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Growing Garden Seeds: A Manual for Gardeners and
Small Farmers

by: Robert Johnston, Jr.

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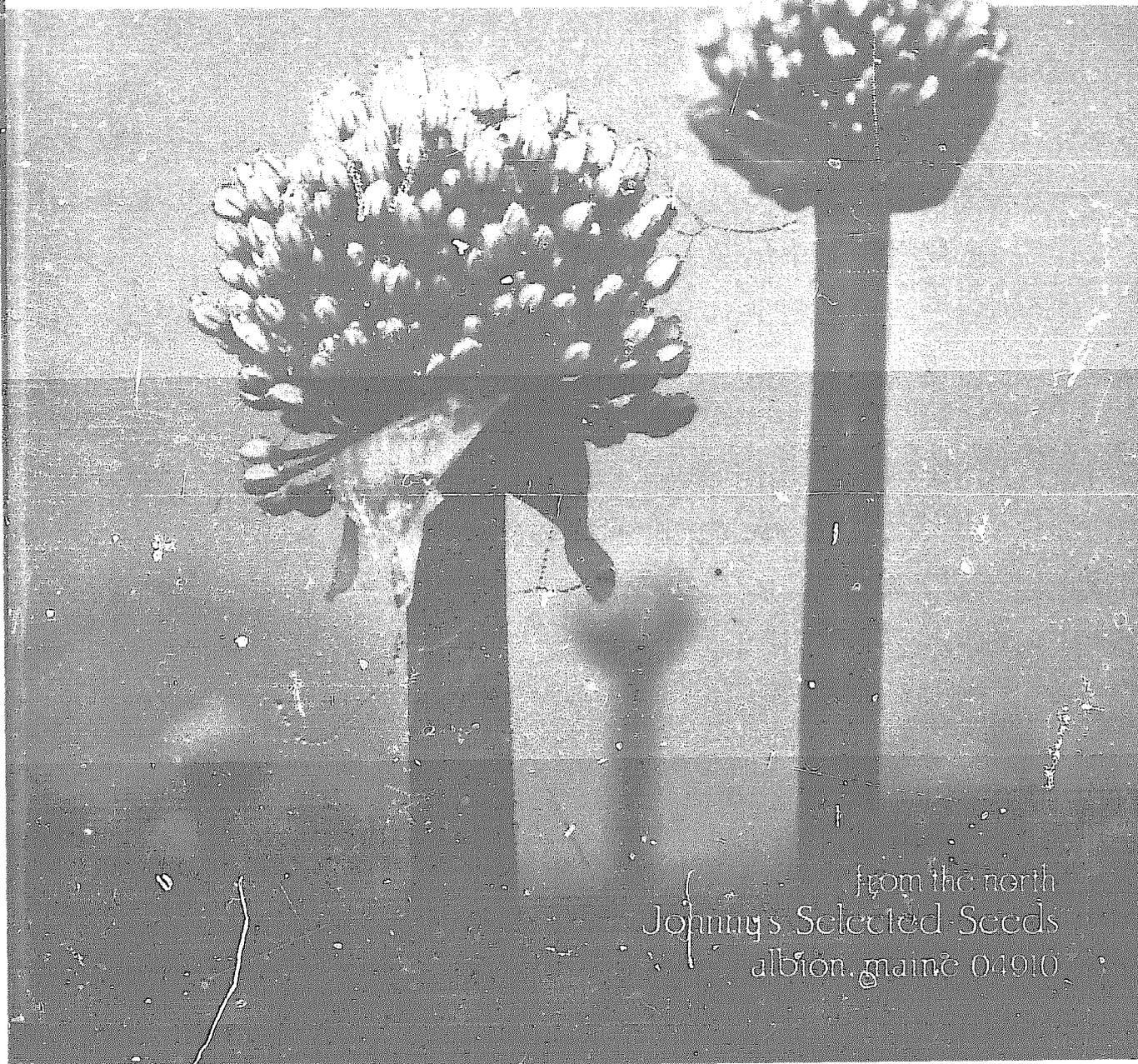
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Growing Garden Seeds

A MANUAL FOR GARDENERS
AND SMALL FARMERS

by Robert Johnston, Jr.



from the north
Johnny's Selected Seeds
albion, maine 04910

For Fred Ashworth -

Who had the eye of an eagle, the
stamina of a dolphin, the patience
of an acorn, the spirit of a child,
and a love for God.

GROWING GARDEN SEEDS, Second Edition.
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Note: Our annual seed catalog is available free of charge
by contacting Johnny's Selected Seeds at the address above.

Cover: Onions in blossom.

PREFACE TO THE FIRST EDITION

Several books and numerous articles on the subject of garden seed production have been published in the past, but none has properly introduced the subject to home gardeners and small farmers. The need for such information has arisen in conjunction with the trend in our country towards a healthier, more locally sufficient agriculture. It is my intent in writing that this booklet answer that need.

Most commonly enjoyed vegetable crops are listed. Only the basic information related to growing and harvesting the seed of these various crops is covered here. Practices associated with the growing of the table crops such as fertilization, basic culture, harmful and beneficial insects, diseases, etc. are not covered here, gardeners by now having been nearly saturated with such material.

While this booklet may well be all too brief, the reason for its depth is threefold. First of all, in my opinion the primary requirement is for a concise, non-technical source of information understandable by all gardeners; secondly, that the book be small enough so as to be affordable by all those with an interest in the subject, and lastly, that my own lack of thorough experience and expertise in growing seed for a number of the vegetable crops would necessitate that a complete and lengthy coverage of the subject be far too academic for the tastes of most gardeners, including myself.

If you would like more detailed information on the subject of seed growing, the following textbooks, which deal primarily with commercial seed production, should be consulted. All are out of print, but often can be obtained at the agricultural libraries of state universities. They have been of great assistance in my own study of the subject and in the preparation of this book.

- 1) Vegetable and Flower Seed Production, L. R. Hawthorn & L. H. Pollard, Pub: Blakiston, New York and Toronto, 1954.
- 2) Agricultural and Horticultural Seeds, F.A.O., Rome, 1961.
- 3) Seed Production and Marketing, J. Cox and G. Starr, Pub: John Wiley & Sons, New York & London, 1927.

Special thanks are in order to Professor E. M. Meader, Rochester, New Hampshire, who has been, over the years, an enthusiastic contributor of tips and ideas on the subject; to Mr. Fred Ashworth, Heuvelton, New York, for his lengthy letters of advice; and to the seedsmen at L. Daehnfeldt, for freely providing information regarding the production of vegetable seed in Denmark.

Johnny's Selected Seeds

Albion, Maine
December, 1976

Rob Johnston, Jr.

PREFACE TO THE SECOND EDITION

In 1976 I attempted to fill a void by writing the first edition of this little book. I never imagined, however, that it was to be so fervently received by gardeners. This second edition represents its fourth printing.

Over the six years that have since elapsed, the issue of our shrinking genetic resources has become well known. Regional and national amateur seed exchanges have been formed, and just recently our federal government's National Seed Storage Lab and associated system of Plant Introduction Stations have received much deserved funding. And more importantly, there has been a notable increase in the number of individuals involved in the art of seed saving. Agricultural skill is primary to a healthy society, and seed production is basic to agriculture. Our children's generation can only benefit from the revived knowledge of amateur seed saving.

This second edition of GROWING GARDEN SEEDS corrects a few technical errors in the first, and incorporates my own additionally acquired knowledge and skill on the topic. I trust that the changes have contributed to a text which is even more encouraging to the success of the seed saver. Myself or another member of our technical staff will be pleased to assist by providing further detail upon request.

