

AN ABSTRACT OF THE THESIS OF

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Title-----SOME OF THE PROBLEMS OF GROWING VEGETABLE-----
-----SEED IN OREGON AND WASHINGTON-----

Abstract Approved:-----Redacted for privacy-----
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America has been dependent on foreign countries for much vegetable breeding and seed production. The American industry is growing but is hampered by lack of research, lack of experience, higher priced labor and a low tariff protection. Reciprocal trade agreements have also complicated the problem by lowering duties on numerous vegetable seeds.

The occupation of several important seed producing countries by Germany, has cut off much of our former supply of vegetable seed.

America is now confronted with the necessity of increasing acreage of vegetable seed, increasing research, plant breeding and improvement. A better understanding of the problems which confront a grower of vegetable seeds is quite necessary. Strains of seed, best suited to the varied conditions of production and market demands, must be studied.

The growth of the vegetable seed industry is not entirely due to the war. There is a better understanding of the value of fresh vegetables in the diet and many more are being consumed. Refrigeration has helped increase the use of vegetables in that they can now be served fresh in any part of the country, due to refrigerated transportation or through frozen food service.

Canning and dehydration of vegetables is also growing steadily.

The increasing number of modern, fresh vegetable markets has caused a greater demand.

The emergency condition due to the war, as well as the steadily increasing demand for vegetable products, requires serious attention to the seed supply. Good seed is essential to the raising of a profitable crop. Purity and germination are of prime importance but still back of this is the plant selection and breeding program. Much of this type of work will have to be done, due to these increasing demands for American grown seed.

There will be over 302,000 acres in the United States, devoted to the raising of vegetable seed during 1941. This Northwest area is

fast becoming one of the leading production centers and new and better methods of handling the crop are becoming common practices.

This thesis is a summary of approved methods of growing and handling vegetable seed, following a study of all available literature and the contacting of many seed growers and dealers in vegetable seed in the Northwest.

The cruciferae, one of the more important vegetable families, has a rather shallow root system requiring soil rich in quickly available plant nutrients. Much seed has been imported for these crops. Some produce seed the first year but most of them are biennial in habit. All members cross pollinate readily so seed fields of varieties as well as species must be separated a considerable distance. Breeding and increase plots are very necessary.

Most of the American grown seed is produced on Long Island and around Puget Sound.

Crop rotation, sanitary methods and occasional applications of a good poison dust or spray will take care of diseases and ordinary pests of the cruciferae family.

The cucurbitaceae produce seed the first year and varieties cross pollinate if grown close together.

Earlier crops are obtained on lighter soils but heavier yields come from the heavier, well drained soils. All like plenty of moisture and warm temperatures. A good poison dust will kill important insect pests.

Crop improvement is mainly by selection. When fruits are ripe, they are picked, broken up and soaked in water to separate the seed from the pulp. The seed is then dried and cleaned before storing in cool, dry storage.

Umbelliferae crops are biennials, producing seed the second year. The wild varieties are very troublesome as they cross pollinate with the cultivated crop.

Shape is very important in carrots and parsnips so a light rich soil is best. Celery does well in peat and muck soils.

Celery and carrots have to be protected during cold winter weather but parsnips do not. Celery must be sprayed regularly to prevent disease.

Large quantities of seed have been imported to supply the demand for good seed.

The chenopodiaceae including beets, chard and spinach, does best on deep well drained soils. Spinach is often raised on the lighter, earlier soils. It produces seed the first year while the other crops take a second year to produce seed.

Selection is very important for improvement in these crops. Isolation of varieties as well as species is necessary to prevent cross pollination.

The liliaceae include onions, a biennial, and asparagus which lives for a number of years.

Selection as to color, shape and sprouting habit is important for onions. Onions are raised almost entirely on peat and much soils, but the seed crop is raised better on the next level higher. Both crops do best on well drained, moist soils.

The leguminosae family are an annual seed producing groups. They do well on most soils but well drained loams are best.

Use of clean seed and field regueing is most important.

Varieties are selected to suit the locality where grown and markets where sold.

It is most important that good strains of vegetable seed be produced. The strain must suit the locality where grown and the purpose for which the crop is to be used.

Pollination, a very important factor, must be watched. Many crop intercross and most varieties of vegetables will cross pollinate unless seed fields are isolated. Volunteer plants and wild forms of the same family must be removed.

Improved machinery and methods of handling are doing a great deal to give the grower of vegetables, better seed.

A close cooperation between seed growers, dealers and handlers will always do much to improve and maintain a high standard for the product. Most of the canners of vegetables and wholesale seed houses furnish the seed and do the final cleaning of the crop where raised.

Breeders of vegetable seed have a most important duty under our conditions.

When a pure, high quality seed is produced, it must be placed in a cool, dry place to keep it in the best possible condition until planted.

SOME OF THE PROBLEMS OF GROWING VEGETABLE
SEED IN OREGON AND WASHINGTON

by

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TABLE I - ACREAGE AND PRODUCTION OF VEGETABLE SEEDS - 1939-1940-1941 (11)

Kind	1939		1940		1941 (Estimated)	
	Acres	Production	Acres	Production	Acres	Production
Beans, Dwf. Green	18,922	15,023,493	21,936	17,619,305	30,040	22,945,890
" " Wax	4,752	3,239,953	3,672	2,355,990	5,332	3,509,250
" Pole	2,994	3,144,296	3,976	4,044,393	5,078	5,307,616
" Dwf. Lima	6,342	6,055,584	8,951	10,386,088	9,626	9,821,300
" Pole Lima	393	464,689	670	778,905	568	710,000
Beet	2,474	2,149,448	1,728	951,041	2,591	1,707,020
Broccoli	-----	-----	22	17,606	90	36,400
Brussels Sprouts	-----	-----	1/10	40	26	14,250
Cabbage	1,083	474,031	473	134,507	1,439	855,725
" Chinese	-----	-----	1/8	50	29	23,600
Carrot	2,940	1,197,673	2,949	750,744	3,965	1,279,300
Cauliflower	-----	-----	11	5,145	69	11,025
Celery	74	59,915	33	11,976	52	18,500
Chard, Swiss	99	101,152	101	72,731	269	202,300
Chicory	23	7,068	29	9,404	34	16,300
Corn, Sw. Hybrids	2,619	2,402,546	3,178	3,451,596	4,981	5,169,010
" " Varieties	3,834	4,484,482	2,533	2,921,375	3,426	4,329,000
Cucumber	1,841	428,957	2,302	468,540	3,753	1,342,180
Dill	15	7,133	28	18,563	66	43,500
Eggplant	394	18,222	108	4,186	191	14,200
Endive	159	100,034	108	42,471	143	76,600
Kale	-----	-----	20	20,000	166	102,492
Kohlrabi	-----	-----	-----	-----	8	3,200
Leek	-----	-----	2	400	11	4,750
Lettuce, Heading	1,792	620,247	2,318	789,446	3,205	1,047,600
" Loose-Leaf	459	226,424	685	327,624	774	390,500
" Romaine	111	58,230	184	71,060	287	116,100
Muskmelon	1,556	343,135	1,637	325,928	2,742	714,865
Watermelon	4,227	384,839	5,289	574,369	5,896	724,900
Okra	158	61,601	97	39,822	117	47,100
Mustard	177	141,577	195	90,608	934	622,500
Onion	1,389	413,787	1,935	343,615	3,250	892,980
Parsley	121	158,397	249	232,990	380	240,850
Parsnip	178	97,365	225	159,244	271	150,450
Peas, Smooth	16,914	17,009,133	63,321	45,075,086	70,611	59,072,840
" Wrinkled	42,088	40,946,136	62,991	55,307,450	106,600	94,572,311
Peppers	1,501	59,429	968	43,389	1,563	79,655
Pumpkin	255	43,005	323	73,885	378	82,395
Radish	3,295	891,244	4,795	1,209,779	8,752	3,165,610
Salsify	26	15,697	62	42,833	32	20,200
Spinech	170	137,550	919	361,952	4,644	3,253,700
Squash, Summer	775	214,429	1,199	329,837	1,560	409,250
" Winter	2,034	184,941	1,382	192,086	1,835	361,525
Tomato	9,541	326,117	9,660	273,595	10,360	344,241
Turnip	1,804	1,004,958	2,092	1,525,472	3,576	3,075,700
Rutabaga	119	82,240	281	179,299	340	269,600

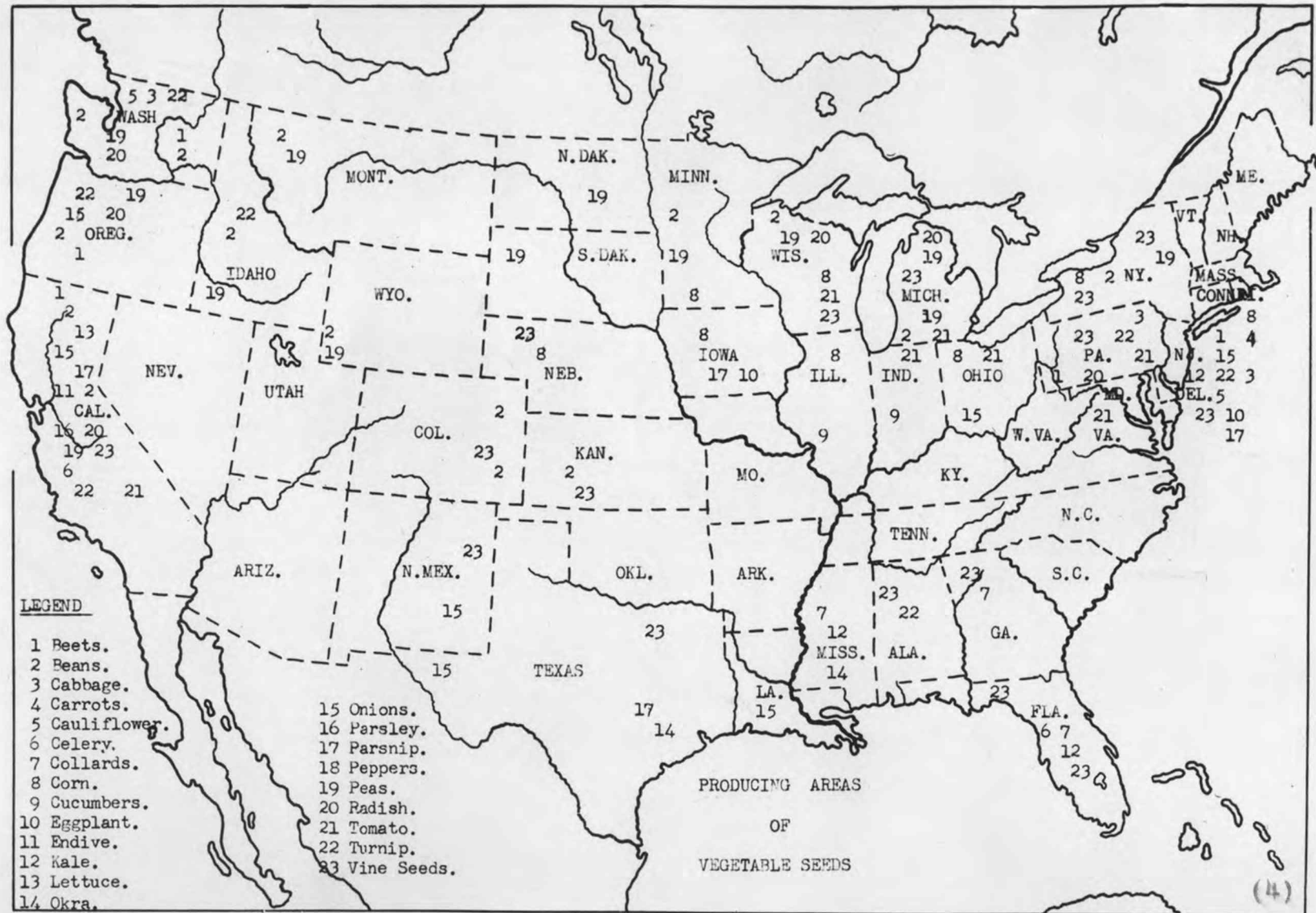


TABLE III. YIELD OF VEGETABLE SEED IN POUNDS PER ACRE

United States Production 1939, 1940¹

Kind	1939	1940
o Beans, Dwarf Green	794	823
o Beans, Dwarf Wax	681	620
o Beans, Pole	1,050	1,037
o Beans, Dwarf Lima	955	1,154
o Beans, Pole Lima	1,182	1,244
- Beet	869	571
- Mangelwurzel	687	513
# Broccoli	---	---
o Brussels Sprouts	---	---
* Cabbage	438	287
- Carrot	407	259
* Cauliflower	---	---
o Celery	810	384
Chard, Swiss	1,022	666
# Chicory	307	326
Corn, Sweet, Hybrids	917	958
Corn, Sweet, Varieties	1,170	1,165
Corn, Non-Sweet	1,847	1,170
# Cucumber	233	219
Dill	476	663
o Eggplant	46	42
o Endive	629	421
# Kale	---	---
# Kohlrabi	---	---
o Leek	---	---
Lettuce, Heading	347	343
Lettuce, Loose-leaf	493	490
Lettuce, Romaine	525	386
Muskmelon	221	200
o Watermelon	91	93
Okra	390	395
# Mustard	800	398
* Onion Seed	298	173
- Parsley	1,309	913
# Parsnip	547	667

¹ Calculated from "Results of Recent Vegetable Seed Survey" by Agricultural Marketing Service, Washington, D.C., January 15, 1941. (11)

Kind	1939	1940
o Peas, Smooth	1,006	660
o Peas, Wrinkled	973	825
o Pepper	40	37
o Pumpkin	169	202
* Radish	270	261
o Salsify	604	783
* Spinach	809	346
o Squash, Summer	277	252
o Squash, Winter	91	94
o Tomato	34	31
* Turnip	557	635
- Rutabaga	691	435

- * Imported in large quantities.
- Imported in fairly large quantities.
- # Imported in moderate quantities.
- o Imported in small quantities.

