

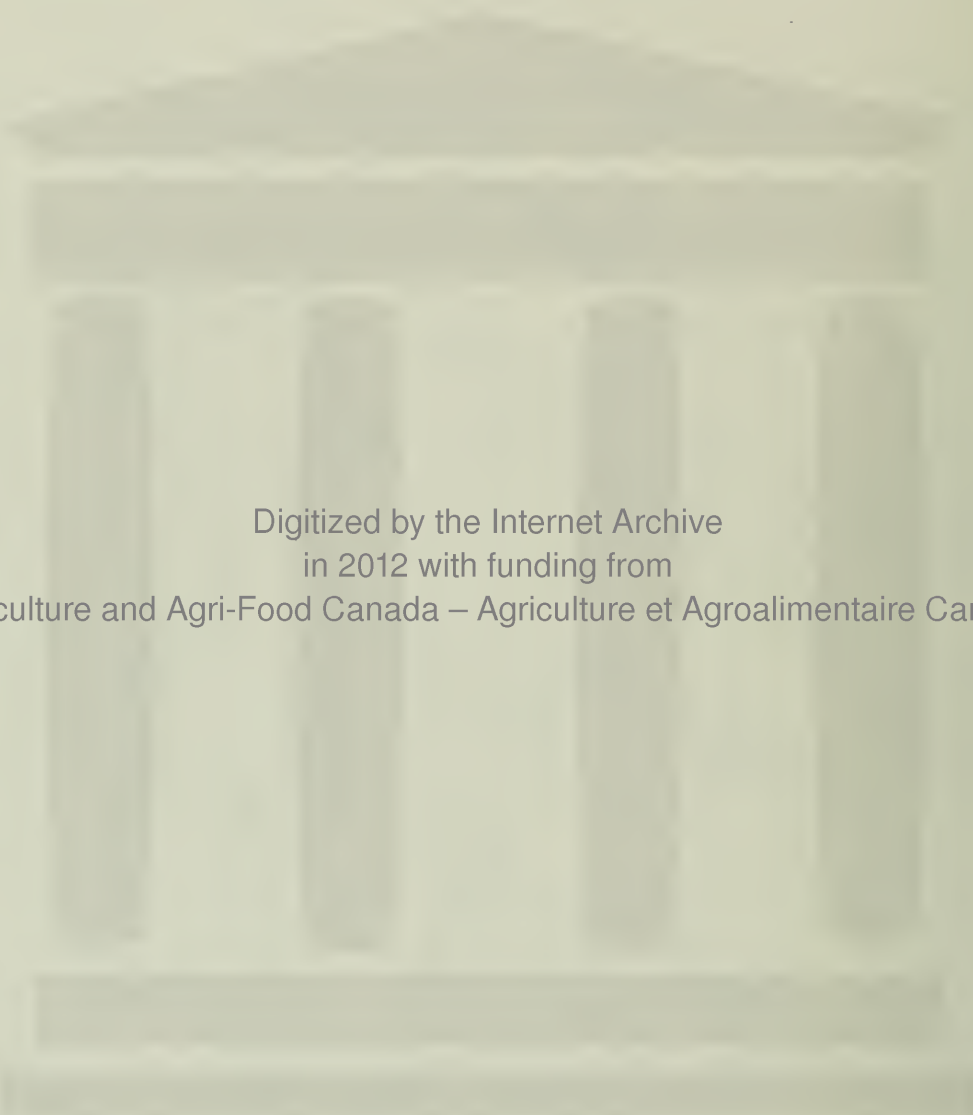
# GARDENING on PERMAFROST

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## A GARDEN ON PERMAFROST!

Residents of many parts of the arctic and subarctic regions can reduce food costs and improve their standard of living by growing their own vegetables and flowers. Provided that the frost-free period is 52 days or more, the killing frost-free period 80 days, and the mean July temperature is 55° F or above, many vegetables and flowers can be grown. Here are some of them, followed by the method in brief:

- Radish, lettuce, beet, chard, and summer turnip, by seeding directly in the garden
- Cabbage, cauliflower, kale, broccoli, Brussels sprouts, and annual flowers, by starting them inside and transplanting them to the garden
- Rutabaga, carrot, and potato, by seeding on ridges or terraces covered with a clear polyethylene mulch, or in cold frames.

Detailed instructions are given in this booklet. For more directions on standard gardening practices write to the Information Division, Canada Department of Agriculture, Ottawa, Ontario, for a free copy of Publication 1081, *Handbook for Northern Gardeners*, and 1192, *Gardening in the Yukon*.