Rob Johnston, Jr.
Albion, Maine
January, 1983

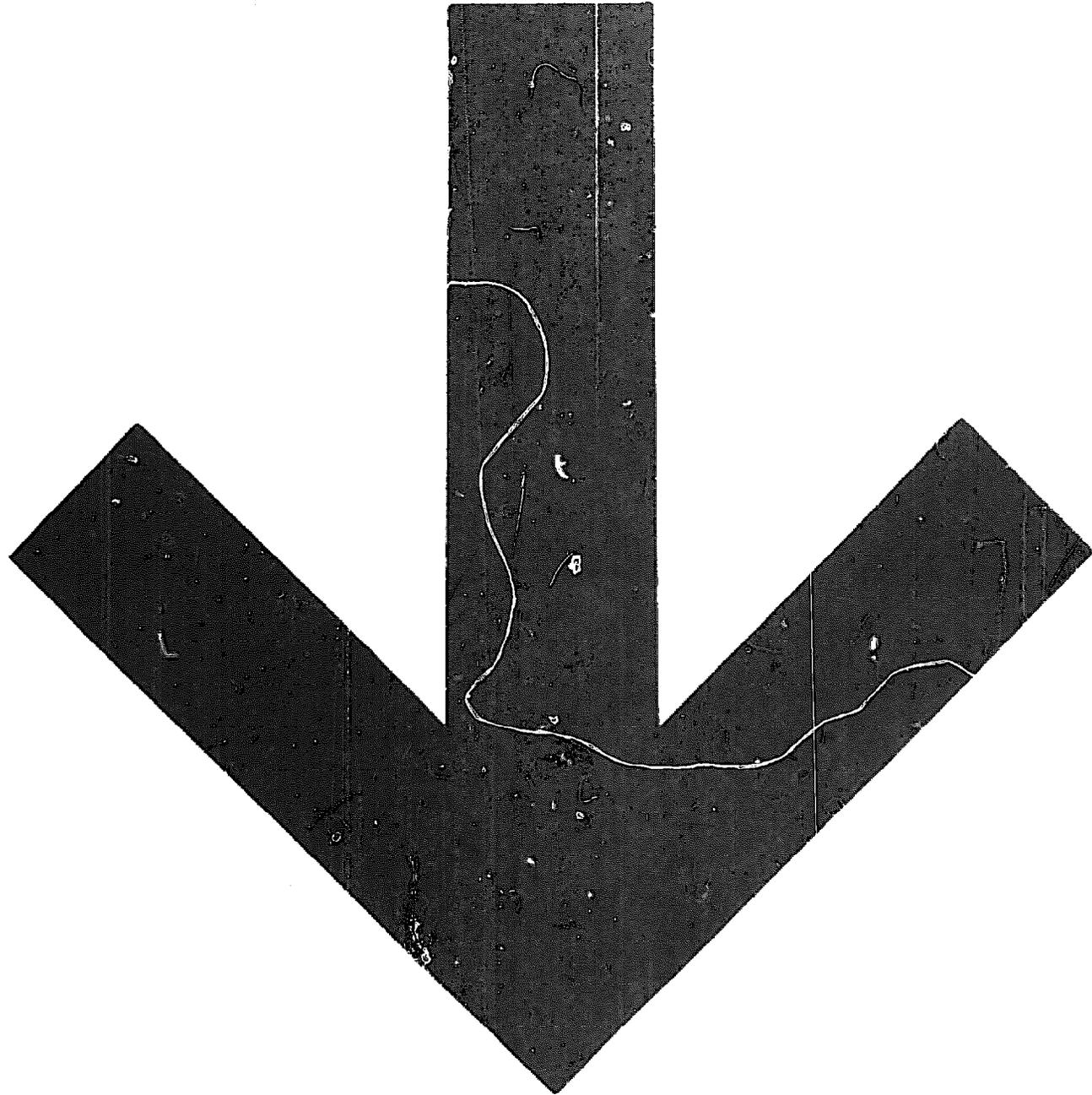


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GROWING GARDEN SEEDS

Part One - General Information

For most gardeners, seed growing is a mysterious rite performed each season by gifted growers supervised by Phd workers, the outcome of which is illustrated in bibles of various editions known as seed catalogs. Certainly not a task to be undertaken by a mere gardener! Like so many aspects of our lives, the subject has been made unnecessarily complex. Most other subjects of concern to gardeners have been thoroughly covered in literature and by word of mouth. Planting a bean seed can be a complicated event for the beginner or untaught person, and such is seed growing without fundamental advice.

Some Fundamentals

1. Plants in Nature make seed without a gardeners help. In our gardens, hence, it is wise to mimic Nature and, by doing so, allow the plant to produce seed.
2. A cantaloupe from Arizona is not a cantaloupe from New York. Environment has its effects on plants, as it has on people. Through natural selection (the local environment's favoring of certain characteristics over others) and selection by the grower, a specific variety has a tendency to become better adapted to a certain location with each generation.
3. Flowering and Seed Production - The flowering plants are the ones which produce seed. The male flower part (stamen) produces pollen. The pollen reaches the receptive female flower part (stigma). The pollen grain germinates and a pollen tube grows down through the style, the passageway between the stigma and ovary, and pierces the ovarian wall. A sperm cell, released by germinated pollen grain, travels down through the pollen tube and enters and fertilizes the ovary, thus completing pollination. The fertilized ovary develops into a mature seed.

Self-pollinated means that the process of pollination occurs within each flower, with no pollen transferred from one flower to another (on the same plant or between plants). Such flowers have both male and female plant parts (called "perfect flowers") and have the mechanism necessary for pollination to occur successfully within the single bloom.

Cross-pollinated means that pollen is transferred from one flower to another, either on the same plant, or between different plants. Pollen is carried by insects or by the wind. The flowers of cross-pollinated plants may be "perfect", "monoecious" (separate male and female blooms on the same plant), or "dioecious" (each plant bearing either male or female blooms).

4. Isolation - Where it is desirable to save seed which will produce plants resembling the parent plants, pollination must occur only within that particular variety. One cross-pollinated variety has the potential to cross (exchange pollen) with another variety of the same species. Hence, if two cross-pollinated varieties of the same species (ex.: two varieties of sweet corn) are to be saved for seed, they must be isolated (separated) from one another, either by time or distance in the field.

Since self-pollinated types do not generally cross, isolation is not necessary unless maintenance of absolute purity in a strain is desired.

5. Reproduction Cycle - Vegetable crops are either a) Annual: flowering and maturing seed in the same year, or b) Biennial: the plants maturing seed after going through the winter in the field or in storage, or c) Perennial: living and bearing seed year after year. Most vegetables are either annuals or biennials.

6. Healthy Soil - Healthy soil produces healthy plants, and, hence, healthy seeds. When raising garden seeds, this healthy condition is potentially passed into future generations, improving the quality of the seed and, hence, the produce.

7. Selection - Adaptation, usefulness, and quality characteristics of a vegetable variety can be improved or down-graded by selection.

The basic type is "Natural Selection", caused by environmental pressures. For example, in the North in a given year, perhaps only half of the plants of a corn crop will produce mature ears and kernels. Naturally, the ears selected for seed would be chosen from these earlier-maturing ears. In this way, Nature forces a crop to either adapt or perish.

The other type of selection is accomplished by the gardener. For instance, not only would one choose for seed ears of corn which did mature well, but further select the most desirable ear types from what are considered to be the best corn plants. What plant characteristics are selected for is a personal matter, as nearly everyone's concept of the ideal is different. The basic ingredient for success in selection is for the gardener to know what she/he is after in a plant, and to select accordingly.

Roguing is the process of discarding undesirable fruits or plants. In cross-pollinated crops roguing is most meaningful when done before the plants flower.

8. Maintenance of Vigor - As a general rule, vigor in a cross-pollinated crop depends upon maintenance of a genetic variety within the strain. Deterioration of the strain results from inbreeding, or severely limiting the number of parent plants, and hence the extensiveness of genetic variability. In a field of corn, for example, there are many genetically unlike plants,

even though the plants may look identical (except F-1 hybrids, discussed later). To save only one or two ears for next year's seed would severely reduce the necessary genetic contributions to the sibling plants. Vigor and yield would be reduced in the resulting crop, and if the practice were carried out several generations, the strain would most likely become useless.

So, to maintain vigor in a cross-pollinated crop, be sure to save seed from several individual plants, even if only a few seeds are needed. NOTE: The exceptions to this rule are the squashes and pumpkins. These crops do not noticeably lose vigor, even if inbred for several generations. Hence, it is allowable to use seed from only one fruit for next year's crop.

Self-pollinated crops, such as tomatoes and beans, are a different story. Since the characteristic of self-pollination is natural inbreeding (plants are being inbred automatically), it is of no importance how many plants are used for seed purposes. In fact, seed from exceptionally good single plants may be saved separately, with good chances of retaining the exceptional characteristics of that single plant. NOTE: In self-pollinated crops, seed produced in each flower or fruit will theoretically contain identical genetic information. Therefore, in the case of tomatoes for example, seeds saved from different fruits from the same plant will produce identical offspring, even if the fruits on the selected plant look different.

9. Hybrids - F-1 hybrid seed is the result of a cross between two genetically distinct parent plants. The plants grown from this seed will usually show more vigor than either of the two parent plants, and often more vigor and uniformity than similar non-hybrid (standard) varieties. Commercially, hybrid seed must be produced each year by crossing the inbred parents. Inbred parents are used because they express characteristics uniformly, and this uniformity is also seen in the F-1 hybrid plants, "F-1" referring to "first filial" or first generation after the cross. Natural crossing in the field may also result in useful hybrids. However, the "F-2" or second generation after the cross, grown from seed saved from F-1 hybrid plants, will not be uniform, and in fact often will have numerous different types as a result of genetic segregation.

To illustrate the uniformity and vigor of F-1 hybrid plants, take the analogy of two hermits (the inbred parents). They meet, have an intense exchange of ideas, - sparks really fly (the hybrid plants). However, this momentary enthusiasm (vigor) eventually wanes, and the two hermits go separate ways. (Seed saved from hybrid plants will not produce offspring with the uniformity and vigor of the parents.)

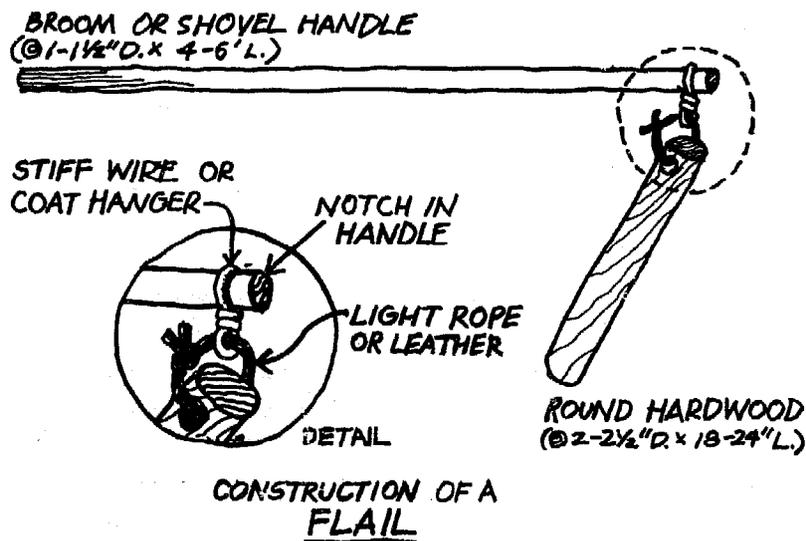
While your own open-pollinated (standard, non-hybrid) varieties will not often have the vigor expressed in hybrids, in the long run it seems more valuable to enjoy the "constant warmth" of well-maintained varieties than to depend on the short-lived "fire" of the hybrids.

