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Container Gardening

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Aménagement en jardin des toits et des balcons.

PREFACE

This publication has been prepared by and for urban gardeners. It is based on 2 years of work on rooftop gardens which was part of a federally funded demonstration project supported by the Department of Supply and Services. Many people were involved in the work, much of which took place at the University Settlement Community Centre in the St. Louis district of downtown Montreal. The Project was organized by the School of Architecture and the Brace Institute of McGill University, Montreal, with the support of the federal government. We would like to thank all concerned for their cooperation and patience.

Most city dwellers are entirely removed from food production. Gardening enables them to attain a degree of self-sufficiency as well as an improvement in the quality of their food, since homegrown vegetables can be harvested at the peak of their ripeness, flavor and nutritional value. Urban gardeners also have the joy and satisfaction of nurturing something green and growing in an otherwise relatively barren environment.

Few cities offer the gardener available land at ground level; on the other hand, there are countless unused rooftops and balconies, sunny and quiet, and often several degrees warmer than the streets below. The person who wants to garden in these areas must bring soil, water and seed to his rooftop or balcony and learn the special techniques of container gardening.

The publication has been edited and published by Agriculture Canada, to help container gardeners across Canada benefit from the experience of the group involved in the original Rooftops Project.

Adapted from a manuscript prepared by: Ron Alward, Sue Alward, Sven Kikals, Miriam Klein, Witold Rybczynski, Miranda Smith and Winnie Tovey of the Rooftops Project of McGill University, Montreal.

All measurements are given in metric units. Where no symbol appears following a dimension, the measure is in millimetres.

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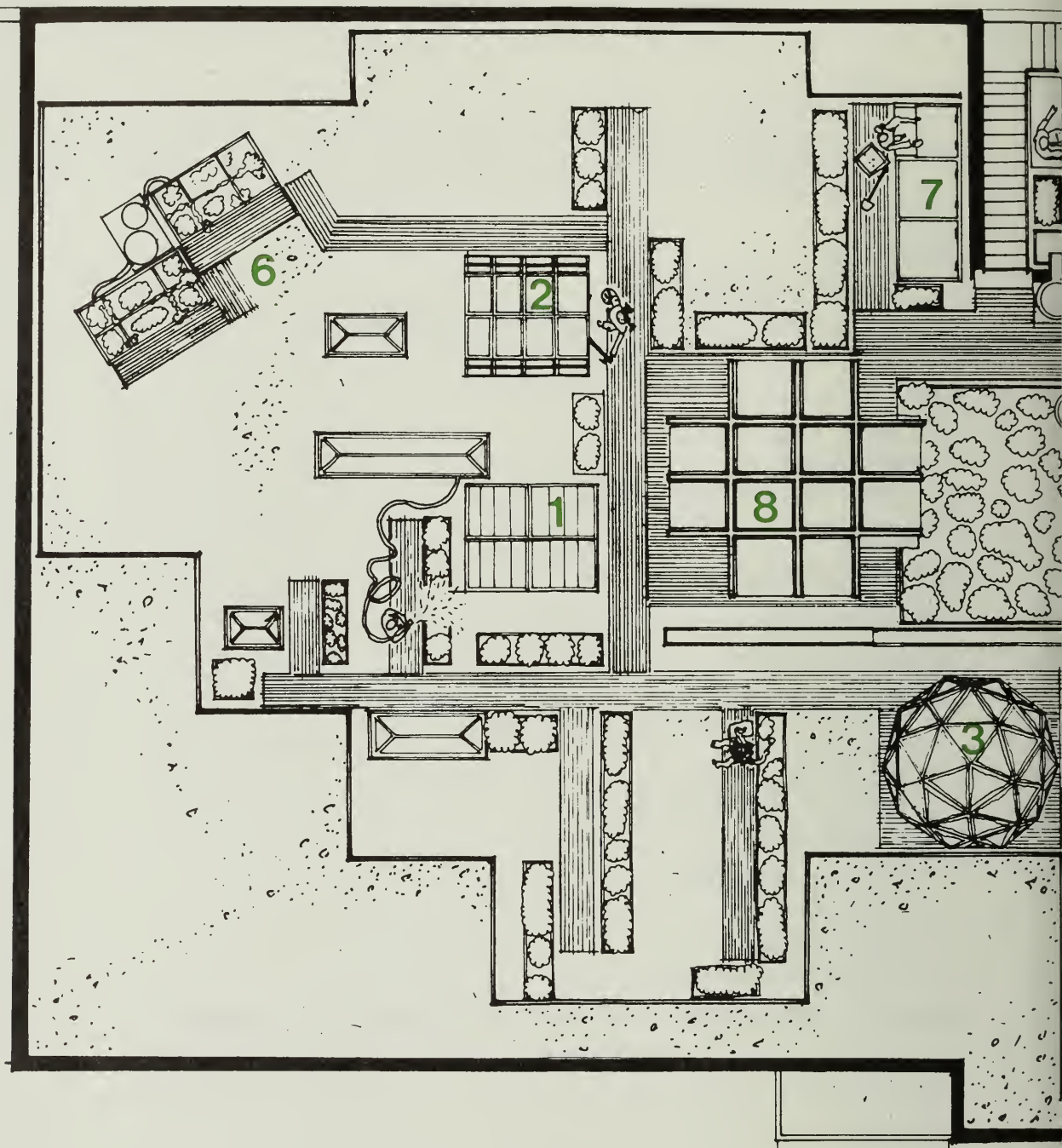
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Rooftop garden project, Montreal.

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WHERE AND HOW TO BEGIN

Access

Ease of access is of prime consideration in choosing a garden site. An apartment balcony need not present problems; a rooftop can, especially if you have to use a ladder to get to it. Remember that you may have to carry up lumber, containers, soil, fertilizers and water, and that's not easy on a ladder. Ideally, a garden site should have a tap for water, or access to a tap, and an electrical outlet for using power tools and a lamp.

Weight

The size of your garden is limited not only by the area of the rooftop or balcony, but by its strength as well. A usable site must be strong enough to support the weight of the gardeners and the filled containers. Problems of weight and its distribution are important in container construction (page 17) and also may influence decisions on other aspects of gardening, such as choosing a soil mix (page 16) and experimenting with hydroponics (page 15).

Scale

Generally, it's best to start fairly small, in both size of garden and initial investment. For the first year, plan to have your garden large enough to be absorbing, but small enough to be learned from and improved on next year. Try to choose a site that can be expanded to uses beyond your present ambitions; gardens have a way of growing from year to year.

Expense

Initial outlay for materials varies widely. Almost any container you can drill a hole in is suitable for plants. All sorts of discarded items—for example, wooden boxes, bushel baskets, garbage containers, children's sand pails and wading pools—make good planter boxes, so long as they are deep enough; however, items such as coldframes and greenhouses have to be bought or built. What you buy and how much you spend depend on your interests, pocketbook and life-style. Building instructions for everything from container boxes to hydroponics units are included in this publication (page 17).