SOME OF THE PROBLEMS OF GROWING VEGETABLE SEED IN OREGON AND WASHINGTON

I. INTRODUCTION

America has been dependent on foreign countries for much vegetable breeding and seed production. The American industry is growing but is hampered by lack of research, lack of experience, higher priced labor and a low tariff protection.

Reciprocal trade agreements have further complicated the problem by a lowering of duties on numerous vegetable seeds.

The occupation of several important seed producing countries, by Germany, has cut off most of our former supplies of seed.

America is now confronted with the necessity for enlarging not only the acreage of vegetable seed production, but also the work of research, plant breeding and improvement. The acreage increase is developing, as shown by table I, but the quality of crop under this emergency program is still problematical.

Vegetable seed producers are divided into a number of classes. There is the small grower, producing seed for his own use and possible some to sell. Then there is the wholesale grower, who on a large or small acreage, produces seed for a wholesale distributor. This is

usually produced under a contract with the distributor furnishing the seed and doing the final clearing. Another type of grower is the one who is producing for a canner or processor of some type. These may or may not do breeding and improvement work. The most important grower, however is the breeder, who spends most of his time on actual plant improvement.

A better understanding of the problems, which confront the growers of vegetable seed, is quite necessary when vegetable production acreage increases as it has been during recent years.

A great deal of work should be done on strains of vegetable seed endeavoring to find which are best suited to the varied conditions of production and market demands in the U.S.

The rapid growth of the vegetable seed industry has been due to a number of things besides the war. People are becoming educated to the value of vegetables as a source of vitamins, minerals and as a roughage in the diet.

Refrigeration has played an important part to further the use of vegetables. They are now kept fresh over a much longer period of time and can be shipped great distances in refrigerated cars. Many vegetables can be had fresh in most markets the year round due to rapid transportation and refrigeration.

Frozen vegetables have increased the vegetable consumption a great deal the last few years. Some of this increased consumption has of course been taken from other types of preserving, but much of it is new. Table IV shows something of this increase.

There has been a sharp upward trend in production of frozen vegetables, since the birth of this industry, until 1939. A reduction then of around 9,000,000# was due to several causes: (1) A substantial carryover of many items from the record production of 1938. (2) Expansion of sales outlets had not kept pace with production. (3) Competition from low priced canned vegetables due to an over supply. (4) Fewer packers froze vegetables in 1939 than in 1938.

From available figures it would appear that this method of handling vegetables will steadily increase due to its convenience for the housewife, the lack of waste and the availability of fresh products the year around.

Canning and dehydrating of vegetables has also moved forward the last few years. Many crops are now preserved, in an almost fresh condition, which we formerly never considered could be so handled.

The growth of modern vegetable markets, in the cities and towns, has done a great deal to further the use of fresh vegetables.

Table IV. Trends in Production of Frozen Vegetables
in Oregon and Washington, by Years
1934-1939

Vegetable	1934	1935	1936	1937	1938	1939
Peas	1,750,000	4,000,000	8,220,000	10,982,166	15,760,841	10,258,885
Peas & Carrots	*	*	*	62,808	536,829	240,815
Carrots	*	*	*	81,703	13,878	10,795
Snap Beans	250,000	1,000,000	1,930,000	2,244,195	3,185,600	1,584,321
Lima Beans	*	*	*	149,356	247,461	130,048
Spinach	*	*	*	792,659	1,324,602	2,104,239
Brussels Sprouts	*	*	*	188,780	375,975	410,070
Broccoli	*	*	*	519,102	983,097	1,006,085
Corn	500,000	1,000,000	1,270,000	1,777,219	2,749,091	658,443
Asparagus	*	*	*	910,090	1,719,015	1,766,349
Cauliflower	*	*	*	237,413	418,935	715,346
Squash	*	*	*	407,087	715,047	806,121
Others	500,000	1,000,000	1,050,000	453,215	1,629,851	613,129
Total	3,000,000	7,000,000	12,470,000	18,805,793	29,660,220	20,304,646

* Included in "Others" prior to 1937

(14)

The increase of foreign elements in our population has increased the market demand for fresh vegetables, as they consume more of this type of food than the older Americans.

The emergency condition due to the war, as well as the steadily increasing demand for vegetable products, requires serious attention to the seed supply.

It is not only necessary that we raise the seed needed but we must make the studies for improvements and new introductions which formerly were carried on by others.

Canners, shippers and handlers of vegetables are anxious to have strains of vegetables which are not only uniform in quality but uniform in maturity. This will save on labor by shortening the harvest season and also gives the processor a sufficient supply of raw product at one time, since the fields will be cleared in one or two times over them.

Good seed is essential to the raising of a profitable crop. Purity of seed is very important. We not only want seed free of other crop and weed seeds but pure as to strain and variety.

Germination of course is important and such tests must be run on all seed offered for sale. Most vegetable seeds germinate quite readily for a year or two and many for three or four or more years. Some few vegetable seeds lose their vitality very quickly and new seed must be

raised every year. It is well to run a test on germination if the age of a lot of seed is not definitely known.

Breeding is a phase of the work which must receive attention. There are two stations which devote all or a major portion of their time to such work. One is the U. S. Regional Vegetable Breeding Laboratory at Charleston, S.C. and the other the Great Plains Horticultural Field Station at Cheyenne, Wyo. Seed growers work along this line also, but most of their efforts are devoted to keeping the seed clean and pure. Many plants readily cross pollinate with other plants so must be grown in isolated fields.

Much time is spent in roguing out the off types and anything not true to the desired characteristics. Selections are made of very desirable plants and increase plots are grown, thus increasing the supply of the more desirable seed.

There will be over 302,000 acres in the U.S. devoted to vegetable seed production during 1941. This acreage is probably being held down due to the scarcity of good labor.

In making this study, it was found that there are few books written on the subject. Those that were reviewed and some which were on closely related subjects were also checked over for what information they might contain. Many journals, magazines and trade paper articles,

which had a bearing on the subject, were read. Following this work, seed growers and handlers, of the West and particularly the Northwest were contacted to get an idea of their problems and how they were handling them.

This Northwest area is fast becoming one of the leading vegetable seed producing centers. New and better methods of handling the crops are becoming common practices.

This thesis is a summary of findings, giving the more approved methods of growing and handling the following vegetable seeds.

II. CRUCIFERAE OR MUSTARD FAMILY

The members of the crucifer family are very important from the standpoint of vegetable production. Many of its species and subspecies are cultivated as garden crops. Some of them are annuals, producing seed the first year. Many of them are biennials, requiring two years to produce seed, while a few members of this group are hardy perennials which live over a period of years.

Closely related members of the group are cabbage, cauliflower, broccoli, brussels sprouts, collards, kohlrabi and kale. These crops all cross pollinate quite readily and therefore must be separated by a considerable distance when grown for seed. Their flower structure is very similar but they vary greatly in vegetative habit.

There is also the problem of intercrossing of varieties when grown close together. It is necessary to allow 160 rods between varieties.

Other cruciferae grown as vegetables are turnips, rutabagas, Chinese mustard, Chinese cabbage, radish and horse-radish. This family also includes stocks, a well known ornamental plant, as well as some of the common weeds, such as shepherds purse and wild mustard.

In general it may be said that crucifers are heavy feeding plants with relatively shallow root systems. They require for best development a soil rich in quickly

available plant nutrients.

1. CABBAGE (*brassica oleracea*, var. *capitata*).

The wild cabbage that is found growing on the Western coast of Europe is thought to be the common ancestor of our present crucifer family. Cabbage was early introduced into the United States as a truck crop for shipment, as a market garden crop and in the home garden. Large quantities are used in the manufacture of kraut. It thrives equally well under the influence of open coast, lowlands and mountain slopes. It likes cool sections with an abundance of rainfall but is adaptable to a large variety of soils and climates as are found here on the Pacific Coast.

The cabbage plant is a biennial, the first year producing a short stem with a head. The second year the bud pushes up through the leaves, branches and bears flowers. The leaves, forming this head, are large, and when mature are ablong-ovate or circular. The outer leaves overlap and form a loose covering over the inner more compact mass of leaves. The root system is finely branched and very extensive. In a mature plant it may extend out from 3-5 feet from the plant. Most of the roots are in the upper foot of soil.

Cabbage is the most important of the leaf vegetables. It is one of the few that can be had the year around.

If the cabbage ground is very acid, an application of lime will be beneficial and should be applied several months in advance of the crop. The organism causing club root of cabbage thrives best in acid soils.

Cabbage should be grown in a rotation with crops not related to it, as close relatives would be attacked by the same diseases and insect pests, and there would be a tendency for disease organisms and insects to accumulate in the soil. The club root organism, the soil fungus causing cabbage yellows as well as the soil infesting bacterium causing black rot, lives over in the soil. The chrysalids of the cabbage worm may pass the winter in old cabbage stumps and other refuse.

DISEASES OF CABBAGE

1. Club root is caused by one of the lower soil organisms belonging to the slime molds. It is more prevalent in the East than in the West. The roots swell and the plant wilts even when plenty of moisture is available. Control..A. Grow on disease free ground.
 - B. Organisms thrive in acid soils. Add lime.
 - C. Destroy all diseased plants by burning.
 - D. Practice crop rotation without other cruciferae.
 - E. Keep down weeds of the cruciferae family.
 - F. Drain wet land for better aeration.

2. Cabbage yellows is one of the most widespread and serious of the cabbage diseases. It is caused by a soil fungus which invades the roots in the seedbed or in the field. It enters the fibrous roots and travels to the stems and leaves. Infected plants are stunted and the foliage turns a light yellow. A cross section of the stem looks watery at first, then darkens and finally turns brown or black. Infected plants drop their leaves soon after transplanting but the top lives on, although it does not form a head. The disease is less prevalent in the North and is not very serious where early spring or winter cabbage is grown. It is most prevalent where soil temperatures are high during early development. Even resistant strains develop a high percentage of yellows when plants are started in infested soils with high temperatures. Resistance is more pronounced as plants get older.

The best method of control is by the selection of resistant strains. This can be accomplished by selecting surviving plants in a field of badly infected cabbage. It has been possible to select resistant strains in nearly all varieties by this method.

INSECT PESTS

1. Cabbage root maggots attack many members of the cruciferae family. The eggs are laid on the stem near the

surface of the ground or in the soil. These hatch in a few days and the larvae feed on the roots and stems. Heavy infestations will kill the plants while lighter attacks reduce the rate of growth.

Control is by crop rotation; use of tarred paper disks around stem of plant; exposing of pupae to severe weather or by the use of Mercuric Chloride solution (1 oz. to 10 gal.). Apply one fourth cupful around each plant several times during the season.