10. Varieties to Use - Begin your seed growing with your favorite varieties, those which have proved their adaptation to your environment, and to your personal liking. Variety selection is very important.

11. Environmental Limitations - Some crops are adapted to nearly all climates, but some climates will pose certain limitations on the growing of some seedcrops. For example, the successful harvest and care of onion seed is favored by dry harvest weather. Hence, commercial seed crops of onion are grown in the semi-arid western states. However, onion seed can be grown in areas of higher rainfall such as the eastern states. With proper knowledge and some experience, seed for most all vegetables can be grown throughout the country, with few exceptions.

12. Handling the Crop - No special tools or machines are needed to plant, cultivate, and bring the crop to maturity for seed. To remove seeds from the plants (termed "threshing" throughout this booklet) commercial seedsmen have special machines for specific crops. No machinery is needed when raising seed on a small scale, although some simple tools make the work much easier.

A flail is a tool used where plants are beaten to remove seed. It is not something that you can buy at a hardware or farm store, but you can make your own as in the following illustration.



The wire hinge which fits around the notch in the handle makes it possible for the "swingle" (the piece of hardwood which strikes the plants) to revolve around the handle, without it becoming bound up, as it does with just a direct twine connection. Some people use leather or a hickory wood split as a hinge, instead of wire. To use the flail, hold the handle to your side horizontally with two hands, and rotate the end of the handle so that the swingle strikes the crop. You don't get nearly so tired using a flail as you do a plain stick.

Cleaning or milling is the final procedure of handling seed after the seed is threshed. In the text which follows you will often see recommendations for "winnowing and screening" after the heading "Cleaning".

Winnowing is the process which utilizes moving air in order to separate the lighter material such as leaves, pods, and hollow seeds from the good, heavier seed. The simplest method of winnowing is to toss the seed above a container (outdoors in a breeze), the good seed falling back into the container, the lighter "trash" being carried away on the wind.

Screening - is the means by which the good seed is separated from other material of similar weight, but different size, i.e. seed of other crops, soil, pebbles, twigs, etc. It is helpful to have screens of various meshes, but it is not necessary to undergo any great expense. Several screen meshes are available from hardware stores, and frames can be built for them if desired.

Specially designed machinery can be purchased to perform any or all of the above harvesting and milling processes. These become practical when larger quantities of seed are to be processed. If you feel that you need a certain piece of machinery, first investigate to see if you can find a suitable used machine. New equipment can be quite expensive.

The following companies sell equipment related to handling seed.

- 1) NASCO, Ft. Atkinson, WI 53538.
- 2) Ferrell-Ross, 1621 S. Wheeler St., Saginaw, MI 48602.
- 3) Burrows Equipment Co., 1316 Sherman Ave., Evanston, IL 60204.

13. Drying and Seed Storage - Seed should be dry before it is put into a container for storage. A good practice to follow is when you feel that seeds you are drying are dry, let them dry another day or so before packaging. This is important with large, once-damp seeds such as squash. Heated, moving air will speed the drying process. When using heat, keep the temperature under 110°F to avoid seed damage.

Without known exceptions, seed of common edibles and ornamentals should be stored under cool, dry conditions, as heat and humidity are the worst enemies of seed viability. The general

formula for success is that the sum of the temperature (F) and the relative humidity should be less than 100. Temperatures well below freezing will not harm seeds unless the moisture content is high. The term of seed viability is also increased by sealing the seed from the air in jars, except for beans and peas, which require "open air". Most good vegetable seeds will maintain germination percentage for several years under the above conditions, with the exceptions of parsnip, onion, and leek seed which has short life. Some gardeners save small quantities of leftover seed and seed they have grown sealed in jars in the freezer. The jar should have a tight lid to prevent moisture exchange when the freezer is opened or the jar removed. This is a good method of saving small lots of seed.

14. Term of Storage - Numerous publications contain charts depicting the number of years specific types of seeds can be stored and remain viable. I believe that this information is unreliable because 1) storage conditions vary, and 2) much depends on the viability of the specific seeds at the time they were initially stored. As was previously discussed, drying seed well and storing in a freezer will extend the storage period considerably.

(estimated safe storage to maintain at least 50% germination)

<u>SEED TYPE</u>	<u>NO SPECIAL STORAGE CONDITIONS</u>	<u>CONSISTENTLY COOL/DRY CONDITONS</u>
Beans, all	2-3 years	4-6 years
Beets	2	3-4
Broccoli	2	4-5
Brussels Sprouts	2	4-5
Burdock	2	4-5
Cabbage, regular	2	4-5
Cabbage, Chinese	3	5-8
Cantaloupe	3-4	6-10
Carrot	1-2	3-5
Cauliflower	2	4-5
Celery	1-2	3-5
Collard	2	4-5
Corn, all	1-2	4-6
Cucumber	3	5-7
Eggplant	1-2	3-5
Endive/Escarole	2	3-4
Kale	2	4-5
Kohlrabi	2	4-5
Leeks	up to 1	2-4

(estimated safe storage to maintain at least 50% germination)
 NO SPECIAL
 STORAGE CONDITIONS

<u>SEED TYPE</u>	<u>STORAGE CONDITIONS</u>	<u>CONSISTANTLY COOL/DRY CONDITONS</u>
Lettuce	1-2 years	3-4 years
Mustard	2-3	5-8
Onion	up to 1	2-4
Parsley	1-2	3-5
Parsnip	up to 1	1-3
Peas	1-2	4-6
Pepper	1-2	3-5
Potato (true seed)	2-3	5-7
Pumpkin	1-2	3-5
Radish	2	3-5
Rutabaga	2	3-5
Salsify	2	3-4
Scorzonera	2	3-4
Spinach	1-2	3-4
Squash	1-2	3-5
Strawberry	2-3	3-6
Sunflower	2	4-6
Swiss Chard	2	3-4
Tomato	2-3	4-7
Turnip	2-3	5-8
Watermelon	2-3	4-6

Extended storage - For extra long term storage of important seeds, I can suggest the following: Dry seeds in a warm, dry place and enclose them, by variety, in paper envelopes. Place the envelopes in a sealed jar containing silica gel, available from dealers of supplies for drying flowers. Store the jar in a freezer. When removal of some of the seed is necessary, first allow the jar to come up to room temperature before opening, so that moisture won't condense on cold inner jar surfaces and contents. Then reseal jar and return to freezer.

15. Testing Seed - To test for the germination percentage of large seeds such as beans, peas, corn, and squash, a simple "rag doll" test works well. Take about an 18-inch square piece of heavy cotton, flannel, or felt, and draw a grid of 100 (10x10), one-inch squares at the center of the cloth, using indelible ink. Wet the cloth with water and hold vertically to allow excess to drain. Place one seed in each square. Fold the sides over the seed (you have 3 inches excess cloth on each side of the grid), and roll up the cloth. Set this roll vertically and leave at

room temperature. Keep cloth moist by sprinkling with water if needed. After a few days unroll the tester and count seeds which have germinated well, this figure being the percentage of germination. Less than 100 seeds may be tested if there is but little seed to begin with.

Paper toweling works well for small seeds. Take a paper towel and fold it in half lengthwise, and then fold it again widthwise. Write the name of the seed you are testing on the towel with lead pencil. Wet the towel, and hold up to allow excess water to drain. Now open one of the folds, spread out 100 seeds (less if seed is scarce) on the towel, and refold. Lie folded towel containing seeds flat on a plate or baking sheet, sprinkling to keep moist if necessary.

Quick germinating seeds take 3-5 days, others like corn, beans, carrots, peppers, etc. about a week. "Normal seedlings" have strong root growth and healthy looking seed leaves, these being counted as having germinated.

An alternative to the above methods is to test by an actual planting in soil, indoors or out.

These "homemade" methods provide a general picture of seed viability. For more official methods, as are used in our lab at Johnny's Selected Seeds, check books at agricultural libraries or consult your State Seed Lab. Our Seed Analyst at J.S.S. will always be willing to answer questions.

BEANS

Snap, Shell, Dry, Soy, Lima, Broad, Garbanzo, Runner, Adzuki, and Mung.

Pollination - Blooms contain both male and female organs, and normally pollination takes place before the flower opens. For this reason, even if bees visit the flowers, cross-pollination is not common. Crossing, however, may occur to a slight degree between two side-by-side varieties. If absolute purity is desired, separate varieties to be saved for seed by another crop, or by 100 feet.

Note: Lima, broad, and runner beans have showy flowers and are regularly cross-pollinated by bumble bees to some extent (within each of the three types mentioned, not between them.) Separate varieties within each type by 100 feet to discourage most crossing.

Culture for Seed - Same as for the edible crop, planting early in the North to assure maturity before frost.

Seed Production - The seeds begin to form and enlarge after pod formation. On the average, seed will be mature and plants ready to harvest about 1½ months after "snap bean" stage. This will vary depending on environmental and varietal differences.