Community

The larger the group of gardeners is, the smaller and more effective the individual expenditure of labor and money. Suggestions on how to find and organize a community of gardeners are given on page 27.

PREPARATION

Containers

For the basic requirements of container boxes, see page 17.

To absorb excess moisture and keep soil from leaching out of containers, mix equal parts of vermiculite and peat moss and put a layer about 2.5 cm thick in the bottom. If desired, instead of this mixture you can use a layer of 5 cm fiberglass insulation (available at hardware stores), but this increases the cost. The use of gravel is not recommended, as it adds a great deal of weight.

Soil

One advantage of container gardening is that you can control the composition of your soil. A fairly light soil mixture is necessary to reduce weight and facilitate drainage.

For inexperienced gardeners, Agriculture Canada recommends the prepared soil mixes (e.g., Redi-Earth, Pro-Mix or Horticulture Mix) as they are easy to use. If you prefer to make your own soil mixture, however, use soil for one-third or less of the bulk, with the remainder made up of peat moss, vermiculite and sand.

PLANTING

The size and depth of your containers will probably vary greatly, especially if you decide to use whatever boxes, barrels and buckets you can find. This can be an advantage, since vegetables have different space requirements; for example, *lettuce* can grow in a 15 cm soil layer, but *zucchini* prefers 90 cm. For purposes of explanation, let us assume that an average planter box measures 400 × 600 × 300 mm deep.

Most new gardeners seed too heavily, both on the ground and in containers. However, it is possible to plant fairly intensively in containers, as the extra water and fertilizer applied compensate for what would be crowding on the ground. In seeding, a compromise between the seasoned gardener's restraint and a beginner's total abandon is ideal.

Seeding Vegetables

Seed vegetables such as *lettuce, beets, swiss chard* and *parsnips* at 5 cm intervals and thin them out later, when the plants can be eaten. You can plant *carrot* and *spinach* seeds closer, at 2.5 cm intervals.

Some plants, for example, *broccoli* and *zucchini,* grow best alone in a box. However, you can plant *tomatoes* and *eggplants* two to a box, and *peppers* a bit more intensively.

In a standard box, 400 × 600 × 300 mm, plant three rows of *peas* at 7.5 cm intervals. *Bush beans* are better seeded at 7.5 cm intervals in two rows. Place *cucumber* seeds 15 cm apart in two rows, but be

sure they are well staked and the soil is deep enough. Plant *cabbages* just three to a box, in zig-zag design, so that the finished heads do not touch.

When devoting a box to a crop that does well in beds (carrots or lettuce), it is better to broadcast the seed than to plant it in rows.

During a wet, cold spring it is wise to cover your seeds with peat moss when planting, as this helps to prevent damping-off. Be judicious in using peat moss, however, as too much can interfere with normal moisture absorption patterns of the soil and root rot may develop.

Companion Planting and Intercropping

Companion planting and intercropping in containers are tricky—much like close friends trying to share a one-room apartment. One partner ends up dominant and it is hard to predict with accuracy which will assume control. A general rule of thumb is to forego any temptation to grow two plants in the same box unless you are reasonably sure of the qualities of both plants.

Marigolds are almost certain to claim more than their fair share of space. They thrive in almost any situation and take over boxes with amazing alacrity. The only successful pairing of marigolds in the Project was with nasturtiums. The box was fertilized very little and was never side-dressed with high-nitrogen fertilizer like other boxes were. This favored the nasturtiums, as they flower most profusely in impoverished soils.

Tomato plants can be companioned with *basil, parsley* or *oregano* seeded into the box. Do not plant basil seedlings as they grow too quickly. Pinch the basil back every so often. Use only the curly leaved parsley as the flat-leaf variety grows too quickly and too large.

Both *peppers* and *eggplants* appear to do best alone in containers; they require too much sun to be mixed with anything tall. However, it is easy to intercrop them with *lettuce* in the spring, seeding the lettuce after the peppers or eggplants have been set out. The lettuce grows quickly and is soon harvested and out of the way of the other plants.

Onions and *garlic* are fairly good companions for almost anything and are ideal as borders along the edges of a box. Be sure to plant them far enough from the main crop to prevent their roots interfering with the other plants.

Use *sage* with members of the cabbage family (*cabbage, broccoli, Brussels sprouts,* etc.) for its repellent properties against cabbage moth and looper. Plant it to the sides of the box because otherwise it will be too shaded.

You can plant *carrots* in alternate rows with *lettuce.* But do not plant them with *peas* in a small space, as the peas shade the carrots too much. In general, carrots are an excellent crop for container gardening,

since the light soil mix is an ideal medium for the plant. Their only disadvantage is that they have a fairly long season.
The most successful intercropped plants in the Project were *radishes* and *lettuce*. Two leafy vegetables of the same general growth pattern also grow well together, for example, *Swiss chard* and *romaine lettuce,* or *chinese cabbage* and *bok choy*. Pay attention to the date of maturity and try to plant one vegetable that will be harvested before the other.

Successful Plants and Varieties

Some vegetables are more practical in containers than others and certain varieties lend themselves more easily to restricted space. Find out the most disease- and insect-resistant varieties common to your area and from them select those having the best size and heat resistance.

Climbers should climb; it really does save space. Some vegetables, such as *cucumbers,* give higher yields when forced to climb, and it is simple to give them the space they need when it is vertical.

Any plant that produces just one small crop and a lot of inedible foliage is a luxury in a box. *Cauliflower* is an example of this. *Broccoli* and *Brussels sprouts* are more practical plants to use.

BEANS — Both pole beans and bush beans have been successful. Bush beans have a short season and can be intercropped with something small and fast, such as radishes or lettuce, while they are growing. The box can also be reused for a second planting after the beans are finished.

CABBAGE — Baby-head cabbage is ideal because it comes to head more quickly than other types and is more compact. Jersey Wakefield is a good cabbage but takes a prodigious amount of space. Though red cabbage is beautiful, it is not a good container plant because it is too large and is slow to head.

CARROTS — Some midget vegetables, such as baby-finger carrots, are hardly worth the effort. An ordinary 20 cm carrot can grow in a box 20 cm deep. If it reaches the bottom, as some do, it can and will bend along the bottom. Children love it!

CUCUMBER — Victory, a self-pollinating variety of cucumbers, gives an excellent yield. However, if it is exposed to open pollination from other kinds of cucumbers, Victory may become distorted.

LETTUCE — Buttercrunch lettuce was found to be the best variety in the Project's roof garden and its taste is superlative.

PEAS — Peas give a high yield, especially the Little Sweetie Edible Podded variety. It is a saving not to throw away the pod and this variety has some resistance to heat. If using a conventional pea, choose a heat-resistant one, such as Wando.

SPINACH AND OTHER LEAFY VEGETABLES — Spinach as a spring crop was not successful in the Project's container garden because of the heat, but the fall crop was good. Bok choy behaves the same as spinach and is suggested as a fall crop. New Zealand spinach does admirably on a roof, as does Swiss chard.

