BRITISH COLUMBIA | Ministry of Agriculture and Food

Greenhouse Crop Selection and Management

Indigenous Greenhouse Factsheets

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Introduction

Greenhouses are often the economic driver of market farms. Because of the initial investment costs and the revenue generation potential, many farmers choose to focus their greenhouse production on the most profitable crops. This economic reality has led to the creation of tomato varieties and growing methods designed specifically for greenhouses, with the goal of increasing yields and producing more uniform crops. If running a profitable enterprise is one of the primary goals of your greenhouse project, then adopting these crops and practices may be a suitable strategy. It should be noted that any crop can benefit from being grown in a greenhouse, and if profitability is not a pressure, then feel free to be creative and explore any number of possibilities. However, if you're growing a large number of crops like tomatoes and cucumbers, it's still very helpful to follow some standard farming practices.

Tomatoes

Tomatoes are an Indigenous crop, originating from South America. The wild ancestor of modern tomatoes is a small, cherry-sized fruit first domesticated by Indigenous peoples in what is now southern Mexico. Indigenous seed keepers—especially the Maya and Aztec peoples—have been developing different tomato varieties for thousands of years. Today, you can still find wild tomato relatives growing in parts of western South America, particularly in the Andean regions, where they continue to be an important genetic resource for tomato breeding programs.

There are many large agri-businesses that invest in tomato cultivar development research leading to patented genetics. These specialized seeds aimed at greenhouse growing are often sold for many dollars per seed. This is a complex issue, as thousands of years of Indigenous knowledge and plant breeding have created a vast diversity of tomatoes, which now form the foundation of modern breeding programs. You can grow heirloom and open-pollinated tomato varieties, which are especially good if you want to save seeds for future planting.

Greenhouse and cold frame tomato cultivation

There are two main strategies to grow tomatoes in hoophouses and greenhouses, working with either Determinate tomatoes or Indeterminant tomatoes. The first approach requires less labour, but it comes at the cost of lower overall yields. The second approach involves more labour and technical effort, and it relies on a heated greenhouse to extend the growing season and produce the highest possible tomato yield.

All tomatoes are either determinant (Bush) or indeterminate (Vine):

Determinate tomatoes:

- Grow to a predetermined height (usually 3-4 feet) and then stop
- Produce most of their fruit over a 4-6-week period
- Are better suited for containers and small spaces
- Often don't require extensive staking or caging
- Good for canning since fruits ripen around the same time

Overall, determinant tomato varieties are excellent if you want a tomato harvest but do not have the capacity to prune and trellis your crop throughout the growing season.

Indeterminate tomatoes:

- Continue growing and producing fruit until killed by frost
- Can reach heights of 6-12 feet or more
- Produce fruit throughout the growing season
- Require sturdy staking, caging, or trellising

- Better for fresh eating since they provide a steady harvest

Indeterminate tomato varieties are commonly used in greenhouses and cold frames because they provide higher yields, maximize space available and better optimize the season extension advantages of greenhouses and cold frames.

Cold frame tomato cultivation guide

Cold frame tomatoes differ significantly from greenhouse varieties, requiring minimal intervention once established. Growing strong, healthy transplants is essential for self-sufficient tomato production. Using protective structures like cold tunnels helps shield young plants from bad weather and sudden temperature changes. Cold frames are a great option for farmers who don't have heated greenhouses or who want to spread out their tomato harvest over the season.

Family: Solanaceae

Cultivars: Indeterminate field tomatoes are the most commonly used. Growing tomatoes in cold frames is a great option for both hybrid and open-pollinated varieties. However, specialty greenhouse tomato cultivars are best suited for heated greenhouses.

If you choose to grow determinate tomatoes in an unheated cold house, which can be a good way to reduce labor, you can skip the pruning and trellising steps mentioned below.

Seed catalogs offer many excellent indeterminate tomato options. Some recommended open-pollinated varieties include:

- Black Cherry
- Brandywine
- Green Zebra
- San Marzano
- Amish Paste
- Cherokee Purple (highly recommended for its excellent flavor and high productivity)

Planting guidelines

Timing: Plant when soil temperature exceeds 16°C. Optimal growth occurs between 18-27°C.