2. Cabbage aphid are a very common pest of crucifers. They are kept in check to some extent by ladybird beetles and syrphus-fly larvae. A good nicotine dust or spray is very effective in control.

3. Common cabbage worm. The adult white butterfly deposits the eggs on the cabbage leaves. The larvae hatch out in from 3-10 days and start eating. There are from three to six generations.

Control can be had by use of an arsenical spray or dust every week during the early growing season.

4. Brassica pod borer (*Ceutorhynchus assimilis*). The adult weevil emerges in the spring and deposits eggs on both wild and tame hosts. The larvae, upon hatching, burrows into the immature seed pod and destroys the young seed. All seed in a pod are ruined but not all pods are entered. A poison dust at the time it emerges is probably the best control.

Many varieties of cabbage are self sterile and have to be cross pollinated to produce seed. Therefore mass selection is used mainly in breeding work, for type improvement. Due to this ease of crossing, and other problems, and work in connection with the growing of good seed, it is not a common practice for commercial cabbage growers to produce their own seed for use the following year. This job is left to the seed specialist. The commercial growers average about 186,000 acres at present.

When the mature or near mature heads are to be used for seed production, late cabbage seed is planted in May in the open ground and early cabbage seed is planted in June. Varieties to be selected will depend on the market demands and opportunities for further production.

A fertile loam is normally selected for seed production. A commercial fertilizer is often added which is high in phosphorus. This hardens the plants, giving a better keeping quality. This is most important when using immature heads.

Transplant into the field, with a hand trowel or a machine planter, in rows about 3 feet apart and with 2 feet between plants. This is done in time to give a well formed immature head by fall.

Give frequent light cultivations and keep the weeds out of the row with a hoe.

In October rogue fields of all poor plants leaving

only the plants which are true to type. These are taken to the seed field and set in rows about 6 feet apart. In November they are covered with dirt to prevent freezing. About March they are uncovered and the seed stalks grow rapidly. They will need to be staked and supported by twine strung on each side of the row. If seed stalks are restricted by the leaves, a cut can be made in the head to relieve this condition. Care must be taken to avoid damage to the bud.

When the seed pods begin to turn yellow, about July 1st, it is time to gather, to prevent shattering. The plants can be placed on canvas to dry or the stake can be pulled and laid crosswise of the ridges and the plant laid on it to hold it slightly off the ground and provide aeration while curing. It will take from 2-4 days for the plants to dry.

Seed shatters at the touch so it is necessary to use canvas covered carriers to haul the crop in for threshing. For small amounts flail out the seed, but for larger quantities a machine can be used to advantage. The threshed seed should be cleaned at once by running through a fanning mill. Spread out in a thin layer to dry. Stir the seed frequently until dry. It should not be stored before it is completely cured as it molds very easily and quickly. When cured, store in a cool, dry, well ventilated storeroom.

Use only seed produced from heads that were quite mature, for stock seed production.

From 2-4 oz. of seed are required per acre.

The average number of seed per ounce is 5,000 (13).

It takes from 20-25 plants to produce a pound of seed although a single plant will often produce as high as 2 ounces of seed. A quart of seed weighs about 24 ounces.

Cabbage seed should germinate about 85% when one year old and the duration of germination is from 3-4 years.

An average production of seed is from 400#-1400#, per acre (4). The average consumption of cabbage seed in the United States is around 650,000#.

Annual importations of seed have been around 200,000-300,000 pounds, the rest being produced here in the U.S. This shows that there is still room for several hundred acres of cabbage seed production. Since we have the correct climate here in parts of Oregon and Washington, it would be well to investigate the culture of this crop more and the methods of handling will bear more experimenting and research.

TABLE V. ANNUAL IMPORTS OF CABBAGE SEED
By Countries of Origin - 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	74,718	55,643	74,651	45,245	57,423	30,521
France	1,160	607	347	114	440	198
Germany	3,531	3,497	6,018	5,453	4,142	2,155
Netherlands	127,612	50,150	66,406	26,486	94,665	30,423
United Kingdom	33,870	11,363	20,715	5,874	12,162	3,631
China	3,617	692	1,097	147	567	73
Japan	4,601	2,070	3,328	998	3,444	770
All Others	1,071	732	890	428	674	275
Total	250,180	124,754	172,452	84,745	173,517	68,046

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	79,447	43,950	130,631	62,424	180,678	80,139
France	5	5	892	324	5,789	2,412
Germany	2,235	1,131	4,959	1,638	221	116
Netherlands	69,088	24,490	137,718	48,185	190,325	64,705
United Kingdom	31,765	9,057	20,073	5,912	10,856	4,169
China	240	50	280	76	20	14
Japan	8,740	1,849	9,048	1,590	9,387	1,858
All Others	1,279	407	568	402	2,841	1,131
Total	192,799	81,339	304,169	120,551	400,117	154,544

2. CAULIFLOWER (*Brassica oleracea*, var. *botrytis*).¹⁷

Cauliflower is of European origin. It is said that it was discovered by the Italians, the Dutch gardeners improved it and the Danish growers perfected it. It is now regarded as the most highly refined member of the cruciferae. When properly prepared, it is without question the most delicious member of the family. The head, or curd as it is called, is the edible portion of the plant. It terminates the main stem and is composed almost entirely of thickened branches of the inflorescence. If the head is not cut when ready the branches elongate and in time the flowers and seed are formed. The leaves are longer than cabbage leaves and much narrower. Most of the roots are found in the first two feet of soil with a few going down to the three foot level.

For many years cauliflower has been a very important field and garden crop. It is much more exacting in its requirements as to soil, moisture and temperature than is cabbage, and is therefore not grown over so wide a range of territory. It is quite necessary to have a cool moist climate for satisfactory commercial production.

Proper climatic conditions are more important than any particular soil. The plants will not head in hot, dry climates or when hot, dry weather prevails in moderate climates. Along the coasts, around the Great Lakes and on Puget Sound are found ideal conditions for the best

production of cauliflower. Some inland sections are favored with the proper climatic conditions. Overhead irrigation has done much to help improve atmospheric conditions where they were not so favorable naturally.

Plants for both early and late cauliflower are started in the same manner as early and late cabbage except that greater care must be exercised. The soil should always be sterilized and can be only moderately rich. Overwatering must be guarded against, and plenty of ventilation is of utmost importance. The aim is to produce a moderate, healthy, unchecked growth from seed sowing until established in the field.

Cauliflower plants are much more tender than cabbage so cannot be started quite as early. March 1st, is about right for the Northern colder sections. The plants are then ready for the field in early May after danger of hard frosts is past.

An ounce of good seed will produce about 2500 good plants.

Early Snowball is the leading variety for early cauliflower as it is a small plant with plenty of foliage to protect the head, and it produces very uniform snowy white heads. The Dwarf Erfurt is also very well known and used by many growers. Danish Giant or Dry Weather cauliflower is used quite extensively as it stands the dry weather better than the other kinds.

Cauliflower requires even greater fertility than cabbage. Lime is used extensively as on soil for cabbage to prevent slub root.

The same insects and diseases that attack cabbage also attack cauliflower.

Whiptail is quite prevalent in some sections. It is the production of long ruffled leaves and no head, or a 'ricey' or leafy head. The plants are dwarfed. Heavy applications of fertilizer or sulphur will sometimes cause this disease as will a severe attack of aphids. Some strains are more susceptible than others. Applications of lime, will often overcome the disease, due to improved soil conditions.

Very little cauliflower seed has been produced in the United States (See Table V for imports). It requires exacting care and the best cultural practices. The price is quite high. It would pay those with the right climatic conditions to investigate the production of this seed crop. There are about 29,000 acres planted for the commercial crop each year.

In producing seed, the highest quality and best market types of varieties should be selected. It is desirable to have strains that are uniform in maturity as well as physical characteristics. The seed field must be isolated to prevent cross pollination and inter-crossing of varieties.

TABLE VI. ANNUAL IMPORTS OF CAULIFLOWER SEED
By Countries of Origin 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	12,389	77,302	9,534	58,312	6,508	38,271
Italy	756	939	306	328	430	408
Netherlands	3,058	20,224	2,923	15,111	3,748	20,467
All Others	298	2,111	450	2,960	663	2,960
Total	17,501	100,576	13,213	76,711	11,349	62,106

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	6,870	43,165	9,076	59,758	7,481	46,328
Italy	391	807	498	558	593	1,793
Netherlands	4,738	30,503	6,060	42,387	3,363	24,763
All Others	35	211	1,673	7,508	410	2,855
Total	12,034	74,686	17,307	110,211	11,847	75,739

Considerable seed is produced by selecting desirable plants in a commercial field and placing a muslin covered cage around them. These cages are made about 4 feet each way and will prevent cross-pollination. A few flies or insects should be left inside to facilitate pollination.

Choose soil types and fertilize as for cabbage. Treat the seed with corrosive sublimate or other good disinfectant for the prevention of seed borne diseases. Seed is sown in the early fall and the young plants are over wintered in cold frames to prevent them from freezing. When growth starts in the spring, transplant in the field, about 3 feet apart in the row and 4 feet between rows and handle the same as cabbage.

Another method is to start the seed in the greenhouse in the early spring. Harden the plants off in cold frames and remove to the field when all danger of frost is past. Handle the same as cabbage.

The average germination of one year old cauliflower seed is 75%, and the average duration of germination is four years.

3. BROCCOLI (*Brassica oleracea*, var. *botrytis*).

Broccoli resembles cauliflower very closely. The main difference is that it is more hardy and requires much longer to mature. The heads are more loose and open, blanching to a pure white without any tying over

of the leaves.

Most of the good broccoli seed has been imported from Europe in the past. For seed production use a good tested strain of seed sowing and transplanting in time to produce good sturdy plants which, at the approach of winter, should be dug and stored in trenches. Keep them protected from frost during the winter and plant out in the early spring. If the weather is mild enough, not lower than about fifteen degrees above 0°F on several successive nights, they will be safe to leave in the field. Cultivate and care for the same as for cabbage. It is very important that all off types and poor plants be rogued out and destroyed.

Harvesting and the handling of the seed is the same as for cabbage and cauliflower.

4. KALE (*Brassica oleracea*, *acephala*).

Kale has been grown for thousands of years and is today one of the most important of the pot herbs. It belongs to the non-heading group of cabbage-like plants. It is a biennial and probably is more closely related to the wild form of cabbage than any other member of the family. Many varieties are quite ornamental with attractive coloring and curled foliage.

Kale grows in warm weather and is also able to withstand mild winters. It thrives best in cool weather

and is largely grown in the North as a fall crop. It is an important truck crop. Large quantities are grown in Virginia and shipped North during the winter. Dairy cows and poultry are fed large quantities of kale during the winter months.

An ideal soil for kale is a well prepared and well drained sandy loam but it will grow and thrive on any good soil. Rather large quantities of fertilizer are often applied to insure top quality and production.

Dwarf varieties are more widely grown than the tall ones. The Siberian group is considered more hardy than the Scotch, which has a light green foliage and is excessively curled. The Scotch kale is of somewhat better quality. Popular varieties are the Dwarf Curled Scotch, Dwarf Purple, Brown Curled and Tall Curled Scotch. Dwarf Curled Siberian or German Greens is a very popular, vigorous growing variety, used by market gardeners.

Quite a little kale seed is being raised in the Pacific Northwest of recent years. For this purpose one should select an isolated field for the same soil type as for cabbage. Disinfect the seed and plant it in early August in rows 3-4 feet apart. The plants should be thinned out leaving good strong plants about every 2 feet. Seed can also be planted in nursery rows and the good plants set out in the field when 6-10 inches high. Cultivate and care for just the same as for cabbage.

Where there is any chance of severe winter weather, a ridge of soil should be thrown over the row, just before the ground freezes. The following spring uncover the plants, and give the same care as for cabbage.

Kale seed has a germination of 85% at one year of age, and the duration of life is about 4 years. There are 7500 seeds per pound. It takes about one pound to plant one acre (13).