TOMATOES — Cherry tomatoes are definitely a good investment. The plants are so prolific and the requirements for space so small that they are ideal for container gardens. The intermediate sizes, such as Starfire, are also good choices, but try to stay away from the Big Boy family.

ZUCCHINI — Gardeners have wondered for many years how to subdue a zucchini. There is a way—put it in a box. Planted one to a box, zucchini gives you a reasonable yield, but will not overwhelm you.

CARE

To grow strong, healthy plants capable of withstanding attacks by pests and diseases, you need a nutritious soil, adequate moisture and plenty of tender loving care. This applies even more to plants grown in containers than to those grown in the ground.

More water and fertilizers have to be added to plants confined in containers than to garden-grown plants, whose roots are free to spread out and take up what they need from the soil. The limited volume of soil in a container dries out very quickly at rooftop or balcony level, where it is often several degrees warmer and sometimes windier than on the ground. As well, water is lost through drainage from the container and nutrients leach out of the soil along with the water. It is also important to realize that, as annuals, most vegetables grow far more quickly than houseplants and this increases their water and nutrient requirements.

Watering

Watering must be done constantly or boxes soon become bone-dry. This is disastrous to the plants, as the roots cannot depend on any subsoil moisture. To encourage good strong root growth in gardens in the ground, you never water a plant until it needs it. However, this doesn't work for container-grown plants, where the *soil must be moist.* Gardeners are also taught never to water in full sunlight, but in a rooftop or balcony garden watering must be done whenever it is needed.

Fertilizing

In general, apply fertilizer about every 3 weeks. Proprietary brands of soluble plant foods (e.g., RX15, 20-20-20 and Rapid-Grow) are probably simplest to use. Follow manufacturers' instructions carefully to avoid injuring plants.

Fertilizer teas are also useful in containers. To make one, suspend a cheesecloth bag filled with compost or milorganite inside a pail of

water; let it sit overnight and then use the liquid, or tea, for fertilizing container plants. The compost or milorganite left in the pail may be used as side dressing for needy plants.

Staking and Stringing

Staking and stringing can greatly increase yields, especially of plants such as cucumbers. Stringing the plants upward gives them maximum exposure to the sun and prevents the vegetables from touching the ground or box.

The best method of staking is to nail a stick to the side of the box, where it can be attached securely without interfering with root growth. For climbing beans, nail a pole to each corner and tie string around and between the poles so that plants can move laterally as well as vertically. When planting vines against a wall, attach a board to the wall and string down from nails on the board, tying the ends of the string to nails at the edges of the box.

COMPOST

Compost is a mixture of decomposed organic materials that is added to soil as a natural balanced fertilizer. It is composed of waste materials such as garden refuse, leaves and household garbage, which are converted by bacteria into rich homogeneous humus. Compost provides nitrogen and other nutrients necessary for plant growth. Its porosity helps hold water and minerals in the soil and its loose, crumbly texture allows air to reach plant roots.

Compost can be made in loose heaps, but container gardeners will find it easier to use a compost box or commercial compost bin. Make sure that compost containers are leakproof and covered tightly to keep out the rain. Figure 1 shows the proper proportions of composting ingredients.

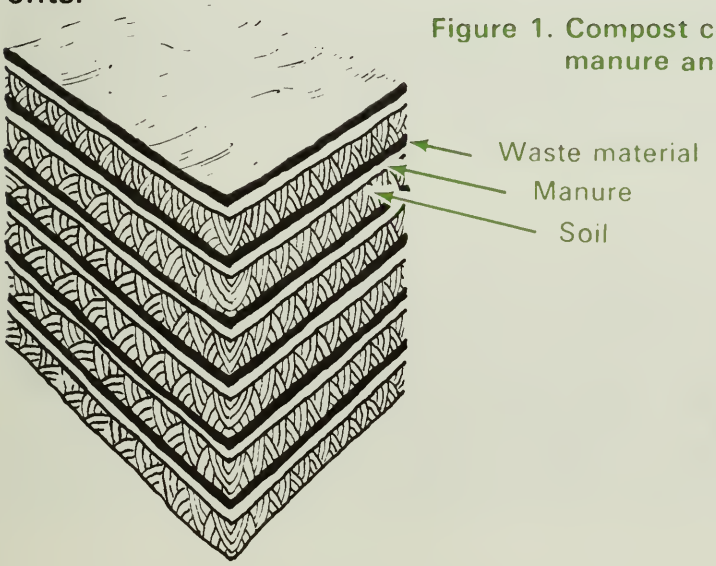


Figure 1. Compost consists of waste materials, manure and soil in proportions of 6:2:1.

Waste materials include most plant wastes or products, for example, weeds (so long as seeds have not matured), kitchen garbage (except meat and citrus fruits), leaves, corn husks, hay, straw, grass clippings, sawdust and coffee grounds. Chop or shred these materials as fine as possible, to expose a larger surface area to biochemical activity and to help aerate the heap.

Manure hastens the rotting process of compost. Also, the addition of about 1.80 kg of garden fertilizer and 0.45 kg of limestone per 45 kg of waste materials is helpful. Bone meal, blood meal, fish emulsion or milorganite can be used instead of manure, with rock phosphate, granite dust or limestone added to hasten bacterial action.

The soil layer in the compost heap provides organisms of decomposition and also helps trap nitrogen, which otherwise tends in part to be released as ammonia and other gases. This nitrogen, in various chemical compounds, is vitally necessary to plant growth.

It's important to keep the compost moist—about as moist as a well-wrung sponge. If rain is a problem, cover the heap with a tarpaulin. If there is not enough rain, make a depression at the top of the heap where water can gather.

Good air circulation is essential, to provide oxygen for the organisms of decomposition. To aerate the heap, turn it periodically as a gardener turns his soil, by stirring, lifting and turning it over with a spade. The interior of a compost pile heats up to perhaps 65-70°C, but the edges are cooler. As the heap is turned, material from the edges is tipped into the center, until finally all the compost has been exposed to these high temperatures, killing weed seeds, fly larvae, parasitic pests and pathogenic bacteria.

Compost is ready to use when it cools down, stops throwing off gases (the distinctive smell of ammonia disappears) and is crumbly, dark and sweet smelling.

Use finished compost liberally. Mix it into soil, use it for side- and top-dressing, or make fertilizer tea with it. Concentrate applications when plants are in flower, since this is their period of greatest output and, therefore, the time of greatest need.

GREENHOUSES

A greenhouse is a valuable addition to a rooftop or balcony garden, particularly where the growing season is short, as in Eastern Canada. An unheated greenhouse can prolong the season by at least a month at each end, paying for itself within a few years. A heated greenhouse is even better, since it is then possible to start plants for setting out later in the season and you can also have plants growing in it during the winter.

Although unheated greenhouses are not practical for starting early plants, (e.g., tomatoes, peppers and eggplants), they are useful for getting a jump on the season with cold-weather crops, such as lettuce, herbs and members of the cabbage family. They also can be used in the hardening-off process for hot-weather plants, that is, gradually introducing them to colder temperatures.