Harvest - As bean plants mature, the leaves begin to die and drop off. Delay harvest if possible until over 90 percent of the leaves have fallen, and the pods are brown. Pull plants out by the roots and complete drying under cover, or in stacks outdoors. Pole beans are left on the poles until all leaves are gone and the plants are "dead ripe". First pull out roots, then pull out poles. Seed may be threshed immediately.

Threshing - When pods are dry (like crinkly, dried leaves) plants are ready to thresh. For small lots this may be accomplished by shelling individual pods, or holding several plants together by the roots and beating back and forth inside a large can or barrel. For large amounts, flailing (beating plants) is recommended.

Cleaning - Clean the threshed beans of pods, chaff, and soil by screening and winnowing.

BEETS

Flowering - Flowers are "perfect" containing both male and female parts.

Pollination - Cross-pollinated. Pollen is very light in weight, and is carried on the wind. Since beet pollen can carry long distances, it is practical to raise seed of only one variety each year.

Culture for Seed - The beet plant is biennial, flowering and reproducing seed in the second year, or after a full-length period of short day-length (such as winter). Two methods may be used.

1) Root-to-Seed - Beets are grown the first year as for the edible crops. Since large roots have no advantage over medium sized ones for seed production, in the North delay sowing until 2½-3 months or

less before expected heavy fall frosts. Before harvest rogue for any undesirable characteristics in the greens of individual plants. Harvest roots before heavy frosts (in the North). Trim off tops leaving an inch of stems attached. Save only desirable type roots for seed. Place beets in storage for the winter (in the North). Moderate storage temperatures (40-45°F) favor subsequent seed stalk formation more than storage temperatures near freezing. Roots are replanted at 18 x 30" spacing in early spring, the root crowns level with the soil surface or slightly covered. Water to encourage the new growth. In mild areas where heavy freezes are absent or occur seldom, roots may be replanted soon after harvest and roguing, or November-December from August sowings.

2) Seed-to-Seed - This method eliminates harvest of 1st year roots. Seed is sown in August - September and the plants are left to stand in the field over the winter. Since beet plants are not particularly winter hardy (for example, not as cold-resistant as carrots), this method is practical only in mild regions such as the South, Southwest, California, and to some extent, the Pacific Northwest coastal area. Although not dependable in the North, the method is occasionally successful if a heavy mulch is applied. One drawback to the method is that no selection by examination of the roots is possible.

Seed Production - The second year large, spreading branches form, eventually bearing flowers and seed. Seed is borne all along these branches. What we refer to as a "seed" is actually a seedball, containing several seeds. This occurs because usually two or more flowers grow together, and the adhering parts dry into the familiar corky seedball. Seed is mature when it is dry and brown.

Harvest - Most seed on a plant will mature at once, but some seed on the tips of the branches is often still green. Pull out plants, cut off roots, and stack under cover to complete drying. When seed and stalks are dry, seed may be removed by stripping by hand from the branches, or by flailing plants over a canvas. Finally, seed is cleaned by winnowing.

Note: Periods of temperatures below 45°F are necessary if flowering and seed formation are to occur the following season. Hence the growth of beets for seed may be limited in areas with extremely mild winters.

BROCCOLI

Flowering - The yellow flowers are perfect, possessing both male and female plant parts. Flowering occurs during summer of the first year or late spring of the second year.

Pollination - Cross-pollinated normally by bees. Isolate 2 or more varieties by another tall crop or at least 100 feet, a much greater isolation if purity is necessary. Broccoli is of the same species

(Brassica oleracea) as cabbage, brussels sprouts, cauliflower, collards, kale, and kohlrabi, and will cross with any of them. Commercially high isolation distances are practiced but for home and local use 200 feet or certainly 1000 feet will be sufficient unless purity is essential.

Seed Production - Since flowering is most strongly induced by the long day lengths of early summer, it is of advantage to have the plants quite large at this date. Most commercial production of broccoli seed is done in areas mild enough to overwinter a late summer or early fall planted crop. Most inland areas north of approximately 42° North latitude in the U.S. have winters too cold to overwinter broccoli, and in these areas the crop must be spring planted or provided winter protection such as insulated coldframes. Where uncertainty exists, experimentation will be necessary. After formation of the edible "heads" (actually the flower buds) yellow flowers appear, followed by insect pollination and seed formation. Seed matures in fall from early spring plantings, and in early summer from overwintered crops.

Note: Individual plants of broccoli are normally not self-fertile, so have at least two adjacent plants flowering to assure seed formation.

Harvest - Like other Brassicas, broccoli seed is borne in narrow pods. Harvest when pods are dry and brittle by cutting plants near the base. Several days of further drying is usually necessary. Plants may be left to dry outdoors except during continually rainy periods.

Threshing - Seed from a small number of plants may be threshed by bagging the plant (or a bunch of seedstalks removed from the plants) and beating. Larger amounts can be flailed over a floor or canvas.

Cleaning - Seed is cleaned from chaff by winnowing and screening.

BRUSSELS SPROUTS

Flowering and Pollination - Essentially the same as for other Brassicas. See "cabbage". The plant is a biennial, producing seed the second year.

Seed Production - In the warm South and Southwest where the weather permits continued growth throughout the winter, the crop may be planted in late summer. In most of the U.S., planting is done in spring to early summer to assure edible maturity prior to dormancy resulting from cold fall or early winter weather. Brussels sprouts plants are very hardy and will safely overwinter in much of temperate U.S. Where the plants will not survive the winter, such as the northern tier inland areas, the plants must be dug in late fall while still alive and stored for the winter at 32-40°F and high humidity. These plants are replanted in early spring. Plants flower and form pods like cabbage. Have at least two plants to assure pollination.

Harvest - Seed matures in late summer. See "Cabbage" for methods.

CABBAGE

Flowering - Flowers are "perfect", each containing both male and female parts. They are borne on long, spreading branches. Since cabbage is a biennial, this occurs the second year.

Pollination - Cross-pollinated, usually by bees. Since individual plants of cabbage tend to be self-incompatible, be sure to have at least two adjacent plants for seed to assure pollination and seed formation. Different varieties of cabbage will cross, and if more than one are grown for seed in a year, the varieties should be isolated by a tall crop, or 200 feet. This should prevent most crossing, but much greater distances are needed to assure purity. Plants of broccoli, cauliflower, brussels sprouts, kale, and kohlrabi are all of the species *B.oleracea*, which also includes cabbage. Different varieties of any of these named vegetables should be isolated to prevent intercrossing, as bees have no regard for the distinctions. However, if two of these varieties are known from experience to flower at different times, they could be planted side by side with no mixing.

Culture for Seed - Two methods are used.

1) Seed production from headed plants - Plants are grown so as to reproduce mature heads before the ground freezes in the North, in late fall in the South. Plants are harvested, leaving roots attached, the outer leaves trimmed, and heads sorted out for desirable characteristics. In the North it is the common practice to store heads in outdoor pits or root cellar over the winter. Optimum storage conditions are high humidity to prevent drying, and temperatures near freezing. Heads can be stored outdoors because with cabbage, some degree of freezing will not damage the tissues due to the fact that the heads will thaw very gradually because of their bulk. In this method plants are reset early the following spring about 2½-3 feet apart, setting the plants deeply so the heads rest on the soil or slightly below. In Denmark it is common to reset the plants immediately after roguing in the fall. Plants are set in furrows and soil is hilled over the plants for winter protection. In the spring soil is drawn away to expose a portion of the heads. This method eliminated the work of transporting and storing heads, and could prove well-adapted to cabbage seed production in parts of the Northern U.S. In mild areas heads can be sorted and immediately replanted as above and require no protection over the winter.

Note: It is common practice in early spring to make cross cuts,

about one inch deep, into the top center of each head to facilitate emergence of the second year growth. Do not cut too deeply or you may injure the growing point in the cabbage's core.

2) Seed-to-Seed - Seedlings are started so that they are in the rosette stage (about half grown, not headed up yet) before cold-weather dormancy (in the North). Before severe weather, soil is hilled to cover or partially cover plants for winter protection. This method saves work because plants are not fall harvested, but simply left in the ground over winter in place. It is important to begin with good seed, as roguing is difficult because plants have not reached the head stage before winter dormancy. Otherwise, the method is advisable except where severe winters prohibit wintering plants in the field.

Staking - Some growers stake cabbage plants the second year to keep the bushy growth upright. This is done by driving in 5-foot long stakes next to plants after seedstalks are well formed, and tying plants to stakes. For larger plantings stakes may be used about 10 feet apart with twine drawn between them on each side of the plants for support. This practice is also an aid in small gardens where space is at a premium to keep plants from sprawling.

Harvest - After flowering, thin pods form bearing the seeds. As seed matures, pods turn brown. Harvest by cutting plants near the base when all but the terminal pods are mature. Plants are then laid out to complete drying. In humid areas, since several weeks may at times be required, plants should be dried under cover if possible. They may be placed on a canvas to catch any seed which may shatter out during the drying process. When dry, seed is easily threshed by beating (flailing) plants. In very small quantities plants may be bagged before beating to retain seed.

Cleaning - Threshed seed is cleaned from pods, stems, and other debris by a combination of screening and winnowing.

CARROTS

Flowering - Flowers are perfect (contain both male and female parts) and are borne in disc-like umbels. There is a single, large primary head, "secondary" umbels borne on stems arising from the main stalk, followed by third and fourth order branches and heads.

