of the dry shell type are of the bush form and are of the green-podded varieties. Snap beans are mostly of the green and wax-podded types. Green shell beans are commonly of the large-seeded types, either wax or green-podded.

In the Southern states, the Limas are termed "butter" beans, and in the Northern states the wax varieties are termed "butter" beans. The large Limas have 2 divisions, 1 division including the flat-seeded varieties, and the other, the fat-seeded type, sometimes called "potato" Limas. Although they are generally grown as annuals, some of the Limas may be grown as perennials in Hawaii, especially the pole or climbing varieties.

The factors most influential in determining the variety suitable for cultivation in a given locality are rainfall, length of growing season, established cropping systems, and market preferences. In so far as the first three factors are concerned, Hawaii is exceptionally favored, and almost all the many varieties tested, which exceed 100 standard sorts, have done at least fairly well in respect to both quality and yield. However, our local markets prefer only a few varieties. Two popular varieties of the dry shell type are the *Maui Red*, or *Red Kidney*, a vigorous growing, prolific dwarf or bush type, quite distinct from any mainland variety, and the *Calico*, a prolific, blotched-seeded bush type of Portuguese origin. Hundreds of acres of these varieties were formerly grown in the Kula, Maui, region. The former was exported extensively to the Mainland. Among the principal buyers was the Army. This trade might be revived by better grading and an increase in the volume of production. Other excellent shell beans having a wide export market are the *Bayo* and navy beans, including the large, white *Lady Washington*, which is a semi-trailing variety, together with the "pinks" which are of like habit. Though grown less extensively than the *Maui Red*, the "pinks" do well locally.

A ton of dry shell beans an acre is not an unusual yield in the Kula region on Maui. The usual price a decade ago was between 4 and 5 cents per pound for the *Maui Red Kidney* and *Bayo*. This gave gross incomes of \$80 to \$100 an acre for each crop.

Because it costs between \$40 and \$50 an acre to produce the crop, the net profit ranged from \$30 to \$60 an acre. In Kula the crop was usually planted between the corn rows at the last cultivation, so that the cost of producing the bean crop was borne in part by the corn crop. Better and more economical production will usually result if the bean crop is grown alone.



Fig. 27.—Field grown bush beans, whether grown as “snaps” or “shell beans,” offer quick returns and large profits to the successful grower.

SNAP BEANS. The market gardener will be concerned primarily in the production of snap or string beans. Most varieties of string beans thrive in Hawaii throughout the year, except in extremely rainy districts and during the rainiest seasons. The most popular variety is the *Kentucky Wonder*, or *Old Homestead*, an old standard pole variety for home use. However, most local markets prefer the flat podded varieties and a smoother and more attractive string

bean than the *Kentucky Wonder*. The best of the flat podded beans is probably *Burpee's Stringless Green Pod*, a bush type that produces profusely. The *Improved Early Refugee*, or "1000 to One," is an excellent second choice, and is used extensively by canners. The *Bountiful* is another excellent bush variety, as are the *Red Valentine* and the *Giant Stringless Green Pod*.

Of the yellow or wax-podded bush varieties, the *Improved Golden Wax* is an excellent variety, as are also the *Challenge*, the *Kidney Wax*, the *Brittle Wax*, the *Crenell Rust Proof Wax*, the *Michigan White Wax*, the *Sure Crop*, the *Unrivalled Wax*, the *Ventura Wonder* or the *Davis Kidney*, and the round-podded, prolific *Black Wax*, so named on account of its black seed. *Hodson's Long Pod* is choice when very young. Of the green-podded pole varieties, *Burger's Green Pod Stringless* (*White Seeded Kentucky Wonder*), *Dutch Case-Knife*, and *Nancy D* are good varieties, though they are not so prolific as the *Kentucky Wonder* and the *McCaslan Pole*, both varieties that should be tested for yields and market.

A variety of green, flat-podded pole beans, with drab colored seeds, not yet identified by its commercial name, grown at Lualualei Homesteads, recently produced on $\frac{1}{8}$ acre (1550 feet of bean row, spaced 4 feet apart) 2824 pounds of prime string beans which sold at 4 cents per pound, or at the rate of more than \$800 an acre. This crop was planted February 18, and the harvest was completed June 8. Seed stocks of this promising variety can be secured through the Agricultural Extension Service.

Since practically all varieties of culinary beans thrive in most parts of Hawaii, the choice of varieties is not so much a problem of suiting climatic influences as of selecting the variety best suited to the purpose for which the crop is grown. Varieties for the local canning or export market may be either green-podded or wax-podded and flat or round in cross-section, and should be chosen on the basis of market requirements, involving both culinary quality and appearance. Stringlessness, tenderness, uniform color and size are all requirements of paramount importance in beans grown for canning. Some day the Hawaiian Pineapple canners or some independent concerns will probably can vegetables, including both string and Lima beans, as an important adjunct to the pineapple canning industry. In the meantime, truck farmers might well experiment in testing varieties for this purpose, submitting their product to can-

ners for canning tests. In 1926 and 1927, the writer grew the *Kentucky Wonder*, the *Refugee*, *Henderson's*, and *Monstrous Limas* as cover crops in rotation with pineapples at his Haiku homestead. A quantity of these were canned by the Haiku Fruit and Packing Company. These canned products were pronounced to be of superior quality by experts a year after canning. Someone should renew experiments of this kind on a larger scale than was possible for a small independent farmer. The Agricultural Extension Service will be glad to lend a hand in securing cooperation between canner and grower.

Of more than 100 varieties tested during the past 30 years, the following varieties are recommended for trial and comparison. Careful selection and the development of only those best suited for the market should be constantly employed.

Dwarf Green Podded. This type of string bean is in great demand in the local markets. Preference is usually given to the flat-podded varieties. These are named in the order of preference: (Flat-podded varieties are followed by the letter "F," round-podded varieties by the letter "R," and the intermediate or oval type by the letter "O.") *Burpee's Stringless Green Pod*—F; *Improved Early Refugee* or "1000 to 1"—R; *Bountiful*—F; *Longfellow*—OF; *Early Red Valentine*—OF; *French Mohawk*—OF; *Canadian Wonder*—F; *Giant Stringless Green Pod*—R.

Pole or Climbing Green Podded. *Lualualei Flat Green Podded Pole*—F; *Burger's Green Pod Stringless* or *Kentucky Wonder White Seeded*—O; *Kentucky Wonder* or *Old Homestead (Texas Prolific)*—R; one of the most prolific and hardiest beans grown in Hawaii, not attractive for market, but excellent for home use and canning; *McCaslan*, similar to *Kentucky Wonder* and *St. Louis Perfection*—R; *White Creaseback*—R; and *Lazy Wife*—O.

Dwarf Wax Podded. *Improved Golden Wax*—F; *Davis White Kidney Wax* or *Ventura Wonder*—F; *Hodson Wax*—O; *Wadwell Kidney Wax*—F; *Refugee Wax*—R; *Improved Butter Wax*; *Pencil Pod Black Wax* or *Prolific Black Wax*—R. Our local market is not very discriminating in its choice of wax beans, so long as they are tender and attractive in appearance.

Pole or Climbing Wax Podded. *Early Golden Cluster Wax*—F; *Kentucky Wonder Wax*—R; *Giant Pole Wax*—F.

The pole beans yield by far the heaviest crops, if they are trellised. When grown on a small scale, they are usually

the most profitable. Their disadvantage is that they require poles, or trellises of some kind, for support. Bush bean types are recommended for large scale cultivation.

How to Prepare the Soil. After a well drained, fertile soil, preferably a silty loam which is well supplied with humus and is fairly retentive of moisture, has been selected, the seed bed should be prepared thoroughly, by plowing and discing. If the crop is grown in rotation with potatoes, as recommended, the cost of preparing the land will be nominal. Little fertilizer will be needed, if the preceding potato crop was heavily manured and fertilized. Soils lacking in readily available plant food will need manuring or fertilizing with commercial chemical constituents. If the ground is already rich in organic matter, from 250 to 500 pounds of super

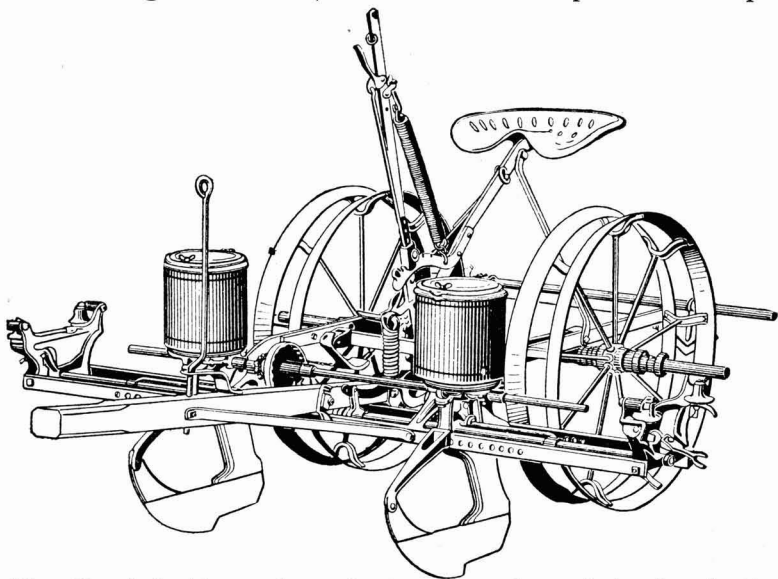


Fig. 28.—A double-row bean planter commonly used also for planting Indian corn.

phosphate for each acre, placed in the drill at time of planting, will usually aid in increasing production. If no fertilizer or manure has been used previously, from 500 to 1000 pounds of a 4-12-8 fertilizer will usually prove satisfactory.

Planting. Seeding may be done with a wheeled hand drill, or with a horse-drawn corn drill, using either a 1- or 2-row planter. Instead of planting the seeds in a continuous drill, the crop may be planted in hills. Most automatic seeders can be adjusted to plant either in drills or hills. When "check row" hill planting is practiced, the hills may be

spaced either 24 inches or 30 inches apart, or rows may be spaced 36 inches apart and the hills from 15 to 18 inches apart in the row. The 2 form spacings will permit machine cultivation in 2 directions, thus effecting a considerable saving in cost of weeding and cultivation. In hill planting, from 4 to 6 seeds should be dropped in each hill. In continuous drill planting, rows should be spaced from 30 to 42 inches apart. On this basis, 25 to 50 pounds of seed will be required to plant an acre, depending on the variety sown and distance of planting.

Care must be taken not to plant bean seed too deeply. Unless the soil is extremely sandy or silty and quite dry, seed should not be planted more than an inch deep; otherwise the seedlings will be unable to reach the surface and, if the ground is heavy and wet, may rot before they begin to germinate.

The bean seed should be plump, clean, well graded as to size, and of strong germination. Few seeds lose their vitality sooner than do beans. Seed more than a year old is likely to germinate only 50 per cent or less.

The growing crop should be given thorough cultivation throughout the growing season. For the first cultivation, the ground may be stirred to a depth of 4 inches and worked close to the rows. This will save expensive hand hoeing. Cultivation may begin as soon as the last plants emerge from the ground. Thereafter, cultivation should be given at regular weekly or 10 day intervals. Each successive cultivation should be further away from the plants and shallower than the preceding cultivation. The later cultivations should be very shallow, for many of the plant roots lie close to the surface.

Beans should not be cultivated when the vines are wet with dew or rain, because such cultivation soils the plants and the organisms which cause diseases are most readily transferred by that means. Should heavy rains prevail and clouded weather persist as the plants begin to pod, disease spots are likely to develop on the pods. Such pods should be picked as soon as the vines become dry and destroyed by burning.

Harvesting of the green pods should begin as soon as the pods are of the maturity demanded by the canner. The plants should be picked clean at each picking to encourage the setting of new pods. Frequent picking helps to secure heavy yields. However, picking the pods when they are wet

should be avoided. Disease-spotted pods are sure to be rejected by the canner.

The cash returns to the grower, should bean canning become an industry in Hawaii, will depend on many factors. The grower should secure the best contract price obtainable and then make every effort to lower cost of production. Mainland bean growers expect to earn at least \$150 gross on each acre. The cost of production will total at least half that amount. However, those suitably located and of good managerial ability should net \$100 an acre each year on this as well as most other rational cropping schemes.

Field beans.	{ Bush.....	Kidney.....	{ Colored White
		Marrow.....	{ Colored White
		Pea.....	{ Colored White
	{ Pole or corn hill.....White or colored		
Garden beans	{ Bush.....	Kidney.....	{ Wax Green pod
		Lima	
	{ Pole.....	Kidney.....	{ Wax Green pod
		Lima Runner (Scarlet Runner)	

POLE BEANS. Pole beans may be planted in either rows or hills. Their culture differs from that of bush beans only in the necessity for wider spacing and for poling or trellising. Pole bean rows should be spaced at least 4 feet apart, and the individual seeds should be dropped from 5 to 8 inches apart in the row, or, if planted in hills, the hills should be at least 15 inches apart, with not more than 5 seeds in each hill. Pole beans should be given support when the plants begin to develop tendrils. Pole beans are sometimes grown without support, but this practice is not recommended, except for growing mature shell beans when the seed is to be threshed out by machinery.

Whether level, ridge, or furrow culture should be practiced will depend on the season and the soil. In very dry localities, especially if the soil is sandy, it is preferable to

plant in furrow depressions, a method which is termed "listing." If the season is wet and the soil heavy, clayey, or irrigated, it is preferable to plant on raised beds, ridges, or elevated hills. Under favorable climatic and soil conditions, flat or level culture should prove the most economical method. Irrigation may be necessary, whatever the method of planting. In such cases, furrow irrigation is much to be preferred to flooding or overhead sprinkling, and the planting should be done accordingly.

LIMA BEANS. Green Lima beans, although not grown as extensively as fresh snap or string beans, nevertheless offer a fine opportunity for the progressive gardener who will devise economical ways for shelling the green Limas rapidly, cheaply, and without damage. As it is, the average housewife objects to the tedious job of hand-shelling in the home, and, because of this reason or because many housewives are ignorant of the delicious flavor and the nutritive value of this wholesome vegetable, it is not as popular as it should be. A large family trade, as well as an extensive canning market, awaits the growers who will, singly or in combination, make the most of their opportunities with the crop.

The following varieties of Lima beans have been tested locally for several years, and are recommended for trial by the market gardener.

Dwarf of Bush. *Burpee's Improved Bush*, *Henderson's New Early Giant*, *Henderson's Improved Small Seeded Butter Limas*, *Ford-Hook Bush*, *Dreer's Improved Challenger* or *Potato Lima*.

Pole Limas. *King of the Garden*, *Burpee's Giant Podded*, *Carpenteria*, *Early Leviathan*, *Ideal*, *Carolina* or *Sieva*, the *Butter Bean* of the South.

Intermediate Type Limas. *The Monstrous*, one of the best varieties grown by the writer at Haiku, is semi-perennial, if pruned.

Cultural Methods. The distances for spacing Lima beans should conform closely to the distances recommended for string beans. If drilled, the individual seeds should be spaced about six inches apart. In the last analysis, the best methods of planting and cultivation will be evolved from personal experience, the best teacher for the market gardener and truck farmer.

All beans of good quality that mature may be utilized as dry shell beans or, if extra choice, for seed purposes. Bean straw, the residue after thrashing mature beans,

makes an excellent feed for livestock, as do the green plants. This material may be used for direct manuring or composting, for it is especially rich in nitrogen.

Insect Pests and Plant Diseases. In common with all other vegetables, the culinary bean is subject to the ravages of numerous insect pests and some plant diseases. Cutworms are likely to cause considerable damage soon after the crop is planted, especially if it is planted on new land. New land should be left bare, fallow, and well cultivated for some months before planting. Weedy border lands should be isolated by digging trenches with abrupt sides, and poisoned bait should be kept ever ready for an emergency. The Japanese beetle attacks the foliage in a manner similar to that of the cutworm, but it does not cut through the plant stem or totally destroy the plant in other ways. Since poisoned bait is not very effective on the Japanese beetle, spraying the crop foliage with arsenate of lead is, perhaps, the best method of control, except in moist localities and during seasons of treatment with the beetle fungus, devised many years ago by Brother Matthias Newell of Hilo. Carriers of this fungus can be obtained from the Territorial Board of Agriculture and Forestry, or they may be prepared by the gardener, by confining a quantity of beetles with moist soil until they die from infection with the fungus present in most soils. When a number of the beetles have developed the green fungus, the dead bodies should be mixed with almost dry soil and the mixture should be scattered over the ground around the attacked plants.

Aphids are a common pest during some seasons of the year. When they are not controlled by the Lady beetle, a liquid spray should be used or the plants should be dusted with nicotine sulphate.

The disease most likely to affect the bean is that known as pod or *anthracnose*. Plants so affected become yellow and drop their leaves, the pods become spotted and deformed, and many of the seeds fail to mature. Much infestation doubtless results from planting infected seed. Only seed from healthy plants should be planted on disease-free soil. Spraying the plants with Bordeaux mixture early in the attack of the disease will give some, but not complete relief. Seed disinfection, though of some benefit, is not reliable, because the fungus is inside the bean seed where the fungicidal solution cannot reach.

Mildew also attacks the bean plant and pod occasionally,

especially in moist, humid seasons. Dusting with powdered sulphur is the best remedy for this malady.

Bean blight, or *bacteriosis*, is a bacterial disease which affects the stems, leaves, and pods of most varieties of beans. When the foliage is attacked, irregular, water-soaked patches, which later become brown and papery, appear, especially during dry weather. The disease progresses slowly, and it may not be noticed until it has made considerable headway. Control is difficult, and should concern itself with seed selection and crop rotation.

Bean rust is occasionally encountered. It may be recognized by the small, raised, rusty-brown powdery specks on the underside of the leaf, which rub off easily as rusty brown powder. Plants that are "rusted" should be destroyed by burning.

Mosaic disease is caused by a so-called virus, and affects the entire plant by causing a crinkling of the leaves and tendency to dwarf the plant. Early or severe infection may result in premature dying or at least in preventing the plants from producing pods and seed. The disease may be transmitted and carried over in the seed in a way similar to mosaic in potatoes. The only effective control is through the use of clean seed and resistant varieties.

BEETS AND SIMILAR CROPS

BEETS AND CARROTS. Table beets and carrots are grown successfully throughout Hawaii. They do best during the cooler seasons of the year. Like all root crops, these thrive in a deep, rich, medium loam soil, well drained and supplied with a considerable amount of organic matter. The soil must be maintained in good tilth throughout the growing season. It usually pays to apply commercial fertilizers broadcast at the rate of $\frac{1}{2}$ ton to each acre. The fertilizer should be plowed 4 to 5 inches into the surface a week before the crop is planted. A 6-6-6 formula should give good results on most Hawaiian soils. Good cultivation and an optimum moisture supply are important requisites for these crops.

The following varieties of beets are recommended for the market gardener: *Eclipse*, *Crosby's Egyptian*, *Detroit Dark Red*, *Early Wonder*. Excellent varieties of carrots for the market gardener are *Red-cored Chantenay* or *Chantenay*, *Danver's Half-Long*, *Ox-heart* or *Gurande*. *Hender-*

son's Coreless and *Tender Sweet* may be tried. The seed of both these crops should be drilled in rows from 18 to 24 inches apart. They should be harvested by pulling only the most mature roots. In harvesting, the grower should go over the field weekly, instead of attempting to harvest all at one time, with the attendant losses from under-sized roots. The roots should be washed clean, then tied in well sorted bundles of 6 or 10. All dead leaves should be removed and the green tops left attached. They should be shipped in crates or boxes of standard size.