COLDFRAMES

For small gardens, coldframes are in many ways more practical than greenhouses, especially in Canada. They are much easier to manage and they can serve double duty—a covered protected area at the beginning and end of the season, and an open growing box the rest of the time. Plants tend to grow better in larger spaces.

The coldframe sizes used in the Project, 3600 × 1800 mm or 2400 × 1200 mm, were large enough to use methods such as companion planting to advantage since there was less competition for space than in a small box. The design was based on the Brace Research Institute's solar greenhouse, so that the coldframes had warm soil early in the spring and late in the fall without the ventilation problems of a conventional greenhouse. The white-painted reflective north wall also prevented early plants from being leggy by providing maximum sun exposure. Instructions are given on page 20.

HYDROPONICS

Hydroponics is a method of growing plants in a soilless medium by flushing soluble nutrients through the medium. The Project's gardeners became interested in hydroponics because of the rooftop location, where the weight of materials was of prime consideration. Soil can weigh from about 95 to 150 kg/m^3, depending on its texture and moisture content. With hydroponics, on the other hand, you can use an extremely lightweight growth medium (e. g., half perlite and half vermiculite, with a little sand added.)

Instructions for building hydroponics units begin on page 26.

STARTING YOUR OWN PLANTS

Starting your own plants is one of the most gratifying experiences of any sort of gardening, and it is an easy process. If you do not have a heated greenhouse, use a bright south window or put the flats on a table or bench under artificial lights.

Medium

The first step is to select a starting medium. There are several to choose from: a soilless mixture (e.g., Redi-Earth or Pro-Mix); a light sterilized soil; or an unsterilized soil covered with a layer of damp peat moss. Each has advantages and disadvantages.

Molds, mildews and damping-off are no problem with a soilless medium. However, this medium has no nutritive value and will not sustain seedlings beyond the time that the second leaves appear. At that time, there are two alternatives: you can prick out (thin out) the seedlings and transplant them into a light soil mix; or you can feed them for a few days with a soluble nutrient solution before pricking out, if for some reason you cannot transplant immediately.

Conversely, a good soil medium has nutritive value, but molds, mildews and damping off can be a problem. Sterilizing the soil greatly reduces the risk of disease, but it too has a disadvantage. One of the things you are doing when starting plants is selecting for vigor; you don't want to lose your whole crop, but it is actually beneficial to lose a few plants. This selection cannot take place effectively in sterile soil.

For these reasons, many gardeners prefer the third medium—an unsterilized, lightweight, moist soil mix, placed in flats or pots and covered with a moist layer of peat moss. Peat moss has a mild antibiotic action and reduces, without eliminating, the seedlings' susceptibility to disease.

Seeding

It is important not to overseed. Seedlings that are too close together are subject to damping-off, because of increased humidity, and they are also harder to prick out. Try to plant seeds one by one so that they are not touching each other.

After planting, spray the surface of the container gently to avoid dislodging the seeds and cover with plastic wrap. Check daily for signs of dryness, germination and damping off. Damping off is easy to spot; a white fuzz (not the root hairs) begins to appear around emerging seedlings. If this happens, remove the plastic immediately. Otherwise, leave the plastic on until seeds have germinated. In a bone-dry environment, erect a plastic tent around the flat to retain some of the moisture.

Prick out the seedlings when the second leaves appear. Handle the plants by the first leaves, not the stems which are easily injured. Using a new, deeper flat with more root space, transplant the seedlings into a lightweight soil mix. Place them about 7.5 cm apart, to facilitate setting out later.

Using Artificial Lights

Lights are a sensible investment if you do not have a heated greenhouse. The cost is small and there are only a few factors to control.

Pests and fungi are not great problems in most homes as it is not humid enough for them. Usually you have to increase the humidity as much as possible, either by tenting the seedlings with plastic or by spraying them often.

A standard artificial lighting setup is all you need. Usually two 40-watt, 120 cm Grolight bulbs (there are many brand names on the market) are used over an area no greater than 60 cm wide. Some means of adjusting the height of the fixture (e.g., chains) or of the plants (e.g., boards or bricks) is necessary, because most failures under lights are caused by low light intensity. Locating the flats 5-7.5 cm below the tubes produces seedlings that will develop into plants with strong stems and be much easier to transplant.

Growing plants under artificial lights opens up a whole new world of gardening. Besides starting your outdoor plants, you can grow salad greens all year round with very little care. You can also start ornamentals and give them the photoperiod they require to bloom. Lights are great fun!

HOW TO BUILD

Container Boxes

Scrounge, buy or build containers at least 20-25 cm deep and note the following before putting soil into them.

HOLES — Containers need to have cracks or holes to let air and excess water pass through. Otherwise, plant roots drown and the plants die. Holes about 10 mm in diameter and 5-7 cm apart are satisfactory. If cracks in boxes are wide enough, don't bother with holes.

RUNNERS OR BRICKS UNDER CONTAINERS — Air and water must be able to pass under containers. Gardeners in the Montreal project nailed pieces of 38 × 38 lumber to the bottoms of boxes, or simply placed wood, bricks or something else suitable under containers to raise them.

WHERE TO PUT CONTAINERS — Generally, boxes filled with soil weigh about 320-440 kg/m^3. However, most roofs and balconies are built to take only 250 kg/m^2. Keep these points in mind:

1. Distribute containers fairly evenly over the strong points of the roof or balcony.
2. The strong points of a roof are the parts near the outer edges, and those above the inside walls and columns. The strongest part of a balcony is right next to the wall.
3. If your garden (surface area of boxes) covers more than a third of the roof, then you'd better have calculations done to assure your-

self of a comfortable safety margin. Besides the weights mentioned above, you need to know:
- the maximum seasonal snowfall;
- the area of your roof;
- the design weight of the roof for snowfall; and
- the structural plans of the building under the roof garden.

WOOD PRESERVATIVES — Apply polyurethane or oil to wooden boxes or use an oil-based paint. Do not use Pentox or creosote, as they are lethal to plants.

Greenhouses

RECYCLED-WINDOW GREENHOUSE — This is made from discarded windows. The window greenhouse (Figure 2) built as part of the rooftop garden project was constructed with 16 greenhouse windows (windows with glass panes overlapping each other from top to bottom, each measuring 900 × 1500 mm), plywood, 38 × 64's, 19 × 38's, 0.2 mm plastic sheeting, a set of hinges for the door, two sets of hinges

Figure 2. Recycled-window greenhouse.

for the two air vents, screening, and a small number of nails and screws.

1. First, a platform 1800 × 2700 mm was built on which to rest the greenhouse. Using spruce 38 × 64's, a frame was constructed and creosoted, since it might sometimes be sitting in water; 15 mm select plywood, was laid on the platform and secured with 40 mm ringed, blued, dry-wall nails. The plywood was painted with two coats of urethane.

2. The two sides and back end of the greenhouse were put together in sections. To construct a side, three window sections were laid down with the inside facing up. They were secured together into a single unit by screwing pine 19 × 38's across the top and bottom. The other side and back end of the greenhouse were done in the same way, except that only two windows were used for the back end.