The help and advice of the Reverend Father Adam, O.M.I., Pastor of Our Lady of Victory Parish, Inuvik, is gratefully acknowledged. Without his suggestions for gardening in the north much of this information would not have been available, and in the writing of this publication he has offered much valuable advice.

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# GARDENING on PERMAFROST

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## INTRODUCTION

More than three-quarters of the land area of Canada is classified as subarctic or polar; however, the summer climate varies considerably in these regions. In some areas, the temperature and length of the growing season are adequate for the commercial production of sweet corn, tomatoes, cucumbers, and other warm-season crops. In other areas, the growing season is too short; and in still others, the



Figure 1. Vegetables grown on permafrost. *Top row:* Lucullus chard, Copenhagen Early Market cabbage, Black Simpson lettuce. *Second row:* Ruby Queen beets, Scotch Curled kale, French Breakfast radish. *Third row:* Scarlet Nantes Coreless carrot, Super Snowball cauliflower, Italian Sprouting broccoli. *Bottom row:* Victory Neckless rutabaga, Warba potatoes, Purple Top Milan turnip.

soil warms up too slowly for successful production out-of-doors. There is, of course, a wide range of intermediate climates.

This publication describes methods of growing plants in areas where the frost-free period is long enough but the soil temperature presents limitations. (Figure 1). These methods have proved effective at Inuvik, Northwest Territories, latitude  $68^{\circ} 18' N$ , where the soil normally thaws out to a depth of only 15 inches and where the frost-free period is only 52 days, the killing frost-free period 80 days, and the mean July temperature  $55^{\circ} F$ .

## CHOOSING THE SITE

Choose a site sloping gently toward the southwest. Be sure there is at least 12 inches of soil below the moss layer. Do not attempt to garden on the gravel fill placed around many of the houses. Remove this gravel until you reach the original soil beneath.

## PREPARING THE SITE

Prepare the garden as early as possible in the spring. If it is prepared early enough, radishes, lettuce, and summer turnips can be planted the first year. The season is usually too short to grow other vegetables the first year. Early preparation of the garden soil during the previous year helps to warm up the soil, lower the permafrost level, and start microbial activity to release plant nutrients.

Remove the trees and shrubs from the garden area and clear a 20-foot border around the garden (Figure 2). Leave trees and shrubs on the west, north, and east sides to act as a windbreak. If there are no trees, build a fence 4 to 6 feet high (Figure 3). It will greatly help to improve the productivity of the garden. To reduce