SWISS CHARD. This plant is a member of the beet family and is also known as silver beet or leaf beet. The broad, thick midribs are large and fleshy and may be prepared like asparagus, while the leafy portion is excellent for summer greens. A prominent seedsman describes his leading variety as "spinach-leaved and asparagus-ribbed."

The greatest value of this useful plant lies in the fact that it produces "greens" throughout the summer and is available when spinach is unobtainable. Leaves may be picked from the plants over a long period. The plant grows to perfection in Hawaii. The seed should be planted in the field in rows from 3 to 3½ feet apart, with the plants from 8 to 10 inches apart in the rows. The soil should be well cultivated and ample moisture should be supplied.

The following varieties are recommended: *Lucullus Crumpled Leaf*, *Green Plume*, and *Large Ribbed White*.

PARSNIP AND SALSIFY OR OYSTER PLANT. The parsnip is closely related to the carrot. To grow large well shaped roots, a fertile, friable sandy loam is best. The seeds are very small and should be drilled in rows from 15 to 20 inches apart. The seed germinates very slowly. It should be planted shallow and the soil should be pressed down to encourage the capillary moisture to reach the seed. The *Hollow Crown* is the most popular variety. *Early Round* and *Half Long* are excellent sorts.

Salsify, or oyster plant resembles the parsnip, but its roots are smaller in diameter than parsnip roots. It is termed the vegetable oyster because the flavor reminds one of the oyster. This is a slow growing vegetable. If better known, this crop would doubtless come into demand. Only one variety is generally catalogued by seedsman. This is *Sandwich Island Monmouth*. The roots keep well throughout the winter if stored in a cool, well-ventilated pit or dug-out. The general cultural directions given for carrots apply to these crops.

KOHLRABI, RUTABAGA AND TURNIPS. These hardy vegetables of the family *Cruciferae*, having fleshy roots as in the turnip, or, short, much thickened, fleshy stems as in the kohlrabi, although not extensively grown in the sub-tropics, should command the attention of Hawaiian market gardeners who are favorably situated for the growing of these cool-weather-loving plants. Even in the lowlands about Honolulu, these species thrive in the winter and early spring months and, when tender and well grown, are always welcomed by the thrifty housewife.

The seed should be sown directly where the crop is to mature. The rows should be spaced from 18 to 24 inches apart and the seed sown at the rate of 4 or 5 pounds to the acre. When they are 2 inches high, the plants should be thinned to stand from 5 to 8 inches apart, the exact interval depending upon variety and season. Rapid growth must be stimulated to secure products of highest quality.

Kohlrabi should be harvested when the fleshy stem is from 2½ to 3 inches in diameter, and must be gathered before the edible portion becomes tough or woody.

The crop should be sold in bunches of 5 or 6 plants. The heavy taproot should be cut off close to the fleshy "bulb." The fresh green tops should be retained. Only choice, tender produce should be offered for sale.

The rutabaga is very similar to the turnip but takes longer to mature and has larger roots. The fleshy, edible portion may be nearly globe-shaped, somewhat elongated, or gradually tapering at the base. The upper part of the fleshy root may be purplish, green, or a variety of these two shades, while the flesh may be orange, yellow, or white in color. The method of culture is similar to that employed in growing turnips.

The turnip is too well known to need a lengthy description. The seed should be planted in the late fall, so that the growing period will be during the cooler seasons of the year. Turnips grown in warm weather become fibrous and bitter. The seed should be sown about ¼ inch deep in rows from 15 to 24 inches apart at the rate of 2 or 3 pounds to the acre. Before the plants start to crowd, they should be thinned out, until they are at least 4 inches apart in the row. This crop matures in from 60 to 80 days, depending on the variety grown and the season. For family trade, turnips should be harvested before they become 3 inches in diameter. The roots should be well graded for size, shape, and color. There should be no insect or mechanical injury,

and the tops should be fresh and clean. For shipment, they are best tied in uniform bundles of 5 or 6 roots, and packed in crates, baskets, or barrels.

Early Purple Vienna and *Early White Vienna* are two well known sorts of kohlrabi which are generally successful. The two varieties differ mainly in outside color, and both have white flesh.

Standard varieties of rutabaga are *Purple-top Yellow*; *Gold-heart* and *White-flesh Neckless*.

Among turnips, the *Purple Top White Globe* requires from 70 to 80 days to mature, and the *Early White Flat Dutch* matures in from 50 to 60 days.

CABBAGE AND RELATED VEGETABLES

CABBAGE. Cabbage is extensively grown in Hawaii's uplands where experienced growers, favorably situated, have made profitable incomes. Unfortunately, little consideration has been given in the past to market requirements, with the result that glutted markets have not been uncommon. The extension service hopes to make reliable forecasts showing the probable market requirements at different seasons and to collect data covering proposed plantings, that growers may be advised against overproduction.

Cabbage is not a difficult crop to grow at altitudes above 1,000 feet and where fertile soils of good texture are available. It is essential that suitable varieties be planted and that good tillage be practiced throughout the growing season. The crop should be liberally manured and fertilized. From 20 to 30 tons of manure and at least $\frac{1}{2}$ ton of 6-12-6 commercial fertilizer should produce a bumper crop if conditions are favorable. The manure should be applied weeks before planting and the fertilizer immediately before planting.

Strong, stocky seedling plants are essential for a good crop. Seedlings may be started in a cold frame or in outdoor seed beds. In extensive field culture, as practiced in the Kula region on Maui, rows are spaced from 3 to 5 feet apart, and the plants set from 15 to 20 inches apart in the row, the distance depending on variety. At these distances from 5,227 to 11,616 plants would be set to each acre. One ounce of virile seed will produce from 2,500 to 3,000 plants, so that about $\frac{1}{4}$ pound will be required to plant an acre.

Seed may be sown broadcast or in drills 12 inches apart. Seedlings require from 6 to 8 weeks to grow to the transplanting stage. Plants should be hardened off by lessening the water supply when the time for transplanting approaches. The night before transplanting, the seed bed should be given a good watering to facilitate pulling the

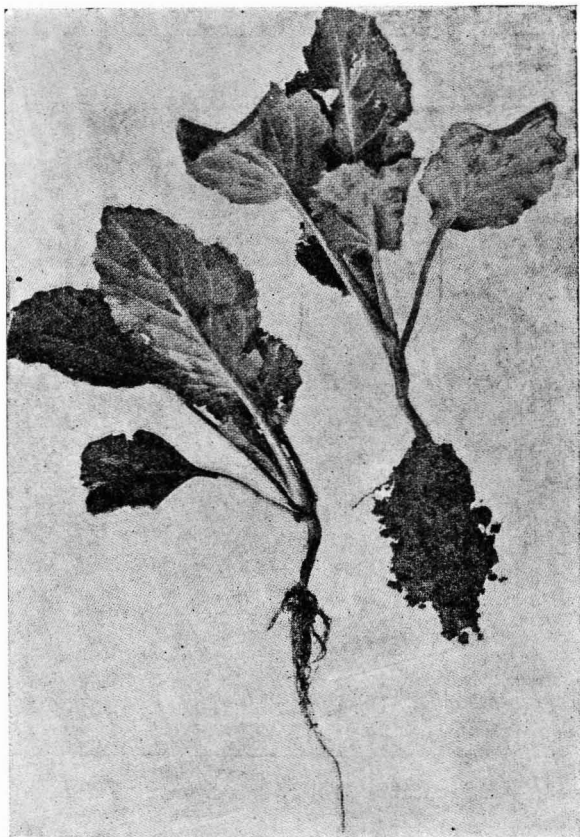


Fig. 29.—As many small roots of transplant seedlings as possible should be preserved. Plant on the right is ideal for transplanting. After Circular No. 262 "Cabbage Production in California," Calif. Agri. Expt. Stat., 1923.

plants. At the time of transplanting, large leaves may be trimmed to reduce transpiration.

Under the non-irrigated conditions found in most of our high uplands, the soil must be brought to the best possible tilth for the seed bed. This is readily done in the deep, fine, silty soils in the Kula region on Maui. It is well to

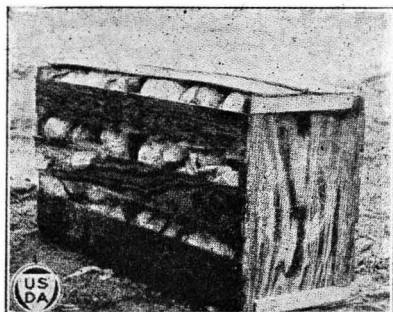
plank such lands before planting, to make the soil firm and to provide a level surface. The seedlings should be set immediately after they are pulled, either in furrows, in level culture, or on the sides of ridges as circumstances warrant. Furrow irrigation should be used in large scale plantings. Cultivation should be sufficiently frequent to kill all weeds and keep the soil mellow. During the later stages of growth, cultivation should be shallow and less frequent than earlier in the season.



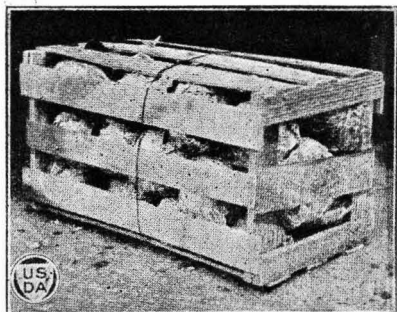
Fig. 30.—A profitable field of cabbages ready for market.

Harvesting should not be done until the heads have attained their maximum development. If rains come near harvest time, earlier cutting may be necessary to prevent bursting. In cool weather, the crop need not be harvested in a hurry. During the winter or cooler periods of the year, if there are no rains, the crop may be left standing in the field until all the plants have matured. Early cabbage is best harvested as soon as the heads reach maturity. All heads should be cut so that a number of the outer leaves remain attached for protection.

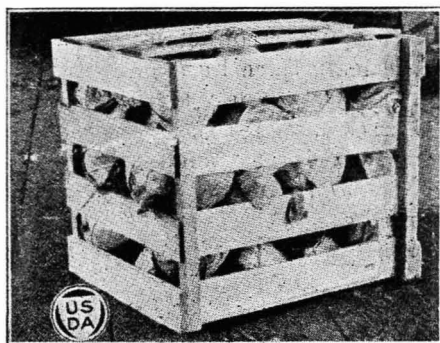
Grading. Standard grades for cabbage have been established by the U. S. Department of Agriculture and may be obtained by addressing the Extension Economist, Agricultural Extension Service, University of Hawaii. The heads of each consignment of cabbage should be graded to uniformity of variety, size, shape, and color. They should be free from injury and seed stems resulting from over-maturity.



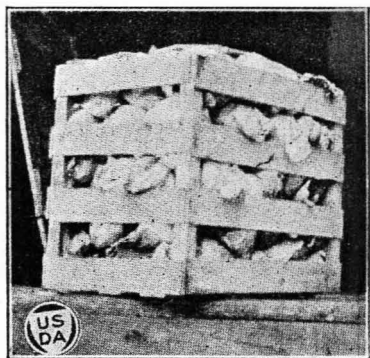
Atlantic coast type of cabbage crate.



Mississippi valley type of cabbage crate.



Colorado type of cabbage crate.



California type of cabbage crate.

Fig. 31.—Cabbage crated for shipment. Good containers help sell the goods. After Farmers' Bull. No. 1423.

Hawaiian growers on the other Islands practice false economy by shipping choice head cabbage in sacks. They should use strong, slatted crates, barrels, or hampers. A standard mainland crate is 20 x 20 x 25 inches. The cabbage should be packed tightly to allow for shrinkage and to prevent the heads slipping. For local markets, careful bulk handling is permissible. In our higher altitudes, such as

upper Kula, Maui, and Waimea or Waikē, Hawaii, part of the late crop may be stored in pits or in well-ventilated dug-outs. The temperature must be kept below 50° F.

Varieties. Of the numerous varieties of cabbage grown in the United States, we recommend making comparative tests of several standard sorts under like soil and climatic conditions. For the early spring crop, the *Wakefield* and *Winningstadt* group, among which *Charleston Wakefield* is to be preferred to *Early Jersey Wakefield*, are popular. *Winningstadt* is liked by market gardeners because of its attractive dark green color. Heads of these varieties are small and best for the special family trade. The *Copenhead Market* group are medium in size, with short stems and globe-shaped, solid heads, surrounded by few outer leaves. This is an excellent variety for the general market gardener occupying expensive land and having a select family trade. *Golden Ace* is a popular variety of this group and matures early. The *Flat Dutch* or *Drumhead* varieties of this group have larger heads, which are light green in color. Among the earlier varieties of this group are *Early Flat Dutch* and *Pride of Erfurt*. Mid-season varieties are *Succession*, *All-seasons*, and *Summer Drumhead*, and late varieties are *Late Flat Dutch* and *Autumn King*.

The *Danish Ballhead* is a group with round, solid heads borne on long, thick stems. The leaves are light green and are covered with heavy bloom. They are finely textured and fold tightly. This variety matures late and is well suited for shipment or storage. Other excellent varieties of this group are *Hollander*, *Glory of Enkhizen* or *Enkhurizen Glory*, *Penn State Ballhead*, and *Late Stonehead*.

The *Red Cabbage* is in limited demand. *Danish Red* and *Monmouth Rock Red* are excellent varieties.

The *Savoy*, a crumpled leaf variety, has limited commercial value.

In addition to the many strains of so-called Chinese cabbage imported into Hawaii from the Orient, the following standardized varieties are grown extensively by our market and home gardeners: *Wong Bok*, a desirable sort, with short, broad heads, and tight, well-blanching leaves; *Pe-Tsai*, with heads larger and narrower than *Wong Bok*; *New Joy*, a distinct type with small, compact, deep green leaves and heavy, long, white stalks, which are considered very appetizing when served like raw celery. Chinese cabbage is considered an all-season crop throughout Hawaii,

although the best crops are grown in cool, moist localities.⁶

Pests and Diseases. Cabbage in Hawaii, as elsewhere, is subject to a number of diseases and insect pests. The good market gardener will be ever alert to "nip in the bud" trouble that can be controlled by precautionary methods.

Cabbage yellows is caused by a soil fungus which invades the roots either in the seed bed or in the field. The fungus enters the plant through the fibrous roots; thence it enters the stems, and finally the leaves, which turn yellow. Cross-sections of the stem give first the appearance of being water soaked, then darken, and finally become brownish black in the later stages.

Black rot is caused by a bacterium that lives in the soil. Infection may take place through either the leaves or the roots. The disease often starts at the margin of the leaves and moves inward and downward toward the stem. The affected leaves usually drop prematurely. In severe cases nothing but the stem may be left standing. The usual symptoms are dwarfing or one-sided growth of the heads. Occasionally the heads rot and drop off. A preventive method is the disinfection of seed before planting by soaking it in a water solution of mercurial chloride (1:1,000) for 30 minutes and then rinsing and drying the seed. Soils on which diseased cabbage has been grown should not be replanted to the same crop for at least 3 years, and transplanted plants must be grown on disease-free soil. Disease-carrying insects should be controlled, for they often carry the infection to non-infested plants.

Club root is a common malady in Hawaii. It is caused by one of the lower soil organisms belonging to the slime molds. The roots with this disease develop swellings similar to, but larger than those caused by nematodes. Plants attacked in the seed bed, become stunted and sickly in appearance. The best method of warding off this disease is to grow seedlings in disease-free soil. Since the club root organism thrives best in an acid soil, liming the soil a month or two before planting will be of some help. The fields should be freed from weeds belonging to the mustard family, to which the cabbage belongs.

Among the common insects that attack cabbage are the cabbage aphid, or cabbage louse, which lowers the vitality of the plant by sucking the plant juices. This pest is

⁶Bulletin No. 60 "Utilization and Composition of Oriental Vegetables in Hawaii," Hawaii Agri. Exp. Station, 1929, contains much valuable information concerning Oriental vegetables.

frequently destroyed by the ladybird beetles, syrphus fly larvae, and hard, driving rains. It is usually best controlled by spraying with a solution made of 1 pint nicotine sulphate, 5 pounds of whale oil soap, and 100 gallons of water. This amount of spray will cover an acre with a single application. Two or more sprayings may be necessary in a season. A nicotine dust made of 95 pounds hydrated lime and 5 pounds of 40 per cent nicotine sulphate also gives good control.

The common cabbage worm is nearly always with us. The eggs of this pest are deposited singly on either surface of the leaf and hatch in from 5 to 10 days. The young larvae are ravenous feeders on the succulent leaves. The larvae often bore deep into the solid heads of cabbage, ruining them for market. Serious infestations may occur in the seed bed and destroy large numbers of thrifty seedlings.

Arsenicals give the best control for this pest and can be applied with little danger to the consumer, if not applied too near the harvest season. The following treatment is recommended. To 3 pounds of powdered lead arsenate and 2 pounds of common soap, 100 gallons water should be added. This is enough for a single application on an acre. Ordinarily, 2 sprayings of this kind should be sufficient, but weekly sprayings covering an extended period may be necessary if the infestation is unusually severe. Excellent control can also be obtained by dusting the plants with a mixture of 1 pound powdered lead arsenate to 10 pounds of air slacked lime or gypsum. The dust sticks best if applied early in the morning while the dew is still on the plants. The cabbage leaf-hopper may be controlled by this means.

CAULIFLOWER, BRUSSELS SPROUTS, KALE, BROCCOLI, AND COLLARDS. These crops are closely related to the cabbage group and thrive best under similar soil and climatic conditions and, with the exception of the collards, require about the same cultural methods. The collards will stand warmer and dryer weather than cabbage, cauliflower, Brussels sprouts, kale, or broccoli, and may be much more closely planted in the field than these others.

These crops respond well to phosphate fertilizers, especially in the cool highlands where they thrive best. It usually pays to side-dress the growing crop with either nitrate of soda or sulphate of ammonia, applying 250 pounds of the former or 200 of the latter to each acre. Fertilizer

should be well cultivated into the soil near the base of the plants.

Harvesting. Great care must be exercised to harvest these crops, especially cauliflower and broccoli, before they become too mature. When the tiny florets which form the "head" begin to open, they are beyond their prime and of little value for any market. Because of inexperience, many growers have sustained great losses from harvesting the crop too late.

To "blanch" or keep the cauliflower head white, the outer leaves may need to be gathered together and tied while the small inner leaves still spread closely over the head. This is essential in the excellent and popular variety called *Snowball*. Some of the late varieties are self-protecting. The same precautions may be taken with broccoli to some extent.

Varieties. The most popular of the early varieties of cauliflower is the *Snowball*. *Burpee's Dry Weather* and *California Wonder* are also excellent varieties.

Leading varieties of Brussels sprouts are: *Improved Half Dwarf*, *Danish Prize*, and *Long Island Improved*.

Successful varieties of kale are: *Tall Green Curled Scotch* and *Dwarf Green Curled*.

Popular varieties of broccoli are: *St. Valentine* and *Curtis' Nine Star Perennial*. The latter under favorable conditions gives from 5 to 10 marketable heads on a single branching plant. Sprouting broccoli is the Italian strain of loose head type which has become so popular in American markets recently. It is cooked like spinach or Brussels sprouts. The best variety of sprouting broccoli is said to be *Calabrese* or *Italian Green*.

Of the collards, the *Southern* or *Georgia Collard* and *Georgia Cabbage-Collard* (a cross between *Georgia Collard* and *Charleston Wakefield Cabbage*) are much in favor in the Southern states.

CANTALOUPE, WATERMELONS, CUCUMBER AND SQUASH

These are termed the "vine crops". They are closely related in that they all belong to the *Cucurbitaceae*, or gourd family. They require the same general culture, and thrive or fail under like climatic and soil conditions. Wind, excessive rains, aphids, and the melon fly are the worst enemies of these crops. These crops are susceptible to several diseases, among which are the bacterial wilt, mosaic, pow-

dery mildew, and others. Frequent spraying with Bordeaux mixture and copper lime dust appears to be the best method for controlling these diseases. Thorough dusting with sublimated sulphur at the rate of from 10 to 15 pounds to the acre at 10-day or 2-week intervals will be most effective for the mildew prevalent in Hawaii. Sulphur should not be used on cantaloupes, for it usually causes severe injury to foliage.