3. The three sections were then raised on the platform and secured at the corners with 7.5 cm screws. They were also fastened to the platform with 7.5 cm screws.

4. Next, the front was put on. One window was fixed in place at a 90° angle to one of the side walls and also to the platform. Then another window was hinged to the first. This hinged window became the door.

5. The roof section, consisting of three windows on each side, was then attached. Two windows were placed end to end, one on each side and overhanging the side walls. Starting at one end, they were propped against each other and secured at the joint and base with 7.5 cm screws. This operation was repeated two more times to complete the roof.

   From the inside, the roof windows on each side at the top and bottom were connected in the same way as the side windows (step 2) with 19 × 38 stripping. Cracks between roof sections were caulked.

6. The triangular openings above the two end walls were covered with plastic sheeting mounted on wood frames in two sections. The upper triangular section of each end was hinged to serve as a ventilation port. The lower part was framed, covered with plastic and permanently fixed in place.

7. Finally, with the hinged vent ports at the top of the gable section opened at each end, screening (to keep out bugs) was stapled over the openings in a way not to hinder closing the ports. When the plastic-covered vents are closed, heat tends to be retained inside the greenhouse and when they are open the greenhouse is ventilated.

Coldframes

A simple coldframe can be made from a discarded storm window and four boards. Be sure to have enough depth inside the coldframe—a minimum is 30-37.5 cm at the back, tapered to 15-22.5 cm at the front.

SMALL, COLLAPSIBLE COLDFRAME — This unit can be used on a rooftop or balcony with a base or at ground level without a base.

1. Cut a 1200 × 2400 mm sheet of 12 mm exterior plywood into two 1200 × 1200 mm pieces; one piece forms the base (optional), the other is cut as shown in Figure 3 to form the sides. Install hinges to the base and sides at the locations shown in Figure 3. Seal these panels against moisture with a good polyurethane varnish. Drill 20 mm holes at 200 mm centers in the base for drainage.
2. For the cover, build a frame from 38 × 64 lumber and steel corner brackets, sized to sit on top of the sides. After painting the frame with polyurethane varnish, wrap polyethylene sheeting over the top and secure it beneath with heavy staples.
3. The finished coldframe, its cover hinged at the back with removable door hinges, can be propped open with a wood block for ventilation. Spring-lock hooks and eyes in front hold the cover securely in windy weather. Units with a base should be placed on runners to allow for ventilation and drainage.

MEDIUM-SIZED, INSULATED COLDFRAME — This coldframe (Figure 4) is essentially an insulated soil container measuring 2400 × 1200 × 400 mm deep. The insulated roofing and window section allows a large amount of sunlight to enter, yet keeps interior heat from escaping at night or during cloudy weather.

Align the coldframe so that its transparent cover faces south. Paint the inside of the sloping north roof section white, so that any sunlight striking it is reflected down onto the plants and soil. This gives more sunlight to the plants, especially from the north side, so that they are not always leaning to the south in search of sun.

To tend or water the plants, lift up the coldframe's hinged front transparent covers; but do this only during warm days and sunny hours, to avoid loss of interior heat. To let air in, prop the covers open.

1. For the base, frame a 1200 × 2400 mm sheet of 10 mm plywood at the edges with pine 38 × 38's using ringed nails. Trim two edges of a 1200 × 2400 mm sheet of 38 mm polystyrene insulation to fit inside the pine frame. Insert in the frame and cover with another sheet of plywood. This gives you an insulated platform.
2. For the side panels, you need four pieces of plywood 2400 × 400 and four pieces 1200 × 400. To make the longer panels, frame two of the long pieces with 38 × 38's, as in step 1, and attach an extra piece of 38 × 38 at the halfway mark for added support. Again, trim polystyrene panels to fit and cover with another sheet of plywood.

Figure 3. Small collapsible coldframe.