Pollination - Cross-pollinated by a variety of insects. Where purity is desired, small plantings should be separated by 1000 feet, greater for sizeable plantings. Where a small degree of crossing is not objectionable, a 200 foot separation should be adequate. Since carrots will cross readily with Queen Anne's Lace (Wild Carrot), and this crossing is generally undesirable, keep any such wild plants in the vicinity clipped so the flowering is not coincidental with the flowering of the cultivated variety.

Culture for Seed - Carrots are biennial, producing seed the second year. Two methods are used.

1) Root-to-Seed - Carrots are grown as usual for the edible crop, and harvested in the fall before the ground freezes (in the North). Roots are selected for desirable appearance and placed in storage for the winter at high humidity and temperatures approaching freezing. In early spring roots are replanted at 12-24" x 30-36" apart, the root crown level with or slightly below the soil surface. Firm soil around roots, watering if soil is dry. It is important to replant roots soon after removal from storage. In areas with mild winters, roots may be replanted after selection in late fall. In the North, roots may be harvested and replanted in early mid-September if a heavy mulch of soil and straw, leaves, or hay is applied to protect roots from heavy freezing. You will have to determine from experience if carrots may be safely wintered over in your location.

2) Seed-to-Seed - Seed is sown in summer (late June-early August, the former where winters come earlier and are more severe), and the crop is left in the ground over the winter. In this method the roots go into the winter in the small, "finger" stage, in which carrots are hardier than when full size. Remember to sow in 30-36" rows because the plants need this room the second year. If snow cover is adequate, the crop should winter over quite well. Some northern gardeners heavily mulch their carrot rows before the ground freezes for added protection. The disadvantages of this method are that winter injury may occur, and no selection for appearance of roots is possible.

Seed Production - Seed umbels mature rather unevenly, and plants are normally harvested when primary and secondary umbels are ripe (seed is brown), usually occurring in September. In small plantings, individual heads may be cut off as they ripen. In larger plantings, plants are pulled out, the roots cut off with a knife, and the plants put in shallow piles or windrows to dry. In dry regions drying only takes a few days, but in humid areas it may take about two weeks. While plants left outdoors to dry may be rained on once or twice without damage, it is better to cure them under cover if possible.

Threshing - Small quantities of seed heads may be threshed by rubbing by hand, whereas larger quantities of plants may be piled and crushed with a heavy roller or beaten.

Cleaning - Clean seed from pieces of stem and other debris by use of screens combined with winnowing. If desired the small "wings" may be removed from the seed by rubbing between the hands.

Note: Periods of temperatures near freezing are necessary if flowering and seed production of carrots is to occur the following season. This may limit production of seed in areas with extremely mild winters.

CAULIFLOWER

Flowering and pollination - Cross-pollinated. Similar to "cabbage". Isolate different varieties of cauliflower grown from seed by 200 feet to exclude most crossing, much greater distances being necessary for purity. Also, isolate from varieties of cabbage, brussels sprouts, kale, kohlrabi, and broccoli, as these plants (including cauliflower) are of the same species, *B. oleracea*, and will cross readily.

Culture for Seed - Cauliflower is biennial in habit, and requires a period of cool or cold weather in order to flower and reproduce seed the following summer. In areas with mild winters, sow in late summer/mid-fall, thinning or planting out to 2 feet apart in the rows. In the cold-winter areas of the North, cauliflower seed growing presents a special problem because 1) the plants will not survive if left in the field to winter over, and 2) the plants will not store in pits or root cellar. To solve this problem, sow seed in an outdoor bed, cold frame, or unheated greenhouse in mid-August to October, the earlier date where winters are earlier and harder. Transplant seedlings in cold frame or greenhouse in 3-inch pots, or 3 inches apart. In regions where winter temperatures do not drop below 5 or 10°F, plants will normally survive the winter in cold frame or unheated greenhouse. In colder areas, some added heat will most likely be needed unless the greenhouse is designed so as to make good use of the sun to temper extreme lows. It may be necessary to re-transplant plants to a greater spacing under glass before moving to the field. Set plants in the garden 2 feet apart when danger of night frosts is past. Plants will stand occasional frost.

Seed Production - After formation of the curd, a small bush of seed-stalks forms bearing yellow flowers followed by seed pods in late summer-early fall. When most pods are brown, before heavy frost, cut plants near the base and bring under cover to complete drying. Use a canvas under the seed to retain any seed which shatters out. Since seed does not often mature before fall, and should not become frozen before it is dry, it may be difficult to mature seed in short season areas. In this case, plants should be covered on evenings when heavy frosts are expected.

Harvest - Seed is threshed by beating plants, and cleaned by winnowing and screening. See "Cabbage".

CELERY

Flowering - Celery is a biennial, producing small flowers and seed the second year. The blooms are perfect (have both male and female parts).

Pollination - Cross-pollinated by insects. If two or more varieties are planted for seed in a year they should be separated by another

tall growing crop or by 200 feet, a greater distance if purity is desired. Celery and celeriac will cross, and should be separated the second year if both are grown for seed.

Culture for Seed - In areas of mild winter weather such as the South, Southwest, and California, sow in July, transplanting to the garden in December or January. In the North, grow as usual for the salad crop, starting seed early indoors or in frames and transplanting when cold spring weather is past. Since celery is biennial and must go through the winter, storage of the plants or protection is usually needed in the North as the plants are not hardy enough to survive severe winters. In the more common method, the plants are carefully dug in fall, before the ground freezes, and are stored in pits or root cellar with the roots in moist soil, temperatures near freezing. Some deterioration of the stalks and leaves is probable, and this should be trimmed off when plants are removed in the spring. Since celery plants make rather heavy roots by fall of the first year, it is possible to trim off the stalks 2-3 inches above the root crown, and store like carrots in the pit or cellar with success. Another method is to leave plants in the garden, protect them by stacking bales of hay or straw on each side of and over the plants, and be certain to remove this cover promptly during spring thawing. When plants or roots have been dug and stored, transplant about 1½-2 feet apart in early spring.

Seed Production and Harvest - In the second year a bushy growth develops bearing small white flowers (umbels). Seed matures (flower heads turn brown) in late summer. Either pull out or cut plants and spread on ground or stack indoors to complete drying. Seed shatters (drops off of flower heads) more easily than seed of carrots, and small numbers of plants should be placed over a sheet or canvas to catch any fallen seed.

Threshing - Thresh seed by rubbing flower heads.

Cleaning - Clean seed from stems and leaves by winnowing and screening.

CELERIAC

Follow instructions for "Celery".

CHINESE CABBAGE AND MUSTARD

Flowering - Both are annuals, producing seedstalks and yellow flowers the first year from seed, the second year when fall sown. Flowers are perfect, containing both male and female parts.

Pollination - Cross-pollinated by insects. Varieties of each vegetable will intercross, and varieties of most species of mustard will cross with Chinese cabbage. Neither will cross with regular cabbage,

or any member of the Brassica oleracea group. (See "Cabbage"). Bees normally do the pollinating. Separate two or more varieties by 200 feet to prevent most crossing, separation by a tall crop also helping isolation. Much greater separation is necessary if purity is desired.

Culture for Seed - Mustard is spring sown in the North, fall sown in mild areas. Chinese cabbage may also be sown as above, but since early spring sowing of Chinese cabbage in the North usually results in bolting to seed prior to formation of heads, no selection is possible. Some seed sources specify which varieties of Chinese cabbage may be sown in the spring for mature heads so that undesirable types can be removed, and still have time to flower and mature seed before severe frosts. (Where winter is more temperate, plant in late summer, the mid-size plants wintering over in the field before flowering the second season.) Seed is enclosed in narrow pods which follow the yellow flowers in summer. Maturity is indicated by a browning of the pods.

Harvest, Threshing and Cleaning - See "Cabbage".

COLLARDS - Refer to "KALE"

CORN

Flowering - Monoecious, producing separate male and female blooms on the same plant. The tassel at the top of the plant is the male bloom bearing the pollen. The silks represent the female, and receive the pollen.

Pollination - Cross-pollinated. The pollen is shed by the tassel, and is normally carried to the silks of other plants (somewhat to the same plant) on the wind. Rarely bees will act as pollinators. Isolate varieties of similar maturity by 1000 feet for reasonably good purity, 200 feet where a low percentage of crossing is not objectionable. A late and an early corn may be planted side by side, if shedding of the pollen (a yellow powdery material) of the early variety does not overlap with the time the silks begin to show on the later variety.

Seed Production and Harvest - Corn will mature 6-8 weeks after pollination, depending on the variety and the weather, or 3-5 weeks after sweet corn eating stage (milk stage). If birds are not a problem, ears can be left to dry in the field. However, ears may be picked after the ear husks are turning brown.

Drying - Generally ears require additional drying under cover. The best method for small quantities is to pull back the husks, tie the

husks of half a dozen ears together with twine, and hang in an airy place. Heated air kept under 100°F may be utilized.

Shelling - Shell all but large numbers of ears by hand. Hold ear in one hand, and twist off the kernels with the other. Note: Some growers discard the kernels at the tip of the ear as they may not be fully developed. Any ear silks or other debris which may be present in the shelled seed may be removed by winnowing.

CUCUMBER

Flowering - The plant is usually monoecious, bearing separate male and female blooms. Identify the female blooms by the ovary (tiny fruit) visible below the flower, and the male blooms by the absence of this ovary.

Pollination - Cross-pollinated. Honey bees are the usual pollinators. Isolate two varieties by 1/4 mile to normally assure purity; for home use 200 feet or separation by another tall crop is sufficient. Cucumbers do not cross with other vine crop species.