TABLE VII. ANNUAL IMPORTS OF KALE SEED
By Countries of Origin - 1931-36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	3,035	451	1,773	396	1,292	228
Netherlands	35,687	6,601	40,751	6,263	43,959	7,138
United Kingdom	2,834	656	1,789	341	3,143	632
All Others	440	151	610	114	50	13
Total	41,996	7,858	44,923	7,114	48,444	8,011

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	1,960	382	4,090	676	4,270	687
Netherlands	81,400	13,856	61,049	11,310	69,307	11,408
United Kingdom	170	41	370	96	96	29
All Others	350	203	-----	-----	348	74
Total	83,880	14,482	65,509	12,082	74,021	12,198

5. BRUSSELS SPROUTS (*Brassica oleracea*, var. *gemmifera*).

This vegetable gets its name from Brussels, Belgium where it has been grown for hundreds of years. It is now grown extensively in this country on Long Island, New York; Half Moon Bay, California and in Southern Louisiana.

A cool moist climate and a fertile soil are needed for the production of Brussels Sprouts. They are closely related to cabbage but have a different habit of head forming. The plant has an unbranched stem with round leaves and the buds appear in the axils of these leaves. Long Island Improved is the leading variety used in the United States.

Insect and disease control is much the same as for cabbage.

Most of the seed that has been used has been imported from Europe. It is possible to produce this seed of good quality any place that cabbage is grown successfully for seed. All seed planted should be disinfected first, to kill all seed borne diseases.

For seed raising one should select plants that have hard, medium sized sprouts, compactly arranged around the stem and dark green in color. In a cold climate they must be taken up and stored in shallow trenches during the winter and set in the field the following spring. In

mild sections they are planted in protected beds 4 by 4 feet. The buds are thinned to seven or eight to the plant. Sometimes the tips are clipped off to make it easier for the flower stalks to emerge.

Seed plots must be isolated to avoid cross pollination and the seed crop is handled the same as for cabbage.

6. TURNIPS AND RUTABAGAS(*Brassica napobrassica* and *brassica rapa*)

As these crops are similar in culture, they will be treated together. Rutabagas are native to Europe while turnips are native to Russia and Siberia where they can be found growing wild today.

Turnips leaves are slightly hairy and the roots are free from fibrous secondary roots. Rutabagas have smooth leaves and often have fibrous roots on the sides of the swollen root.

When raising these crops for seed, selection of the varieties that are in demand by market gardeners is of prime importance. Clean soil should be selected to get away from soil borne diseases. A fertile sandy soil or loam should be thoroughly fitted and fertilized with a complete fertilizer which is high in potash to aid keeping qualities. Treat all seed used with a good disinfectant to kill any seed borne diseases.

Rutabagas are planted for seed in early July and turnips in early August. In the colder sections where

roots must be lifted for winter storage, 15-18 inches is given between the rows for hand cultivation, and 24-30 inches for horse or power cultivation. Plants are thinned to 6-12 inches in the row. In the West where roots can be over wintered in the field the rows are made 36 inches apart and plants sometimes thinned to 12-15 inches in the row. In other cases no thinning is practiced.

Frequent clean cultivation is given throughout the growing season.

In colder sections the roots are dug before danger of frost damage. Tops are cut off taking care not to injure the center bud. The roots are stored in a well drained pit one foot deep and covered with straw. Soil enough to prevent freezing is thrown over them, and the pit should be so made as to prevent water getting to the stored roots. Ample ventilation must be arranged for these pits. Before placing the roots in the pit, they are inspected and all off types are discarded.

In the spring a fertile loam soil is fitted, and fertilized with a complete fertilizer high in phosphorous. Transplanting is done in early spring in rows 3 feet apart and the roots are placed 12-15 inches apart in the row. The roots are packed firmly in the soil with the bud exposed.

In the warmer sections the roots are left right in

the ground and a furrow is plowed over them just before freezing weather. This dirt is removed the following spring and cultivation started for the seed crop.

When the seed pods turn yellow, the stalks are cut, and when dry enough to thresh out they are threshed. The seed shatters very readily so must be handled carefully to prevent loss. After threshing, the seed must be cleaned spread out thinly and stirred frequently until thoroughly cured. It is then sacked and stored in a cool, well ventilated storeroom.

TABLE VIII. ANNUAL IMPORTS OF TURNIP SEED
By Countries of Origin - 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	5,779	818	4,473	478	67,100	5,723
Germany	3,580	394	575	74	4,233	294
Netherlands	196,968	19,942	111,359	10,814	268,002	23,337
United Kingdom	577,067	63,367	267,897	24,796	796,740	60,480
Canada	245,144	24,539	61,711	6,199	6,284	709
Japan	55,072	7,535	37,415	2,901	60,849	4,546
All Others	6,530	1,507	5,627	1,242	8,723	1,955
Total	1,090,140	118,102	482,057	46,504	1,211,931	97,044

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	26,099	2,465	5,359	625	8,437	951
Germany	500	57	-----	-----	275	31
Netherlands	261,857	31,382	142,630	16,962	156,920	16,684
United Kingdom	602,440	59,255	516,596	50,527	403,543	36,932
Canada	693	193	18,356	1,727	242	77
Japan	116,405	12,818	244,558	17,135	149,344	9,779
All Others	4,389	967	1,491	461	2,667	561
Total	1,012,383	107,127	928,990	87,437	721,428	64,915

TABLE IX. ANNUAL IMPORTS OF RUTABAGA SEED
By Countries of Origin - 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	2,031	294	1,370	246	77,071	4,701
Germany	1,270	135	25	4	300	36
Netherlands	47,360	5,429	27,072	2,772	72,541	6,215
United Kingdom	79,636	10,318	40,359	4,788	109,186	10,535
Canada	39,200	3,938	18,917	1,892	29,279	2,928
All Others	175	10	5,200	381	50	6
Total	169,672	20,124	92,943	10,083	288,427	24,421

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	36,512	2,756	26,683	2,288	10,257	884
Germany	-----	-----	900	97	-----	-----
Netherlands	64,779	7,417	40,410	4,755	48,359	5,217
United Kingdom	23,352	2,780	59,279	5,704	34,797	3,179
Canada	360	64	215	99	100	37
All Others	-----	-----	-----	-----	3,760	793
Total	125,003	13,017	127,487	12,943	97,273	10,110

III. CUCURBITACEAE OR CUCUMBER FAMILY

In this family only three genera contain species important as food: Cucumis, cucumbers and melons; citrullus, watermelons, and cucurbita, pumpkins and squash. These are all planted in the spring and mature seeds the same year. There are hundreds of species, about half of which are credited to America and the rest to the old world.

Some cucurbits are ornamentals, other are used as medicines and still others as insecticides. The different genera differ in character of their pollen and in chromosome number and thus do not cross naturally.

1. CUCUMBERS (Cucurbitaceae cucumis sativis).

Cucumbers are one of our oldest cultivated vegetables. They have been cultivated in India for at least 3000 years. They are mentioned in the Old Testament as a food in ancient Egypt, have been cultivated in the Orient for about 3000 years and in America since the time of the earliest settlement.

Cucumbers are raised for slicing fresh and for pickling. They are second in production, for vegetables raised under glass. There are around 100,000 acres planted in the United States for commercial pickle production and about 40,000 acres for fresh sales, besides the large home garden acreage, which is hard to estimate.

Because of the short time it takes to mature a crop, cucumbers can be raised in almost any climate. For an early crop the light sandy soils are best, but yields are better on the heavier soils and the bearing period is longer. Whatever the soil type, it should be moist but not wet. Peat soils produce very heavy crops of fine quality. Soil should be plowed early and harrowed frequently before planting time. This controls weeds and helps retain the moisture. A green manure crop is of great value and stable manure applied to the soil is very good as the plants should have a rapid unchecked growth and they will do this in soil that contains plenty of vegetable matter. Sometimes a furrow is plowed out and a heavy application of well rotted stable manure applied. This should be well mixed with the soil where the row is to be planted. 1000#-1500# of a complete commercial fertilizer of around 4-8-10 formula is very good for cucumbers.

Planting should be done after the soil is warm and there is practically no danger of further frosts. The hills should be from 5-6 feet apart each way. Sometimes they are planted in rows 5-6 feet apart and more closely in the rows. 8-10 seeds are planted in each hill, and the smaller plants are cut out early in the season leaving 3-4 plants per hill or one every foot if in drills. It has been proven that the size of the plants

at thirty days is directly proportional to the areas of the cotyledons in the seedlings. There is also a positive correlation to size of stem, rate of growth and production.

Cultivation and hoeing should start as soon as rows can be readily seen. Cultivation should be shallow at all times and as frequent as necessary to keep the weeds down until the vines interfere with the work.

Among the pests are the melon aphid, striped beetles and twelve spotted beetles. They can be controlled by dusting with calcium arsenate and gypsum or a 4% nicotine dust, soon after the plants show above ground.

Diseases that are common to cucumbers are anthracnose, leaf spot, scab and downy mildew. They may be held in check by spraying with a 4-4-50 Bordeaux mixture. Bacterial wilt and mosaic can be checked best by keeping insects under control and by cleaning out all diseased plants as soon as they show. Pull all host plants in the vicinity and burn them.

The United States each year uses about 1,000,000# of seed (4). Most of it is grown in California, Colorado and Michigan. The fruits are left on the vines to mature and are all gathered at once, just before they freeze. For seed production, it is very necessary to have planted good seed, of varieties in demand, to rogue out all plants not up to standard and to remove all poor fruits.

After gathering, the fruits are passed through a thresher or pulp machine which crushes them and separates the seeds and juice from the rind. They are then put in large containers to ferment until the pulpy seed coat is broken, after which they are washed. Some machines have been made that will wash them without the fermenting process, and a cleaner, brighter seed is obtained.

Washing is of two kinds. One is based on the principle that the seeds are heavier than water and will sink while the pulp is lighter and will float. The other is the shaker type where the seeds are shaken and the pulp washed out at the same time.

After washing, the seed must be dried. This can be done by spreading it out in a thin layer on cloth covered frames and exposing to the sun or by using a mechanical drier. The seed must be stirred frequently for rapid drying. Never should the air get over 100 degrees F. When dry, the seed should be fanned to clean out light and broken seeds. Sack in clean sacks and store in a dry, well ventilated warehouse.

Production averages around 250# per acre (4). Thirty average fruits will produce a pound of seed.

A pure line cannot be obtained by single plant selection since cucumbers are self sterile. Improvement can be obtained, and should be, by selecting a few

outstanding plants, saving the seed and planting a short row of each as a test planting the following year. Some will be much better than others, and the remainder of that seed can be used to increase the supply of good seed.

Pollination is done by insects, so it is necessary to have insects present when the plants are blooming.

2. MELONS (Cucurbitaceae cucumis melo)

The species melo is divided into a number of sub-species.

1. Var. reticulatus - netted or nutmeg cantaloupes. Fruit having netted skins, shallow sutures and ribs. Flesh light green to reddish orange in color.

2. Var. cantaloupensis - European cantaloupes or rock melons. They are not netted and have warts or scales on them with a hard rind.

3. Var. saccharinus - pineapple melons much like group 1.

4. Var. flexuosus - inedible, long crooked, non netted fruits.

5. Var. inodorus - winter melons. Honey dews and casabas. Smooth ridged skins, not netted, ripens late and keeps well.

6. Var. acidulus - Cucumber melon. Inedible.

7. Var. chito - garden lemon and vegetable orange. Used for preserves.

8. Var. dudain - inedible, small, round, highly scented fruits. Pomegranate melon.

The name cantaloupe was originally applied to a variety grown at the castle Cantaloupe, near Rome. In the United States the term is applied to all netted melons. The larger fruited cantaloupes are known as muskmelons because of the aroma of the ripe fruits. Muskmelons are native of Southern Asia and have been grown for centuries in European countries.

Muskmelon growing has increased rapidly of recent years. There is now a total of about 100,000 acres producing these melons in about half of the states in the union. Production is centered in the dry arid regions, under irrigation.

The history of commercial melon production in this country is practically a history of Rocky Ford strains. These have been developed in Colorado from Netted Gem, which is a variety introduced from France about 1880, by W. A. Burpee, a seed grower of Philadelphia.

Since about 1900 the culture and popularity of melons has increased very rapidly as varieties have been greatly improved, transportation is better and refrigeration has been developed. Melons are produced in the best adapted areas, and shipped all over the

country for a long and popular season.

The root system of muskmelons consists of a large thick tap root and several branches six to eight inches below the surface of the soil. These branches grow outward and downward for several feet and are well supplied with fibrous roots.