Fig. 32.—Idealistic view of vine crops grown in continuous beds instead of the usual "hill" method. Especially adapted to growing cucumbers and small early cantaloupe.

Cultural Methods. The first requisite of a good vine crop is that sturdy plants be developed. The land must be well-drained and should be well-tilled and manured, but it should not be fertilized to excess, especially by the use of quick-acting, nitrogenous fertilizers. These vine crops can be used profitably in rotation with Irish potatoes. In such a rotation, a green-manuring crop should be included to maintain the soil humus.

Most of these crops, especially those that ramble least, should be planted in rows rather than in hills. The rows should run parallel to the direction of prevailing winds, unless some protective barriers such as pigeon peas, uba cane, or other temporary or permanent windbreaks are planted at close intervals. The windbreak problem may be solved by piling bushes in windrows parallel to the rows, so that the plants may attach their tendrils to them. Mr. David Fleming, of the Baldwin Packers at Honolulu, Maui, a very successful melon grower, spreads pigeon-pea brush flat on the ground as the vines begin to run. The brush holds the vines in place during windy weather.



Fig. 33.—The watermelon demands shelter, a warm, fertile, sandy soil, and reasonable moisture. These are the principal requisites of most vegetable crops.

The best soils for this class of plants are loams that are light, sandy, porous, and moderately rich. If only heavy soils are available, the hills or rows should be slightly ridged to carry off excess moisture in case of heavy rains. In ridge or row planting, the hills should be spaced from 4 to 10 feet apart in rows that are about twice as far apart as the hills within the row. From 1 to 3 pounds of seed should plant an acre. If seed is plentiful, it should be sown thickly, with 8 or 12 seeds to each hill. When well established, the hills should be thinned out to leave the 3 or 4 best plants on each hill. In extensive field planting, wide, open furrows should be plowed at proper distances for each ridge. The fertilizer should then be spread in the furrows. Then back-furrows should be made to cover the manure and to form the ridge, which should be slightly rounded, smoothed off, and made firm. This is best done by means of a plank, shaped to give the proper surface outline. If the soil is sandy loam, the seed should be covered with about an inch of earth; in heavier soils, the covering should not be more than $\frac{1}{2}$ inch.

As soon as the young plants appear above ground, cultivation should be started. If wide spacing of rows is practiced or if the vines send out runners to excessive length at the expense of fruiting, it might be well to pinch back the vines a fourth or a third. The intervening space may then be planted to a row of cow peas, soy beans, culinary beans, or peanuts. Such a cropping system will not only add direct money returns to the trucking enterprise but will provide certain cultural benefits such as better protection against wind (if planted at right angles to prevailing wind), better insect and disease control, equalization of the soil fertility and tilth, and fuller employment of the land, equipment, and labor.

If cut-worms and Japanese beetles are present, poisoned bait should be spread about the hill before the plants appear. As the young plants appear, they should be examined, especially on the underside of leaves, for aphids. When the first of these pests appear, the plants should be sprayed or dusted with nicotine sulphate. As the young fruits appear, they must be safeguarded from that ever-present pest, the fruit fly. For protection, the fruits and stems may be covered with thin layers of coarse excelsior shavings.

Although most vine crops prefer the cooler moist seasons of the year, they will continue to bear for a consider-

ably longer period if the fruit is kept completely gathered as it becomes ready for use. Cutting back the vines a fourth or a third will often prolong the season and increase the size of the fruit.

Irrigation. A dependable amount of moisture is essential to producing a good crop of all the members of the gourd family. Between the setting of the fruit and ripening of the first fruits, when both vines and fruit are developing rapidly and when the weather is hot and dry, frequent and copious irrigation becomes necessary. If moisture is lacking at this critical period, a large percentage of small or "pony" melons are likely to result. During the



Fig. 34.—How to handle the vine crops such as cucumbers, cantaloupes, summer squash, etc. This crop is the fall end of a "double cropping" or "successive cropping" system in which the vine crops follow early spring potatoes. This is an important lesson which the Hawaiian truck farmer must learn before he can succeed.

picking season, water should be again applied in amounts barely sufficient to prevent the vines from wilting. This practice gives quality and solidity to the fruit. Mulching

the plant about the roots with straw or rice hulls helps to conserve moisture and tends to keep the soil cool.

Harvesting. With cucumbers, summer squash, and most melons, it is more important perhaps than with any other vegetables that harvesting be done at the proper time. They should be gathered the moment they reach full size and before the seeds start to harden. The "fruits" should be carefully cut from the vine with a sharp knife. The crop should be gathered in the cool of the morning or evening.

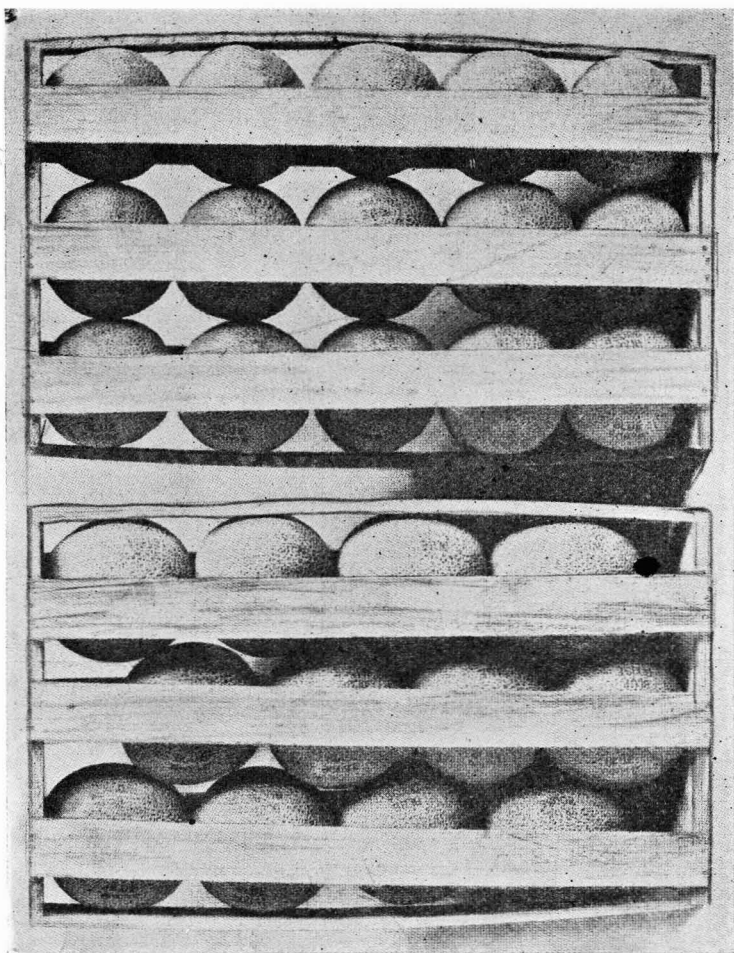


Fig. 35.—Cantaloupes packed in flats. Above—15 "standard" melons to the crate. Below—12 "Jumbo" melons. Note the trademark stamped on the individual fruits. After Circular No. 308 "Cantaloupe Production in California." Calif. Agri. Expt. Stat., Univ. of Calif.

To judge when fruits of the vine tribe are ready to harvest requires considerable experience, especially with those varieties which do not readily separate from the stem. One of the best indicators of ripening is in the small tendril where the stem of the fruit is attached to the vine. While the fruit is still developing, this small tendril remains fresh and green, but as the fruit ripens it turns brown and dies. Another good indication in many of the melon tribe is that the white or uncolored portion of the skin where the fruit lies on the ground takes on a creamy or yellowish tinge as the fruit ripens. Experienced growers depend chiefly on the sound of the melon when struck sharply with the knuckles of the hand. Ripe fruit gives a slightly hollow sound. A firm pressure on a ripe watermelon will cause "give" and a slight crack within. If kept in a cool place for a day or two, melons become sweeter.

It is estimated that more than 10 per cent of marketed watermelons and cantaloupes are so green that they are unfit for use. Every care should be exerted to prevent so great a loss.

Failure of the plants to set fruit satisfactorily during the main growing season results from lack of pollination. These vine crops bear separate male and female flowers on the same vine and the transfer of pollen is usually effected by bees or other insects. If insects fail to pollinate the flowers, hand pollination may be resorted to.

To produce extra large fruit, especially in melons and pumpkins, the farmer should fertilize heavily, supply ample moisture, and space the plants adequately. Inferior fruits should be thinned out. The fewer fruits on each vine, the larger will be the fruits produced, other conditions being equal. As the fruits develop, straw or grass should be placed under them.

Varieties. Varieties and strains in the vine crops are very numerous. The following varieties have been selected as the most satisfactory for Hawaiian conditions. However, the progressive market gardener should test other varieties.

Cucumbers: *Improved Long Green*, *Early Short Green*, *Giant Peru*, *Davis Perfect*, *Extra Long White Spine* or *Evergreen*, *Ford Hook Famous*.

Gherkin: *West Indian* (very prolific) and *Extra Early Green Prolific*, or *Boston Pickling*, are early maturing, prolific fruiting sorts that fit well as a short rotation crop. A demand for gherkins for pickling could be developed in

Hawaii. A small pickling factory should prove profitable, if carefully managed. Our imports of this commodity amount to several thousands of dollars annually.

Cantaloupe or Muskmelon: *Rocky Ford* or *Improved Netted Gem*, *Improved Perfecto*, *Improved Burrill's Gem*, *Tip-Top*, and *Honey Dew*.

Watermelon: *Black Seeded Chilian*, *White Seeded Angeleno*, *Florida Favorite*, *Kleckby Sweet*, *Klondike*, *Perfection*, and *Tom Watson*.

Squash and Pumpkins: Summer varieties of squash are extremely susceptible to melon fly attack, especially the *Bush Scallop*. Others are *White Bush Scallop*, *Golden Summer Crookneck*, *Straight Neck* (new), *Green Warted Hubbard*, *Sugar* or *Boston Pie Pumpkin*, and *Estampes*.

Those who intend growing cantaloupes should write for Agricultural Notes No. 7, "Growing Muskmelons in Hawaii."

CHAYOTE. This comparatively little known vegetable should be more extensively grown by the market gardener. It is sometimes called vegetable pear, mango squash, or mir-liton, and is botanically related to the squash and cucumber family. It thrives everywhere in Hawaii, frequently in places where the summer squash fails. Its pear shaped "fruit" may be eaten boiled, mashed, fried, stuffed, and baked, or it may be used cold in salads, in fritters, or made into sweet pickle. When cooked, its taste is not unlike that of summer squash. To some persons, chayote tastes like stewed oysters, or like salsify, the so-called oyster plant. Unlike most squash, the chayote holds its form perfectly when it is cooked. There are two varieties: One cream white in color, the other of a pale green tint. A chayote of average size should weigh about 1 pound, and should be about the size of a Bartlett pear.

The great advantages of the chayote over summer squash, for which it is a good substitute, are (1) that it is practically immune to fruit and melon flies; (2) that the plant has long life and fruits over a long season; (3) that it yields prolifically; (4) that it keeps well in storage; (5) that it is cheaply grown; (6) and that it makes an excellent trellis plant especially suited to cover unsightly out-buildings.

Chayote culture is extremely simple. Dormant plants (fruits), or those slightly sprouted, should be set out shallow in well-prepared garden soil in a sunny locality. The large end should be set down and slanting. The soil around

the plant should be packed down slightly and, as the shoots develop, a trellis should be provided to support the weight of the plant.

The plants should begin to bear fruit in midsummer, and should continue fruiting throughout the fall months.

Plant one strong "seed" or plant to each hill. Spaced 5 feet apart in rows which are from 5 to 8 feet apart along the trellis or in open rows with equal spacing, the crop should run from 680 to 1,742 plants an acre.

The local public will need to be educated to the use of this excellent squash-like vegetable, although it is a much appreciated article of diet in Southern California and in the south generally.

CELERY

Much has been said of the possibilities of growing celery commercially in Hawaii. The fact remains that at none of our numerous agricultural fairs has choice market-



Fig. 36.—The heavy celery should be grown. Note also overhead system of irrigation.

able celery been exhibited. Hawaii appears to lack typical celery soil. The best celery is almost universally grown on well-drained, easily-tilled muck soils of high fertility and high water-holding capacity. Celery is distinctly a cool weather plant. Were it possible to drain some of Hawaii's high-lying, swamp lands, such as those at Waialeale on Kauai, and then to permit the soil to aerate, these might become ideal celery areas. Notwithstanding these obstacles, the venturesome market gardener might well experiment in the production of the deservedly popular salad crop if conditions are at all favorable.

Planting. A light, rather than a heavy loam soil should be selected. This should be heavily manured and fertilized. From 30 to 50 tons of manure and at least $\frac{1}{2}$ ton of high grade chemical fertilizer should give the crop a good start. A large supply of humus seems essential for the proper development of this crop.

The plants should be started in cold frames and transplanted to the field 3 to 4 months after the seed is sown. Approximately $\frac{1}{2}$ pound of seed will produce enough plants to set out an acre. Before planting in the field, the farmer should bring the soil into the best possible tilth. If the soil is very light and loose, it should be rolled. The planting may be done in single rows, in flat beds for irrigation by flooding, on either side of a ridge, or in double rows on beds similar to the method recommended for lettuce culture. The propagating bed should be well watered before the seedlings are transplanted, so that the roots will not be unduly injured. The tops, as well as the roots, should be trimmed back before the plants are set out, in order to lessen wilting and facilitate planting. Irrigation water should be applied immediately after the plants are set.

The distance between rows will depend largely on the method of blanching to be practiced. When the soil is used to "hill up" for blanching, the plant rows should be 4 or 5 feet apart. When paper or boards are used, the rows may be a foot closer together. The plants should be spaced from 6 to 8 inches apart in the row.

The celery plant grows slowly during the first few months, and cultivation must be frequent and thorough.

Blanching. This process consists of destroying or preventing the formation of chlorophyll in the central leaves and may be accomplished by excluding the light, either by banking with soil or by the use of boards or paper set on end close to the plants. Blanching may also be caused by

the use of ethylene gas. The field method of blanching requires several weeks. Prolonged blanching may cause the stems to become pithy and unfit for sale.

Harvesting. When ready for harvest, the celery should be cut with a sharp spade, gathered, washed, graded, and packed in crates for shipment. Small stocks should be tied in bunches of a dozen each. Large stocks should be tied in bunches of 6 or 8 plants. The number of dozens packed in each crate should be stenciled on the outside of the crate.

Diseases. Celery is subject to a number of diseases. In the Glenwood district of Hawaii, where the crop grows fairly well, early and late blight and bacterial leaf spot must be contended with. These maladies may be kept fairly well in check by treating the seed with a 1:1000 mercuric chloride solution for 30 minutes, rinsing and drying the seed after the treatment. After the plants are in the open ground, they should be sprayed frequently with Bordeaux mixture.

Varieties. *Golden Self-blanching* is one of the most popular varieties, with erect plants which form a solid, large heart during the blanching period. The leaves are a pleasing yellowish green. There are both dwarf and tall strains of this variety. The former is recommended for our warmer lowlands and the latter for our higher altitudes.

Giant Parscal is the most important of the late winter sorts, with deep green foliage which blanches slowly.

Golden Plume is similar to *Golden Self-blanching*, very compact and less likely to become stringy than other sorts.

CORN

Sweet corn of good quality is always in demand in the Honolulu markets, and it is possible that a profitable export trade might be built up for this crop, if it were grown in sufficient quantity during the off season on the mainland.

By planting it in different locations at different elevations, sweet corn may be produced throughout the year. In the warmer lowlands, especially on the leeward sides of the islands, the crop is confined primarily to the winter and spring months. As the warm, dry season approaches, the crop becomes stunted, unless it is irrigated. And, in any event, attacks from aphids, the leaf hopper, ear worm, and mosaic disease are prevalent during the summer months. On windward Oahu, one extensive grower of sweet corn

found the best months for growing the crop to be September, October, November, and December. In the Makawao and Kula districts of Maui, excellent sweet corn has been grown throughout the summer months, and at Haiku, the best season is from February until the end of June. Sweet corn matures to the roasting ear stage in from 60 to 80 days.

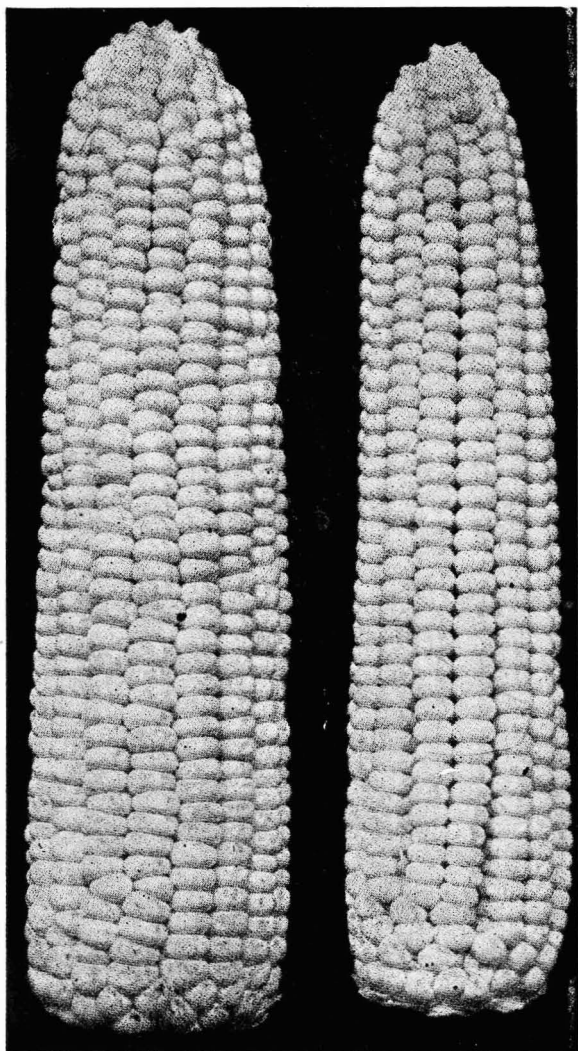


Fig. 37.—Late and Early Evergreen Sweet Corn. The Evergreens are the heaviest yielders and well suited for Hawaiian conditions.

Varieties. There are many varieties, and success with this crop will depend more upon the selection of a suitable variety than upon any other one factor. A few varieties of corn are especially recommended for the truck farmer on windward Oahu and in similar locations. The first choice should be *Alameda Sweet*, which bears ears about 8 inches long, with large, deep, ivory white kernels, tender skin, and a rich sweet flavor. Aside from its excellent quality, the strong tight husks which cover the ear protect it from the bird and worm depredations which cause so much loss each season. *Early Monmouth* is a good second choice for the truck farmer, because of its good quality and its strong protective husk. *Early Evergreen* (either Stawell's or Ferry's) is a fine old standard variety which matures late. This variety is suitable for canning purposes, because of its deep, white, sweet kernels. For the more intensive market gardener, the following early maturing varieties, which bear smaller ears than those listed above, are recommended: *Country Gentleman*, which, although its kernels are arranged in irregular rows, possesses an unusually fine flavor; *Alpha*, a very early variety, with small ears; *Golden Bantam Evergreen*, with deep yellow kernels, is much liked by some for its fine flavor and texture; *Charlevoix*, a comparatively little-known variety which should be tested by all commercial gardeners.