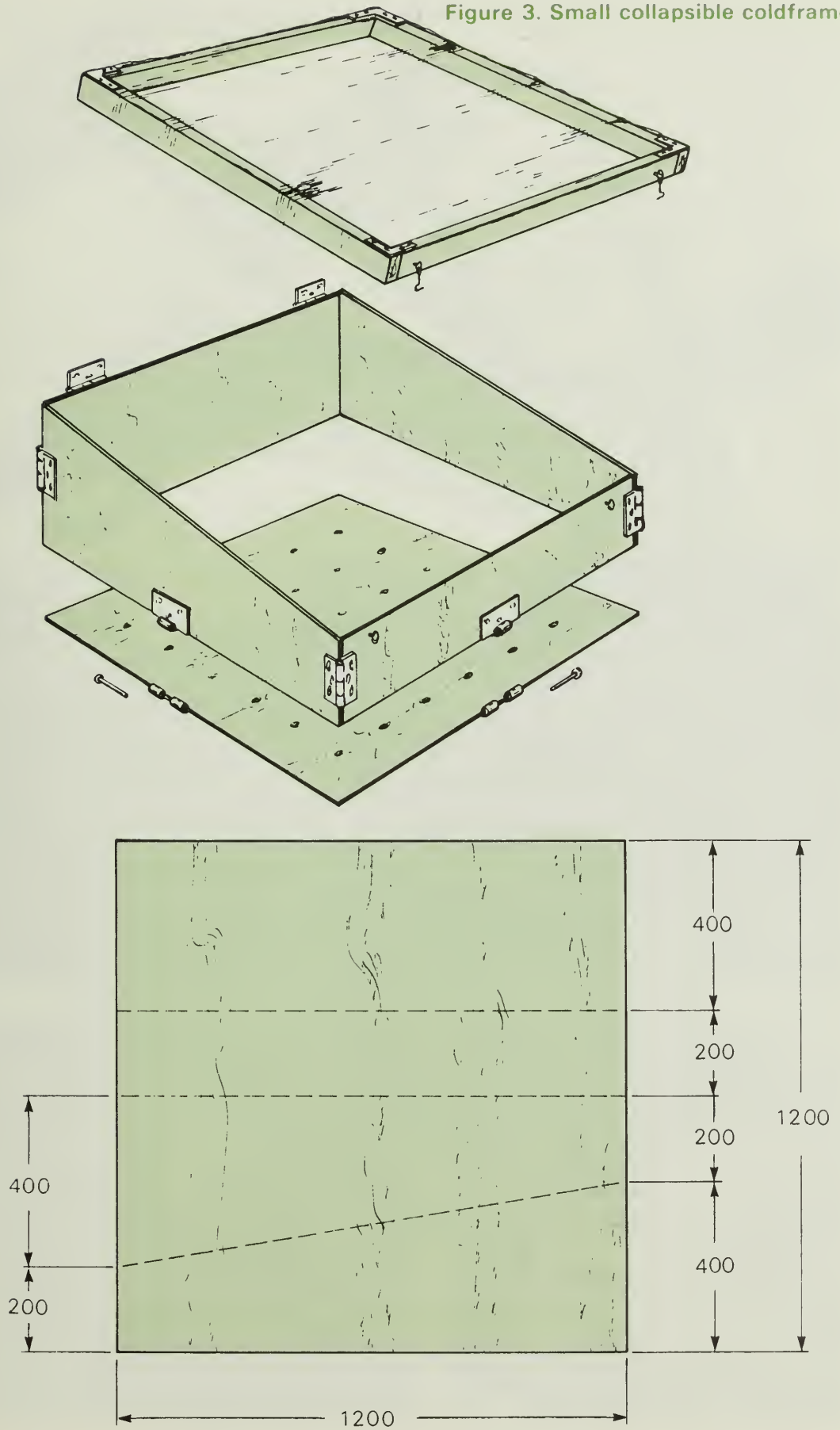
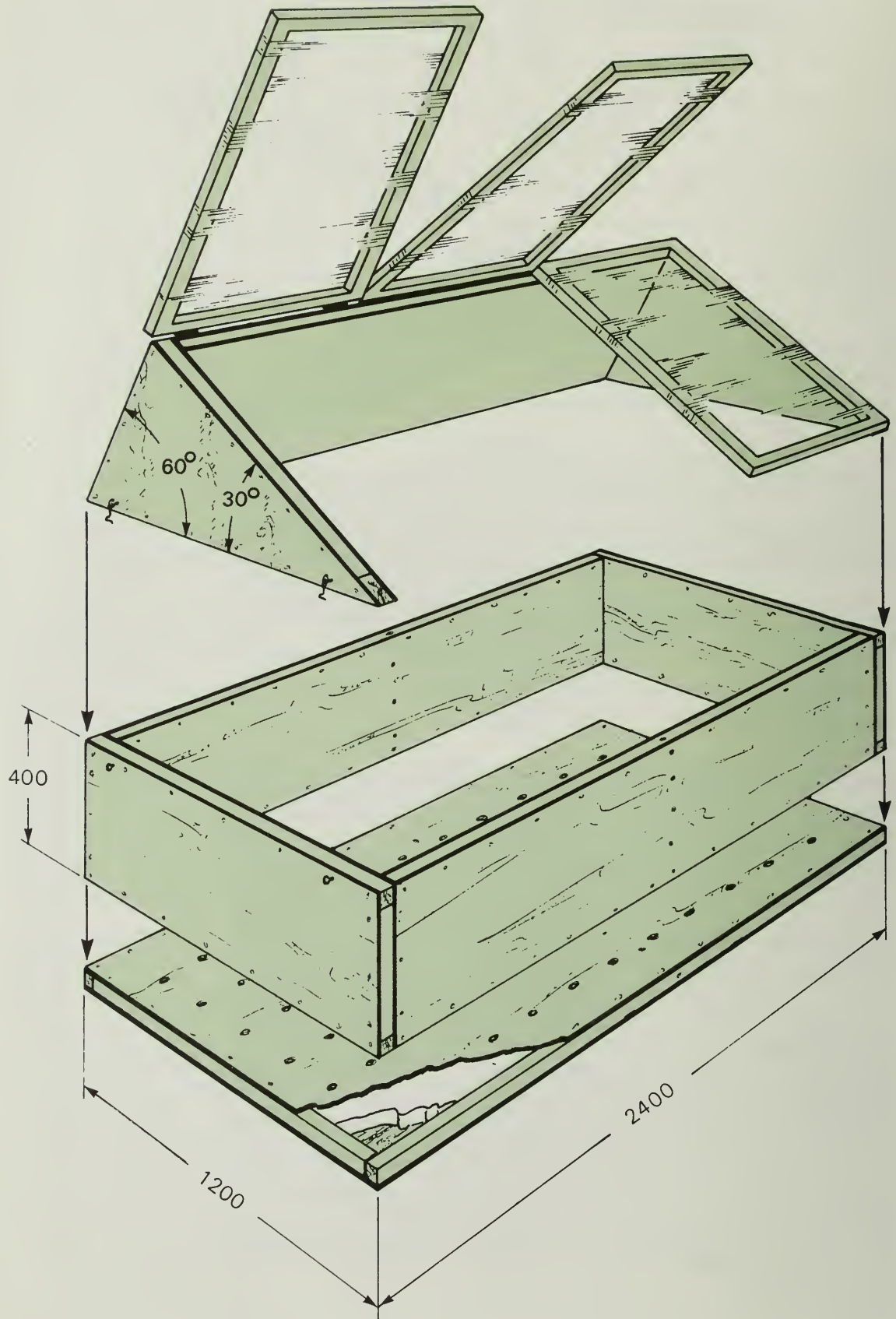
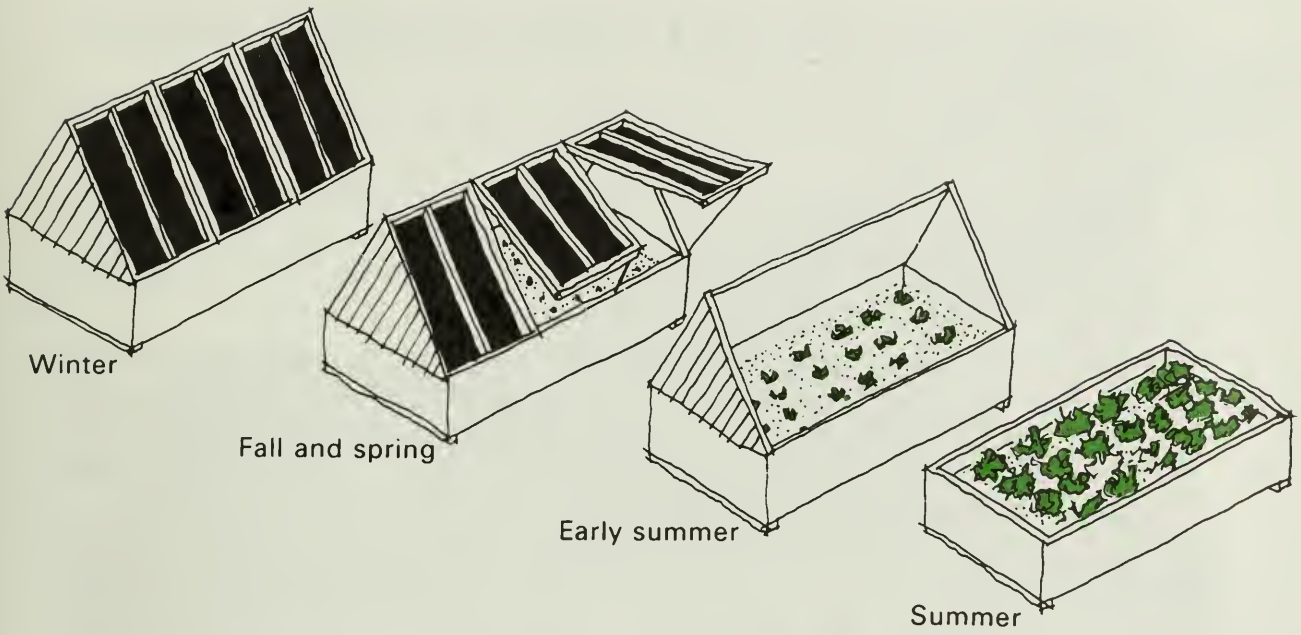


Figure 4. Medium-sized insulated coldframe.