The stems lie on the ground trailing out 8-10 feet in length. There are primary branches arising from the lower leaf axils and secondary branches arising from them. The fruiting branches arise from all three and are herbaceous at first, later becoming woody. The leaves are alternate and have nonforked tendrils opposite them.

In picking varieties to grow, select the ones of highest quality and production and best adapted to the market demands, or use to which they are to be put.

The plants of most American varieties bear staminate and hermaphroditic flowers on the same plant. The flowers open about two hours after sunrise and close in the afternoon of the same day. The anthers dehisce soon after the corolla is wide open. The pollen is oily and sticky so the honey bees play a very important part in the pollination process. They gather honey from the flowers and scatter pollen all over the flower as well as crossing onto other flowers.

Muskmelons can be grown in almost any soil, skill-

fully handled, but show a great preference for the sandy types which are easier to handle and produce an earlier crop. Alkaline and neutral soils are best and peat and muck are very poor. Vegetable matter in the soil is very important for good crops. Moisture is most important in any type of soil. Insufficient soil moisture always results in weak vines and small fruits.

A low humidity during ripening develops a thick coarse netting and solid flesh which makes good melons for shipping. A low humidity and no rain will prevent fungus diseases which would defoliate the plants unless carefully sprayed. Premature defoliation lowers the yield, shortens the season and impairs quality of the fruit.

Land for melons should be plowed early and have from 300-500# of a good complete fertilizer applied and worked into the seedbed. For seed raising, this plot of ground must be at least forty rods from any other melons to prevent cross pollination of varieties or species.

New melon seed should germinate 95% and it will maintain its viability for eight or ten years in cool, dry storage. There are about 1,600 seeds per ounce (13).

The seed should be disinfected with corrosive sublimate or some other good disinfectant to avoid injury from Anthracnose, a seed borne disease. The seed is planted after all danger of frost is past. Sometimes plants are

started inside in the colder sections and for real early ones transplanted in the field. Some places protective covers are used to protect the plants until danger of frost is past and they are well started.

When planted in hills, they should be 4-5 feet apart depending on the variety. Some growers drill in rows 5 feet apart and thin the rows out later on. When planted in hills 15-20 seeds are planted in each hill. They are thinned out to 3-4 good healthy plants when the second true leaf appears.

The same diseases are found as in cucumbers, and the same methods of prevention are practiced.

Cultivation should be shallow and frequent until the vines grow together covering the ground.

Irrigation, where done, should be in furrows between the rows. This allows the fruits to rest on dry soil and yet the plants get plenty of moisture for a rapid growth.

For seed production it is necessary to rogue out all off types when they appear. If all undesirable plants are removed at once, the lowering of quality of the seed through cross pollination will be prevented. The fruits are harvested in two or three pickings, and the final selections made. This also allows for complete maturity and yet no fruits spoil with the seeds in them. This part of the work cannot be over emphasized as high

quality seed is of utmost importance. The vigor of the plants, disease resistance, productiveness, quality of fruits and uniformity are all very important factors in selection.

Fruits probably will have to be cut open for the final analysis of the fleshy part, before threshing. There are from 400-600 seeds per fruit. A standard crate of melons will yield about a pound of seed. Melons yield from 150-300 crates per acre (4).

Threshing and handling and drying is very much the same as for cucumbers.

Breeding and increase plots must be maintained as melons readily cross pollinate with other species and varieties. Distinct types can be had by isolation.

There is produced in the United States annually over 600,000# of seed. Most of this comes from Colorado, California and Iowa. In Colorado, around Rocky Ford, the yield of seed averages about 220# per acre.

3. WATERMELONS (*Cucurbitaceae citrullus vulgaris*)

Watermelons are natives of Africa and were introduced into America by the earliest settlers. The commercial acreage will run about 263,000 acres. Much of this is in the Southern states. The varieties grown are probably all selections developed from the older types.

The plants of watermelons resemble the *Cucumis*

although the leaves are divided into three or four pairs of lobes which in turn are lobed and toothed.

The root systems are extensive but shallow, never going down more than 1-2 feet. The laterals exceed the length of the stems.

Pollination is the same as for cucumis, being done mainly by bees and insects.

Watermelons must have warm days and nights and a long growing season for the best results.

Soils for watermelons are much the same as for muskmelons except that they will tolerate acid soils and will give higher yields on such soils. They are usually grown commercially in large fields. The hills should be 10 by 10 feet or in rows 10 feet apart and 2-3 feet apart in the rows.

Cultural practices are much the same as for the muskmelons and the insect pests and diseases are about the same.

Watermelons cross with citron so this point must be closely watched in seed raising. Different varieties must be kept a mile apart in order to be reasonably sure they will not cross. Little has been done on a systematic breeding program. Most of the best known commercial varieties are selections from chance crosses.

Qualities to watch out for in breeding and selection are resistance to disease, uniformity, production, color

of flesh and seeds, thickness of rind, solidity of flesh, quality of flesh, and flavor.

Large quantities of seed are necessary for planting in the United States. Most of the best quality seed is raised in Florida, Iowa, Colorado and California. Much of the seed used is obtained by first taking off a crop of commercial melons and then saving the seed from those that are left. This is a very poor method of securing seed, but due to the low price it is often obtained in this manner.

Mature melons are gathered and crushed in a pulping machine and the seed separated by floatation. They are then dried and stored like other melon seeds.

4. PUMPKINS AND SQUASH (*Cucurbitaceae cucurbita*)

There are three species of *cucurbita* which are cultivated annuals:

1. C. Pepo - leaves hairy, five lobed, often with white triangular spots at angles to the veins. Peduncles of fruits 5-8 ridged and deeply furrowed.

(a). Field pumpkins.

(b). Vegetable marrow.

(c). Crookneck summer squash

(d). Scallops or bush squash.

2. C. moschata - leaves more rounded but lobed. Calyx tube not companulate. Peduncles five ridged and

enlarged next to fruits. Pumpkins and squash (winter). Seeds margin darker than face, rough and often swollen.

3. C. maxima - leaves kidney shaped. Commonly not lobed or with short rounded lobes. Calyx tube of staminate flowers campanulate. Peduncle of fruit cylindrical or claviform, never ridged.

(a). Winter squash (Seeds pure white or clear brown).

Pumpkins and squash are common vegetables grown in nearly every home garden but not raised commercially for shipping, to any great extent. Wisconsin, Michigan and New York ship some.

Considerable canning and dehydration is being done. This is done mainly in Oregon and California. The main qualities necessary are good color and texture of flesh.

Summer squash are picked green for market while the mature winter squash and pumpkins are stored for winter use.

A fertile sandy loam, silt loam or clay loam is best for this group of vegetables. The soil is prepared and handled in the same way as for other vine crops.

When the fruits are mature, they are gathered and stored until there is more time for separating the seed. The fruits are cut open and the seed scooped out and placed in a tank where they can be macerated with a rake

or some such instrument until the seed is free from the pulp. The seed may be loosened by trampling on a tight floor. They are then washed out at once as fermentation would discolor them and spoil their salable appearance. The seed comes to the top and can be removed. They should be spread thinly on a cloth and left to dry without stirring. This allows the outer coat to come off and leaves the seed clean and bright. Run through a fanning mill, then sack and store in a cool well ventilated storehouse.

Breeding plots should be used for the other vine vegetable crops.

IV. UMBELLIFERAE OR PARSLEY FAMILY

This family received its name from the shape of the inflorescence which is much the shape of an umbrella. Some members are grown for their food value while others are of value because of their essential oils which are used in seasoning. Some of the more important plants of this group are carrots, parsnips, parsley, celery and dill. They are all biennials, producing seed the second year. Many of the wild forms are poisonous and are sometimes mistaken for the tame plants and are eaten with ill effects.

1. CARROTS (*Daucus carota*)

The carrot is a native of Europe and adjoining Asia and probably was developed from the wild varieties. This vegetable is appreciated more in Europe than it ever has been in this country. This is possibly due to lack of knowledge as to how to prepare it for eating. As its value in the diet is better known, it has become more popular and is now one of the most important market garden crops. There are about 43,000 acres planted for the commercial crop. Large quantities are sold as young bunched carrots. As they mature, some are sold in bulk for human consumption and tons are raised for stock feeding.

Shape is very important in producing carrots for market. A well drained sandy soil is good. Any soil that bakes is very poor for the production of smooth root crops such as carrots. The young carrot plants are very tender so a fairly clean soil is necessary as pulling out weeds is hard on the young plants.

The field in which carrots are planted for seed should be clean and fertile. A well drained loam is preferred. 500 to 1000 pounds of a complete fertilizer, high in phosphorous, is a good addition to the soil.

Since carrot varieties readily cross and also cross with the wild forms, seed fields must be isolated. Sections where wild carrots abound cannot be used for seed raising unless they can be cleaned up first.

The varieties which are most important for market are the Denver Half Long, Chanteney and Nantes. The cortex or outer part of the root is the part that contains the largest part of the valuable food elements, so varieties with small cores are highly desirable. There are several large rooted high producing varieties that are very good for stock feeding.

Carrots are biennials. For seed raising, carrots are seeded in July in rows 12-18 inches apart, for hand cultivation, and 30-36 inches apart for horse or machine cultivation. In California the soil is irrigated at first to give the plants a good start and then the water

is withheld later on to harden the roots so they will be firm for transplanting. The plants are thinned to 2-4 inches for better root development and handled the same as they are for market sales. The roots are removed from the field before danger of frost injury, as frost damages the roots and they will quickly rot. They are sorted and all off types, diseased or crooked roots are discarded. The tops are removed, taking care not to injure the center bud, and then the roots are stored in a pit or cellar where the temperature can be held just above freezing. The atmosphere of the storage house should be moist.

When all danger of frost is past, the roots are firmly planted in rows 36 inches apart and 6-10 inches apart in the row. The roots are placed at a 45 degree angle with the tops even with the surface of the soil. The reason for such planting is because of the ease of planting.

In California, where 80-90% of the seed used in the United States is raised, the roots are planted right away or within two weeks from digging time. In Oregon and Washington, the roots have to be stored until spring.

When ripe, the entire plant is pulled and cut off just below the lower branches. Leave in piles in the field for from 2-3 weeks. Then pile on large canvas sheets and let dry. When dry, run through a thresher or

TABLE X. ANNUAL IMPORTS OF CARROT SEED
By Countries of Origin - 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	1,310	\$ 690	1,282	\$ 408	6,800	\$ 2,094
France	2,517	816	17,568	4,707	25,248	8,879
Netherlands	9,086	3,231	6,743	1,883	11,306	3,717
United Kingdom	2,652	1,205	6,704	2,448	7,506	2,791
All Others	186	68	2,195	566	9,610	2,598
Total	15,751	6,010	34,492	10,012	60,476	20,079

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	3,174	\$ 1,488	1,823	\$ 967	1,218	\$ 395
France	10,112	5,742	6,048	2,441	3,973	1,157
Netherlands	13,133	6,189	9,243	4,249	9,514	4,210
United Kingdom	2,021	841	2,230	873	350	176
All Others	509	172	146	41	716	373
Total	28,949	14,432	19,490	8,571	15,771	6,311

roll out with large wooden rollers. The coarse stems can be screened out and the balance run over gravity seed cleaners and rubbing machines.

The average yield is about 600 pounds per acre (4). If plants are cut too green or ripen prematurely, due to care or weather conditions, a large number of seeds are not viable. This is a matter to watch very closely when raising seed.

2. PARSNIP (*Pastinaca sativa*)

Parsnips are biennials. The wild plants were native of Europe and possibly Northwestern United States. Early history tells of their cultivation by the Greeks and Romans. Many think parsnips are poisonous, especially the second year. It is very possible that they are confusing them with poison hemlock, which looks somewhat similar.

Parsnips are used widely, although they are not among our most important vegetable crops. The edible part is the long white root which is quite sweet and aromatic.

The seeds are sown early in the spring, about one half inch deep and from 15-18 inches between rows. They germinate quite slowly so the land should be comparatively free of weeds. When from 1-2 inches high, the plants should be thinned to about 4 inches. They are quite hardy when once started. Growth is slow so an entire season

is necessary for development. The best growth is made in the cool weather of the fall season. The roots are quite hardy and are often left in the ground over the winter.

Much of the seed used in the United States is grown in California. A deep sandy loam seed bed is prepared and planted in August, in rows 12 inches apart. When grown, they are dug and graded. The tops are cut back to about 3 inches and the roots kept out for about a week before planting back for seed production. This is done in well prepared soil spacing them 3 feet by 3 feet. The crown is set flush with the surface.