Culture. A rich, moist, light loam is the best soil for growing corn. Because corn grows rapidly, it is a greedy feeder and must be supplied with readily-available plant food and sufficient moisture to sustain its rapid development. The corn roots forage over a wide area of ground, necessitating the best possible tilth for the soil to as great depth as the land will permit. The land should not be cultivated deeply after the plants appear for danger of injury to the roots.

The land should be heavily manured before the crop is planted. Three good plowings at monthly intervals and as many disc harrowings should be given the land. Immediately after the last discing, the field should be marked off into 4 or 5-foot rows, and the seeds should be planted, by means of a horse corn planter set to drop the seed in drills from 4 to 6 inches apart in each row. Unless the soil is already very rich, a fertilizer attachment should be used on the seed planter to apply a 6-12-6 fertilizer at the rate of from 200 to 350 pounds for each acre. Because both these operations are performed at one time by this method,

the cost is nominal. A skilled workman, with a well trained horse or mule, can plant and fertilize from 3 to 5 acres a day. The market gardener may use a wheeled hand drill, or plant directly by hand.

Hand or horse cultivation should begin as soon as the corn shows above ground. The ground should be kept mellow and free from weeds throughout the growing season.

Harvesting. After it begins to tassel, the maturing corn must be watched carefully, and picked before it becomes over-ripe. After the picking season begins, the grower should go over the field daily, examining by "feel" the most fully developed ears, which should be harvested with regularity and thoroughness. The plants that are stripped of their ears should be broken down, in order to avoid confusion. The green residual corn plant makes a good feed for dairy cows. The cured sweet corn fodder is an excellent feed for chickens, if the sheaf is suspended off the ground for them to pick.

Under favorable conditions, yields of corn will range from 500 to 600 dozens of marketable ears for each acre during a growing season of from 75 to 90 days. The average price during the past year was approximately \$1.25 per bag of 7 dozen ears. However, choice ears have sold for \$2 and even \$2.50 per bag. An acre of good sweet corn should produce a crop netting at least \$100. The cost of production should not exceed \$75 for each acre.

Pests. The two most dangerous pests are the cut-worm, which attacks the seed at time of planting, and the ear-worm, which attacks the ear as it begins to set seed. For cut-worms, poisoned bait should be used in the manner recommended in the chapter on insect control.

The corn ear-worm, also known as the tomato fruit-worm, tobacco bud-worm, and cotton boll-worm, is a serious pest in Hawaii and wherever corn, tomatoes, tobacco, and cotton are grown. The moth that lays the eggs from which the worms hatch may be dull olive green, yellowish, or nearly white, and almost an inch long. It is most active at night, when most of its eggs are laid. One female may deposit from 500 to 2,000 eggs, which are usually placed on the leaves, silk tassels, and husks of the corn plant. The eggs hatch in from 3 to 5 days. When mature, the larvae are approximately 1½ inches long. They pupate in the soil. During the summer, the pupa lasts about 14 days, but the fall broods may pupate throughout the winter.

Fortunately, the eggs, larvae, and pupae are destroyed frequently by predacious enemies, parasites, and weather conditions. The larvae are also cannibalistic, and when they meet they fight until one is killed.

Perhaps the best remedy is to dust the plants with a mixture of equal parts of powdered lead arsenate and flour of sulphur. The first application should be made when the silks are an inch long and this should be repeated every week. This treatment is especially effective when the treated ears have long tight-fitting husks, as in the case of the *Alameda Sweet* and *Early Monmouth* varieties.

Aphids, which occasionally attack corn, are best destroyed by dusting with tobacco powder, or by spraying with nicotine sulphate. The corn leaf-hopper, which congregates in the heart of the young plant, is best controlled by the use of fine tobacco dust. The plants infested with mosaic disease should be destroyed.

EGGPLANT

When properly cared for, the eggplant succeeds in Hawaii as in few other places. It is typically a subtropical plant, requiring a rich, sandy loam and ample moisture for its fullest development. Although the plant is universally grown in Hawaii, it is not always grown to perfection, for the reason that sufficient care is not taken to provide suitable soil conditions and well grown seedlings, which are the two main factors for success. When the growth is once checked from any cause, this plant rarely recovers.

The plants should be propagated in a cold frame and developed into strong, stocky seedlings. Spindling and poorly grown plants cannot possibly produce a satisfactory crop.

Methods of Propagation. The seed should be sown in flats or in cold frames. When the seed leaves are fully developed, the seedlings should be potted off or reset in the seed bed 4x4 inches apart to give ample room for full development. Special care should be taken to avoid injuring the sensitive roots when transplanting them into the field. In well prepared soil, the rows should be spaced from 3½ to 5 feet apart, and the plants set from 24 to 30 inches apart in the row. The land should be well cultivated and the plants irrigated when necessary. An excess of water should be avoided. Good drainage is essential.

Harvesting. It is essential that the fruits be harvested in their prime. Because the fruit is used in the immature

stage of development, care must be taken not to let it attain its full size. Mature eggplants, although beautiful in appearance, are little more fit to eat than a rubber ball, so the grower must develop a sixth sense to tell him when the plants are ready for harvest.

Packing and Selling. Because eggplants may be one of the most attractive of vegetables, every effort should be made to enhance their appearance. First of all, the fruits must be prime in degree of maturity and freshness. Second, they must be graded uniformly to standard sizes, shape, and color, and must be free from blemishes of all kinds. For distant shipment, each fruit may well be wrapped in heavy white or thin paraffin paper to retard shrinkage through loss of moisture. Only the bright, plump fruits are in demand. The eastern markets use for shipping cases the standard 60-quart berry boxes and bushel hampers. Good shipping cases are essential if Hawaii is ever to ship fruit long distances for export.

Sales could certainly be greatly increased if this excellent vegetable were presented to the consuming public in the best condition. Another means of popularizing this wholesome product, as it might many other vegetables, are demonstrations to the housewife of the best ways to prepare eggplant for the table. The Home Economics Division of the Cooperative Extension Service is ready to cooperate with the commercial gardener.

Diseases and Pests. This crop is comparatively free from troublesome pests. Occasionally a blight and fruit rot appear in isolated cases. The fungus causing this malady is spread by spores on the seed and by *mycelium* in the seed bed. The disease may be carried over between seasons in the field in discarded dead plants. The most effective prevention methods are to destroy all diseased plants by burning, to use seed from non-infected fruit only, and to plant only in soil that is free from the disease. Spraying plants with Bordeaux mixture will check the spread of the disease, unless heavy rains prevail. A variety of eggplant known as *Florida High Bush* is said to be resistant to the wilt and fruit rot.

The planter should guard against the red spider, the cut-worm, the Japanese beetle, and aphids. The spider is an extremely small, reddish or yellowish mite, which usually attacks the underside of the leaves, especially during dry periods. It causes the leaves to turn pale and die. The best treatment for this pest is a dusting with a mixture of $\frac{3}{4}$ powdered sulphur and $\frac{1}{4}$ hydrated lime. From 30 to 40 pounds of this dust should cover an acre.

LETTUCE

Hawaii market gardeners produce large quantities of lettuce throughout the year, but the demand for imported California lettuce grows apace. This is because the critical consuming public demands crisp, solid head lettuce. The local market gardener has thus far failed to supply head lettuce equal in quality to the imported ones.

Although lettuce succeeds best in the cooler seasons of the year, such as the late fall, winter, and early spring months, the California grower succeeds in producing fairly good head lettuce throughout the year in certain favored localities near the coast.

Much of California's success in lettuce culture has resulted from a favorable climate and from the suitability of the varieties of lettuce grown to the specific conditions. Nevertheless, cultural methods have aided in the success of California lettuce growers. Our local growers have given insufficient study to varieties, seed selection, and location, and most local planters crowd their plants unduly. Other important factors in the production of good, tender head lettuce are an ample and regular water supply and rational fertilization. This crop, above all others, should be irrigated by the furrow system, and not by superficial surface irrigation so generally practiced in Hawaii.

Climate and Soil Requirements. Lettuce suffers during hot, dry periods, which cause the production of loose heads, a bitter taste in the leaves, and an earlier development of seed.

Although lettuce will grow on any fertile soil in good tilth where there is an ample supply of moisture, it thrives best in a moist, rich, compact, sandy loam which can be irrigated by the furrow system and can be drained thoroughly. If the drainage is poor, the crop should be grown on raised beds or ridges.

Manuring and Fertilization. Since crisp, tender, sweet lettuce is the product of rapid growth, the soil must be supplied with ample quickly-available plant food. Well composted manure, fortified with super or reverted phosphates at the rate of 100 pounds to each ton of manure, should form a good plant food base. From 10 to 20 tons of such compost to the acre of unmanured land should increase yields at least 50 per cent. The crop will mature a week or 10 days earlier than it would otherwise, and will produce larger heads of better quality. However, manure

and highly organic composts should not be used to excess, especially during the warmer season, when their use is conducive to the production of excessively large, loose heads. When manure or composts cannot be obtained in sufficient quantities to supply all the needed organic matter, leguminous green manure crops grown under fertilization, especially with phosphates and potash and, possibly, lime, may be used to advantage. The lettuce may be planted a month after the succulent, green-manuring crop has been turned under.

The minimum applications of concentrated chemical fertilizers to soil intended for lettuce culture should be at the rate of 500 pounds to each acre, and the maximum might exceed a ton for each acre. The chemical fertilizer recommended in the fifth chapter sells locally for about \$62.50 per ton. Because the lack of nitrogen usually limits the growth of the lettuce plant, additional nitrogen may be applied as a side dressing or in the irrigation water in the form of nitrate of soda, sulphate of ammonia, or one of the highly concentrated synthetic forms, such as calcium nitrate or urea. Dried blood is an excellent organic form of nitrogen. Finely ground bone is a good source of phosphorous and lime. The phosphorous and lime should be applied at the time the plants are set out.

While part of the complete commercial fertilizer may be drilled in the rows immediately before the seed is sown or the plants set, the ammonia salts or nitrates, because of their quick action and ready loss through leaching, should be side-dressed after the plants are well established and, preferably, after the plants have been thinned out. From 50 to 100 pounds of these nitrogen salts may be used on each acre at each application. Not more than three applications should be made during the growing period. These highly soluble fertilizers are best applied immediately before irrigation. However, they may be applied in the irrigation stream, a practice common on some of the sugar plantations.

Care should be taken to avoid too much nitrogen fertilization and irrigation when the plants are about to head, because of the danger of overstimulation, which causes oversized, soft heads that may rot or burst. Excessive nitrate absorption may also cause the lettuce to poison those who consume large quantities of it, although this is a remote probability. Liquid manures and night-soils have no place in the culture of lettuce or any salad vegetables,

although such materials may be composted with barnyard manures and other organic matter and, when completely disintegrated, used sparingly.

Preparation of the Land and Cultural Methods. Good soil tilth is essential to the rapid growth and perfect development of the lettuce plant. After the ground has been well tilled, the land should be leveled and the beds or ridges made of uniform height, so that the irrigation water can be applied evenly over the bed.

In California, the general practice is to grow two rows

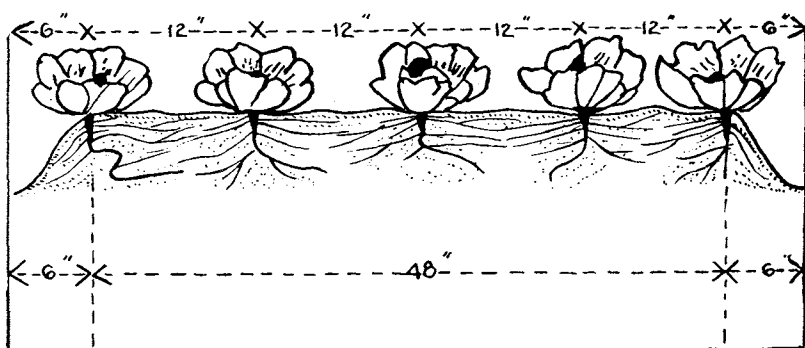


Fig. 38.—Cross section of a typical lettuce bed in Hawaii. Plants crowded to excess. (See Fig. 40.)

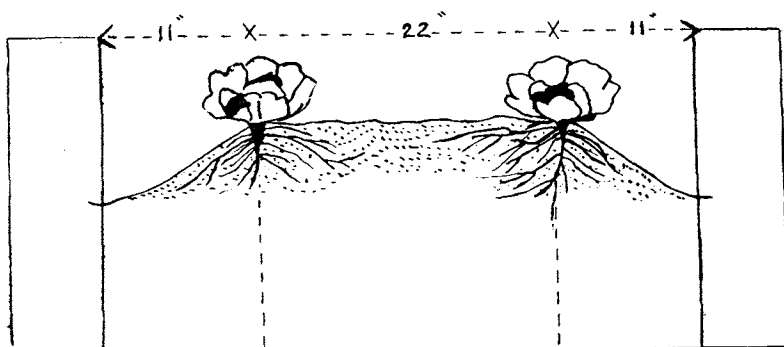


Fig. 39.—Cross section of a typical lettuce bed in California culture. Especially suited to extensive field culture. (After Schwalen & Wharton.)

of lettuce on a bed or ridge, with furrows between the ridges for irrigation. The beds vary from 18 to 22 inches in width, as do the furrows. The beds are seldom less than 3 feet from center to center. The furrow may be made with

single or double listers, celery hillers, or plows. Then the top of the ridge is smoothed in a way similar to that used in preparing beds for pineapples before applying the mulching paper. Planting follows immediately the formation of the plant beds.

In Hawaii, lettuce is usually first sown in a seed bed and then transplanted. When this method is followed, the plants should be from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches tall, stocky and well-hardened before they are set out. When the seed is sown directly in the beds where the crop is to mature, the usual method in California, a wheeled drill seeder of standard type may be used effectively. On the large California lettuce farms, the ridges are often plowed, smoothed off, and the seed sown in one operation by a specially devised implement. Such elaborate equipment is hardly justified under the more restricted conditions in Hawaii.



Fig. 40.—Hawaiian method of lettuce culture. Plants crowded to excess.

Lettuce seed is small and should be sown at a depth of $\frac{1}{8}$ inch. It is important to pack the soil over the seed. It should be sown at a rate to produce not more than 10 plants to each running foot, because heavier seeding increases the cost of thinning and is wasteful. When all cultural conditions are favorable, approximately $1\frac{1}{2}$ pounds of seed will be required to plant each acre.

The distance between the plants in the rows should not be less than 12 inches in the double row ridge planting, and at least 20 inches between the rows and ridge centers.

In single row planting, plants should be set at least 12 inches apart in rows or ridges spaced 18 inches apart.

Where transplanting is practiced, spacing the plants may be simplified. The plants should be "blocked" out about 12 inches apart in the row, by means of a special short-handled hoe and, at the same time, they should be



Fig. 41.—Lettuce breeding. Hawaii Agri. Expt. Stat., University Farm, 1931.

thinned by the other hand until only one is left in a place. Thinning is an important operation in direct-seeded lettuce and is usually done under contract, a part of the contract money being withheld until the work is finished in a satisfactory manner. Beds and furrows are usually cultivated before thinning, and all weeds left by the cultivator should be removed by those doing the thinning. The plants should be thinned before they start to crowd. In favorable seasons, this may be three weeks after planting. In less favorable seasons, there may be no crowding for a month.

Thinned-out plants may be transplanted when conditions are favorable.

Irrigation. When furrow irrigation, the approved method, is practiced, the water should be allowed to "sub" through the beds. Irrigating the beds immediately after planting or sowing is the usual practice, although some prefer to irrigate before planting, especially if the soil is dry. The water is often kept running in small streams down the furrows until the plants are well established. This cools the soil and insures a good stand. In rainy weather, such irrigation is unnecessary. In heavy soils inclined to bake, deep furrows should be used with a small head of water, in order to prevent over-saturation of the soil.



Fig. 42.—Lettuce beds at Kalakaua Avenue, Honolulu. Illustrating intensive Market Gardening as practiced by the Oriental gardeners throughout Hawaii.

Harvesting. When the heads begin to grow firm, they are ready to be harvested. Immature heads are softer and darker in coloring than are prime mature heads, and will wilt more readily. On the other hand, over-mature heads may develop a "core" and may be tough and bitter. When ready to harvest, the heads should be light colored, firm and crisp. At this stage, they should be harvested by cutting just below the surface. The outer leaves should not be trimmed until the lettuce is in the packing shed, because

they afford a protective covering. The heads should be packed into light, open baskets or crates in the field as soon as they are picked. Moisture and soil should be shaken from the heads before they are placed in the containers.

Lettuce heads supercharged with moisture are crisp and brittle, and the leaves require careful handling to prevent damage in transit. Therefore, every precaution must be taken to prevent bruising.

Lettuce heads that show decay, that have begun to develop seed stalks, and those which have burst should be discarded in the field. Wilted heads or those gorged with water should not be harvested. Only heads that are prime when harvested can be kept so for market. All heads cannot be harvested at one cutting to the best advantage.



Fig. 43.—Choice head lettuce is the result of suitable variety and good cultural practice.

Grading and Packing. All loose, diseased, and damaged leaves should be trimmed off at the packing shed, and loose, deformed, undersized, and excessively large heads should be culled. Culled material can be used to advantage for feeding poultry, cattle, and swine. The selected heads

may then be packed for shipment in standard size, slatted crates. The standard crate is 24½x18x13 inches in size, and holds from 3 to 7 dozen heads, depending upon the size and shape of the lettuce heads. The crates should be lined with heavy, water-proof paper when intended for distant shipment. Lettuce that is to be held for more than a day should be placed in refrigeration. It should never be permitted to wilt.

To compete against California's very successful fresh lettuce shipments, Hawaii growers will need to give careful attention to seemingly small details. One of the most important of these details is the matter of maintaining the highest quality and standards possible.

The United States standard grades for lettuce, formulated by the Bureau of Agricultural Economics, United States Department of Agriculture, require that all heads of lettuce under U. S. No. 1 grade (1) be of like variety characteristics, (2) be fresh and well trimmed, (3) show no decay, split, or burst, and (4) be free from seed stems, doubles, and from damage caused by dirt, tip burn, disease, insects, or mechanical cultivation. Not less than 75 per cent of *Iceburg* type lettuce must be firm and the remainder should be fairly firm. Heads of the *Big Boston* type must be fairly firm. "U. S. Fancy" is of even higher grade than that mentioned above, especially in regard to the firmness of the heads.

These are standards to which the Hawaii grower must aspire, if he is to compete successfully with the growing imports from California.

Varieties to Plant. Although the surest and most successful head lettuce now grown in Hawaii is *Henderson's Mignonette*, an early maturing variety ideal for the home garden, this variety is not popular with the trade, because of its small size and its bronze-tipped outer leaves. California and other great lettuce-growing districts have standardized the *New York* variety, and it is upon this one variety that California's important lettuce industry has been built. This variety is also known as *Los Angeles*, *Los Angeles Market*, *Wonderful*, *New York Special*, and *Mountain Iceberg*. Other promising varieties are *Crisp Heart*, *May King*, *Salamander*, and *Unrivalled*. The *New York* variety is extensively grown by Hawaii's market gardeners, but it does not head well in our warm lowlands, except during the coolest season.

Hoping to develop a good head lettuce especially suited

to Hawaiian conditions, the Hawaii Experiment Station several years ago undertook to breed new varieties and to establish a superior strain. This they seem about to accomplish, by crossing the standard strains of *Iceberg* with *Los Angeles White*, types which are similar in that they both produce firm heads and crisp curly leaves, are light in color, and of excellent flavor. This hybrid strain, now fairly well established and running about 50 per cent true to type, is not yet ready for distribution. However, during the past year, fully 20 per cent of the heads of this variety weighed a pound or more each. The heads are well formed and fairly firm. Housewives who have tested this lettuce state that they consider it equal, if not superior, to the imported lettuce for salads.

Market gardeners may well look forward to the introduction of this new variety by the Hawaii Experiment Station.