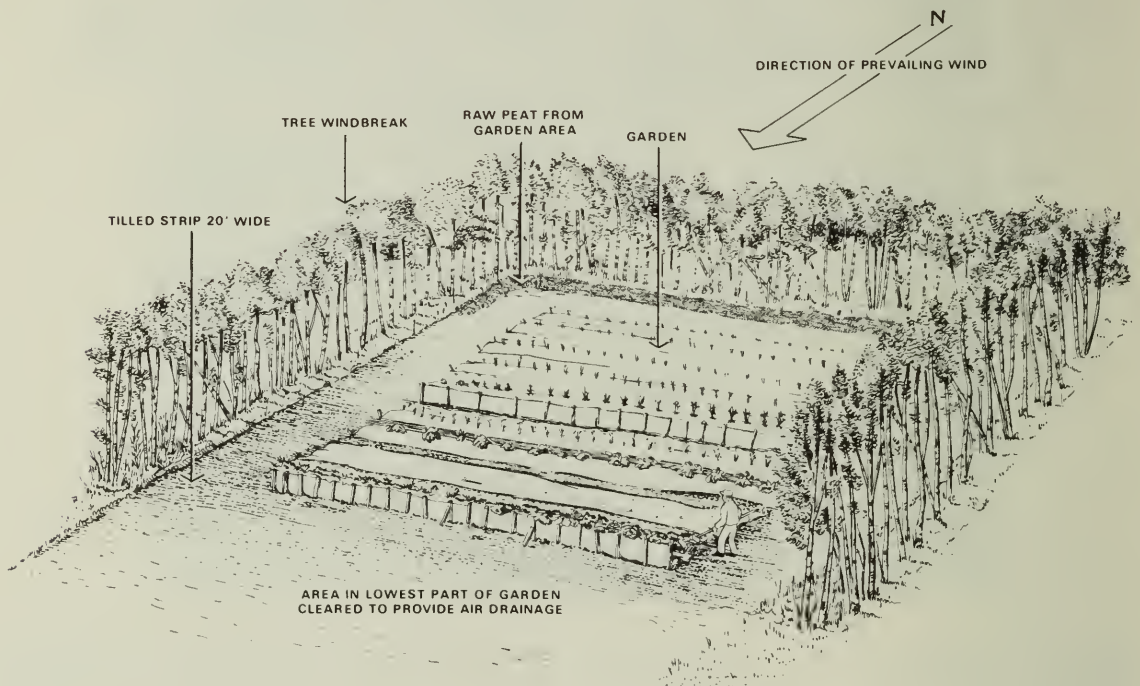


Figure 2. A good garden area. In towns the windbreak would be a fence.



Figure 3. Father Adam in his garden at Inuvik. Note the low fence used as a windbreak and the cold frames with sashes removed.

the danger of frost, clear a path through the trees at the lowest part of the garden. Cold heavy air will then move down and out of the garden and be replaced by warm air from the upper region of the slope.

If clearing is done with a bulldozer, conserve as much as possible of the surface layer of soil. Remove only roots and stones. After the garden area is cleared and the soil is worked, the active layer is deepened, but the soil gradually subsides. Therefore, provide a drain to allow the melting ice to flow away.

## PREPARING THE GARDEN

Prepare the garden by one of the following methods.

Break the layer of moss into small pieces. Be sure the moss layer is well turned over and lower layers of moss are mixed with upper layers. If good topsoil is available, put about 14 inches of it on the garden.

As another method, remove the layer of undecomposed moss and pile it at the edge of the cleared area. It will help to protect the garden and provide a source of organic matter for later on. Plow or dig the area and remove stones and roots.

Radish, leaf lettuce, chard, beet, and summer turnip can be seeded directly into the garden, but for other plants, cold frames, ridges, and terraces are needed. If such plants have been grown in the house or greenhouse, put them in cold frames to harden them off before you set them in the garden. Sow early crops of radish, lettuce, and beet in cold frames. Transplant some of the lettuce to the open garden after the plants have hardened off, and leave the rest to grow to maturity in the frames. Use ridges and terraces (Figure 4) covered with clear polyethylene mulch to