Some places the seed is sown early in the spring in rows 3-4 feet apart and thinned to 8 inches in the row.

Frequent shallow cultivation is necessary as well as hand hoeing to keep the weeds down. The roots are left in the field over winter and cultivation started again the following spring. If this method is used, it is quite necessary to dig a portion of the field and sort very carefully to get some select roots to plant for stock seed. A symmetrical root with a broad crown, uniform taper and free from forks or side roots is desirable. These selected roots should be planted out in an isolated field in order to have pure high quality seed for planting the following year.

Parsnip seed is only viable for from 1-2 years so it

TABLE XI. ANNUAL IMPORTS OF PARSNIP SEED
By Countries of Origin 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
France	3,075	\$ 346	5,578	\$ 512	2,990	\$ 303
Netherlands	6,220	718	5,002	553	4,643	544
United Kingdom	6,088	890	1,732	252	15,562	1,710
All Others	237	71	1,010	85	850	76
Total	15,620	2,025	13,322	1,402	24,045	2,633

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
France	7,143	\$ 978	2,969	\$ 355	2,900	\$ 415
Netherlands	7,570	955	9,250	1,388	6,858	1,076
United Kingdom	6,063	921	2,813	457	1,087	173
All Others	30	6	350	28	1,782	118
Total	20,806	2,860	15,382	2,228	12,627	1,782

is advisable to raise new stock seed every year. There are about 2800 seeds per ounce and it takes from 2-4 pounds to plant an acre (13).

When most of the seed heads turn brown and the stems start to dry, the seed is ready to harvest. The seed stalks sometime reach a height of six feet. The branches are cut and allowed to dry until the seed can be rolled or threshed out with a machine. It is then screened and run through a fanning mill. Then it must be dried thoroughly and sacked and stored in a cool dry place.

3. PARSLEY (umbelliferae carum petroselinum)

Parsley is a native of the old world. In ancient times, it was used in every sauce and salad. Now it is used mostly for seasoning and as a garnish. Hamburg, or turnip rooted variety, is grown for its roots and is handled about like carrots. The foreign population uses it for seasoning in soups and stews and other edible purposes.

Parsley is a biennial. The seeds germinate very slowly and are often started under glass, transplanting once before being set in the field. They are very hardy and can be set out about as early as cabbage.

For seed production the plants are set a foot apart in the row and three feet between the rows. All poor,

TABLE XII. ANNUAL IMPORTS OF PARSLEY SEED
By Countries of Origin 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
France	66,478	\$ 3,271	151,690	\$5,155	30,765	\$1,500
Germany	206,795	9,450	12,725	518	370	60
Netherlands	20,960	3,461	8,827	1,621	9,307	1,375
United Kingdom	12,924	2,197	2,820	509	2,202	437
All Others	1,123	290	3,147	335	1,088	244
Total	308,280	18,669	179,209	8,138	43,732	3,616

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
France	13,031	\$ 861	216,841	\$ 8,833	79,079	\$3,219
Germany	9,959	351	300	56	6	2
Netherlands	6,527	1,105	9,333	1,449	9,134	1,474
United Kingdom	1,583	333	2,895	503	996	157
All Others	68,399	2,202	1,425	304	5,856	456
Total	99,499	4,852	230,794	11,145	95,071	5,308

off type plants are rogued out and the others are given good clean cultivation.

In cold climates the plants must be overwintered in cold frames or trenches but in the Santa Clara valley, where the seed business is largely localized, the seed is planted in May or June in raised beds. One acre of seedbed will plant 40 acres for seed. In December the plants are lifted, sorted and transplanted 32 by 36 inches. In September the seed, which is slow to mature, is ready to harvest. The entire crop is ready at one time. This is done by stripping the seed bearing branches and drying them. They are then rolled, screened and milled. The average yield is around 800 pounds per acre. The plain leaved varieties are the heaviest producers of seed.

4. CELERY (Umbelliferae apium graveolens)

Wild celery is a native of Europe, Southern England and Asia. The original kinds had hollow petioles and as late as 1821 that kind was considered the best. Now only those with solid petioles are grown.

Celery ranks next to lettuce as a salad crop. It is probably more popular in America than in any other country. It is grown in most every state, but the greatest production is in New York, Florida, Michigan and California. This amounts to about 42,000 acres.

Peat, muck and fertile loam soils, rich in organic matter are best for celery production. These soils are easily worked and have a high water holding capacity. It does not do well on acid soils but will tolerate considerable sodium chloride after it gets started.

Celery requires a constant and liberal supply of moisture, growing best in cool weather. Highest quality is produced when matured during the cool season of the year except when freezing weather occurs. In some places where temperatures are quite moderate, it can be matured the year around.

When growing celery for seed production, get the very best seed, disinfect it to kill any blight spores, and plant in May in beds of well prepared soil. Transplanting is done when the plants are one fourth to three eighths inch in diameter at the crown. This is about July. The soil should be well prepared, fertile and moist.

Celery seed is very small and rather slow to germinate. The seed retains its power to germinate for from 6-8 years (13). Some growers buy quantities of seed at a time and try it out before planting a large acreage of any particular seed. Late celery blight lives for three years on the seed.

The roots of the celery plant are trimmed as well as the tops before setting in the field. This aids the work

of setting out the plants. The fibrous roots will start quicker and the plants will not show ill effects of the change as readily. The plants are kept moist from the time of digging until they are set out. All this work is done by hand. Plant in rows 3-4 feet apart and 6 inches apart in the row. A heavy application of complete fertilizer, heavy in potash, is recommended.

Cultivate shallow but frequently throughout the growing season and hoe out all weeds from the rows. Most of the roots are in the top six inches of soil.

Spray every ten or fourteen days with a 5-5-50 Bordeaux spray to prevent fungus troubles.

Rogue the fields of all off types such as off colors, hollow or pithy stalks and plants that show signs of mosaic disease.

Plants are removed from the fields before danger of frost and stored in cold frames or trenches. When trenches are used, a narrow one foot deep trench is made in well drained soil. The plants are set upright in this trench and the roots covered with soil. Nail two 12 inch boards in a V shape and place inverted over the plants so they will have some air and ventilation, and be protected from rain. As it gets colder, cover with litter and dirt to prevent freezing. If put in cold frames the same precautions are taken. It is very necessary that plants be dry when put in trench or cold frames.

A well drained sandy loam soil is best for seed production. It should be heavily fertilized, with a complete fertilizer, heavy in phosphorous. This aids in giving solidity, disease resistance and keeping quality.

The seed field must be isolated from all other celery fields of different varieties to prevent cross pollination. Transplant, when all danger from hard frost is past, in rows four feet apart and eighteen inches between plants in the row. Give frequent cultivations and keep the rows clean.

The heads ripen unevenly. Cut when a large part of the cluster turns brown. They can be cured on canvas sheets in the field or in open sheds. When dry, flail out or run through a separator. The seed is then fanned clean and spread out on a clean floor to dry. Sack and store in a cool well ventilated storeroom.

Some of the finest heads of seed should always be selected and stored separately and planted in isolated positions. Some of the seeds from each such plant should be planted in separate rows and in this manner tried out. The remainder of the seed of each should be saved separately. Seed of the best one could be used to increase that variety.

A very desirable precaution against fungus diseases is to spray with a 4-4-50 Bordeaux spray before taking the plants to the field.

Bacterial leafspot which occurs in the Northern part of the country is identified by irregular circular lesions of a rusty brown color. This is controlled by the use of the Bordeaux spray at intervals of from a week to ten days.

Early blight, which is quite widespread and causes considerable loss, is identified by a wilting of the plants. The older leaves look like they had been scorched, finally falling over and are soon covered with a grayish, velvety mass of fruiting bodies. The same spray as above put on every week or ten days will take care of this disease.

Late blight, which is found where ever celery is grown is generally considered a cool weather disease. It causes circular lesions on the leaf blades and attacks all parts of the plant above ground.

This disease is carried on the seed for two or three years. Such seed must be either immersed in water at 48 degrees centigrade for thirty minutes, or soaked in warm water for thirty minutes, drained and then immersed in a 1-1000 corrosive sublimate solution for thirty minutes. Rinse and dry. The warm water softens the seed coat and causes the spores to exude from the pycindia and the poison kills them.

A Bordeaux spray of the 5-5-50 strength should be applied to the crop at regular intervals to avoid any trouble from this disease.

Blackheart a non-parasitic disease is found in most celery districts. The center heart leaves are blackened, and older leaves turn brown and shrivel up.

The cause of this disease is an unbalanced water relation. The cure is to have the best possible growing conditions for the plants.

Pithiness sometimes causes considerable loss to the celery growers. It can be eliminated by selection and proper growing conditions.

V. CHENOPODIACEAE OR BEET FAMILY

This family contains a number of genera and species noted for their halophytic nature. They are native to seashores and saline places. The cultivated members, useful as vegetables, are very important in home gardens, for market gardening and for canning. These are beets, chard and spinach.

1. BEETS (*Beta vulgaris*)

Beets are natives of Europe and North America. They are of rather recent origin, having been first developed by the German people about 1558. The market gardeners practice very intensive cultivation of this crop. The fleshy leaves are used as greens, and the roots for pickling and cooking. About 11,000 acres are devoted to the commercial crop.

Beets are rather shallow feeders but a deep, moist, well drained soil is best for them. A sandy loam is very good for the early crop. In heavy soils the roots are not as smooth and round and many fibrous roots develop.

The production of beet seed seems to vary from year to year according to the price being paid. When the price is low, much seed is imported, but when it is high as at present, we produce large quantities.

In growing garden beet seed, select varieties in demand by the market gardeners. Strains of Detroit Dark

TABLE XIII. ANNUAL IMPORTS OF BEET SEED
By Countries of Origin. 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	14,311	\$ 2,324	915	\$ 166	22,412	\$ 3,601
France	98,022	14,560	34,860	4,034	242,768	33,777
Germany	3,050	365	4,250	396	7,328	921
Netherlands	158,009	24,487	100,807	12,644	229,127	26,365
United Kingdom	75,887	12,059	35,039	5,139	66,540	8,242
All Others	1,961	790	2,651	613	3,898	875
Total	351,240	54,585	178,522	22,992	572,073	73,771

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	22,180	\$ 3,189	9,657	\$ 1,930	15,822	\$ 2,422
France	53,682	8,586	54,442	7,901	24,870	2,849
Germany	11,300	1,563	8,000	1,015	12	2
Netherlands	200,770	33,801	306,311	48,069	200,985	28,283
United Kingdom	72,434	11,075	29,224	4,668	30,947	5,078
All Others	1,494	508	13,177	1,037	7,818	1,050
Total	361,860	58,722	420,811	64,620	280,454	39,684

Red are standard. They are globular having a small crown and leaves and a small tap root. The interior is a vivid red color.

Soil should be selected early and 500 to 1000 pounds of a good commercial fertilizer applied to the plowed field and worked in well. By frequent shallow cultivation most of the weed crop is eliminated. The seed is planted in drills 14-18 inches apart depending on type of cultivation to be used. As soon as the plants are well established, they should be thinned to 2-3 inches apart in the row. All off types are rogued out as they are found.

The beet roots are harvested before danger of frost as they are quite tender. They are then sorted to get rid of all coarseness of leaves or roots and odd shapes. The tops are removed carefully so that the center or vital growth center is not hurt. They are placed in a shallow pit and covered with straw and soil enough to protect them through the winter. In some places where the winters are not severe, they may be protected right in the row by plowing a furrow over them before injurious frosts. In Western Oregon and Washington, they are overwintered in the field due to the mild climate.

In the spring the roots are removed from the pit or are uncovered, as the case may be, and the roots are again sorted. A test is made with a tester to see the color of the interior and quality of each root. Off

colored and poor quality roots are discarded. Tap roots are cut off to one inch in length as it has been found that when long roots are bent in setting the plants are never as vigorous and do not produce as much seed.

Much of the beet seed used in this country has been imported from Europe with a duty rate of 4¢ a pound. Much is being done on the Pacific Coast, especially in the Northwest, to discover new and improved methods and thus encourage the production of this valuable crop.

The beet plants bear large quantities of pollen, thus making it necessary to have variety plantings at least a half mile apart. They also must be isolated from sugar beet fields.