Pests and Diseases. Lettuce in Hawaii has not generally been subject to many destructive insect pests or diseases. Cut-worms, grasshoppers, Japanese beetles, and slugs occasionally do minor damage. Control methods for combating these and other pests are treated in another chapter.

Bird depredations occasionally cause damage when the lettuce is young. The rice grower who branches out into vegetable growing will know how to handle this pest. The United States Department of Agriculture recommends the use of poisoned grain, a formula for the preparation of which is given in the chapter on pests.

A common disease of lettuce in California is "tip burn," which is most prevalent when warm weather follows cool, foggy, or cloudy weather. Excessive irrigation seems to favor this non-parasitic disease. No remedy for "tip burn" is known. "Slimy soft rot" or "slime" is caused by a fungus. Conditions favorable for "tip burn" seem to favor this latter disease. Should this disease appear here, the affected heads should be destroyed by burning. "Downy mildew" is also caused by a fungus. The disease is indicated by slight green or yellow areas on the upper surface of the leaf. On the under side, the affected areas appear as downy white molds. These finally become brown. Affected plants should be destroyed.

"Brown blight" is said to have caused much damage in the Imperial Valley in California. The disease stunts

the plant, and partly headed plants show irregular blotches and streaks of dark brown, with withered leaves. Fields in which the disease appears for the first time should be planted with other crops the following season.

It would seem worth-while to treat all imported seed before planting, although it is not known to what extent these diseases are carried by lettuce seed.

Yields. Yields are the most variable factor in crop production, and lettuce is no exception. California lettuce growers produce from 200 to 335 crates on each acre, and, as the crate of average size contains about 4 dozen heads of lettuce, the yields may be said to average 1,000 dozen heads for each acre. With ordinary wide planting, as recommended in this bulletin, a 50 per cent stand of salable heads would equal the average California yields. Honolulu wholesale prices would probably range between 25 and 50 cents per dozen heads for prime lettuce, which would give the producer from \$250 to \$500 an acre for this short season crop. It is not possible to state cost of production at this time, but \$200 an acre seems a reasonable estimate.

Conclusions. The possibilities for the development of an important minor industry in lettuce growing in Hawaii appear to be excellent. Not only is there a large local consumption of lettuce, but our large shipping interests will doubtless demand large amounts of fresh lettuce when we can supply a prime product on short notice. Much of Hawaii's future outlet for fresh vegetables can be developed through catering to our ever increasing steamship passenger service. The average consumption of head lettuce on each steamer between Honolulu and Pacific coast ports is at least one gross heads a day, about 60 dozen heads per voyage. From Honolulu to the Orient, the consumption is about double. A conservative estimate of the potential outlet for lettuce on steamers touching the port of Honolulu is 15,000 dozen heads a year, valued at from 50 cents to a dollar per dozen.

Many acres of land in Hawaii might be converted to lettuce culture. Oahu alone has more than a thousand acres of marginal rice land that could produce excellent lettuce and other vegetable crops in rotation.

ONIONS, GARLIC, AND LEEK

ONIONS. Next to potatoes, cured onions are the vegetable crop most extensively imported into Hawaii. The 1930 imports amounted to 4,731,187 pounds, valued at \$177,419. There seems to be no good reason why the truck farmers of Hawaii should not grow most of the onions consumed in Hawaii and, possibly, export some stocks to the mainland during off seasons there. A decade or two ago, very choice Bermuda onions were grown on windward Oahu, on Maui, and in several other districts of the Territory, but heavy importations from Australia finally caused this infant industry to languish and die.

Onion growing is an intensive culture and only the skilled truck farmer, favorably located in respect to soil and climate, should attempt to grow onions extensively. No attempt should be made to produce onions in excessively rainy districts, because of the weed factor and the difficulty of ripening the bulbs.

Varieties. Perhaps the most important consideration is the varieties to grow in Hawaii. We have tried several of the standard sorts, such as *Australian Brown*, *Silver King*, *Prize Taker*, *Red Wethersfield*, *Southport Yellow*, *Globe*, and *Yellow Danver's Flat*. However, only the *White* and *Yellow Bermuda* and the *Crystal White Wax* have proved wholly satisfactory. Nevertheless, those who propose to grow onions for dry bulbs should try all promising varieties. The matter of next importance is to secure the best seed obtainable. The seed used should be true to type and of high germinating ability. Choice seed costs from \$3 to \$6 per pound, according to the variety of the previous season's seed crop. Four to five pounds of seed are usually sown on each acre.

The Soil and Its Preparation. A rich, sandy, or silty loam, well fertilized, is the most likely to produce a profitable crop of large, shapely bulbs of high quality, the only kind that can compete successfully with the imported onions.

The soil should be put into the best possible tilth and the surface made level before planting is undertaken. Clods of soil and plant debris have no place in an onion patch. All weeds and weed seeds should be destroyed before the crop is sown. The excessive cost of weeding the onion patch has made many an onion crop unprofitable. No farm operation will prove more profitable in onion culture than

repeated harrowing and "planking" to destroy weeds, make the soil fine, and level the ground before planting. It is well to apply whatever fertilizer is needed a week or two before planting. The fertilizer should be broadcast at the rate of 500 pounds to a ton of the following mixture: nitrate of soda or sulphate of ammonia, 500 pounds; dried blood, 350 pounds; acid phosphate, 1,000 pounds; sulphate of potash, 150 pounds. This equals 1 ton of a 5-8-4 formula. If the soil is inclined to be acid, lime should be applied a month or two before the crop is sown.

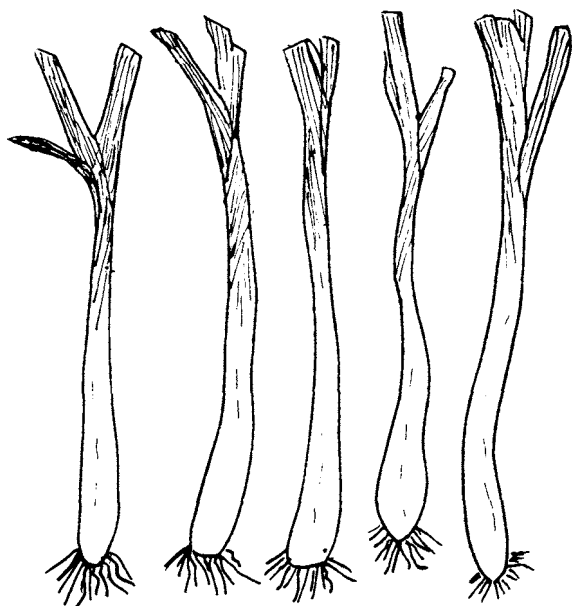


Fig. 44.—Seedling onion plants trimmed ready for transplanting by the "New Onion Culture" method. After Farmers' Bulletin No. 354, "Onion Culture." Natural size.

The onion rows may be spaced from 12 to 18 inches apart and should be as straight as possible to facilitate cultivation between the rows. For areas of 5 acres or less, a man-pushed, wheeled, mechanical drill seeder will be adequate for sowing. Do not attempt to sow extensive areas by hand, for this practice is uneconomical, wasting both time and seed. The seed should be placed at a depth of $\frac{1}{2}$ inch and the soil should be pressed down. Ample moisture in the soil is needed to germinate the seed without resorting to irrigation within a week after sowing. Under favorable conditions, the seedlings will appear within 7 days. During

the first month, the plants will need very careful cultivation because of their small size. The hand wheeled cultivator should be run between the rows at frequent intervals to keep the soil mellow and free from weeds. Occasionally it may be necessary to rake lightly by hand, in order to break the crust of earth over the seed, so that the delicate seedlings can break through. Hand weeding may be necessary at the beginning and must not be neglected.



Fig. 45.—Onions pulled and ready for topping. Yield 800 bushels per acre.

Thinning must be resorted to, if there is overcrowding of plants. Thinned-out plants may be replanted to good advantage, if the seedlings are of the right size.

Scallions, "thick necks," doubled, and misformed bulbs are usually the result of poor seed and improper cultivation.

Harvesting and Curing. When the necks or base of the stems of the onions shrivel and the tops fall over and wilt

following normal growth, the crop is mature and ready to harvest. If the tops dry from the tip toward the base while still erect, the neck of the bulb is not closed and the bulbs will not keep well in storage. Such bulbs should be sold with as little delay as possible. The grower should determine whether the crop is to be stored or placed on the market immediately before he begins the harvesting. For immediate marketing, the bulbs should be well ripened. If they are to be stored, they should be harvested somewhat earlier and allowed to cure in storage. Over-ripening results in a tendency to rot. When retarded, the ripening process may often be hastened by rolling a very light roller or barrel over the onion tops to break them down. This process is termed "barreling."



Fig. 46.—Onions drying in windrows, showing crates used for curing and storing.

Onions are usually pulled by hand and thrown in wind-rows of about 10 onion rows to dry. Sun-scald must be guarded against, especially in the *White Crystal Wax* and *White Bermudas*. When they have been allowed to lie in the sun for a day or longer and are thoroughly dry, the bulbs should be topped with a sharp knife or a strong pair of shears, sorted to grade, and crated or bagged. Slatted crates, instead of sacks, should be used for fancy Bermuda onions. When onions are to be stored, they must be thoroughly cured. Good storage onions should crackle like dry

wood shavings. In order that the bulbs may remain bright and attractive in appearance, they should be packed loosely in bushel crates, placed where good ventilation is afforded, and they should be kept cool and dry throughout the period of storage. If this cannot be done, the grower should dispose of the crop as soon after harvest as possible.



Fig. 47.—Inside of storage houses, showing method of stacking crates of onions.

Growing Onions from Sets. Onion bulbs are usually grown from seed sown directly where they are to mature. The transplanting of small seedlings from a seed bed, known as the "new onion culture," is often practiced with success, but requires the most favorable conditions, tedious work, and much skill. On the other hand, early onions may readily be grown from "dry sets." These "sets" are small bulbs produced by growing the plants under an excessively crowded condition and then drying them prematurely. Dry sets may be grown on any productive soil. Between $\frac{1}{2}$ pound and 1 pound of seed may be sown to each square rod ($16\frac{1}{2} \times 16\frac{1}{2}$ feet). When the bulbs are about $\frac{1}{2}$ inch in

diameter, they should be permitted to ripen prematurely and, when dry, they should be pulled and stored for use as "sets." From 3 to 4 weeks may be gained by this method of culture.

In parts of southern Texas and California, most of the Bermuda varieties and large Spanish and Italian onions are grown from transplanted seedlings or "green sets." The seed is sown in late summer or early fall in open beds. When ready for transplanting, the seedlings are pulled and the roots trimmed to a length of about $1\frac{1}{2}$ inches. The tops are cut back severely. Careful irrigation is necessary to establish transplanted green sets.

Irrigation. In the Bermuda district of the Southwestern states, surface irrigation is almost universally practiced. The Bermuda onions are planted mostly in comparatively level beds with dividing ridges and are flooded once each week or 10 days during the growing period. About a week before the plants are set, the soil is flooded. Then it is worked over with disc and smoothing harrows immediately before the planting. Within a day or two after planting, the land is again flooded and the surface water drawn off; this process is repeated with alternate cultivations as often as the land becomes dry. Toward the end of the growing season, the irrigations are diminished and then suspended to allow the bulbs to ripen. Usually 10 irrigations are required for each crop. The cost is about \$1.50 an acre for each irrigation or \$15 an acre for the crop.

Grading. The mature bulbs should be graded by passing them over a slatted table, the slats being set about $1\frac{1}{2}$ inches apart to allow debris and small onions to pass through. Further grading can be done on a modified potato grader. In general, U. S. Grade No. 1 onions must be of similar varietal characteristics, firm, mature, well-shaped, free from doubles, splits, bottle necks, scallions, earth, onion tops, or other foreign matter, and from damage caused by sprouting, bruises, disease, and insects. A tolerance of 5 per cent is allowed below the requirements of this grade, but not over $\frac{2}{5}$ of this tolerance is allowed for decay. U. S. Grade No. 2 is of a somewhat lower standard, especially for the varieties of larger size.

Most mainland grown onions are marketed in 100-pound, "grass packs." These are of coarse, open mesh,

affording good ventilation and making an attractive container through which the bulbs can be seen. Choice Hawaiian grown *Crystal Wax* and *Bermuda* onions should be marketed in bushel crates to prevent injury of the tender bulbs in transit. Standard size onion crates are 20 inches long, 16 inches wide and 14 inches deep, outside measurements.

Pests and Diseases. The greatest enemy of the onion in Hawaii is the onion thrip. Thrips congregate at the inner base of the leaves and suck out the plant juices, causing the plant to deteriorate rapidly. The adult insect is only about 1/25 of an inch long and pale yellow in color. The eggs are laid just beneath the leaf surface and hatch in 4 or 5 days.

It is difficult to control thrips by sprays or dusts. Therefore, it is best to exercise every possible preventive measure. To this end, the cultivation of headlands and waste places will do much to keep down weeds and grass that harbor the pest. All vegetable trash that cannot be buried should be burned. There are said to be a number of parasites that prey upon the thrips, among which the spotted ladybird serves a most useful function. Heavy driving rains frequently destroy great numbers of the pest.

Of the several insecticides recommended for controlling thrips, finely powdered tobacco dust of high nicotine content usually proves fairly effective and has been found useful in controlling the thrip on pineapples. From 40 to 50 pounds of tobacco dust to each acre will be required for each application. Soap-nicotine-sulphate spray, once considered an all around specific, has been found ineffective in destroying the eggs or the nymphs. Many of the winged adults likewise are unaffected by this spray.

Of diseases, the onion mildew is prevalent in some seasons. The first indication of this disease is a faint, violet, furry covering on the outside of the leaf, especially conspicuous when the foliage is wet. In a few days the leaves become pale green, then yellow, and finally collapse. Control methods recommended by the best authorities are as follows: Plant the rows in direction of prevailing winds to avoid stagnant air, provide good drainage, and avoid close proximity to windbreaks which interfere with a free circulation of air. Dust the plants with flour of sulphur, or spray them with a 5-5-50 Bordeaux solution.

Onions should be planted on new ground whenever possible, or a 3 to 5 year rotation system should be used.

Yields, Cost of Production and Profits. Under favorable conditions of soil, season, and management, yields should range from 10,000 to 20,000 pounds of salable bulbs for each acre. Hawaii's 1930 importations of bulb onions brought an average of 3½ cents per pound. Locally grown *Bermuda* onions have sold for as much as 7 cents per pound wholesale, with an average price of 4 cents. On this basis, growers might expect gross incomes of from \$450 to \$800 an acre.

The cost for producing the crop checks up about as follows:

Rental of land per acre.....	\$ 25
Tillage: 4 plowings, harrowings and plankings @ 12.50 per acre.....	50
Manure and fertilizer.....	100
Seed	25
Cultivation and weeding.....	75
Irrigation	15
Harvesting, grading, and packing.....	50
Incidentals (spraying materials, etc.).....	10

Total cost of production.....\$350

In other words, a minimum crop should sell for more than the cost of production, and a maximum crop should pay a handsome profit.

Green Onions for Bunching. The production of green onions is the phase of onion culture that has received greatest attention in Hawaii. For this purpose, the varieties known as multipliers and top onions are generally employed. However, green bunching onions are also grown from ordinary varieties by sets, from inferior and damaged large bulbs, and directly from seed. The multipliers and top-onions are best suited for this purpose.

Culture of Green Bunch Onions. For the economical production of this crop, the seed, sets, or bulbs used for propagation may be planted at all seasons of the year in Hawaii, although the late fall, winter, and spring months are the most suitable. They may be planted in raised beds in winter and on level or depressed beds in summer. The rows should be spaced at least 12 inches apart, with the plants set closely together. The soil should be rich and mellow. The space between the rows may be mulched with rice straw, a practice which causes the onions to blanch and become milder in taste.

Marketing Green Onions. In marketing this class of onions, the farmer should pull the young shoots at the

proper stage of development. The roots should be trimmed, and the outside sheath leaves peeled off, leaving the stem white and clean. The onions should be tied in bunches of from 10 to 50, according to size. Raffia makes the best standardized tying material. The tops should be slightly trimmed, after bunching. The bunches should be packed in waxed-paper-lined crates for shipment or sale on the local market. This phase of the onion industry is limited to small plantings and is profitable as a side-line for the general market gardener.

The extensive onion bulb producer has an opportunity for profit on part of his crop for a special trade. In thinning out his crop at successive stages, many of the young, medium sized bulbs may be disposed of for pickling, as bunch onions for stewing purposes, or for preparation like early young creamed potatoes. Housekeepers might be educated to avail themselves of this by-product, to the advantage of all concerned.

GARLIC AND LEEK. Garlic and leek are closely related to the onion and may be grown by the same methods. Although there seems little inducement to produce leek extensively in Hawaii, the dried and cured garlic might have possibilities, for a large quantity is imported from the mainland. In addition, there are possibilities for export.

Garlic, like onions, is produced by planting the separate bulbets, or "cloves," which are tightly clustered in bunches enveloped in a silvery skin. The rows may be spaced about 15 inches apart and the "sets" spaced about 6 inches apart in the row. They may also be planted without separating the bulbets. This would necessitate setting the plants a foot apart in the row. They should be planted shallow in well cultivated, rich, light soil, to allow for free expansion of the bulb.

Garlic, a true perennial, will continue to grow year after year, producing bulbets without replanting, while the onion is short-lived and must be harvested as soon as it matures. The usual price is about \$3 or \$5 per 100 pounds.

PEPPERS

All varieties of pepper thrive in Hawaii, for the pepper is typically a sub-tropical plant. The "hot" or pungent varieties are valued primarily for seasoning, while the milder sorts are used for salads, stuffing, and pickling.

It is best to start the seedlings in cold frames and transplant them to the field when the plants are well

established, the general handling of the crop in this respect being similar as in the culture of tomatoes.

The soil for peppers should be rich and of good tilth. Spacing between the rows is usually from 36 to 42 inches. The plants should be spaced from 18 to 24 inches apart in the row for field culture. Pepper plants should be treated in the same manner as tomatoes.

Varieties. Peppers of the *Bell* type are non-pungent, large, chunky, and thick walled, with deep depressions at both the stem and flower ends. The best varieties in this group are the *Chinese Giant*, *Bull Nose*, *California Wonder*, *Ruby King* and *Ruby Giant*, the last two being somewhat elongated. These varieties are grown most extensively for use as green peppers.

The *Pimiento* type peppers are medium sized, elongated and tapering, thick fleshed, and smooth surfaced. The leading variety is *Perfection*.

Chili is one of the well known pungent "hot" types used mainly as a condiment. When dried and ground, it produces the red pepper of commerce. The two leading varieties are *Red Chili* and *Tabasco*.

Cayenne is considerably larger than the *Chili* group and is distinctly pungent. The leading varieties are *Long Red Cayenne* and *Anaheim*.

Paprika pepper is of Hungarian origin. It is mildly pungent, and has thicker walls than *Cayenne* and deep red conical pods. This pepper is much sweeter than any of the other pungent types and is more freely used in the ground form than *Cayenne*.

It is believed that pepper culture has great possibilities in Hawaii.

IRISH POTATOES

Potatoes should prove a profitable crop for the truck farmer operating on an extensive scale. The most favorable time for growing potatoes in the lowlands is during the early spring months, when the weather is cool and moist. This is also the season of best prices. Potatoes make a splendid crop to follow a crop which matures late in the fall, such as beans. Truck farmers interested in this crop should send for Agricultural Extension Bulletin No. 15, "Commercial Potato Production in Hawaii."

SWEET POTATOES

There are few regions where more varieties and a better quality of sweet potatoes are grown than in Hawaii. Here it may be said to be a universally grown crop. Nevertheless, the markets are often bare of prime stocks and are frequently glutted with inferior stocks. The reason for this is that no truck farmer has seriously considered the sweet potato as an important, staple vegetable that can be harvested every week throughout the year, capable of high standardization and close grading to meet a select trade.