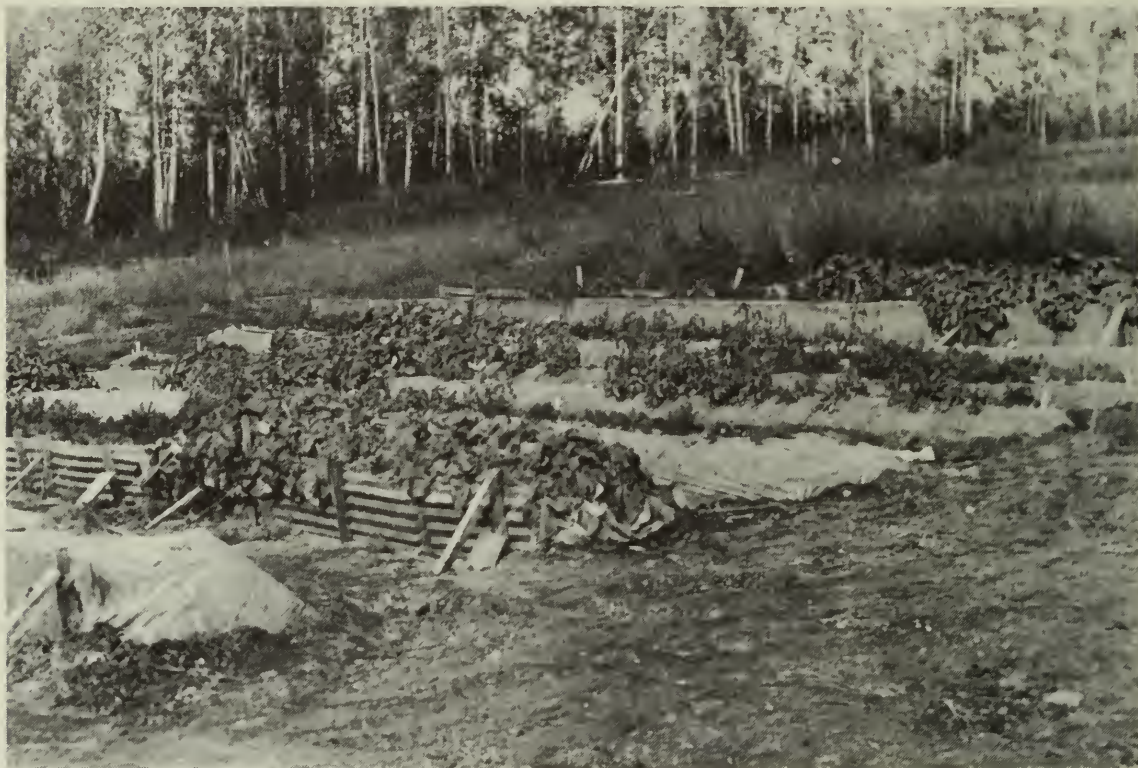


Figure 4. Vegetables growing in ridges and terraces in the garden of the Research Station. Note the natural windbreak in the background.

grow potatoes, carrots, and rutabagas. Complete the construction of cold frames, ridges, and terraces in the fall before freeze-up. If you wait to build them in the spring, the soil may be frozen or too wet and soggy, and construction could interfere with seeding and transplanting.

### **Cold frames**

Make the cold frames 6 feet wide of 2x8-inch rough lumber. The length will depend on the size of the garden and what will be grown in the frame. For most home gardens, a frame 6 feet long will be large enough for hardening off plants. Make longer frames, up to 30 feet or more, for growing early crops.

Place the planks in position on edge and drive stakes into the ground to hold the sides in place. Be sure the corners are square. Nail a brace of 2x4-inch wood across the frame at 6-foot intervals.

Make the sashes, or covers, from 2x2-inch lumber and cover them with clear polyethylene. When the sashes are not in use store them out of the sun.



## Ridges

Draw topsoil into ridges 10 to 12 inches high and about 2 feet wide. The higher the ridges the higher the soil temperature, but, on the other hand, the harder it will be to keep the soil moist enough for plant growth.

## Terraces

On sloping land, place pieces of plywood, 12 to 14 inches wide and  $\frac{1}{4}$  inch thick, on edge across the slope. Brace the lower side with 2x2-inch stakes, 2 feet apart. Pull the topsoil from behind up against the plywood until the soil is level with the top. On flat land use two pieces of plywood 2 to 3 feet apart and fill in the space between them with good topsoil (Figure 5).

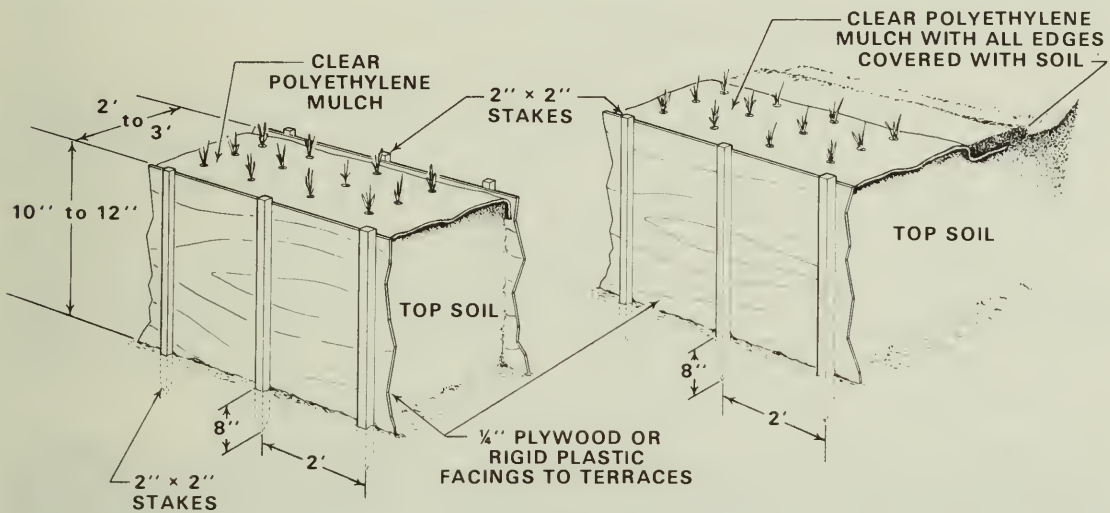


Figure 5. Terraces. *Left*: on flat ground; *right*: on side of hill.

Cultivate the garden, cold frames, ridges, and terraces, often during the summer to warm up the soil and lower the permafrost level. Before freeze-up, when the soil is dry, plow or dig the soil and leave the surface as rough as possible. The soil must not be packed down, but left fairly loose, especially on the surface. An open surface increases the amount of air in the soil, and helps to increase its warmth and release plant nutrients.