Some growers pinch out the center when seed plants get 1½-2 feet high so they will branch out and thus produce more seed. When two thirds of the seed are ripe, the stalks are cut and left to dry. They must be handled carefully as the seed shatters very easily. The seed is threshed when dry and cleaned as clean as possible by fanning. Cleaners are then used to further separate the seeds from the stems.

Breeding and increase plots must be maintained as beets cross pollenate readily, and the best seed is none too pure. Each plant has to be raised under cover in these plots and then test rows are planted from the seed of all desirable plants.

The beet leafhopper is a most destructive insect pest. They carry the disease known as curly top or crinkle disease.

This disease is found on tomatoes, beans and a number of weeds such as peppergrass, Russian thistles, mesquite and lambs quarter. The hoppers feed on these plants and then carry the disease to the beet plants and they soon become affected and their leaves curl. Infected plants produce a large number of fibrous secondary roots. Young plants are often killed and older ones are dwarfed.

The best method of controlling this disease is to select resistant strains. Another method of overcoming loss is by early planting so that the plants have a good start before danger of attack by the leafhoppers. Isolation from patches of weeds which harbor the leafhopper and from other crops attacked by these pests, is also recommended.

Leafspot is a bad disease and sometimes destroys the leaf tissue. Sanitary measures and a bordeaux spray will prove of great value in controlling this trouble.

2. CHARD (*Beta vulgaris* var. *cicla*)

Chard is a very old vegetable crop. According to Sturtevant, chard was the 'beta' of ancient times and of the middle ages. It was mentioned as early as the seventh century in Chinese writings.

Chard is known as Swiss chard, silver beet and leaf beet. It is one of our best pot herbs. It is not grown much by market gardeners but is found in many home gardens. The leaves are picked from the outside and the center is left to grow. The plants grow to a height of two feet and have yellowish green, crumpled leaves.

These plants stand considerable cold weather. For overwintering a mulch around the plants serves well. They can be forced early in cold frames. Plants are thinned to about 12 inches apart in the row.

Seed production is very much the same as for table beets. The plants are much more hardy than table beets so seldom have to be lifted and protected during the winter.

Breeding and increase plots must be handled the same as for beets, and the seed plots must be kept a considerable distance apart and away from beets since they are so closely related and will cross pollinate.

3. SPINACH (*Spinacia Oleracea*)

Spinach has been cultivated since ancient times. It is a native of Asia and was introduced into Europe at a very early date. Only recently has it become of major commercial importance. The food and vitamin value of the succulent leaves are now quite well understood. Large quantities are sold all over the country. Spinach

is raised in the South for winter shipment to the North, in the North as a market garden crop and in the Pacific Northwest as a canning crop and a fresh frozen food. It thrives in a cool climate but will stand hot weather. Commercial acreage now amounts to about 25,000 acres.

There are three groups of spinach of economic importance.

- (1). Norfolk--upright plants with thick crinkly leaves. It bolts quickly.
- (2). Round leaved--compact plants close to the ground. Slow growing, with dark green leaves. Does not bolt readily.
- (3). Thick leaved--large plants with long broad leaves with pointed lobes. A very heavy producer. Used for canning in the North West.

Spinach does well on a large range of soil types but produces heaviest yields, as a rule, on heavy loams. The lighter soils are good for winter production, but often a nitrogenous manure must be applied to keep the leaves from turning yellow.

Spinach is a cool season plant. It will stand 10-15 degrees below freezing. Plants grown during the cooler part of the year contain more sugar and total solids.

There are several forms of sex expression in spinach. Some plants have only male or female flowers, others

are monoecious while some are vegetative males. The latter has only staminate flowers and the leaves toward the top of the flowering branches are fully developed. Monoecious plants are relatively rare.

Pollen is moved from anthers to stigma by air currents and cross pollination is the rule. It is produced abundantly over a long period. Pistillate flowers, if not pollinated, remain receptive for 2-3 weeks. Since pollen is produced so abundantly and is dissiminated by wind, it is necessary to have varieties, raised for seed, planted at least a half mile apart. This crop must also be grown away from other members of the chenopodiaceae family.

Spinach is not very tolerant to acid soils. If the soil to be used is acid, lime should be added. Manure should be added to the soil or a green manure crop should be included in the crop rotation. Early plowing and thorough fitting will do much to maintain moisture and eliminate weeds.

Early planting must be done because when the longer days come, the plants bolt quickly and a much lighter crop of seed is obtained.

In sections where the plants can be overwintered outside, the seed can be planted in the fall or winter, but in other sections the seed must be planted in the spring. Spinach, for seed, is planted in rows about

TABLE XIV. ANNUAL IMPORTS OF SPINACH SEED
By Countries of Origin. 1931-'36 (11)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	32,063	\$ 3,472	36,200	\$ 2,445	96,319	\$ 6,609
Germany	3,977	283	32,390	2,082	19,253	2,075
Netherlands	1,938,822	164,759	2,252,126	175,288	3,527,809	304,848
United Kingdom	53,243	5,017	51,880	4,084	45,673	3,687
Japan	1,368	116	1,695	95	2,143	169
All Others	1,145	197	12,205	952	92,167	4,478
Total	2,030,618	173,844	2,386,496	184,946	3,783,364	321,866

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
Denmark	161,124	\$ 12,285	200,055	\$ 15,711	274,845	\$ 18,963
Germany	19,841	1,775	69,100	6,562	-----	-----
Netherlands	3,128,736	291,312	2,955,387	272,708	2,937,150	245,602
United Kingdom	79,523	6,482	65,963	5,458	37,098	2,979
Japan	8,362	534	16,848	1,167	914	62
All Others	4,043	387	1,005	85	6,416	565
Total	3,401,629	312,775	3,308,358	301,691	3,256,423	268,171

twenty-four inches apart and the plants are thinned to six inches in the row. The rows must be kept cultivated and all weeds kept out.

All off types should be rogued out before the plants bolt. These can be easily seen at the rosette stage, and if removed then, it will prevent any danger of cross pollination.

The female plants usually have more foliage than the male plants, so it is well to get a strain that has few of the less dense male plants. The spindly male plants can be rogued out before they produce pollen.

The crop should be cut when the majority of the seeds are ripe but should not be allowed to become over mature. The stalks can be cut with a scythe or mowing machine. When thoroughly dry, it is ready to thresh and clean. The seed grows in clusters. Unbroken clusters, which run over the scalper sieve, must be flailed out. Spread seed out thinly to dry and when thoroughly dry, store in a cool, well ventilated storeroom.

VI. LILIACEAE OR ONION FAMILY

The liliaceae or onion family is widely distributed throughout temperate and subtropical countries. A number of important foods as well as ornamental plants belong to this family. Lillies are the ornamentals, while the important vegetables are onions, asparagus, garlic, leeks, shallots and chives. The first two vegetables are the most important and the only ones to be considered in this thesis.

1. ONIONS (*Allium cepa*)

Onions are believed to be of Asiatic origin. They are one of the oldest articles of food, having been grown since the earliest periods of history. They are mentioned in the Bible as one of the things for which the Isralites longed for in the wilderness and complained about to Moses. The onions of Egypt are mild and of excellant flavor. They were eaten raw as well as cooked by the peoples of all classes.

There are many species of wild onions which are native to America. The cultivated crop was first raised in Massachusetts early in the seventeenth century.

Onions are usually considered a biennial, but the bulbs, which are the main source of food, are grown the first year. There are also the multiplier types which

are of the perennial habit.

Onions are universally planted in home gardens and in commercial fields totaling about 138,000 acres.

This vegetable keeps the year round and is used every day in the year which makes it one of the most satisfactory and leading vegetable crops.

The bulb is the main part used for food, but the tops are used also for seasoning. They do not produce a true stem but have a hollow tube like structure.

The root system is quite fibrous. Roots continue to arise from the stem plate during the entire growing season. They extend in all directions in the soil as much as 12-18 inches.

A soil for onion growing should be practically level to prevent damage from washing. Seeds, sets and young plants are readily washed out on sloping fields. The soil must be retentive of moisture, yet it must be well drained, free from stones and easy to work. Large areas of peat and muck lands are used for onion raising. Here the crop is raised with less expense due to ease of working the soil and richness of the soil. This type of soil is dark colored and warms up early, which is a distinct advantage. They are rich in organic matter and thus hold moisture and do not suffer from drought to any extent. A good sandy loam, properly enriched, is very fine also for onions and produces a solid, heavy

bulb of superior keeping quality.

Seed for a crop of onions is very important. Type and variety are important in selecting seed for a crop, but age is also very important as onion seed loses its ability to germinate very rapidly. Only the pure and best seed will pay for the raising of a crop. Many of the large onion growers raise their own seed so that they can be sure of their stock.

Most of the onions for the late market and storage are seeded directly in the field in a well prepared seed bed. The soil must be worked up fine, be rich and free from debris. A complete fertilizer, rich in potash, is often advisable for onion soil. The rows are spaced from 8-18 inches apart and the seed planted from one half to one inch deep depending on the soil type used. It takes from three to four pounds per acre. By making germination tests of the seed, it is possible to tell how thickly the seed will have to be planted. Eight to twelve plants per foot are enough, and extra plants can be removed at the time of the first weeding.

Onions are ready to pull when the toposes begin to break over. They are cured in the field. The tops are then removed and the bulbs are ready for storage.

In selecting onions for seed raising, keep in mind the shape and characteristics of the variety to be grown. Select similar bulbs and in this way improvement in strain can be made. Size, shape, color and sprouting

habits must be watched closely. A size slightly smaller than that of an ideal market product may be used for seed production if other characteristics are good. Onions that sprout early are not desirable as they will not keep well. All thick necks or "scallions" must be removed as they are worthless.

Although a large portion of our onion crop is grown on the lower soils, we find most of the seed being raised on the higher lands just above this level.

Onions are stored in shallow bins, one above the other, with plenty of ventilation and free from frost. If they are frosted, the bulbs must not be touched until completely thawed out. Bulbs for seed production must be kept from freezing as this is likely to cause premature sprouting which is disadvantageous. Toward the end of the storage season, onions for seed production are selected. By this method one can select the ones that have kept best and show the least signs of sprouting.

A well prepared soil is used for seed raising. Bulbs are planted in rows from three to four feet apart and in furrows about six inches deep. The bulbs are set three to six inches apart depending upon the size and variety. Usually the bulbs are set about their diameter apart in the rows. They should be set deep enough so the entire bulb is covered when the soil is

drawn in. The covering process may not all be done at once, but some of the soil may be drawn in to support the seed stalks as they grow.

Spring planting, for seed production, is usually followed. Storage in the soil is not very good for bulbs for this purpose. In mild sections of Oregon, fall planting is done with entire satisfaction.

Seed fields must be isolated to prevent cross pollination. Forty rods is sufficient distance between varieties. Bees are very fond of onion flowers and aid greatly in the pollination. Breeding and increase plots are very necessary to maintain quality and improve the crop.

The seed is ready to harvest when the first seed pods break open and they must be gathered then to prevent shattering. It often takes several times over the field to harvest the crop. The stalks are cut just below the head, put in a barrel or sack and removed to a well ventilated storehouse where they can be spread out until thoroughly dry. If there is no danger of rain, this may be done on a canvas in the open field.

Onion seed is threshed out, when dry, with a flail or a small threshing machine. It is then fanned clean, and the seed immersed in water. Stirring will cause the light, poor seed to float and they can be skimmed off and disposed of. The plump, heavy seeds sink, and

TABLE XV. ANNUAL IMPORTS OF ONION SEED
By Countries of Origin. 1931-'36 (1)

	1931		1932		1933	
	Pounds	Value	Pounds	Value	Pounds	Value
France	5,537	\$ 2,632	4,169	\$ 1,530	4,883	\$ 1,830
Italy	40,670	16,943	25,313	10,230	19,735	9,755
Netherlands	5,984	3,511	9,551	4,543	5,490	2,729
Spain	4,702	2,285	4,929	2,653	7,739	4,680
United Kingdom	17,497	6,933	11,132	4,747	16,266	9,578
Canary Is.	112,706	123,396	161,432	97,980	103,090	77,550
All Others	2,915	1,897	13,736	12,574	2,977	1,887
Total	190,011	157,597	230,362	134,257	160,180	108,009

	1934		1935		1936	
	Pounds	Value	Pounds	Value	Pounds	Value
France	7,990	\$ 3,975	4,789	\$ 2,253	6,254	\$ 2,115
Italy	16,755	9,170	19,842	12,484	8,059	4,639
Netherlands	6,491	3,326	7,862	4,506	15,797	6,474
Spain	6,134	4,428	7,894	5,607	-----	-----
United Kingdom	6,216	3,301	28,638	25,909	3,316	2,429
Canary Is.	120,706	125,738	143,299	114,143	146,076	109,124
All Others	45,698	37,517	40,022	30,126	15,136	8,650
Total	209,990	187,655	252,346	195,028	194,638	133,431

the water can be drained off. Spread out on cloth sheets in the sun to dry. The seed should be stirred from time to time until dry. It is then given a final cleaning and stored in sacks in a well ventilated storeroom.