Shelter: Use tunnels or caterpillar tunnels to retain heat and prevent weather-induced diseases.

Figure 1. Asssorted tomatoes from Amisk Farm hoophouse

Starting seeds

1. Sow seeds 7-8 weeks before planting in 72-cell trays with low-fertility germination soil.
2. Maintain 24°C on heat mats until germination, using domes for moisture retention.
3. After emergence, keep daytime temperatures at 24°C and nighttime at 18°C.
4. Repot seedlings into 10 cm (4 in) pots after three weeks.
5. Start hardening off your plants about a week before transplanting by gradually exposing them to outdoor conditions. During this time, add a small amount of fertilizer to the pots.

Planting guidelines

- **Spacing:** Plant when soil temperature exceeds 16°C. Optimal growth occurs between 18- 27°C.
- **Fertilization:** Apply compost or well-aged manure along with an additional organic fertilizer such as blood meal. Potassium sulfate and Sul-Po-Mag are also highly recommended.

Irrigation

- Use drip tape (4 lines per bed) under landscape fabric. Avoid sprinklers to keep the foliage dry.
- Adjust irrigation based on weather: 3 cycles/day for sunny, 2 for partly cloudy, and 1 for cloudy days. Water at least three hours after sunrise.

Transplanting

- Ensure soil temperatures exceed 16°C, ideally **19°C.**
- Plant landscape-fabric-covered beds, cutting 12 cm (5 in) holes for each seedling.
- When transplanting, bury the seedlings up to their first leaves (cotyledons) to help them grow stronger roots.
- Install 1.5 m (5 ft) stakes every 4 plants, securing them with bale rope as they grow.

Figure 2. Amisk Farm I-FEAST trainees learning how to prune and trellis hoophouse tomatoes.

Maintenance

- **Pruning:** Remove suckers and lower leaves every two weeks to improve air circulation and light penetration. Prune leaves up to 60 cm (24 in) from the ground as fruits ripen.
- **Weeding:** Remove weeds emerging through the landscape fabric.
- **Final Stages:** Six weeks before the last harvest, prune plant tops to redirect energy to ripening fruits.

Harvest and storage

- Pick ripe fruits twice a week, and handle each fruit only once to avoid bruising or damage.
- Store tomatoes in cool rooms at 12°c for several days.

Pest and disease management

- Prevent issues by monitoring plants, maintaining proper irrigation, and pruning regularly. Select disease-resistant varieties and plant under cover when possible.

Greenhouse tomato cultivation guide

Greenhouse tomatoes can prove to be a profitable crop for a small greenhouse operation, with many producers choosing to grow them exclusively. If you have a heated greenhouse, it is well worth the time to learn the necessary techniques to grow these types of tomatoes well. Indeterminate tomato varieties grow for 6 to 7 months and can produce a large amount of fruit from each plant.

Family: Solanaceae

Cultivars: Highly recommended to work with modern greenhouse bred hybrid cultivars. These seeds are costly, but worth the investment in terms of fruit consistency and greenhouse environment optimization. Consult seed catalogues for recommendations.

Rootstock: Hybrid cultivars bred specifically for rootstock use.

Planting guidelines

- **Cycle:** Start seedlings mid-January. Graft after three weeks and transplant mid-March. Harvest runs until October.
- **Seedling Care:** Use organic potting mix. Sow rootstock and scion seeds simultaneously in 128-cell trays. Maintain soil temperature at 27°C until germination.

Grafting and early growth

- Graft seedlings when stems reach 1.3-1.6 mm in diameter.
- After recovery, repot the plants into 15 cm wide pots using soil that is rich in nutrients. Space pots to enhance light access.
- Water less frequently but thoroughly, allowing soil to dry between cycles.
- Support plants with small stakes and tomato clips as they grow.

Spacing and trellising

- Beef Tomatoes: 33 cm (13 in) in-row spacing.
- Cherry Tomatoes: 20 cm (8 in) in-row spacing.
- Trellis plants in a "V" shape using two wires and UV-resistant string for maximum light exposure.