## PLANTING THE GARDEN

### Transplanting cabbage, cauliflower, broccoli, kale, Brussels sprouts, and head lettuce

In the fall before freeze-up, collect as much good topsoil and sand as you will need to grow your plants. Store it in a convenient place. During the winter collect used drinking cups, both paper and plastic, or buy peat pots or plant bands (Figure 6). Order the seed and other supplies as early as possible. Store the seed in a cool, dry place.

Two weeks before seeding, bring the potting soil and sand inside to thaw. Mix 3 parts of soil and 1 part of sand. Add  $\frac{1}{4}$  ounce of 16-20-0 fertilizer and  $\frac{1}{4}$  ounce of 0-0-60 fertilizer to 3 gallons of the mixture of soil and sand. Add enough



Figure 6. Types of containers. *Left to right:* square peat pots, 1¾ inches and 3 inches at top; paper and plastic drinking cups; square plant bands, 3 inches and 1¾ inches, showing, behind each, the band flattened for ease in shipping.

water to wet the soil thoroughly. Punch drainage holes in the bottom of the paper and plastic cups. Fill the containers. Gently firm the soil, leaving the soil level ¼ inch below the top of the container. To sow, gently press the seed into the soil, and cover the seed with 1/8 inch of soil or sand.

Plant the seed in one of the following ways. Sow seed in a large can or shallow box (called a flat). When the seedlings have two true leaves, transplant them to individual containers. As an alternative method, sow two or three seeds in each container. When the seedlings have two true leaves remove all but the most vigorous plant in each container (Figure 7). This method is best for beginners.



Figure 7. Cabbage seedlings ready to be thinned out. The two large heart-shaped leaves are the seed leaves, or cotyledons, and the small leaf between the seed leaves is the first true leaf.

Keep the containers in a warm place, preferably where the temperature is between 70 and 75° F. As soon as the plants appear, give them as much light as possible. If they are grown in a window, turn the containers every day to assure even, upright growth. If the plants start to grow tall and leggy, increase the amount of light, or reduce the temperature, or both.

At all times keep the soil moist but not wet. Overwatering causes the seed to rot and sometimes causes damping-off of the plants. If death of some plants is noticed, stop watering and allow the surface of the soil to dry out, or sprinkle a little dry sand over the surface. Stir up the surface occasionally.

Water the plants once a week with a ½ cup of solution made from 1 ounce of 16-20-0 fertilizer dissolved in 1 gallon of water.

As soon as the snow begins to melt in spring, put the sashes on the cold frames over the snow. The snow will melt more quickly than it would without the sash on, and the water will soak into the ground. Melting snow will usually provide sufficient water for the plants when they are in the cold frame, and further watering may not be necessary.

When the snow has melted in the frames and the danger of severe frost has passed, choose a warm day and move the plants from the house or greenhouse to the frames. Break out the bottoms of the cups but keep the peat pots intact. Bury the containers in the soil in rows 8 inches apart. Make sure the containers are completely covered with soil and that the soil is packed firmly around them. Put the sashes back on.

If there is danger of night frost, cover the sashes in the evening with tarpaulins or jute bags. In the morning remove the tarpaulins or bags to allow sunlight to reach the plants. Do not open or remove the sashes unless the temperature in the frame exceeds 80° F and there is too much condensation inside the frames.

Leave the sashes on for the first 7 to 10 days. Then if the outside temperature is 45° F or above, slide the sashes back, leaving a 2-inch opening at the top. Gradually increase the size of the opening each day. After about 10 days leave the sashes off all day and during warm nights.

When it is warm enough outside to plant in the garden, dig the plants out of the cold frame and plant them immediately in the garden. Remove cups and plant bands, but do not remove the peat pots. Dig a hole large enough to bury all the roots. Plant cabbage, cauliflower, broccoli, kale, and Brussels sprouts 2 feet apart, and head lettuce 1 foot apart. Water each plant with 1 pint of a solution of 1 ounce of 16-20-0 fertilizer in a gallon of water.

For early crops leave a few plants to grow to maturity in the cold frames. Keep the sashes on at all times except when the outside temperature exceeds 60° F. At such times, open the sashes a little every day.

At Inuvik, soil is brought in about the middle of April to thaw out, vegetables are seeded inside about April 26, sashes put on about May 1, and plants put in cold frames between May 15 and 18. The sashes are opened about May 25, and the plants are put in the garden between June 5 and 10. In eastern regions the season may be as much as a month later.