It takes from 125-150 bushels of onions to plant an acre. Each bushel should product about 3-4 pounds of seed.

Onion smut is prevalent in the Northern onion growing sections. The seedlings only, are affected and will die when three to five weeks old as a rule. This disease occurs at temperatures of from 50-80 degrees F.

Control is by sanitation, use of onion sets, and the use of formaldehyde drip in the row at seeding time. Use one pint to sixteen gallons of water and 200 gallons of mixture per acre.

Mildew is a common disease in most parts of the United States. It produces a violet fur like covering on the leaves. They turn a pale yellow and collapse.

Control is by moisture control by aeration and air drainage; crop rotation, planting onions one year in three or four; sanitation; spray several applications of Bordeaux 4-4-50 plus three pounds of fish oil per fifty gallons of spray.

2. ASPARAGUS (Officinalis

Asparagus is one of the important food members of

the lily family. It has been cultivated since before the Christian era and is a native of temperate Europe and Asia.

This crop may be grown on almost any soil type but does best on a rather low, well drained loam or silt loam. Commercial acreage now amounts to about 113,000 acres.

Seed selection is very important since the crop lives for a number of years. The Washington strains are bred for rust resistance and are the best to be had at this time.

Select a well drained fertile loam. The soil should be well prepared and enriched with about five hundred pounds per acre of a good complete fertilizer.

The seed is planted in rows twelve to fifteen inches apart, for hand cultivation, or twice that far for horse or machine cultivation. The seeds germinate very slowly. Radish seed is often mixed with it so cultivation can be started earlier. Frequent cultivations are made, and plants are thinned to three inches apart as they get large enough. The plants can be left in the field until spring. Just before growth starts, they should be dug and graded. All poor plants are taken out and destroyed.

The permanent asparagus field is now selected. The soil should be a deep, rich loam, plowed deep for

best results. The roots are set deep in rows five feet apart and two feet apart in the row. They are covered with two inches of soil at first, and the rest is worked in as they are cultivated. A field for seed production must be isolated from any other plantings, as they cross pollinate readily.

It takes three years to produce a crop of asparagus. During this time the field must be kept well cultivated and free from insect pests and diseases. Heavy fertilization is practiced.

Asparagus is one of our very important vegetable crops as it is grown in the home garden, for the commercial fresh market and more and more for canning and freezing.

Large size and a superior quality are the points to strive for in selection. Some plants will produce over a longer period than others and others are more desirable because of other characteristics.

Asparagus rust is the only disease that does any serious damage in America. The rust destroys the chloroplasts that carry on photosynthesis and the reserve supply of food is reduced. These lesions appear on the stems above ground and in severe cases cause the mature stalks to look a reddish brown.

Sulphur is used for control of this disease, but rust resistant varieties are the best means of

controlling it.

For seed raising extreme care must be taken in the selection of desirable roots. If stalks are not cut, they will shoot up very rapidly and branch and bloom. Pollination is almost entirely done by insects, especially bees. Wind pollination is practically negligible as the pollen does not dry until the flowers dry up. The fruit is green at first turning red as it ripens. The fruit is a small spherical berry made up of three locules. If the set is perfect, there are two seeds in each locule or six in each berry.

When mature or killed by frost, the seed stalks are cut and the berries removed by beating. The berries are now crushed and put in a barrel of water where they are stirred vigorously. They are allowed to stand a short time for seeds to settle and then they are taken out, rinsed and spread out to dry. The seed then can be cleaned with a fanning mill. Keep only the heavy seed. This should be sacked and stored in a cool dry place.

Increase and breeding plots should be made from selected plants and thus the quality can be kept up and improvement made. These plants should be taken in the proportion of one male to three females for correct pollination.

VII. LEGUMINOSAE OR PEA FAMILY

The legumes are one of the largest groups of cultivated plants. In this group are several genera of peas and beans which are classed as vegetables. Others are food crops, forages and green manure crops.

The genus *Phaseolus* includes common beans, scarlet runner beans, lima beans and many others less important.

The genus *Vicia* includes the broad beans and the vetches.

The genus *Vigna* includes the asparagus bean and cowpeas.

The genus *Pisum* is the garden pea.

1. BEANS *Phaseolus vulgaris*

Phaseolus vulgaris has never been found in the wild state but was being cultivated in America by the Indians in the 16th century, from Canada to South America. Many distinct varieties were grown. It is thought that the common bean originated in tropical America and has spread from there.

Most beans are annuals although some species are perennial. The stems are herbaceous, becoming woody as they get old. In the bush varieties, the stems are short and erect. Runner varieties have stems two to four feet long, while the pole varieties grow eight

to ten feet in length and entwine around any supporting object.

The tap root is short with shallow branching laterals which grow to about fifteen inches in length in all directions. The fibrous roots penetrate to a considerable depth under favorable conditions. They are a good dry land crop. On the roots may occur the nodules formed by the bacterium, *Bacillus radicicola*, which has the power of fixing atmospheric nitrogen so that it can be used during the current growing season. These nitrogen fixing bacteria can live for several years in the soil but do not occur universally, so it becomes necessary to inoculate the seed with a culture of the bacteria.

Beans grow rather quickly but are sensitive to frost, so it is necessary to raise them between the cold weather of spring and fall. They thrive best on a deep, well drained soil. They do best on soils high in calcium and respond very favorably when acid soils are treated with lime.

Beans are to be found in every home garden and are raised extensively for fresh markets, canneries, freezing and for dry use. They rank about third as a cannery vegetable. About 310,000 acres are devoted to the commercial crop.

Planting of beans begins about the average first

free of frost date for the given locality. The dwarf and runner types are usually planted in drills while the pole types are planted in hills. Distances will depend on methods of cultivation.

The seed should be clean and free from disease. Frequent shallow cultivations should be given being careful not to disturb the feeder roots. Beans should not be cultivated when wet with dew or rain as this will spread some of the diseases that attack this group.

The bean weevil, a close relative of the pea weevil, is a pest of dry beans. They occur almost everywhere beans are grown. The adults lay the eggs on the pods during the growing season, and the small white larvae hatch out in from five to twenty days, depending on the temperature. They then bore through the pods into the seed where they feed for from eleven to forty-two days before pupating. Pupation also occurs in the seeds. The warmer the temperature, the more generations there are. The weevils are in the beans when they go into storage. The adults emerge during this period and continue to multiply in the dry beans.

Control of the bean weevil is by limiting the insects in the field and by fumigation of the seed, before storing, with carbon bisulfide or other

fumigants. The liquid is poured out on top of the beans at the rate of three to eight pounds per 1000 cubic feet, of tight bin. The most efficient temperature for this operation is around 75 degrees F.

Heating will also kill the weevils and does not injure viability. 120-145 degrees F. for from five to six hours is safe and effective where beans can be spread out in thin layers.

It is very important to secure clean seed when planting for seed production. In the Western states where the atmosphere is dry and there is a minimum of rainfall, there is little loss from any of the common diseases.

During the later cultivations as the crop is approaching maturity, all diseased plants and off types should be rogued and removed from the field.

When the crop is mature, it should be harvested to prevent losses due to weather injury. The crop is usually pulled with a regular bean puller and after curing for several days, a number of rows may be raked together with a side delivery rake. They are then shocked and left till cured when they may be stacked or put in a shed until threshed. They may also be run through a combine at this time. If stacked, they should be covered with a tarpaulin to protect from sun and rain.

When ready to thresh, the beans are either run

through a regular bean thresher or a grain thresher with the cylinder run quite slow to prevent breakage.

Beans are easy to clean after threshing as they are heavier than any trash that might be left with them.

For seed, the beans should now be fumigated and stored in a cool dry place.

2. PEAS *Pisum sativum*

Peas were first found growing wild in Asia before they were cultivated. They were then introduced into India and Europe and into the United States about 1828.

The pea plant has a long tap root which may go down from four to six feet in some soils. The roots support the Nitrogen fixing bacteria which form upon them the nodule or tubercle growth.

Peas are one of the most important vegetables grown in the United States. They are grown in nearly every home garden for home use and in truck gardens for early and summer time sales. Large fields are also raised for commercial canning and freezing. Total commercial acreage amounts to about 462,000 acres.

Types of peas are divided up into dwarf, half dwarf and tall. The dwarf peas are the most popular since they need no support.

A cool, moist and well drained soil is necessary for large yields. A sandy loam is very desirable.

Clay and silt loams are very good for the late crops of peas. Peas like an abundance of humus but do not care for excessive nitrogen.

Peas are planted from early March, as soon as the ground can be prepared, to August for the very late crop. In the very light soils, the seed is covered as much as two inches and one inch for very early plantings. As the season advances, the depth is increased. Brills are from eighteen to thirty-six inches apart. It is well to use plenty of good seed.

In the wheat growing regions, peas are being planted and harvested much like other farm crops and hauled like hay to the thresher where they are threshed, sifted and canned. This crop is grown on the summer fallow ground.

Pea aphids are one of the most serious pests. They attack the tender tips and soon devitalize the plants. Early and late crops are planted to avoid the most serious infestations. Rotenone dusts containing .75% rotenone and 3% oil (soyabean, fish, etc.) applied with power dusters keep the aphids controlled.

The pea weevil is also a very serious pest. Seed should be fumigated to prevent this loss.

When raising peas for seed production, one must select varieties adapted to the locality in which the crop is to be raised and also the locality where the

seed is to be sold.

Two types of peas are used. The smooth seeded ones are more hardy than the wrinkled ones and are also of lower quality.

Peas are nearly self fertile but may cross, so it is well to separate fields, which are being raised for seed, at least forty rods.

When raising seed peas, it is advisable to use a long rotation to prevent loss from disease. Fertilize with a fertilizer heavy in phosphorus. Acid soils will have to be limed as peas do not do well on acid soils.

It is well to get good clean seed and plant early at the rate of eighty to ninety pounds per acre. The seed should be inoculated before planting. All off types and diseased plants should be rogued out of the field to keep the seed pure and clean.

Peas are mowed just before the vines get dead ripe and left in windrows. When they are thoroughly cured, they should be threshed or stored in a shed or stacked for later threshing. A regular bean thresher is used or a specially equipped grain separator. The cylinder is run slow and the shakers fast. The seed is later cleaned with a fanning mill and possibly hand picked to get rid of off type and colored seeds. If necessary, the seed should then be fumigated to kill

the weevil. Store the seed in a cool, well ventilated storeroom.

Breeding and increase plots are quite necessary for maintaining and improving this crop.

VIII. SUMMARY

It is most important that good strains of vegetable seed be produced. This will mean one that matures properly in the locality where planted and may be one that is not susceptible to some disease that is prevalent. A good strain of seed must produce a crop that is uniform of quality and maturity, thus saving on labor and allowing for field clearance in a minimum of time. Often a strain will have a habit of growth or maturity that allows it to escape the destructive work of an insect pest.

Pollination is a major factor in the production of desirable seed in many crops. Many of the vegetable crops cross pollinate with other members of the same family and most varieties intercross readily. There is also trouble from crossing of the cultivated crop with the wild form. This is all taken care of by use of isolated fields and care in roguing of volunteers and wild related plants.

A close cooperation between growers, dealers and handlers of the seed crop does much to improve and maintain quality in vegetable seed.

Work is being done and must continue to be done on improvement of machinery for handling the seed crop. Methods are improving and should continue to

improve in avoiding injury to the seed after it has been produced.

After a pure, high quality seed has been produced, it is placed in storage. This storage is most important. It must be cool and dry so the seed will remain in the best possible condition until taken out to plant.

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