Winter
Fall and spring
Early summer
Summer

Make the shorter end panels the same way and join to the side panels as shown in Figure 4.

3. Build the top side panels in the same manner as the panels in step 2.
4. Using 38 × 38's, build three window frames 67.5 cm wide, with length according to top angle. Lay them along the front (lower angled section) and hinge them to the back panel. Cover with plastic (two layers are better than one).
5. Paint all panels with polyurethane varnish before assembling. Fasten the wall and base panels together with 100 mm wood screws. Paint the top panels on the interior with a glossy white paint and join them to the wall panels with hook-and-eye door latches, for easy removal in warm weather.
6. For drainage, drill 20 mm holes at 200 mm centers in the base and line the holes with plastic hose. Place the coldframe base on runners to allow for ventilation and drainage.

LARGE INSULATED COLDFRAME— This coldframe (Figure 5) is essentially the same as the medium-sized one just described. However, its exterior dimensions are 3600 × 1800 mm, giving it just over twice as much growing space as the medium-sized coldframe. Entry into this coldframe is by two north-side doors. Recessed areas big enough to kneel in are left just inside the doors to allow the gardener to close the doors and tend the plants completely from inside. Ventilation is accomplished by opening the doors or propping open the transparent covers. Drill 20 mm holes at 200 mm centers in the base for drainage and line these holes with plastic hose.

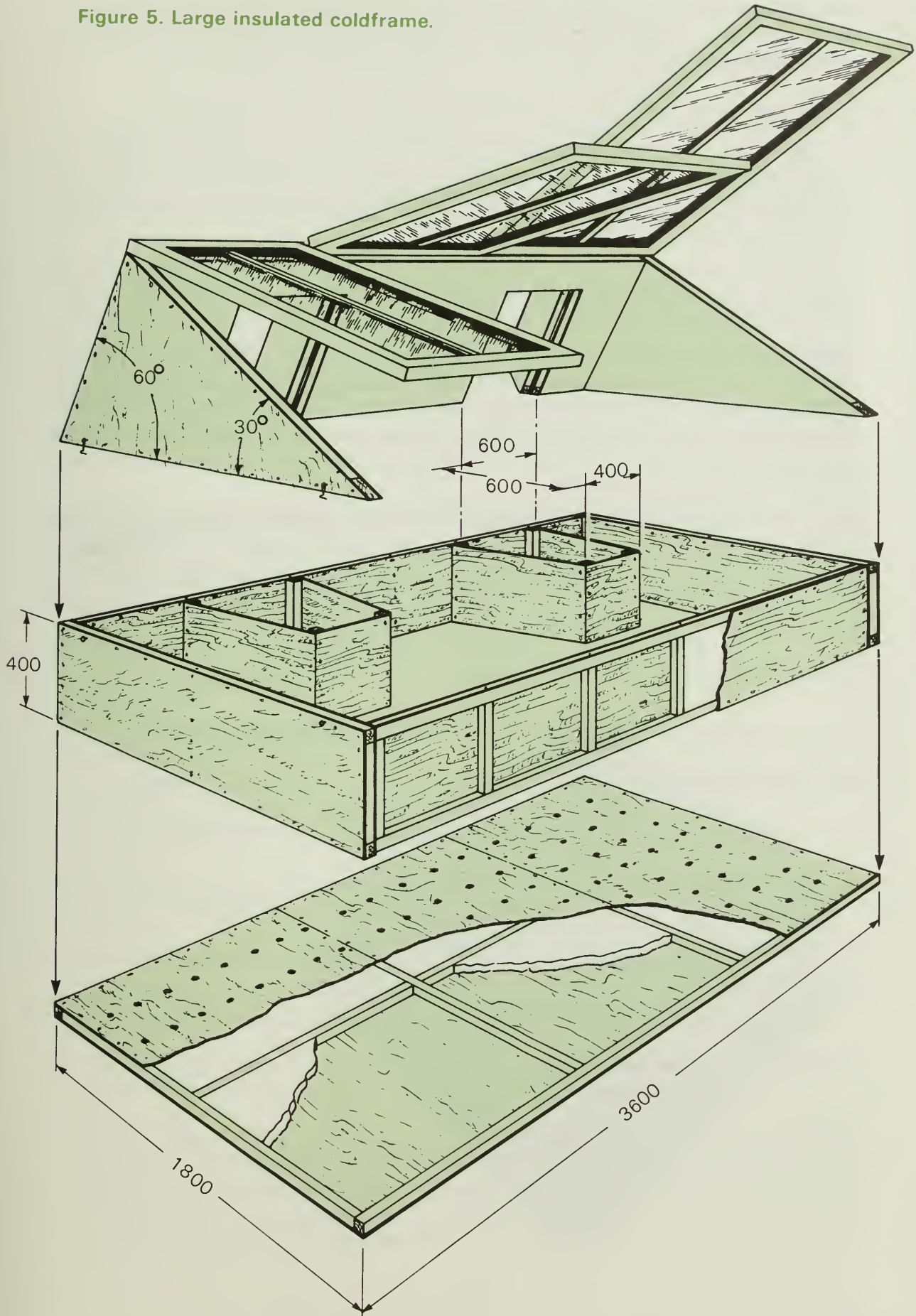
HOTBEDS (HEATED COLDFRAMES)— The simplest way of heating the interior of a coldframe is to run some underground electrical heating cable through the soil. This keeps the root area warm and, since heat has a natural tendency to rise, the airspace above the soil is also heated.

Another method is to bury copper pipe in the soil to carry hot water from any convenient source. However, this system can freeze unless it is running all the time during cold weather. Piping exposed to the outside should be well insulated.

Both the electrical heating cable and the hot water pipe should be buried below root level.

Another system tried by the Project's gardeners used waste heat from a chimney for heating hotbeds. An air-to-liquid heat exchanger was installed in the chimney, near the bottom. Antifreeze was circulated through this heat exchanger and then, via an insulated closed pipe system, through heat exchangers in the soil and air in several hotbeds. Heat picked up by the antifreeze solution as it passed through the chimney heat exchanger was given up inside the hotbed by two finned

Figure 5. Large insulated coldframe.



air-heat exchangers and a pipe coil passing through the soil. This system was quite effective, but it is probably too costly for families and small groups to use.

Hydroponics Unit

HOME UNIT — The hydroponics growing unit (Figure 6) consists of a watertight box, with drainage holes along the sides and front, and tilted towards the front (use a strip of wood not more than 18 mm thick along the bottom back of box for tilt).

Select four pieces of 38 × 286 planking, cut to the size wanted. Drill 12 mm holes in three of the pieces, two holes in each side piece and three holes along the front piece, as indicated on drawing.