### **Seeding radish, leaf lettuce, beet, chard, carrot, and summer turnip**

These crops can be seeded directly into the garden, but for early crops, sow seed between the rows of transplants in the cold frames. Several days will be saved if seeds are presprouted. Place the seeds on damp paper towels in a temperature of 60 to 70° F. Examine the seeds every morning, and when the first root, or radicle, appears (Figure 8), sow right away. If the radicle becomes too long, many of the seeds will die. With the corner of a hoe or rake, or a pointed stick, make a furrow ¼

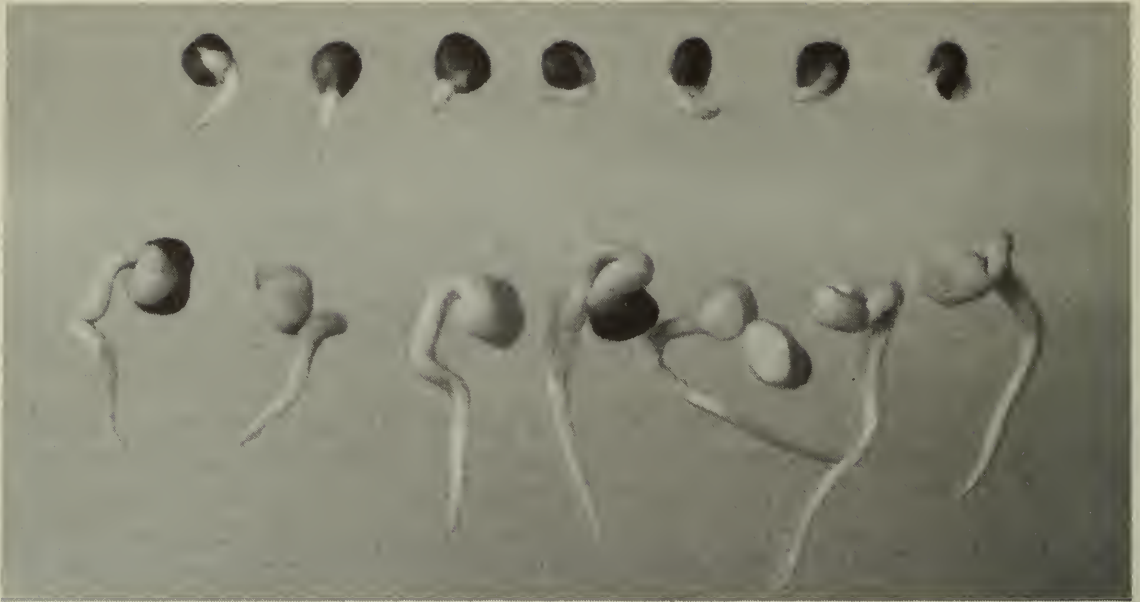


Figure 8. *Above:* Sprouted seeds with radicles just appearing. These seeds are ready to be planted. *Below:* Sprouted seeds with long radicles. If planted in this condition many of the seeds will die.

inch deep. Be sure the soil at the bottom of the furrow is damp. Sow seeds about four times thicker than is needed to get the required number of plants per foot. Cover the seeds and firm the soil. Replace the sashes. For most rapid growth keep the temperature in the frame at 70° F. If the temperature exceeds 80° F, slide the sash off sufficiently to lower the temperature to 70° F. Remove the sashes when the plants touch them or the leaves will be burned by the sun.

Seeding in the garden is done in the same way, but rows are usually 18 inches apart. If the rows are closer than 18 inches, leave a pathway 18 inches wide every 4 feet.

When the first true leaves appear, thin radishes and carrots to 1½ inches apart; leaf lettuce, beets, and summer turnips to 2 inches apart; and chard to 4 inches apart. When the plants are large enough to eat, remove every second plant. Continue to do this all summer.

To provide a continuous supply, sow radish, lettuce, beet, and chard every 2 weeks for four successive sowings.

## Potatoes

Whole potatoes and cut pieces at least 2 ounces in weight produce the best yields. Bring the potatoes out from storage about 3 weeks before they are to be planted in the garden. Cut the larger ones into pieces having two eyes. Put the pieces in damp sand or well-decomposed peat, in a warm place where there is bright light. Keep the sand or peat moist. In 3 weeks the dark green sprouts should be about ½ to ¾ inch long. Put them outside in the frame for a few days to harden off, then plant them in a cold frame, ridge, or terrace. Cover the tubers and cut pieces with no more than ¼ inch of soil but be sure all the sprouts are above ground. Cover the potatoes with a clear polyethylene mulch and cut holes in it to expose the sprouts.