It must be puzzling to every thinking person that in 1930 Hawaii imported 122,226 pounds of sweet potatoes from the mainland at a cost of \$7,333, an average of 6 cents per pound, when our locally grown sweet potatoes went begging at 2 cents per pound! Twenty years ago, sweet potatoes were shipped in the off season, to California, when they sold for from 5 to 8 cents a pound wholesale and netted for the grower from 3 to 5 cents per pound. Well may our market gardeners and truck farmers ponder these facts and act accordingly.

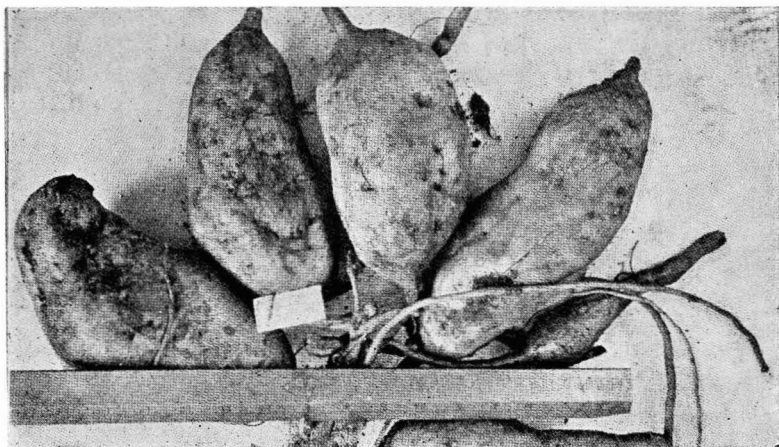


Fig. 48.—A fine "hill" of sweet potatoes. Hybrid variety No. 3874, bred by Mr. H. L. Chung at the Hawaii Agri. Expt. Stat. They make a fine off-season crop, conserve fertility, maintain a good soil texture and control weeds. (Courtesy Hawaii Agri. Expt. Stat.)

The following cultural directions are gleaned mainly from the writer's personal experience as a grower and shipper of prime stocks produced in the Haiku, Maui, district during the years 1914-1920.

Soils, Fertilizers and Cultural Methods. The largest yields and highest quality of sweet potatoes are produced on light, sandy loams, although soils of closer texture produce good roots. The truck farmer who desires his crop to have good keeping qualities, suitable size, good shape, and smooth, bright appearance, should avoid heavy and moist soils, which favor excessive vine growth and ill-shaped and soggy tubers which will not keep well.

Unless the soil is inherently rich in humus, it will pay to green-manure or to add manure and fertilizer. Organic fertilizers, if used, should be applied before the crop is planted, or they will stimulate excessive growth of the vines. The excessive use of nitrogenous fertilizers should be avoided for the same reason. Ordinarily, a 4-12-8 formula, applied at the rate of from 500 to 1,000 pounds to the acre in the plant row furrow at time of planting or, better still, a week before planting, will usually give profitable results. The fertilizer should be well cultivated into the bottom of the furrow.

The rows should be marked off 36, 48, or 60 inches apart, depending upon the variety, richness of the soil, the amount of moisture present, and the general cultural methods adopted, and the cuttings placed 15 or 18 inches apart in the row for ordinary field culture. If the rows are 4 feet apart, these spaces should give 8,712 and 7,260 hills respectively to each acre. Under favorable conditions, each plant so spaced should yield from 2½ to 5 pounds of potatoes, a total of from 18,000 to 40,000 pounds of tubers from each acre. Half of even the largest of these yields should be marketable as prime stock.

Such crops as these should yield from \$200 to \$300 an acre every year. To produce the crop on a field scale should not cost more than \$150 an acre. In suitable localities where an ample supply of seed stock of the best varieties is available, sweet potatoes can be made the most economical and profitable truck crop that the Hawaiian farmer can grow.

The canning of sweet potatoes offers possibilities in Hawaii. If such an industry were established here, it should provide a fine outlet for the so-called "second" grade potatoes. These could be produced for less than \$20 per ton.

The culls make excellent feed for swine and poultry,⁷

⁷See Circular No. 4, "Poultry Feed Supplements" by C. M. Bice, Hawaii Agricultural Experiment Station, 1932.

especially when cooked and fed with tankage. If produced extensively enough, sweet potatoes may become the means of making our swine and poultry industries of great importance by virtue of the cheapness of cull sweet potatoes as feeds. Poultry and swine should be kept as an adjunct to the truck farm enterprise. The sweet potato tops are also valuable swine and dairy stock feed, especially when cooked and balanced with animal proteins such as milk powder, dried blood or tankage.

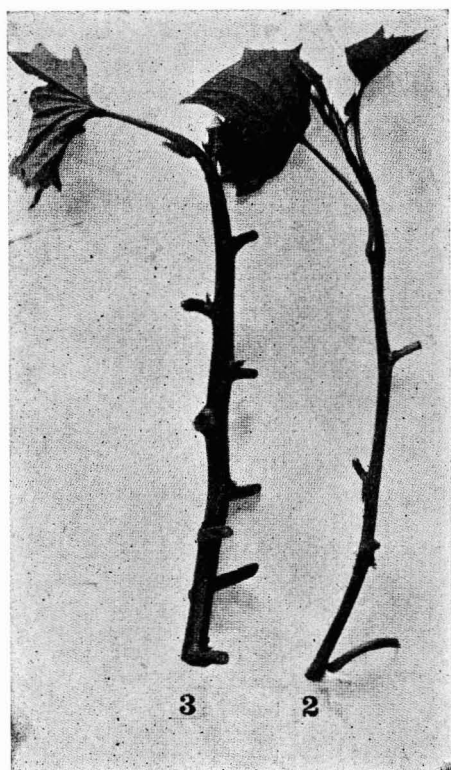


Fig. 49.—Sweet potato cuttings ready for planting. No. 3, an ideal, strong, close jointed cutting. No. 2, weak and spindling (Courtesy Hawaii Agri. Expt. Sta.)

In Hawaii, sweet potatoes are grown from cuttings. Vigorous tip and second section cuttings are preferable to mature butt cuttings, because the latter are usually slow to root. Stocky 12-inch cuttings, with from 7 to 10 sound

eyes, are best. Whenever the season and general cultural conditions permit, flat, level culture should be practised. Ridge culture may be resorted to in the wet season, in regions of excessive rainfall, or where the soil is heavy.

After plowing the furrows to a depth of 7 inches and applying the fertilizer, the farmer should set the cuttings at a slant along one side of the furrow to a depth of about 8 inches. Then, he should plow a light "furrow slice" against the cuttings, only half filling the trench. The soil at the base of each cutting should be then pressed down. The farmer should then plow a second furrow against the cuttings to form a slight ridge over the center of the plant row, taking care not to cover the cutting completely.

If ridge planting is used instead of level culture, it is best to apply the fertilizer along the marked row and to cultivate it in at the general soil level. A furrow should be plowed from either side toward the center to make a ridge over the fertilized strip. The cuttings should be planted in the center of this ridge by means of a dibble,

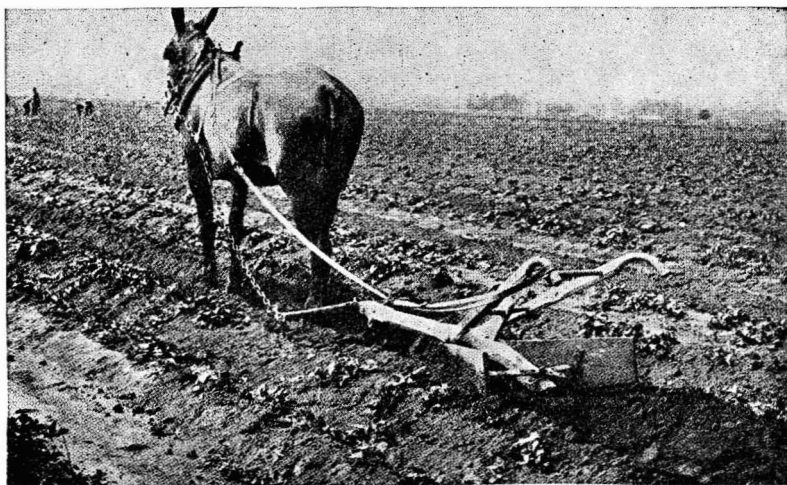


Fig. 50.—"Hilling" or "siding up" the sweet potato beds with a specially constructed implement. The standardized celery hiller makes a suitable instrument for this work. (Courtesy USDA.)

and the soil about them should be packed lightly. Such mass methods of planting are extremely economical and effective in comparison with the old-fashioned methods.

Cultivation should begin soon after the plants are set

and should be continued every week or 10 days until the vines begin to spread over the intervening space. The vines may then be turned back into alternating rows to permit further cultivation between every other row. Very little hand hoeing should be necessary, a fact which should greatly reduce the cost of production.

If level culture is practiced, some hilling is usually desirable. For this operation a "celery hiller" or a "middle-buster" plow makes a very effective tool. The farmer should avoid covering the vines with soil, for vines so covered form roots too early in the season at the expense of setting tubers. In from 12 to 15 weeks, the vines should cover the ground completely, even with 5 foot row spacing. No further attention is necessary until the crop is ready for harvest.

Harvesting. Maturity of the crop is indicated when the earth above the plant hill rises and cracks like a

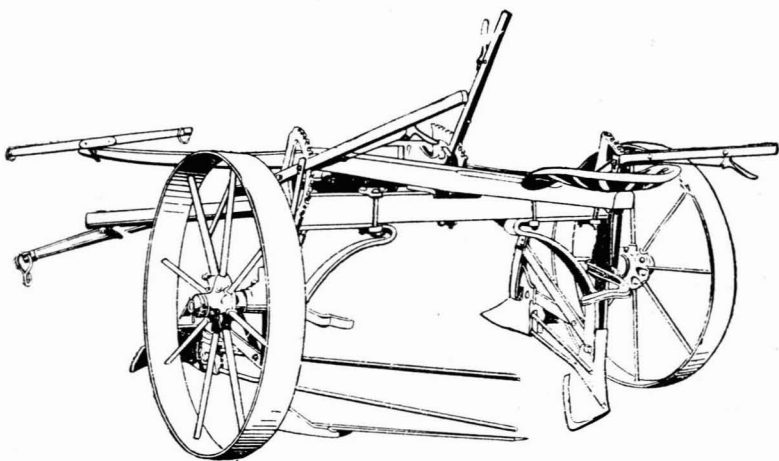


Fig. 51.—A double-row cutter for harvesting sweet potato vines, when grown in flat culture, and mature vines of shell beans.

miniature volcano and the vines cease to grow. Samples may then be inspected. Sweet potatoes should be carefully handled to avoid bruising and should not be dug when the soil is wet or the weather rainy.

Before digging, the farmer should cut the vines from the hills with a sharp hoe, knife, or improvised vine cutter. One of the latter is described in Circular No. 84, Mississippi Agricultural Experiment Station, by J. C. C. Price, horticulturist, as follows:

"A Simple Sweet Potato Vine Cutter. It has always been a problem with the sweet potato grower to devise some satisfactory way of getting vines out of the way at digging time. Especially where the vines are rank, they choke the plow or digger in such a way as to make it very difficult and unpleasant to plow out the potatoes. To overcome these difficulties, the writer has devised a very simple method of cutting these vines and leaving them on the ground so they may be turned under as the potatoes are turned up, thus getting the vines out of the way for all time, putting them where they will rot quickly, and returning the humus to the soil.

"Any farmer may make one of these implements at a cost of not more than a dollar for new material, and the average farmer can scrape up enough material to make one with practically no cost at all. The material necessary to make one of these implements is:

- 4 pieces of 2" x 4" timber 4 ft. long
- 3 pieces of 1" x 12" plank 30 in. long
- 1 dozen spikes
- 1½ pound of 8 d nails
- 1 piece of trace chain or heavy wire
- 20 mowing machine sections, (old ones that have been removed from blades will do just as well as new ones).

"This list of materials is for a cutter adapted to 3½ foot rows, as the outer sections should run six inches from the row. Measure several rows and make the implement 12 inches less than the width of the average row.

"This cutter is made by placing a 2 x 4 edgewise and another 2 x 4 flatwise on it, with the edge of the flat piece in line with the flat side of the piece setting edgewise, and nailing with spikes. Two pieces or runners are made this way. Place the two runners so that the last 2 x 4 will be the inside of the sled and the other 2 x 4 will be 2 inches above the ground. The mowing machine sections are nailed to the outer edge of the runner and to the outer edge of the 2 x 4 extension. The 1 inch boards are nailed on top to form the sled.

"This implement is too light to cut the vines by its own weight, so a man or boy may ride it, running the implement between the rows, and at the end, lifting it over into the next row, and so on. In extremely heavy vines, it may be necessary to run twice, but in the average potato vines, a single time will be sufficient. Then follow with a turning

plow or a middle-buster, and, as the potatoes are turned out, the soil will turn back on the vines in the middle, completely burying them.

"This simple vine cutter has been used at the Horticultural Department of the Mississippi A. and M. College for the last 2 seasons. It gives satisfactory results and very few potatoes are damaged. Care should be taken that the mowing machine sections on the outer edge do not extend past the edge of the 2 x 4's more than an inch. Unless potatoes are very close to the surface, they will not be injured. Less damage is done with this implement than by running a hay rake over the patch."

Ordinary vine yields range from 10 to 15 tons an acre. At Haiku, Maui, as many as 20 tons of vines have been harvested. After the vines have been removed, the pota-

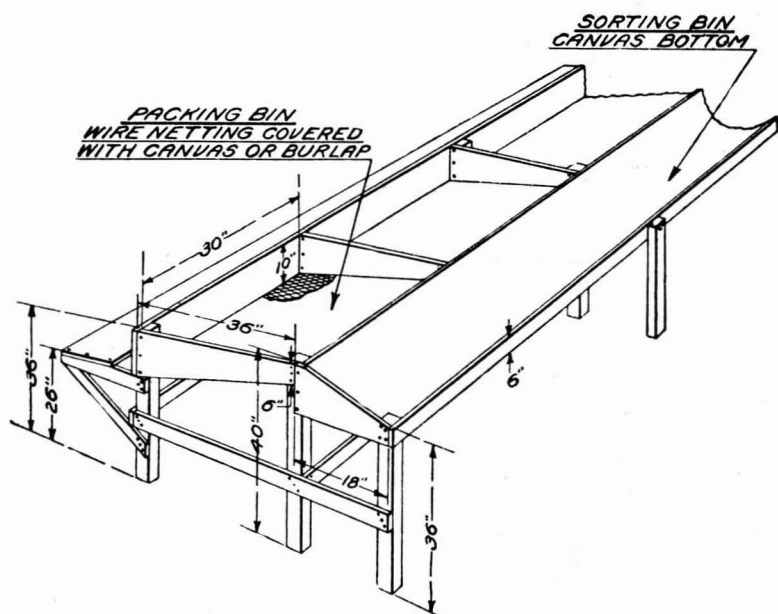


Fig. 52.—Type of sorting and packing bin in general use where grading is done after the field crates are emptied into a sorting bin. After Farmers' Bulletin No. 1291.

atoes should be dug by running a regular sweet potato digger under the plant row. An ordinary plow with a special, short moldboard may be used. Hand digging is altogether too expensive, except under unusual circumstances.

Grading. The potatoes should be sorted into three

grades as they are gathered. The best grade should be composed of well shaped, smooth potatoes of large uniform size. These are "primes." The "seconds" are the next best grade, and the remainder are culls suitable for hog feed. Sweet potatoes should be marketed by grades and not as "job lots." The eastern states 5/8 bushel basket would probably meet the fancy of our local trade and stimulate purchase. For distant shipment the bushel hamper and 100-pound sack would probably be most satisfactory. Barrels might also be considered as containers for long shipment.

When thoroughly dry, the prime potatoes should be packed in new sacks or crated in new containers. "Seconds" may be placed in old sacks.

Storage. If carefully handled and free from disease, surplus sweet potatoes may be stored and held for higher prices. Proper storage facilities must be provided, or the total product may become a dead loss. Soon after sweet potatoes are stored, they give off moisture. This must be carried off through proper ventilation. The stored product should not be handled until it is ready for disposal. The potatoes may be packed in bushel hampers or crates or placed in bins in bulk. The most frequent errors in managing storage are careless handling, storing infected crops, and lack of proper ventilation.

Varieties. Hawaii has developed innumerable varieties of sweet potatoes and yams and has imported "seed" of most standard mainland varieties for trial. These varieties represent every possible shape, size, and color. Imported varieties have rarely equaled the indigenous varieties in yield or quality. The *Jersey Sweet*, or *California Merced Sweet*, which is probably akin to the *Yellow Jersey*, is one imported variety possessing superior baking qualities. It has generally proved a shy bearer in Hawaii, although during 5 years' trial, a constant improvement in yield was noted. This variety should be given further trial.

Several years ago, the University of Hawaii received from an Eastern breeder a new strain of *Yellow Jersey* called *Priestly*. While the first crop proved very small and inferior in quality, the second and third plantings showed decided improvement. Until these varieties are thoroughly established, Mr. H. L. Chung, Extension Animal Husbandman, formerly agronomist of the Hawaii Experiment Station, and an extensive breeder of sweet potatoes in Hawaii, recommends the *Yellow Yam*, *Native Red*, and *California*

Leaf for general commercial planting. To these the writer would add *New Era*, an extremely prolific, vigorous growing, red variety, which has produced tubers of excellent quality at Haiku, Maui. This variety has yielded a total of 18 tons of tubers and 21 tons of tops on a measured acre in a favorable year under favorable field culture. Haiku Ranch, growing this variety as a 7 months' crop for hog and cattle feed, reported yields amounting to 30 tons an acre in 1917. The *Madeira*, a whitish variety developed by Mr. J. C. Jarves at Homestead, Kauai, is also worthy of trial.

The most important commercial varieties of sweet potatoes grown in Florida, which supplies the early eastern market, are *Porto Rico*, *Improved Porto Rico*, *Triumph*, *Nancy Hall*, and *Big Stem Jersey*. Farmers who are experimentally inclined may test out these varieties with a view to their introduction in Hawaii for the export trade. California and other Pacific Coast markets would probably prefer these varieties to the varieties generally grown in Hawaii.

Pests. Fortunately, the sweet potato in Hawaii is remarkably free from disease and insect pests. The worst pests found here are the leaf-miner and the stem-borer, which are difficult to combat once they infest the crop. No method of control for the leaf miner has been discovered. Crop rotation is the best method for the control of the stem-borer.

Hawaii Experiment Station Bulletin No. 50, "The Sweet Potato in Hawaii" by H. L. Chung, Extension Specialist in Animal Husbandry, formerly Specialist in Tropical Agronomy, Hawaii Experiment Station, is an exhaustive treatise on sweet potato culture in Hawaii.

SPINACH

Large quantities of spinach are consumed in Hawaii, largely because of its generally accepted value as a dietary source of vitamins and minerals and because succulent leafy "greens" are universally recommended by the medical profession, especially in the tropics. While comparatively little fresh spinach is produced in Hawaii, large quantities of the canned product are imported, and it would seem worthwhile for the local market gardener to give some attention to the crop.

Two entirely distinct genera of plants come under the designation of spinach. The commercial or common spinach, which is so extensively canned, is least tolerant of heat and thrives best in a moist, rich soil at moderate temperatures, such as prevail in the winter months in our lowlands, and over a more extended period and area at the higher altitudes. The so-called New Zealand spinach, on the other hand, thrives in hot weather and with a limited moisture supply where the ordinary spinach would not grow satisfactorily.