Seed Production and Harvest - Fruits are ready to harvest for seed when they are of mature color. Black spined varieties are golden; white spined varieties are pale yellow. In the North the vines may be left to be killed by frost, at which time the fruits are visible and easy to harvest. Mature cucumbers, if not frosted extensively, may be stored a few weeks indoors before seed extraction, which, in the case of a slightly immature crop, will help to finish ripening the seed.

Seed Extraction - Slice fruits in half lengthwise. Push out pulp and seeds with thumb and fingers into the chosen containers, preferably non-metallic. After all the seed has been extracted, stir the pulp, and keep container(s) in a warm (at least 65°F) place. Resulting fermentation will reduce the jelly-like pulp surrounding each seed to a thin liquid. Stir twice daily. Fermentation will generally be complete in 3-6 days. The best seed will sink to the bottom of the container, the lighter, inferior seed rising to the top. Generally speaking, fermentation is complete when the seeds feel rough instead of slippery.

Washing Seed - Pour off the seeds that float into a second container. The best seed will remain. Fill first container with water, stir, let seed settle, and pour off water. Repeat washing until seed is clean. Often there is some good seed in the material that floated. If so, this normally can be salvaged by filling the container with water and stirring. Some good seed may settle out which is washed as above.

Drying - Spread washed seed out on paper or screens. In sunny weather dry seed outdoors, otherwise dry in a warm, airy room. If artificial heat is used in drying, do not exceed 100°F. Stir seed periodically to encourage uniform drying.

Cleaning - Pieces of skin or other debris which remain in dried seeds may be removed by winnowing, which will also remove any hollow seeds not discarded in the washing process.

EGGPLANT

Flowering and Pollination - See "Peppers".

Culture for Seed - Same as for the edible crop.

Harvest - Seed matures after the fruits reach edible size. A fruit will generally contain mature seeds when thumb pressure applied to the fruit leaves an indent, instead of springing back out to normal as it does when the fruit is still at a good edible stage. However, seed from harvested, edible size fruits will sometimes mature if fruits are allowed to sit at room temperature for several days.

Seed Removal - Cut and crush fruits to a mass of pulp and seeds. Wash seed free as in instructions for tomatoes. Fermentation is not recommended. Spread out seed on paper or screens to dry.

Cleaning - Clean seed from pieces of dried pulp by winnowing and screening.

ENDIVE

Flowering - Biennial, producing seedstalks and flowers the second year. The blue flower heads are 1-1½" in diameter when open.

Pollination - Self-pollinated. Two or more varieties grown for seed may be planted in close proximity without much if any crossing. If purity is required, separate varieties by another crop, or by several yards.

Culture for Seed - Being biennial, and not suited to indoor winter storage, endive is planted so as to winter over in the field. In the North sow in mid to late summer, and apply mulch before heavy frosts if winter snow cover is not dependable. In mild areas sow seed August-October. Thin plants in spring to 12" apart in the rows. Seed matures in June after "feathering" of the flowers. See "Lettuce" for harvesting procedures.

KALE AND KOHLRABI

Flowering and Pollination - Essentially the same as for the other Brassicas. See "Cabbage". They are biennials producing seed the second year.

Culture for Seed - Normally kale and kohlrabi are grown by the seed-to-seed method, meaning that the crop is allowed to winter over in the field. Kale is very hardy and will often winter over in the North if a well-drained location is available. To be safe, kale intended

for seed where winters are severe in the northern tier states should be sown late enough (approximately July) to be of only moderate size going into the winter, and the plants should be thoroughly insulated with mulch. Kohlrabi is not as hardy, and where temperatures drop below 0°F, the mature bulbs with roots should be stored for the winter at near freezing and high humidity, then replanted the next spring. Kohlrabi is left to stand in the field in major Northern European growing areas such as Holland and Denmark, and in coastal Washington, USA.

Seed Production, Harvest and Cleaning - Plants flower the second year and mature seed in late summer or fall. See "Cabbage" for details of harvest and crop handling. Note: Kale and kohlrabi are of the same species (*B. oleracea*) as cabbage, broccoli, cauliflower, and brussels sprouts, and should be isolated by 1000 feet from any variety of these crops (or other varieties of kale and kohlrabi), as much greater isolation recommended if varietal purity is desired. Also, individual plants of kale (and of kohlrabi) tend to be selfsterile, so be sure to have at least two adjacent plants flowering to assure seed formation.

LEEK

Flowering - See "Onion". Leek flowers are similar except they are of a pinkish rather than white color.

Pollination - Cross-pollinated. See "Onion".

Culture for Seed - Leeks are grown as for the edible crop from spring sowing or planting out. Select out undesirable types in the fall. Plants are allowed to winter over in the field, the hardy types not being susceptible to winter injury. The early, tall stemmed summer types should be hilled up with soil in areas with cold winters for some winter protection. Where winters are too tough to winter over mature leeks, I suggest planting later than normal so that the plants are half size or less going into the winter. They tend to be hardier when small. A heavy mulch may be applied.

Seed Production, Threshing, Cleaning - See "Onion".

LETTUCE

Flowering - The yellow flowers are perfect, containing both male and female parts. Lettuce is an annual, and the bushy seedstalks form the first year, unless summer-fall sowing is practiced.

Pollination - Self-pollinated. There is only a slight chance that any crossing will occur, so varieties grown for seed can be adjacent, and the harvested seed will usually be true-to-type. To be certain of purity, separate varieties by another crop.

Culture for Seed - Lettuce normally produces seed the first year. However, the plants may require a long period to complete the seed maturing process (depending on the variety) and early spring planting is needed in the North. In fact, it is advisable to sow early in cold frames later planting out the seedlings to get an extra-early start. Space plants 8-12" apart in the row. Some types of lettuce, especially late or slow-bolting types such as the crisphead varieties will not mature seed in the North from spring planting. In this case a well-drained location should be chosen and seed sown in August-early September so that plants are 1½-2" tall by the time heavy frosts stop growth. Lettuce plants at this stage will usually survive the winter, especially where there is good snow cover in cold areas. A heavy mulch should be applied to be removed early in the spring. In mild areas where frosts are light, seed is sown in the fall for most varieties.

Seed Production - The seedstalks form in mid-summer from early spring plantings, earlier where seed was summer or fall sown. In crisphead varieties, the seedstalk may have trouble emerging from the tight head, instead just curling inside. To prevent this problem, peel back the head leaves to expose the growing point as soon as heads

are mature. Another method is to make two longitudinal crosscuts into the head. After the yellow flowers appear, they obtain a feathered appearance, similar to but much smaller than the feathery stage of dandelions going to seed. Not all flowers mature like this at once. When about 50 percent of flowers are in feather, clip plants off above the base with a knife or pruning shears, and bring plants in to dry. (In dry, warm weather plants may be left out to dry after cutting.) Another method is to shake standing (not cut) plants into a bag at several different times during the seed maturing period, a method which will generally give the cleanest seed.

Threshing - After plants are somewhat dry, the seed is threshed by shaking plants vigorously inside a barrel or bag. Plants do not have to be completely dry to do this, but should be cured several days after cutting.

Cleaning - Lettuce seed is cleaned by winnowing and screening. Although it is often difficult to obtain perfectly clean seed without more refined machinery, it is certainly adequate for home and local use.

MUSKMELON

Flowering - Bears separate male and female blooms (monoecious), although often the female flowers are hermaphroditic, containing both male and female parts. These varieties, which characteristically produce both perfect and male flowers, are known as andromonoecious. The female blooms are identified by a tiny fruit (ovary) below the bloom.

Pollination - Cross-pollinated, although andromonoecious varieties exhibit a certain amount of self-pollination. Honeybees are the usual pollinators. For varietal purity isolate different varieties by 1/4 mile; 200 feet is sufficient to prevent crossing to a great degree. Muskmelons will not cross with other vine crops species.

Seed Production - Seed is ripe when the melon is ripe, usually indicated by a cracking of the stem, and a sweet fragrance of the fruit. Scoop out seed and pulp into a suitable sized container (a drinking glass is fine for one or two melons). Leave this at room temperature for 2-4 days, stirring twice daily. The resulting fermentation reduces the pulp encasing each seed to a thin liquid. When this fermentation is complete most good seed will be at the bottom.

Washing, Drying, Cleaning - See under "Cucumber".

ONION

Flowering - Small, white, perfect (having both male and female parts)

flowers in the form of globular umbels. They are borne on the top of upright stems, and number from one to 20 per plant depending on variety and environmental differences.

Pollination - Cross-pollinated, mainly by honeybees. Separate two or more varieties grown for seed by at least 200 feet. If purity is desired, much greater isolations are required.

Culture for Seed - Grow bulbs as normal for the edible bulb crop, either from seeds or sets. In the North bulbs are usually harvested and graded in the fall and stored indoors for the winter. Large bulbs produce more seed than small bulbs. Depending on the variety and specific soil and climate, some growers replant the selected bulbs in the fall. Depend on this method only after your experimentation shows that the fall replanted bulbs will survive the winter. It is safest, however, to harvest and store bulbs. Best storage conditions are dry, airy, and temperatures cool, 32-40°F. Stored bulbs are replanted in spring, as early as possible, 6-12" apart in rows as narrow as cultivation will permit. Cover bulb leaving the top (neck) barely exposed.

Notes: In mild areas where onions are normally seeded in the fall for the edible crop, bulbs should be harvested, selected, and replanted. In the North, another method where onions can be wintered over outdoors is to plant somewhat later than normal so that the plants go into the winter at an immature stage, when roots are still strong and hardiness is greater than with mature, dormant bulbs.