If pieces lighter than 2 ounces are used, start them at the end of April and grow them the same way as cabbages for transplants. Plant them on ridges or terraces.

Clear polyethylene mulches increase the earliness and yield of all vegetables because they raise the soil temperature as much as 12 degrees. They are most effective when used on terraces to grow potatoes, carrots, and rutabagas. Ridges and terraces increase soil temperature by as much as 4 degrees. A combination of ridges, or terraces, and mulches raises soil temperature as much as 16 degrees.

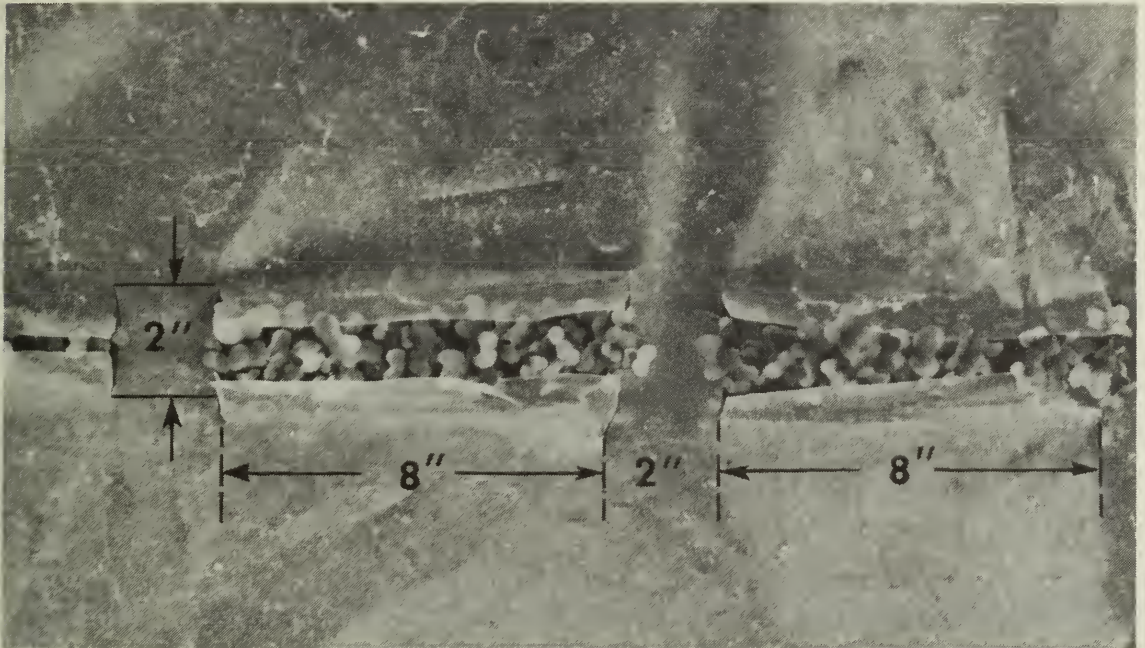


Figure 9. *Top:* Plastic mulch with intermittent slits, used when plants grow close together. *Bottom:* Plastic mulch with plus-sign slits, used when individual plants are spaced some distance apart.

## Applying clear polyethylene mulch

Obtain clear polyethylene, 3 feet wide. The plastic of 2-mil thickness produces the best results and is readily available from suppliers of building material.

In preparation for transplanting, put down the polyethylene a week or more before you expect to move the young plants into the garden. The soil will then be warm and the plants will go into a favorable environment. Seed can be sown through slits in the plastic but it is easier to plant the seed first and then cover the soil with plastic.

In preparation for laying the plastic, make furrows 2 inches deep all around the area to be mulched. To accommodate the 3-foot width of the polyethylene dig the furrows 2 feet 8 inches apart.

On a windless day lay out the plastic with its edges in the furrow. Cover the edges with soil and tramp the soil firmly. If the edges are not completely buried, the wind will get under the plastic and blow it away. Put a 3- or 4-pound rock every 3 or 4 feet along the center of the mulch, but not on top of a vegetable row. The sooner the mulch is laid after seeding, the greater the benefit.