Culture. The common spinach, as a fall and winter crop, especially in the warmer lowlands, will require irrigation in all but the wetter districts. A rich, heavy to medium, loamy soil is best. The land should be leveled carefully before the seed is sown. Lime and an abundance of organic matter and nitrogenous fertilizers are essential for the production of large and choice crops of spinach. Beds may be from 5 to 10 feet wide and of any desired length. A drop of from 3 to 5 inches per 100 feet, dependent on the nature of the soil, is desirable to facilitate irrigation by flooding. The borders of the beds should be carefully ridged to confine the irrigation water and to prevent waste by washing. In excessively wet locations, adequate drainage must be provided. Abandoned rice lands should be well suited to this crop. It is possible that many acres of the crop could be grown for canning in the spring or for exporting during the winter months. The seed should be drilled with a mechanical drill in rows not less than 15 nor more than 20 inches apart. The seed should be covered with earth from $\frac{1}{2}$ to $\frac{3}{4}$ inch deep. About 5 pounds of seed will be required to sow each acre. The seeds should be dropped about an inch apart and the plants thinned later until they are from 2 to 4 inches apart. The thinned plants make fine, tender greens. Irrigation should start immediately after planting, and should be frequent thereafter.

If the land is exceptionally free from weeds, the seed may be broadcast at the rate of at least 10 pounds for each acre.

Harvesting. Spinach may be harvested at any time after 5 or 6 rosette leaves are formed, usually 5 or 6 weeks after the seed was sown. The market prefers medium, well-grown, crisp, tender leaves free from coarseness. The largest plants should be harvested first, by cutting the tap root just below the lower leaves, or by pulling out the entire plant and trimming it afterward. Care should be taken

to avoid soiling and bruising the leaves. Immediately after harvest, the spinach should be taken to the packing shed to prevent wilting.

It is best to avoid washing. When graded, the plants may be tied in neat pound bundles with clean raffia.

For shipping long distances, the spinach should be packed in bushel baskets lined with oiled paper, to prevent wilting.

Varieties. The following varieties are recommended for trial: *Savoy*, an early, attractive variety for market use, with leaves crumpled and erect, forming a tall, vase-shaped plant; *Thick Leaf*, a moderately rapid grower, and a heavy yielder, with leaves spreading, broad, slightly crumpled near the base. (The well-known variety *Viroflay* belongs to this type); *Long Standing*, a slow-growing, small plant classed as one of the round-leaved varieties which bear deep green, thick, leathery, and smooth leaves either on short stems or long ones; *Prickly Seeded*, a spiny seeded variety grown extensively for canning purposes.

Insect Pests and Diseases. Spinach suffers little from insect pests in Hawaii. The slugs and leaf-chewing insects which occasionally attack it are best controlled by spraying with lead arsenate solution. **However, great care must be taken not to spray too close to harvest time, since this spray is a deadly poison.** Some of the most prevalent diseases on spinach raised on the mainland are downy mildew, or leaf mold, leaf spot, rust, wilt, and mosaic. Some, if not all, of these diseases may be carried through the infected seed. Bordeaux and other standard copper carrying spray solutions are said to be only partly effective on these diseases. Treating seed with mercurial solutions, of which several trade forms are on the market, is recommended.

TOMATOES

Tomato production in Hawaii offers, perhaps, as great an opportunity for the local market gardener and truck farmer as any vegetable crop that can be grown profitably on either a large or small scale and over a wide area. There is not only a heavy demand for local consumption throughout the year, but there are great possibilities for canning and for exporting fresh tomatoes. Both private and com-



Fig. 53.—Staked tomatoes grown at Dr. A. K. Hanchett's homestead, Hoolehua, Molokai.

mercial gardeners have produced prime tomatoes throughout the year from altitudes near sea level to altitudes above 3,000 feet. Notwithstanding our facilities for local production, Hawaii imported from the Mainland during 1930, fresh tomatoes weighing 665,850 pounds, valued at \$74,908, and the equivalent of 731,237 pounds of canned tomatoes, valued at \$53,848. This makes the total value of imports of this commodity in a year \$128,756.

The further possibilities of producing the crop for

export at a time when mainland markets are bare has not yet been determined. So far as is known now, the one limiting factor is the danger from fruit fly infestation. No serious thought seems to have been given to the possibilities of this crop, which has in the past been grown only in small areas and usually in a slipshod manner.

Standardized growing and marketing methods are needed in this field. It is recommended that vegetable growers who are already well established and experienced in tomato growing form an association to standardize the varieties, grades, and amounts to be grown to conform to the needs of a well defined trade. The Agricultural Extension Service of the University of Hawaii can give material assistance in planning an organization adequate to meet the production and marketing needs.

Varieties. Innumerable varieties of tomatoes are listed in the seed catalogs. However, the commercial grower need concern himself with less than a dozen varieties. For the inexperienced grower, only the following are recommended: *Livingston's Globe*, vines straggling, fruit pink, medium size (3 to 4 to a pound), almost globe shape, firm and ships well. *Mariglobe*, fruit and plant growth similar to *Globe*, which is one of its parents, color bright red, globe shaped, and medium-sized, somewhat more resistant to wilt and nail-head disease than most other sorts, introduced by U. S. Department of Agriculture. *Improved Stone*, plants large and strong, fruit red, oblate, smooth and medium large in size, is used extensively for canning purposes. The variety, *Norton*, is a strain of *Stone* and is said to be more resistant to the wilt disease than *Stone*. Otherwise the two varieties are almost identical. *San Jose Canner* (*Morse Strain*), a strain of the old *Trophy*, is bright red, meaty, and of the flavor preferred by canners, large in size and a heavy yielder. California growers report yields up to 20 tons and over per acre on an extensive field scale. *Victory*, medium size and uniform in shape, solid, deep red inside, produces few seeds, high sugar content, excellent for canning and shipping, heavy bearing.

Soil Requirements. The tomato succeeds on a wide range of soil types, so long as good drainage and tilth is maintained. Sandy soils are conducive to early maturity, and heavy clay loams produce crops which mature more slowly, but which give larger and more economical yields. Muck and peaty soils are not so well adapted to tomato culture, because they tend to cause excessive vine growth at

the expense of fruit development. However, liberal applications of phosphates and potash, with the exclusion of nitrogen, will often make this class of soils suitable for tomato growing. In general, well-drained rice soils are well adapted for this purpose.

The moisture requirements of tomatoes must be carefully considered. Excessive moisture stimulates vine growth too much. The application of moderate moisture, maximum cultivation, and possibly, mulching with paper or straw are conducive to large yields of sound and firm fruits, suitable for shipping. Fortunately no account need be taken in Hawaii of the temperature factor. There is no region in Hawaii below 3,500 feet elevation where the crop cannot be grown practically the year around.

Methods of Propagation. Good crops of tomatoes are as dependent upon well-grown plants as upon any one other factor. Having secured virile seed of superior varieties and strains, the grower should start the seed in open beds or cold frames. When they are well started, the seedlings may be transplanted several times before they are planted in the field. From 1 to 2 ounces of seed will be required to produce plants sufficient for an acre of ground. Tomatoes are also readily propagated by cuttings. Superior strains which may lack fixity of type may be perpetuated by propagating vegetatively.

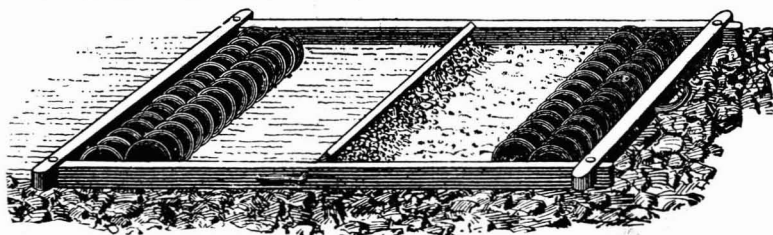


Fig. 54.—A home made device for leveling and smoothing the soil before seeding.

It is important that the seed bed be well prepared. The $\frac{1}{2}$ inch on the surface may well be composed of sifted soil passed through a $\frac{1}{8}$ inch mesh sieve. The seed should be thinly sown, only about 5 to the inch, in drills about 6 inches apart. This rate of planting should provide about 3,500 plants to a bed 4 feet wide and 30 feet long, a liberal amount to plant on an acre. The seed should be covered by soil to the depth of about $\frac{1}{8}$ inch. The soil should be packed down gently. The bed should be watered with a

fine spray and covered with muslin frames, suspended well above the ground. The seed-beds should be well-ventilated and the seedlings hardened gradually before they are transplanted. The seedlings should be transplanted into other beds, flats, or pots, when they show their second pair of leaves. Care should be taken not to overcrowd the young plants. Only strong, stocky plants will give a good account of themselves in the maturing crop, and every effort should be made to grow only sturdy plants.



Fig. 55.—Size of tomato seedlings when ready for the first transplanting. Remove the plants from seed-bed with soil on roots as shown on right.



Fig. 56.—Size and condition of plants when transplanted a second time before finally setting in field. After Bul. No. 180, Maryland Exp. Stat., 1914.

Transplanting. Transplanting to the field should begin soon as the plants are ready. This should be usually about 45 days after the date of sowing. At this time, the plants should be 6 or 8 inches tall.

The field rows should be spaced 5 feet apart and the plants set from $2\frac{1}{2}$ to 5 feet apart in the row. The former spacing should give 3,484 plants to each acre, and the latter 50 per cent of this number.

Before the seedlings are transplanted, the land may be marked off in shallow check rows, by means of the home-made adjustable sled marker shown in Fig. 57, or by plowing a shallow furrow for each row and cross-furrowing for the intervals desired. The plants should be set

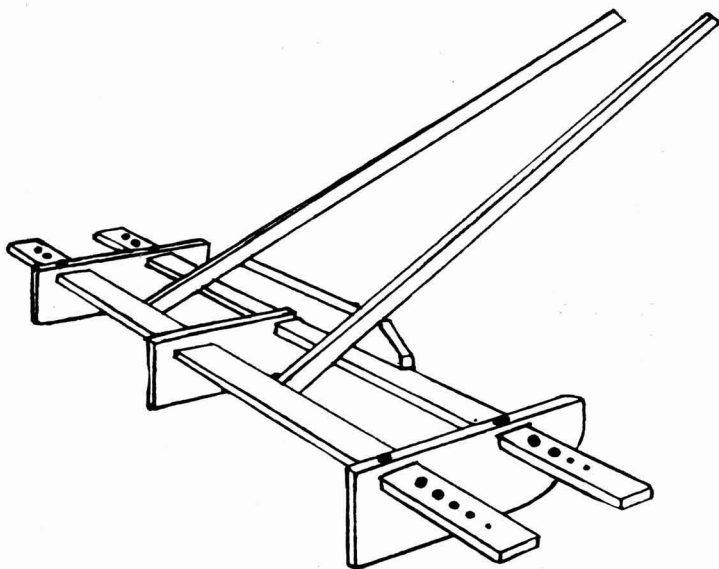


Fig. 57.—Home made adjustable sled marker.

out by means of a trowel or a spade at each marked intersection.

The common method of planting on the mainland is to thrust the spade blade into the soil in an upright position, to push the handle forward, and to set the plant in the V-shaped opening. The spade is then withdrawn and the soil made firm about the plant. Planting is most rapid and effective when done by two men, especially if extensive planting is done.

Unless the soil is moist, plants should be irrigated immediately after they are set. This is best done on a large scale by running a furrow alongside each row as close to the young plant as possible. Subsequent cultivation, which should be frequent, should work the soil toward the plant. With each successive irrigation, the furrow is made



Fig. 58.—Plants removed from flats for setting in the field. Note the ball of earth on the roots. After Bull. No. 180, "Tomato Variety and Planting Tests," Maryland Agri. Expt. Stat. 1914.

further from the plants until finally it is midway between the rows. The water thus penetrates to the roots without wetting the surface of the ground around the plant stems.

Only enough irrigation should be given to keep the plants growing thriftily. Too much water causes excess vine growth at the expense of the fruit and may cause the blossoms to drop. The plants should not be irrigated when they first begin to flower or during the latter part of the fruiting season.

Under Hawaiian conditions, it usually pays to stake and prune the plants. The best local practice has been to use 6 foot stakes, driven firmly into the ground to a depth

of 2 feet. As the main stem elongates, it should be tied to the stake loosely enough to permit free growth. The main side shoots may all be pinched back, or several may be retained for tying to the stake. Any stems which grow

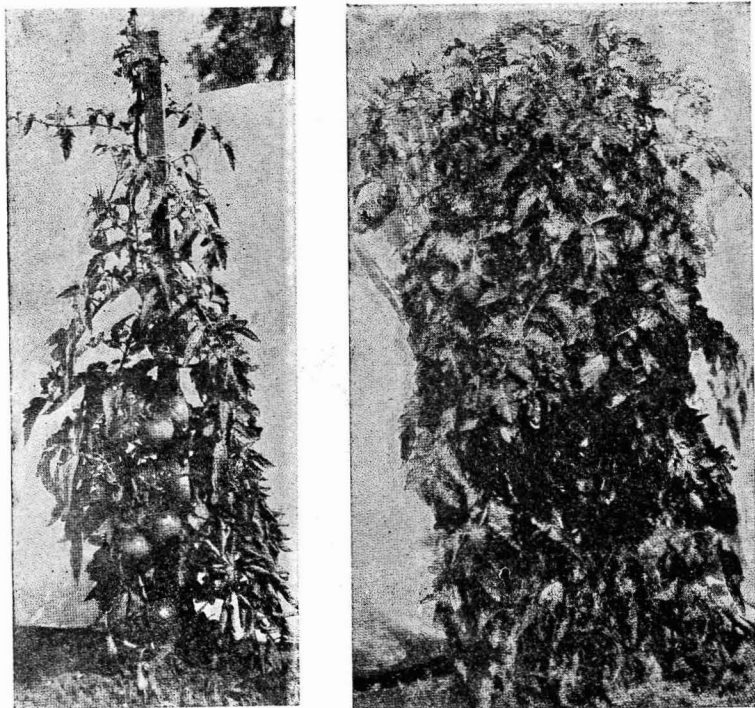


Fig. 59.—Left. Tomato plant pruned to a single stem. Such practices have added increased yields up to 80 percent at University of Hawaii Farm.

Right. Tomato plant pruned to several stems. After Bulletin No. 144, "Growing Tomatoes for Early Market,"

out of bounds should be cut back. Growing tomatoes on trellises of coarsely woven wire has proved satisfactory.

Harvesting. The time at which the fruit is picked depends upon the purpose for which it is to be used. For shipment to near markets, the tomato should be picked when most of its surface shows a distinct pinkish tinge. For more distant markets, it should be picked when the first blush of color appears on any part of the fruit. The field should be picked over every other day after the harvest is begun. Care must be taken not to bruise the fruit. The pickers should remove the stem from the fruit, in order to prevent puncturing the skin of other fruits.

Grading and Wrapping. The ripe fruit should be disposed of locally without delay. The remainder should be hauled to the packing shed for grading and packing for shipment. Tomatoes should be graded for firmness, size, shape, and color. The fruits should be carefully dumped into shallow bins or, if large quantities are to be handled,



Fig. 60.—Tomato plants trained on wire trellises. After Farmers' Bull. No. 1338, "Tomatoes as Truck Crop."

on to a canvas conveyor belt. Each grower should adopt definite grading standards and should adhere to them closely. For distant shipments, it may be advisable to wrap each individual fruit in tissue paper. Almost all the tomatoes imported now from California are wrapped.

Artificial Ripening. Fruits packed in the green-mature state will ripen in 1 or 2 weeks. The quality of such fruit is much better when it is ripened in the open than when it is ripened wrapped in paper. Therefore, the wrapped fruit should be unwrapped, and those showing sufficient ripeness disposed of at once.

In recent years, tomatoes and other fruits have been extensively treated with ethylene gas to cause ripening. The gas is administered in small amounts in the storage chamber. A concentration of 1 part ethylene to 4,000 or more parts of air has been found to reduce by 50 per cent the time required to change tomatoes from the green to



Fig. 61.—Well-packed six-basket carriers of the 144 and 180 packs ready for lidding. Tomatoes at each end of the crate are even with the headpiece, while stock near the center of the crate shows about 1-inch bulge. After Farmers' Bulletin No. 1291.

full red color. This product is obtained in compressed form in steel cylinders, from which it is discharged directly into the air-tight treating rooms, the amount being regulated by a gas meter.

Tomatoes for Canning. The tomato is third in value of the vegetable crops of the United States. A large portion of the crop is canned or made into soups, purees, and cocktails. To furnish the tomatoes for this manufacture, 1,000,000 tons are produced on more than 200,000 acres annually. It has been thought possible that Hawaii might do something in the way of canning this crop, if production were developed to a sufficient volume. The crop should be grown on a large scale at a profit of \$50 or \$60 a ton.

Diseases and Insect Pests. The damping off of young seedlings in the seed bed is best avoided by renewing the

soil in the seed bed every year, by avoiding overcrowding, too much moisture, and lack of ventilation.

Of the two so-called blights, "early" and "late," the early blight, or leaf spot, is the most destructive. It is caused by the fungus *Macrosporium solani*. The late blight is caused by *Phytophthora infestans*. Both these diseases affect the potato as well as the tomato. A cool, humid atmosphere appears most favorable to these diseases. The early symptoms are numerous black spots on the leaves and stems. If conditions are favorable to the disease, the spots enlarge rapidly, and the entire plant bleaches and dies. Fruits may be affected in all stages of maturity. Thorough spraying of the plants with Bordeaux mixture is the best method of control. Several sprayings are likely to be necessary, if the diseases are prevalent. From 100 to 300 gallons of spray solution to each acre will be needed to do the job thoroughly.

According to Beattie, in Farmers' Bulletin No. 1338, mosaic disease "produces on the leaves mottled areas of different shades of green and sometimes crinkles and distorts the leaves, causing the plants to be weak and unfruitful. There are various types of this disease. The fern-leaf type, in which the leaves become very narrow, and the shoe-string type, in which the leaves develop only as long strings, are the most important.

"Mosaic is readily transmitted from plant to plant by aphids and other insects and also by contact. Plants grown in greenhouses, where there are older tomatoes affected with the disease, while not showing any trace of the mosaic when moved to the field, will invariably develop it later. The disease is readily carried from one plant to another in pruning and tying. When mosaic once appears there is very little that can be done to eradicate it, the main point being to exercise extreme care in the growing of plants to avoid transferring it to the field."

Fusarium wilt is most destructive in warm weather. When it gets a foothold, the fungus spreads rapidly and is likely to infest the soil for a long time. It enters through the roots of the plant and progresses upward. The first symptoms are usually a yellowing of the lower leaves. Where this disease is prevalent the only control lies in planting resistant varieties, such as *Norton*, *Mariglobe*, and *Marvel*.

Blossom-end rot attacks either the green or ripe fruit in the form of brown discoloration of the blossom end of

the fruit. The disease is best controlled by supplying the best tillage and an adequate supply of moisture throughout the season.

Yellows is caused by a virus. It is said to be transmitted by a species of leaf-hopper. Some control is insured by planting resistant varieties.

Of insect pests, the tomato's worst enemy is the fruit fly. While this pest is controlled to some extent through introduced parasites, as many as 50 per cent of all tomato fruits produced may be stung and infested with maggots by this fly. If very prevalent and if the price of the fruit warrants the added expense, the surest control is to bag the fruits or to wrap them with soft elastic tissue paper. Control may also be afforded by laying thin layers of excelsior shavings over the fruits during the period of their development. The fly seems very shy and the rough-netted covering afforded by the excelsior appears to discourage it from approaching the covered fruit.

The large larvae of the horned tobacco-worm moth occasionally attacks tomato plants and may quickly defoliate the plant. The worms are easily poisoned by spraying the plants with a lead arsenate solution, containing 3 pounds to 100 gallons of water. This amount is sufficient to spray an acre.