Secure the four pieces of wood planking to a sheet of 18 mm plywood with screws, leaving a plywood border of at least 50 mm along sides and coming to a dull point in front (as shown). The planks secured to the plywood must also be attached with screws to each other at the corners. Apply glue to all joints for added strength, as well as to help produce a watertight seal.

Apply urethane to all visible areas of container, at least three coats, and one coat to the 6 mm round molding. Then tack molding to plywood with finishing nails, leaving a 50 mm gap as indicated. Paint molding and border areas with two more coats of urethane varnish. Apply silicone sealer along all inside joints of the box.

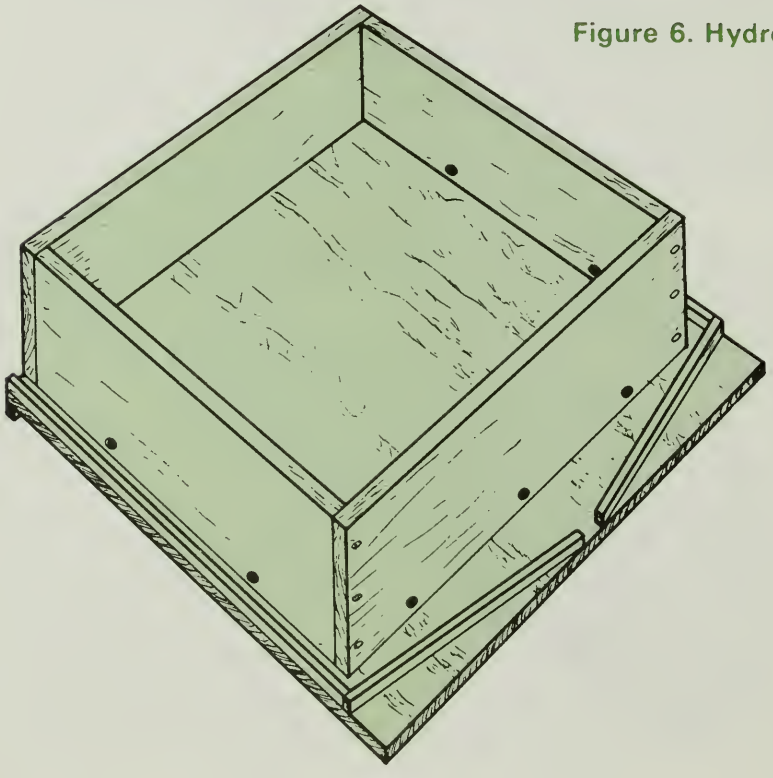


Figure 6. Hydroponics unit.

LARGE UNIT — A larger hydroponics unit, like the one used at the rooftops garden project, can be built similarly to the soil container section of the medium-sized 1200 × 2400 mm coldframe (Figure 4).

Elevate the container about 50 mm at one end and drill four 25 mm drainage holes at the other end. Corks can be used to plug these holes during feeding.

Run three 38 mm PVC pipes, with holes drilled every 25 mm along them, through the medium in the coldframe at a depth of about 38-50 mm. Block these pipes with corks at one end and let the ends on the other side project through the coldframe.

You'll need a large container, such as a garbage can or 180 L drum, to be raised above the level of the coldframe so that the nutrient solution is gravity fed. Drill three holes in the side of the container near the bottom and insert a piece of 25 mm PVC pipe about 90 cm long into each hole; seal around the joints to prevent leakage. To feed plants, insert these pipes into the ones in the growing medium.

HOW TO ORGANIZE A COMMUNITY ROOFTOP GARDEN

1. Find others who are interested (use posters, community radio and community newspapers).
2. Choose a suitable roof. Make sure that:
   - it is strong enough to take the weight of gardeners and garden boxes;
   - you have clear (preferably written) permission to use it;
   - it has easy access;
   - it gets plenty of sun, is not too windy and (preferably) has some shade, as it can get baking hot on a roof; and
   - you can hook up water hoses without too much trouble.
3. Build decking to protect the roof membrane. Decking platforms are easy to make and allow flexibility.
4. Construct some sort of safety rails around the perimeter of the roof.
5. Scrounge or build planter boxes. Make sure they are elevated on runners, bricks or other base, not sitting directly on the roof.
6. Hook up a watering system. For example, connect a hose to the shower in a bathroom and pass it through the skylight onto the roof.
7. Work out a clear marking system to identify the boxes. Project gardeners labeled file cards with laundry pens and inserted them into upside-down plastic bankbook holders stapled onto each box. The cards were prevented from falling out by thumbtacks which could be removed for insertion of new cards.

8. Order earth by the cubic metre from a nursery. It may be cheaper if you buy in quantity.
9. Haul the earth up. Relay style worked well in the Project. Two people shoveled earth into feed bags bought specifically for that purpose; the next two people ran the bags to the stairs; two others carried them up to a fourth group of people, who dumped them and sent the bags back. At first, a winch was used, but it was far simpler to do the job by hand. (Of course, if you decide to garden hydroponically this particular problem is minimal.)
10. Arrange to have some gardening consultants make suggestions about mixing growing mediums, planting, fertilizing, composting and pest control.
11. Obtain basic tools such as a shovel, a pitchfork, scoops and pails. It is useful to have either a toolshed on the roof or in some nearby safe storage space.
12. Build or buy a compost container and work out a schedule of composting.
13. Devise a schedule so that all the requirements of roof maintenance are consistently carried out. This includes watering, harvesting and general plant care, such as picking off yellow leaves or leaves touching the medium and checking for insects.
14. Arrange a weekly meeting so that questions and problems that come up can be looked after in the gardening group.

FOR MORE INFORMATION

Write Agriculture Canada for other free publications on horticulture. The address is:

Communications Branch
Agriculture Canada
Ottawa K1A 0C7

CONVERSION FACTORS

Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	x 0.04	inch
centimetre (cm)	x 0.39	inch
metre (m)	x 3.28	feet
kilometre (km)	x 0.62	mile
AREA		
square centimetre (cm^2)	x 0.15	square inch
square metre (m^2)	x 1.2	square yard
square kilometre (km^2)	x 0.39	square mile
hectare (ha)	x 2.5	acres
VOLUME		
cubic centimetre (cm^3)	x 0.06	cubic inch
cubic metre (m^3)	x 35.31	cubic feet
	x 1.31	cubic yard
CAPACITY		
litre (L)	x 0.035	cubic feet
hectolitre (hL)	x 22	gallons
	x 2,5	bushels
WEIGHT		
gram (g)	x 0.04	oz avdp
kilogram (kg)	x 2.2	lb avdp
tonne (t)	x 1.1	short ton
AGRICULTURAL		
litres per hectare (L/ha)	x 0.089	gallons per acre
	x 0.357	quarts per acre
	x 0.71	pints per acre
millilitres per hectare (mL/ha)	x 0.014	fl. oz per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	lb per acre
grams per hectare (g/ha)	x 0.014	oz avdp per acre
plants per hectare (plants/ha)	x 0.405	plants per acre