Seed Production - Stems grow, eventually bearing the flower heads. The stems are brittle, easily broken, so care should be taken when cultivating. Normally, there is a flowering period of nearly a month during summer as not all flower heads develop at once. The black seeds eventually become exposed, and in small plantings individual seed heads may be cut as the seeds are exposed. In larger plantings all umbels are cut when about 25 percent of the heads have black seed exposed. Seed is not dry at this stage.

Heads must be dried in trays (flats built for starting seedlings are good) in the sun or under cover. Stir seed heads occasionally.

Threshing - Seed is ready to thresh when it is dry and easily rubbed from the heads. Drying of the heads will often take over two weeks. Since seed is easily cracked or broken, it is best to thresh small quantities by rubbing seed heads.

Cleaning - Winnowing and screening will usually do a satisfactory job. Sometimes, however, parts of the umbells will still remain, and this debris may be removed by a separation in water, the good seed sinking and poor seed and debris floating. After this "washing", immediately spread seed out to dry on paper or screens.

Note: Where bulbs are winter hardy in the field they may be left in another year to produce a second crop of seed.

PARSLEY

Flowering - Parsley is a biennial, producing seed stalks and flowers the second year. The blooms take the form of small umbels, similar to carrots. The flowers are perfect, having both male and female parts.

Pollination - Cross-pollinated by a variety of insects. If two or more varieties are grown for seed in a season, isolate varieties by 200 feet in small plantings if a slight degree of crossing will not be objectionable. Where purity is desired, isolate by 1000 feet or twice as far if the plantings are sizeable.

Culture for Seed - Sow seed in spring or summer of the first year, thinning plants to 9-12" apart. If desired, plants may be dug in late summer, and the plants of desirable type re-planted. Parsley is very hardy, and will survive most winters unprotected if planted in well-drained ground. Where winters are too severe for this, apply a heavy insulating mulch in the fall.

Seed Production - In the spring and summer of the second year growth takes the form of branched seed stalks bearing small flower heads. The crop is mature in late summer indicated by a browning of the seed.

Harvest - In small quantities, individual seed heads may be cut when mature. For larger harvests, cut plants near the base and pile shallowly outdoors or undercover. Cover is recommended if harvest takes place during a rainy period, but a couple of showers during the drying period will normally do no harm.

Threshing - When seed heads are dry, seed may be rubbed free by hand in small quantities or in larger lots plants crushed with a heavy roller.

Cleaning - Threshed parsley seed can be cleaned by winnowing and screening.

PARSNIP

Flowering - Small, yellow-green, perfect flowers form umbels, similar to carrots but more open and spreading.

Pollination - Cross-pollinated by a variety of insects. Where two or more varieties are grown for seed, separate varieties by 200 feet to eliminate most crossing. If purity is desired separate plantings by over 1000 feet.

Culture for Seed - Parsnip is biennial, flowering and forming seed the second year. In the North, spring planting should be practiced, same as for the edible crop. In mild climates, mid-summer plantings are most common. Two methods of handling the crop may be used.

1) Root-to-Seed - In the North parsnips are harvested the following spring, before new growth begins. In mild areas where seeding was

done in mid-summer, this usually is done in January. Roots are then selected for desirable characteristics and replanted 2-3 feet apart, the root crowns at or just below the soil level.

2) Seed-to-Seed - As above, but plants are simply thinned to 2-3 feet apart without the root harvesting and selection process being done. Note: Parsnips are very hardy, will survive most winters unprotected if planted in well-drained soil.

Seed Production - During spring seedstalks form bearing the flowers in summer. The seeds are flat and quite large because of their wing-like structures. Mature seed is dry and light brown. When most seed is brown cut plants near the base and lay in the sun or bring under cover to complete drying. Parsnip seed will shatter (fall from the plant) readily when dry, so harvest should not be delayed.

Threshing - For a small number of plants seed may be stripped off by hand. Large amounts can be flailed with some success, but some seed will usually remain, requiring stripping by hand.

Cleaning - Parsnip seed is light in weight, and is difficult to winnow without losing some seed. Screening also helps. However, usually parsnip seed will be quite free of stems and leaves, and often requires no cleaning.

PEAS

Pollination - Pea flowers are, by design, self-pollinating like beans. Pollination takes place before the blossom opens, thus preventing cross-pollination by insects. However, the flowers are showy and less tightly closed than bean flowers, and honey or bumble bees sometimes pry open blossoms, causing crossing. So, if purity is required, separate pea varieties by a tall crop or by at least 100 feet.

Culture for Seed - As normal for the edible crop. In the North, best quality seed is from early spring sowing.

Seed Production - After the edible stage when the seeds are soft and bright green they approach maturity and begin to dry. Maturity is complete when the seeds rattle in the dry pods.

Harvest - Pull out entire plants. Complete drying under cover or in stacks outdoors. Make sure to harvest promptly when mature, as seeds may sprout if the pods are in contact with moist ground.

Threshing - Thresh by flailing (beating). Small amounts can be threshed by beating plants inside bags to retain seed.

Cleaning - Clean peas of pods and soil by winnowing and screening.

PEPPERS

Flowering - Perfect (having both male and female parts) flowers

followed by the fruits containing the seeds are produced during the same year planted.

Pollination - Mostly self-pollinated. Bees may create some crosses between adjacent varieties if more attractive nectar is not available in the vicinity. Where near purity is desired, separate varieties by a tall growing crop and 50 feet or so.

Culture for Seed - Same as when raising the edible crop.

Harvest - Pick peppers when fruits are of ripe color, at which time the seed is mature. Most market type bell peppers turn red when ripe. Seed may be saved from under-ripe fruits if they have first been allowed to ripen at room temperature after picking. Remove the seed mass from the fruits and allow to air dry. Rub to separate seed after drying. Washing is not necessary, best may be to clean seed of debris which will float. Cleaning can also be accomplished with screens and winnowing.

POTATO

Flowering and Pollination - Use of the true seed borne in fruits at the top of the plant is becoming more well known, and its extraction and drying is similar to that for tomatoes (see "Tomato"). What is normally called "seed" is actually a tuber. Flowers are generally self-pollinated, but even if crossing does occur the tubers used for planting will not be affected. Hence, different varieties can be grown in the same area, and all saved for next year's planting.

Culture for Seed - Same as for the edible crop.

Harvest - Select tubers from desirable plants when digging. Some growers keep the largest potatoes for seed, but there is no advantage to this. It is more common to use the large tubers in cooking, and save the small ones from the best plants for next year's seed, which eliminates the need to cut tubers into pieces prior to planting.

RADISH

Flowering - Radishes are normally annuals, producing seed during the first year. Some oriental (Daikon) types are biennial in habit. Flowers are white, pink, or violet in color.

Pollination - Cross-pollinated, primarily by bees. Separate two or more varieties grown for seed by 200 feet to eliminate most crossing, over 1000 feet if near purity is desired.

Culture for Seed - The small types are sown in early spring in the North, early winter in mild areas. Two methods are then possible:
 1) Root-to-Seed - Harvest roots when of edible size. Sort for desirable characteristics, clip tops to within an inch of the root, careful not to cut the small, young, central leaves. Replant roots

8-12 inches apart, covering the root crown by a half inch of soil. Water after replanting.

2) Seed-to-Seed - Thin plants to 3-12 inches without harvesting plants to be left for seed. Little selection is possible. The Oriental (Daikon) types should be summer sown so as to reach good size before heavy frost. Harvest roots and store over winter. See "Carrots". Replant roots in early spring 12-18" apart, the root crowns even with or slightly below the soil surface. In areas where radishes can be grown during the winter, Daikon types can be seeded in the fall and left in the field over the winter. If desired, roots may be harvested and selected for replanting in the spring. Seed Production - Bushy seedstalks form during summer which bear the flowers which are followed by seed pods.

Harvest - Allow most of the pods to turn light brown. The plants will still have a few green leaves and stems. Cut plants near the base, or pull out plants, and complete drying under cover or outdoors.

Threshing - Pods will not shatter (release seed on their own) so threshing is somewhat more difficult than for crops such as cabbage and turnips. If pods are well dried, beating plants is successful. For small quantities of seed, pods may be opened by hand.

Cleaning - Threshed seed is cleaned by screening and winnowing.

RUTABAGA

Flowering - Biennial, producing seedstalks, yellow blossoms, and seed during summer of the second year.

Pollination - Cross-pollinated, primarily by honeybees. If two or more varieties are grown for seed, separate by 200 feet to eliminate most crossing, 1000 feet or more for purity.

Culture for Seed - Raise as usual for the fall harvested roots. Harvest plants before heavy frosts, and cut tops 1-2 inches above the root crown. Store under cool (approaching 32°F), humid conditions as for carrots. Replant roots early the following spring, root crowns level with or just below the soil surface, one foot apart. Water after replanting.

Seed Production - Seedstalks form during spring of the second year bearing the flowers, followed by pods containing the seeds.

Harvest - When most pods on a plant are brown and dry, but before seed begins to shatter (drop from pods), cut plants near the base. Complete drying under cover.

Threshing - Thresh when pods are brittle by beating plants inside of bags to facilitate retaining seed.

Cleaning - Separate pods and other debris from threshed seed by winnowing and screening.

Note: In areas with relatively mild winters rutabagas may be wintered over in the field, which eliminates having to transport and

store the crop.

SALSIFY

Flowering - Biennial, producing seedstalks, flowers, and seed the second year. Flowers are dark purple and open during early morning around dawn, closing before noon.