The tomato fruit-worm (corn ear-worm) bores into the green and ripening fruits and may cause much damage. Both calcium and lead arsenate dusted in the plants at the rate of five pounds to the acre have been found to give good control.

Root galls, caused by small worms commonly known as nematodes, often cause serious damage to tomato plants. The best method of control is to starve the worms in the ground by either clean culture or by growing such crops as corn and velvet beans, crops which the pest will not attack.

MINOR CROPS

HORSE RADISH. Horse radish thrives best when grown in medium heavy, deep, rich, well-drained soil that is easily cultivated. Before planting, the ground should be plowed deeply, and brought into good tilth. The rows should be at least three feet apart, and the root pieces should be set out a foot apart in the row by means of an "oo" or dibble, thrust straight down in the loose soil. The tops of the

roots should be set an inch below the surface, and the soil packed firmly on the sides, but not on top. New plantings should be made each fall or spring in order to produce large thick roots. If the old roots are left in the ground for the second year, they will split up, or will divide into a number of smaller, branching roots, which are not marketable.

The sets for planting are small pieces of the slender side roots, which are trimmed off in preparing the main root for market. These are offered by Pacific Coast seedsmen at approximately \$2 per 100 sets or \$10 per 1,000. From 10,000 to 15,000 sets are required to plant an acre. To avoid planting the roots upside down, it is customary to cut the top of the sets off square and the lower end slanting. The sets can be kept for some time, if layered in moist sand. The roots are usually harvested in the winter months and may weigh as much as 1 pound. The *Maliner Kren*, or *Early*, from Bohemia, is the generally preferred variety.

A good demand could be created for this crop in Hawaii, because the freshly grated roots are superior to the imported pickled product. California growers report acre yields valued at \$500.

PARSLEY. Parsley is used for garnishing meats and fish and for flavoring soups. While universally used, a little parsley goes a long way. An acre of thriving parsley would probably supply more garnish than all Hawaii could consume. However, every market gardener might well grow a small bed of these popular greens, which are best when freshly picked and delivered before wilting. Small market gardeners who sell their produce directly to retail customers would do well to "throw in" with every sale a bunch of prime parsley.

Parsley seed germinates slowly and should be soaked in tepid water for several hours before planting. The seed should be sown in shallow drills of well-fertilized soil, in rows at least 15 inches apart. When the plants are well established, they should be thinned until they are 3 inches apart in the row. Thinned plants may be transplanted into small pots and, when established, an excellent market may be built up for the potted plants, or a potted plant may be presented to each of one's customers as an occasional goodwill offering.

Parsley must not be permitted to run to seed. When the plants approach maturity, they should be cut back se-

verely to renew undergrowth. Parsley beds should be reseeded every 2 or 3 years.

The best "all-around" market variety is the *Champion Moss Curled*, because of its attractive appearance. The plain, or smooth leaved variety is preferred by some, because of its richer parsley flavor. An ounce of seed will plant a bed 4 feet wide and 50 feet long, large enough for the average small market gardener.

Parsley is attacked by few pests and diseases.

RHUBARB. Rhubarb can be grown successfully only in the cool uplands in Hawaii, at altitudes of 2,000 feet or more.

The plant can be grown either from seed or root divisions. Plants grown from root divisions will produce stalks for market a year earlier than those grown from seed, but the best results have been secured by growing from seeds. The losses incurred in the use of imported plants are usually large and expensive, with the price of roots ranging from \$5 to \$10 per 100.

An ounce of seed at \$2 will produce hundreds of plants. The disadvantage of growing from seeds is that a large number of the seedlings must be discarded because they are not true to type. The three varieties recommended for trial in Hawaii are the *Crimson Winter*, the *Victoria*, and the *Cherry*. To grow large stems of rhubarb, rich, mellow, well-drained, well-cultivated soil is essential.

Well-established roots should be planted, while they are dormant, 2 feet apart, in rows at least 5 feet apart. The crown of the plants should be set 2 inches or less below the surface. The soil should be kept fairly dry until the plants are well-established. Most gardeners make the mistake of irrigating rhubarb either too much or too little. Uniform moisture is essential for this crop. If possible, the soil should be kept slightly moist throughout the growing season, and good drainage is essential. The rhubarb bed should be kept well-fertilized and should be replanted every three years.

APPENDIX A

CLASSIFICATION OF VEGETABLES

Formerly vegetables were classified under two headings, "tender" and "hardy." Under "tender" were included those plants which are easily injured by frost and which require a high temperature for their success, such as tomatoes, beans, melons, cucumbers, sweet corn, and others. The heading "hardy" included such vegetables as peas, cabbage, spinach, asparagus, lettuce and radishes. The line of division is difficult to draw, and as a result our best investigators have established a system which is based primarily upon the methods of culture, although other factors are considered. This system was devised by Prof. L. H. Bailey, and is endorsed by prominent authorities as the best method for dividing the vegetables. We quote from Professor Bailey's book entitled "The Principles of Vegetable Gardening," page 240:

CLASS I. ANNUAL VEGETABLES

Sub-Class I. Crops grown for subterranean parts.

Group I. Root Crops.

- Beet (*Beta vulgaris*)
- Carrot (*Daucus Carota*)
- Parsnip (*Pastinaca sativa*)
- Radish (*Raphanus sativus*)
- Salsify (*Tragopogon porifolius*)
- Scorzoner (*Scorzonera Hispanica*)
- Turnip and Rutabaga (*Brassica*)
- Horse-radish (*Cochlearia Armoracia*).
(Horse-radish and dandelion are perennials; but as now grown, they do not occupy the ground more than a year.)

Group 2. Tuber Crops.

- Potato (*Solanum tuberosum*)
- Sweet Potato (*Ipomoea Batatas*)

Group 3. Bulb Crops.

- Onion (*Allium Cepa*, *A. fistulosum*)
- Leek (*A. Porrum*)
- Garlic (*A. sativum*)
- Shallot (*A. Ascalonicum*)
- Chive (*A. Schoenoprasum*)

Sub-Class II. Crops grown for foliage parts.

Group 4. Cole Crops.

Kale and Borecole (*Brassica oleracea*)

Brussels Sprouts (*B. oleracea*)

Cabbage (*B. oleracea*)

Cauliflower and Broccoli (*B. oleracea*)

Kohlrabi (*B. oleracea*)

Group 5. Pot Herb Crops (used for "greens").

Spinach (*Spinacea oleracea*)

Chard and Beet (*Beta vulgaris*)

Orach (*Atriplex hortensis*)

Purslane (*Portulaca oleracea*)

Dandelion (*Taraxacum officinale*)

Mustard (*Brassica species*)

Group 6. Salad Crops.

Lettuce (*Lactuca sativa*)

Endive (*Cichorium Endivia*)

Celery (*Apium graveolens*)

Parsley (*Carum Petroselinum*)

Cress (*Lepidium sativum*)

Upland or Winter Cress (*Barbarea vulgaris*)

Water Cress (*Nasturtium officinale*)

Sub-Class III. Crops grown for fruit or seed parts.

Group 7. Pulse Crops.

Bean (*Phaseolus, Dolichos, Vicia*)

Pea (*Pisum sativum*)

Group 8. Solanaceous Crops.

Tomato (*Lycopersicum esculentum*)

Eggplant (*Solanum Melongena*)

Pepper (*Capsicum annuum*)

Physalis, or Husk Tomato (*Physalis*)

Group 9. Cucurbitous or Vine Crops.

Cucumber (*Cucumis sativus*)

Melon (*C. Melo*)

Gherkin (*C. Anguira*)

Watermelon (*Citrullus vulgaris*)

Luffa (*Luffa Aegyptiaca* and *L. acutangula*)

Zit-Kwa, or Wax Gourd (*Benincasa cerifera*)

Pumpkin (*Cucurbita*)

Squash (*Cucurbita*)

Group 10. Corn, Okra, Martynia.

Sweet Corn (*Zea Mays*)

Okra (*Hibiscus esculentus*)

Martynia (*Martynia proboscidea*)

- Group 11. Condimental and Sweet Herbs.
Group 12. Mushroom. (Culturally and otherwise the mushroom is so unlike other garden vegetables that it demands special and separate treatment. Therefore, it is not discussed in this book. It is not a vegetable gardening subject, although usually so classed.)

CLASS II. PERENNIAL VEGETABLES

Asparagus (*Asparagus officinalis*)
Rhubarb (*Rheum Rhaponticum*)
Docks (*Rumex*)
Sorrel (*Rumex*)
Artichoke, Globe (*Cynara Scolymus*)
Artichoke, Jerusalem (*Helianthus tuberosus*)
Sea Kale (*Crambe maritime*)

APPENDIX B—TABLES

TABLE I

Number of Hills or Plants on an acre of land, for any distance apart, from 10 inches to 6 feet, the lateral and longitudinal distances being unequal. (Waring).

Dis- tance	10	12	15	18	20	2 ft.	2½	3 ft.	3½	4 ft.	4½	5 ft.	5½	6 ft.
in.	in.	in.	in.	in.	in.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
10	62726													
12	52272	43560												
15	41817	34848	27878											
18	34848	29040	23232	19360										
20	31363	26136	20908	17424	15681									
2	16136	21780	17424	14520	13068	10890								
2½	20908	17424	13939	11616	10454	8712	6969							
3	17424	14520	11616	9680	8712	7260	5808	4840						
3½	14935	12446	9953	8297	7467	6223	4976	4148	3565					
4	13068	10890	8712	7260	6534	5445	4356	3630	3111	2722				
4½	11616	9680	7744	6453	5808	4840	3872	3226	2767	2420	2151			
5	10454	8712	6969	5808	5227	4356	3484	2904	2489	2178	1936	1742		
5½	9504	7920	6336	5280	4752	3960	3168	2640	2263	1980	1760	1584	1440	
6	8712	7260	5808	4840	4356	3630	2904	2420	2074	1865	1613	1452	1320	1210

TABLE II.

AVERAGE WHOLESALE PRICES OF LOCALLY GROWN FRUITS AND VEGETABLES FOR THE YEAR, 1931

COMMODITY	JAN. (cts)	FEB. (cts)	MAR. (cts)	APR. (cts)	MAY (cts)	JUN. (cts)	JUL. (cts)	AUG. (cts)	SEP. (cts)	OCT. (cts)	NOV. (cts)	DEC. (cts)	AVERAGE (cents)
Beans, Lima, lb.	7.2	5.0	6.6	7.3	5.8	5.0	4.8	4.8	5.6	5.6	6.2	5.9	5.9¢
Beans, Shelled Lima, lb.	18.1	16.2	18.7	20.0	15.6	13.1	12.0	12.5	13.1	15.0	15.0	15.0	15.5¢
Beans, String, lb.	4.3	4.6	4.4	4.0	4.4	7.5	9.8	6.7	6.5	6.4	7.8	6.9	6.1¢
Beans, Wax, lb. ....	.....	.....	4.7	4.4	5.1	7.2	9.8	7.1	6.7	5.1	7.0	8.5	6.5¢
Beets, bch.	3.4	2.5	2.5	2.0	1.7	1.7	2.6	2.7	3.0	2.5	2.6	.....	2.4¢
Cabbage, Ch., lb.	3.2	4.0	3.5	4.0	4.4	4.5	5.0	4.7	4.6	5.1	3.7	4.5	4.4¢
Cabbage, Head, lb.	2.5	2.1	1.3	1.3	2.7	1.0	1.3	1.5	3.0	5.3	6.2	4.2	2.6¢
Carrots, bch.	3.4	3.3	2.7	2.7	2.7	2.5	2.7	2.7	3.3	3.6	4.2	3.7	3.1¢
Cucumbers, Ch., lb.	65.0	76.2	72.5	82.0	65.0	65.0	72.0	82.5	96.6	95.0	100.0	100.0	79.7¢
Cucumbers, Japanese, lb.	5.3	5.5	5.5	5.7	4.8	4.7	6.0	5.8	5.6	6.2	6.4	6.1	5.5¢

Daikon, Ch., lb.	3.0	2.1	1.6	2.1	2.0	2.5	2.0	2.0	2.2	2.3	2.5	2.5	2.2¢
Daikon, Japanese, lb.	1.0	1.1	1.0	1.0	1.0	1.5	....	1.5	1.4	1.2	1.5	1.5	1.3¢
Eggplants, Long, lb.	5.7	5.9	5.5	5.7	5.0	4.6	4.5	4.2	3.6	4.0	4.5	5.0	4.8¢
Eggplants, Round, lb.	3.4	3.3	3.4	3.0	2.6	2.5	2.1	2.2	2.1	2.2	2.5	2.9	2.7¢
Garlic, lb.	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0¢
Ginger, lb.	8.5	8.7	7.2	9.1	11.6	11.8	14.6	17.0	13.5	8.9	8.0	7.5	10.4¢
Gourd, Dishcloth, lb.	9.3	9.1	9.2	9.4	7.6	14.9	18.4	14.5	8.0	6.8	7.0	8.1	7.6¢
Gourd, Whiteflowered, lb.	2.5	5.5	2.4	2.0	2.0	2.2	2.4	....	3.0	3.0	3.0	3.0	2.8¢
Lettuce, doz. ....	....	15.0	22.5	15.0	15.0	15.6	17.5	....	....	....	....	....	16.6¢
Lotus Root, lb.	5.4	5.5	5.5	5.5	6.6	6.7	6.9	6.3	5.7	5.0	4.7	3.8	5.6¢
Melon, Ch. Pres., lb.	3.5	4.0	4.2	5.2	4.8	3.0	3.0	3.0	2.6	2.5	2.5	3.2	3.4¢
Melon, Oriental Pkl., lb.	5.5	5.7	5.5	6.0	5.7	6.0	7.0	6.0	5.0	5.4	5.5	5.5	5.6¢
Onions, Green, lb.	4.7	4.5	4.5	4.5	4.0	4.0	4.1	4.0	4.0	3.7	3.6	3.7	4.1¢
Pears, Balsam, lb.	7.5	7.1	7.7	8.2	7.0	6.0	6.0	6.0	5.0	5.0	5.0	5.0	6.2¢
Peas, Chinese, lb.	65.0	55.0	46.2	40.0	38.7	45.0	58.0	53.5	53.7	55.0	52.5	52.5	50.3¢
Peppers, Sweet, lb.	6.8	8.4	10.5	10.2	9.2	10.0	7.7	6.4	5.5	7.3	7.2	7.2	7.9¢
Potatoes, Irish, lb.	3.0	2.5	2.4	3.4	3.3	2.4	2.3	2.5	2.2	2.5	....	....	2.6¢
Potatoes, Sweet, lb.	2.4	2.1	1.4	1.5	1.7	1.5	1.4	1.5	1.5	1.2	1.2	1.2	1.5¢
Pumpkin, Hawaiian, lb. ....	....	2.5	3.6	3.0	3.0	3.0	3.0	2.7	1.7	2.5	2.5	2.5	2.7¢
Pumpkin, Japanese, lb.	4.3	4.2	4.2	5.0	5.0	5.0	5.0	4.5	4.8	4.0	5.0	5.0	4.6¢
Soybeans, lb.	6.4	5.8	5.5	5.7	5.7	6.0	6.0	6.0	5.0	5.4	5.6	5.6	5.7¢
Spinach, Ch., lb. ....	....	4.0	3.5	3.5	3.5	3.5	3.5	3.7	4.0	4.0	4.0	4.0	3.8¢
Spinach, Japanese, lb. ....	....	5.5	5.0	4.2	4.2	6.4	7.0	7.0	6.2	4.3	4.5	4.5	5.3¢
Squash, Chinese, lb.	4.5	6.7	....	....	....	....	....	....	....	....	....	....	5.7¢
Sweet Corn, lb.	5.0	4.6	6.0	....	....	....	....	....	....	....	2.0	2.1	3.9¢
Taro, Chinese, lb.	1.7	2.0	2.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	2.0¢
Taro, Hawaiian, lb.	1.2	1.5	1.8	1.5	1.4	1.5	1.1	1.2	1.5	1.5	1.5	1.2	1.4¢
Taro, Japanese, lb.	3.5	3.5	4.0	4.3	5.0	5.0	4.9	5.0	3.5	2.6	3.2	4.0	4.0¢
Tomatoes, Globe, lb.	6.2	5.1	6.5	3.8	4.9	5.0	....	6.0	6.0	5.4	5.4	3.8	5.1¢
Tomatoes, Pear, lb. ....	....	....	4.2	3.0	3.0	4.0	....	5.0	5.0	5.3	5.0	4.7	4.3¢
Watercress, bch.	3.1	3.4	3.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0¢
Yams, lb.	2.2	2.4	2.5	2.3	2.6	2.7	3.5	3.9	3.5	2.1	1.6	....	2.6¢
Cantaloupes, lb. ....	....	13.0	11.7	12.0	10.8	9.0	....	7.0	7.3	8.0	....	....	9.9¢
Papayas, lb.	2.5	2.8	2.3	2.5	1.2	1.0	1.1	1.6	2.6	2.5	2.0	1.7	2.0¢
Pohas, lb.	12.8	13.0	13.6	12.9	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.7¢
Strawberries, lb. ....	....	....	30.0	27.5	27.5	27.5	....	....	....	....	....	....	28.3¢
Watermelons, lb. ....	....	....	....	6.0	6.2	5.2	5.0	5.0	5.0	4.7	5.0	....	5.2¢

Note: Compiled from "The Weekly Market Review" as published by the Agricultural Extension Service, University of Hawaii, U. S. Dept. of Agric. Cooperating.

TABLE III
AMOUNT AND VALUE OF VEGETABLES IMPORTED TO
HAWAII FOR THE YEAR 1930

Commodity (FRESH, CANNED and DRIED)	Amount (POUNDS)	Value (DOLLARS)
Artichokes	9,520	\$ 714
*Asparagus	294,940	56,286
*Beans	3,547,922	214,366
Beets	33,600	1,008
Bell Peppers	2,225	117
Broccoli	6,600	545
Brussels Sprouts	20,975	2,045
Carrots	84,525	2,536
Cauliflower	199,104	22,399
Celery	160,218	16,965
Chinese Cabbage	15,360	576
Garlic	60,291	8,139
Head Cabbage	158,175	5,932
Lettuce	720,240	66,622
Lima Beans	57,800	3,035
Melons	32,538	3,010
*Mushrooms	132,474	45,759
Onions	6,001,074	82,602
Parsnips	34,050	2,043
*Peas	852,178	77,732
Pickles	381,114	44,881
Spinach	3,650	329
Squash	3,588	404
*Sweet Corn	339,152	31,588
Sweet Potatoes	171,060	4,264
*Tomatoes	1,397,087	128,756
Turnips	86,000	3,870
*Vegetables, other	1,217,591	137,578
White or Irish Potatoes	17,490,180	365,969
TOTALS	33,513,231 lb.	\$1,330,070

*Includes canned or dried vegetables.

Asparagus (canned)	285,364 lb.	\$ 55,137.00
Beans (canned)	1,179,542 lb.	\$ 96,864.00
Beans (dried)	2,368,380 lb.	\$117,502.00
Mushrooms (canned)	27,896 lb.	\$ 7,812.00
Mushrooms (dried)	104,488 lb.	\$ 37,947.00
Peas (canned)	763,198 lb.	\$ 72,759.00
Peas (dried)	75,180 lb.	\$ 3,420.00
Sweet Corn (canned)	339,152 lb.	\$ 31,588.00
Tomatoes (canned)	731,237 lb.	\$ 53,848.00
Vegetables (canned)	1,217,591 lb.	\$120,649.00

Compiled from "Monthly Summary of Foreign Commerce of the United States, Dec., 1930. Courtesy of the Plant Inspection Office, Board of Commissions of Agriculture and Forestry.

UNIVERSITY OF HAWAII

DAVID L. CRAWFORD

President

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