As soon as the seeds germinate, cut slits in the plastic to let the young plants grow through. For plants growing close together, make the cut 8 inches long and leave 2 inches between cuts (Figure 9, *top*). For plants spaced far apart make two intersecting cuts 5 inches long, in the shape of a plus sign (Figure 9, *bottom*). If the plants are left under the mulch in the bright sun they will be burned and will probably die.

## CARING FOR THE GARDEN

In unplanted areas and between rows keep the soil cultivated at all times. Cultivation helps to warm up the soil, reduce water loss, and kill weeds. Cultivate only ½ inch deep and close to the plants, but avoid injuring the roots. Remove weeds whenever they appear.

Watch for insect damage on the plants. If not controlled, insects can do a lot of harm in a short time. Most insects can be controlled with chemicals. Consult your agricultural representative or provincial authorities for recommendations. All insecticides must be used as soon as the insects or their damage are noticed.

As soon as the crop is harvested, spread refuse such as green leaves and grass evenly over the garden. Apply 2½ pounds of 16-20-0, 5 pounds of 45-0-0, and 2 pounds of 0-0-60 fertilizer to every 1000 square feet of garden. Plow or dig the garden site, being sure to bury the refuse. Leave the surface as rough as possible.

Organic matter in the topsoil gradually decomposes and after about 3 years more topsoil must be added. If a little topsoil is added every year it will make the task much easier. Either haul in new topsoil or remove the topsoil from the border strip around the garden. Replace the soil taken from the border strip with the moss removed when the garden was cleared. In this way a supply of decomposed organic matter will be available for many years.

Collect soil, flats, and other containers so that you will be prepared for the following year.

## KINDS AND VARIETIES OF VEGETABLES

In the following section, vegetables are grouped according to ease of growing. The first group contains those that are easiest to grow and the last group those that

are hardest. If you have difficulty in growing plants in any group, try growing them by the method used for the next, more difficult group. For example, if you find lettuce hard to grow from direct seeding in a greenhouse, you should plant it in a cold frame.

- Plant seed of the following vegetables in the garden.

<i>Kind</i>	<i>Varieties</i>
leaf lettuce	Black Simpson
radish	Comet, French Breakfast or Cherrybelle
beet	Ruby Queen
chard	Lucullus
summer turnip	Purple Top Milan

- Plant in cold frames to produce these crops early and to provide the necessary long growing season.

<i>Kind</i>	<i>Varieties</i>
All plants in the preceding group	
carrot	Scarlet Nantes Coreless
rutabaga	Laurentian or Victory Neckless (can also be transplanted to garden)
parsley	
chervil	

- For the following vegetables, plant the seed in the house or greenhouse, harden in cold frames, and transplant to the garden.

<i>Kind</i>	<i>Varieties</i>
cabbage	Copenhagen Market Early or Viking Extra Early
cauliflower	Super Snowball or Early Snowball
kale	Green Curled Scotch
broccoli	Italian Sprouting
head lettuce	New York 515 or Imperial 456

- Sow seed of these vegetables on ridges or terraces and cover the seed with clear polyethylene mulch.

<i>Kind</i>	<i>Varieties</i>
rutabaga	Laurentian or Victory Neckless
carrot	Scarlet Nantes Coreless or Chantenay
pea	Little Marvel or Alaska
potato (sprouted)	Warba

- Perennial vegetables.

Chives, perennial onions, and rhubarb are usually grown from plants obtained from a nursery and require no special culture.

## THE ORNAMENTAL GARDEN

The following ornamentals can be grown, and will greatly improve the appearance of the home.

### Annuals

These varieties are preferred for northern areas.

	<i>Kind</i>	<i>Varieties</i>
Direct seeding	alyssum California poppy baby's-breath	Carpet of Snow and Rosie Double Mission Bells Copenhagen Market
Transplants	marigold  dianthus African daisy annual stocks single petunias	Pacific Beauty, Petite and Choice Double Double Gaiety

Grow transplants in the same way as you treat vegetable transplants.

### Perennials

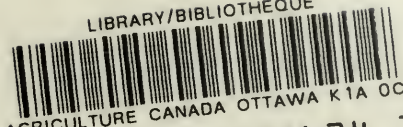
The perennial ornamentals that have grown best are: delphinium, native lupine, arabis, penstemon, yarrow, baby's-breath, nemesia, anemone, and flax. For lawns use a mixture of 2 pounds of Kentucky blue grass and 2 pounds of creeping red fescue to 1000 square feet.

### Trees and shrubs

Native trees and shrubs, including birch, American cranberry, willow, potentilla, and several others should be used in preference to imported trees and shrubs.



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