Pollination - Self-pollinated. See "Lettuce".

Culture for Seed - Grow plants as usual for the edible root crop. Normally roots are harvested in the fall (early winter in mild areas where planting occurred later), selected for desirable types, and replanted about a foot apart. This selection process isn't necessary and the plants may simply be thinned instead of harvested and replanted. Flowers "feather" like dandelions when mature, but flowers on a single plant mature unevenly over a period of days or even weeks. Harvest by picking individual seed heads as they mature. Spread out picked heads to complete drying.

Threshing - Thresh by rubbing dry seed heads.

Cleaning - Clean salsify seed by winnowing and screening.

SPINACH

Flowering - Three types of plants occur. 1) Those only producing male flowers; 2) those only producing female flowers; 3) those bearing both types. Species which have separate male and female plants like spinach are called "dioecious". Spinach is an annual producing seed the first year, or during the second year when fall planted.

Pollination - Cross-pollinated. Pollen is carried by the wind long distances, and it is best to grow only one variety per year if purity is necessary.

Culture for Seed - Seed should be sown in early spring, or in the fall where spinach will survive the winter. When plants reach edible size the stunted, slender plants and the first 10 or 20 percent of bolters (plants going to seed) should be removed. These are usually male plants which are inferior to other types mentioned above for table spinach, and removing them will tend to reduce the presence of these less productive males in the next generation, thus improving the strain. Thin plants to 6 inches apart.

Harvest - Seed normally ripens in mid-late summer. Ripening is usually uneven, and harvest may be delayed until all plants are beginning to turn brown. Cut plants near the base and complete drying under cover or outdoors in shallow stacks if weather is clear.

Threshing - Thresh by flailing (beating) plants, or small quantities

by removing seed by hand.

Cleaning - There are often some seeds still stuck together after threshing. These can be rubbed by hand to separate. Clean debris from seed by winnowing and screening.

SQUASH AND PUMPKIN

Flowering - There is no botanical difference between pumpkins and squash. Plants are monoecious, producing separate male and female blooms. The male blooms appear on long stems above the vine, female flowers are borne atop a small preliminary fruit (ovary) which is normally directly attached to the vine.

Pollination - Cross-pollinated, various types of bees being primary pollinators. Varieties of the same species must be isolated by at least 500 feet to prevent most crossing, or over 1/4 mile for purity if this is necessary.

Species - There are four known species of squash as follows:

1) *C. maxima* - The stem is soft or corky and cylindrical; leaves have rounded lobes. Includes: Buttercup, Hubbard, Delicious, Banana, and Hokkaido. 2) *C. pepo* - The stem is 5-angled, and gradually expands towards attachment to the fruit. Branches are also 5-sided. Leaf lobes are usually pointed and angled. Includes all common summer squashes, all acorn types, the orange Jack-O-Lantern (pumpkin) types, Delicata, Lady Godiva, and Spaghetti. 3) *C. moschata* - Stem is smoothly 5-angled, thinner than the stem of *C. pepo*, and expanding abruptly at the fruit, soft hairs cover branches and leaves. Includes Butternut, Kentucky Field, and Cheese types. 4) *C. mixta* - Includes the Cushaw squashes and others previously classified under *C. moschata*. Characteristics are similar, the difference being in the non-crossability with *moschata* because of differences in chromosome numbers.

Crossing - The general rule to follow is that all varieties of one species will cross readily. For example, zucchini will cross with acorn and yellow crookneck, all of which are members of *C. pepo*. According to some texts certain interspecies crosses are possible (namely that *C. pepo* will cross with *C. mixta* and *C. moschata*, and that *C. maxima* will cross with *C. moschata*) but we have not experienced any interspecies crossing in our fields. We have heard from individuals experiencing *maxima-moschata* crosses, such as Buttercup X Butternut, but this type of natural crossing is certainly not common. In conclusion, you can generally save seed from different varieties planted in close proximity as long as they are of different species.

Harvest - Seed is mature when fruits are mature. Many gardeners prefer to check storage and eating quality before saving seed. Be sure when saving summer squash for seed to permit the fruits to become large, hard, and gourd-like, occurring about 2 months after the young,

edible stage.

Seed Processing - Cut fruits and scoop out seed and pulp. Separate out the seeds by hand, or use the assistance of water when large quantities are handled. Hardware cloth (heavy screen) helps to screen seed from pulp when washing with water. A portion of the seed of some squash varieties will tend to sink in water, while some will float. The heaviness (sinkability) of squash seed is not necessarily associated with quality. A mature squash seed is plump and firm, but it may either sink or float. Flattened and/or hollow seeds are immature, and will grow weakly or not at all.

Drying - Immediately after washing (or after separating the seed out by hand from a single fruit), spread seed on paper or screens to dry. Do not use artificial heat over 110°F. Wait until you are certain seed is well dried before placing in a container for storage.

Cleaning - There is bound to be some hollow (flat, lifeless) seed in each lot. Remove this seed by winnowing.

SWISS CHARD

Flowering, pollination - See "Beets". Swiss chard is a biennial. It will cross with beets and the two should be separated over 1000 feet, farther if purity is required. For the gardener, in general it is best not to raise both beets and Swiss chard for seed in a season, unless crosses (which could be of use) are not objectionable.

Culture for Seed - Sow seed in the spring in the North, late summer in areas where chard is normally grown during the winter. Even in cold areas the plants are usually hardy enough to stand the winter in the field. Thin plants to a foot apart, rows 2-3 feet apart. Undesirable types can be removed anytime before the seedstalks begin to form during the second year.

Seed Production, Harvest, Cleaning - See "Beets".

TOMATO

Flowering - The yellow flowers are perfect, bearing both male and female parts.

Pollination - Generally self-pollinated. Bees almost never visit the flowers, especially if sweet nectar from plants such as squash, melons, or ornamentals is available nearby at the same time. Unless absolute purity is desired, different varieties may be grown in a small garden spot and seed saved from each.

Culture for Seed - Same as when growing the plants for the edible fruit. Mark the most desirable plants as those from which seed will be saved. In large plantings remove or mark the undesirable or off-type plants to avoid when picking fruits for seed.

Harvest - Pick fruits when ripe.

Seed Processing - Crush fruits in a suitable size container to free seed and pulp. Stir at least twice daily. The resulting fermentation reduces the pulp surrounding each seed to a thin liquid and allows the seed to sink to the bottom of the container. This process requires about 4 days at around 60°F, only 2 days at 80°F. It is best to allow seed to ferment at below 70°F. to prolong fermentation for over 3 days so that the bacteria which could cause canker disease in the following crop are destroyed. Fermentation longer than necessary will severely reduce germination. When seed has settled in the container and feels rough, having lost the jelly-like placental coating, wash seed as follows: add water, stir and allow seed to settle, pour off liquid; repeat until seed is clean. Note: The light, immature seeds will float off in the washing.

Note: If desired, seed may be saved in conjunction with juice, sauce, or paste processing. Be sure to remove seed prior to cooking. A drinking glass is a sufficient container in which to ferment a small amount of seed.

Drying - Dry seed soon after washing by spreading on paper, screens, or glass, out or indoors. Seed dries within a day in dry, sunny weather. After drying, break stuck together seed by rubbing between the hands. This rubbing will also remove some of the fuzz on the seed which does not contribute to germination.

TURNIP

Flowering - Annual, producing seed the first year. Yellow flowers are perfect, containing both male and female parts.

Pollination - Cross-pollinated, generally by bees. If two or more varieties are grown for seed, separate varieties by at least 200 feet, much greater distances being necessary if purity is desired. Also, isolate from Chinese cabbage and mustard if these are being grown for seed.

Culture for Seed - In the North sow in early spring. Where mild climates permit the growing of turnips during the winter, fall planting is recommended. After table-sized roots are produced they may be pulled, topped to within 1½ inches from the root, and the desirable types replanted. The crown of the root should be even with or slightly below the soil surface, 8-12 inches apart in 2-3 foot rows.

Note: It is not necessary to harvest, select, and replant roots. If desired, simply thin plants to 8-12 inches apart.

Seed Production - With the coming of long days in early summer, seed stalks form, eventually bearing yellow flowers followed by seed pods. Maturity is indicated by a browning of the pods.

Harvest - When most pods on the plants are dry, cut plants near

the base and pile shallowly under cover, or outdoors during good weather to complete drying.

Threshing - Thresh by beating (flailing) plants over a canvas or tight floor. Small quantities may be bagged before beating to easily retain seed.

Note: Some turnip varieties will behave biennially in certain regions. In this case, roots must be lifted in the fall, sorted in a cellar, or pit over the winter (humid and temperature approaching 32°F), and replanted in early spring.

WATERMELON

Flowering - Monoecious, producing separate male and female blooms. The flowers are yellow, rather small, and form during summer of the first year. Female blooms sit atop the tiny, preliminary fruits (ovaries).

Pollination - Cross-pollinated. If two or more varieties are grown in a year, separate by 400 feet to eliminate most crossing, over 1000 feet if near purity is desired. Bees are the usual pollinators.

Culture for Seed - Grow as normal for the edible watermelons. When melons are ripe, seed is mature. Most gardeners will obtain enough seed simply by retaining the seed when melons are cut for eating. Large quantities may be cut and mashed by beating pulp, and the seed separated by floating off any debris in water, the good seed sinking. Seed may be washed before spreading out to dry. Any pulp which remains after drying is cleaned by winnowing and screening.