Fertilization

- Apply compost, alfalfa meal, chicken manure, feather meal, potassium sulfate, and Sul-Po-Mag bi-monthly. Adjust based on EC testing.
- Use fertilizer on different sides of the plant each week.

Irrigation

- Use drip tape (4 lines per bed). Program irrigation cycles based on weather: sunny (6/day), partly sunny (4/day), cloudy (2/day).
- Start cycles 3-4 hours after sunrise and end 6 hours before sunset.

Transplanting

- Plant grafted seedlings with the graft union above soil level. Install heating systems for consistent temperatures between 23-25°C during the first week.
- Activate only the inner drip lines initially, expanding to all lines as roots develop.

Pruning and maintenance

- **Weekly Tasks:** Lower and lean plants, prune suckers, and trellis.
- **Leaf Pruning:** Remove lower leaves to enhance airflow and direct energy toward fruit production.
- **Climate Control:** Adjust daily and seasonal temperatures to balance vegetative and reproduction growth.

Pollination and pest management

- Introduce bumblebees every 12-16 weeks or self- pollinate by tapping overhead wires.
- Implement biological pest control with predatory insects and maintain cleanliness to prevent diseases.

Harvest and storage

- Harvest twice weekly, clipping fruits to avoid plant damage. Store tomatoes in cool rooms at 12°C.

Special considerations

- Manage humidity levels (65-80%) to prevent fungal diseases.
- Use reflective tarps to enhance light and optimize soil activity for nutrient absorption.

Cucumber

We have incredible success growing cucumbers in our double-walled unheated greenhouse, although The plants grow so well and produce so much that it can be hard to keep up with picking everything. We love to grow pickling cucumbers as well as to make our own supply of pickles. Community members also regularly request cases of pickling cukes.

Figure 3. Pickling cucumbers grown in the Amisk Farm double-walled greenhouse

Family: Cucurbitaceae.

Cultivars: Parthenocarpic varieties (which don't need pollination to produce fruit) are recommended. Many hybrid cucumber varieties bred for greenhouse growing are available from seed suppliers. If you don't have a heating system, using field cucumbers is also a good option.

Crop planning

To ensure a continuous harvest, it's helpful to stagger your cucumber plantings. The next generation should be transplanted eight weeks after the previous one. This ensures that production from the new generation begins as the older one declines.

Before transplanting, ensure all necessary greenhouse setups are in place:

- Cultivation wire
- Misting system

- Greenhouse net (if applicable)

Starting seeds

1. **Seed Starting:** Plant one seed per 15 cm (6 in) wide pot. Seedlings typically remain in a heated nursery for about 28 days.
2. **Soil Mix:** Use a high-quality organic potting mix, ideally inoculated with mycorrhizae.
3. **Watering:** Keep the soil moist before seedling emergence. After emergence, maintain a consistent temperature of 18-19°C and allow the soil to dry slightly between waterings. Avoid watering after 2 PM in spring and 4 PM in summer.
4. **Transplant Readiness:** Seedlings are ready for transplant when they have 2-3 true leaves and well-established roots.

Intensive spacing

- **English Cucumbers:** Plant one row per bed, spaced 45 cm (18 in) apart.
- **Pickling Cucumbers:** Plant one row per bed, spaced 30 cm (12 in) apart.
- **Bed Layout:** Cucumbers are planted on 75 cm (30 in) beds with 30 cm (12 in) pathways.

Fertilization

- Every two months, apply a mix of compost, alfalfa meal, feather meal, Sul-Po-Mag, chicken manure, and potassium sulfate to your soil. Conduct an EC (electrical conductivity) test every two weeks to monitor salt content and adjust fertilization as needed.

Irrigation

- **Irrigation Type:** Use drip tape (4 per bed) under plastic mulch. Avoid overhead watering to prevent fungal diseases.
- **Irrigation Management:** Cucumbers require consistently moist soil. During peak production in summer, each plant may need 3-4 liters of water per day. Schedule 1-5 irrigation cycles per day, starting 2-3 hours after sunrise and ending 5-6 hours before sunset. Adjust the number of cycles based on weather conditions (sunny, partly cloudy, or cloudy days).

Transplantation and setup

- **Bed Layout:** Beds are 1 m (42 in) from center to center, with 75 cm (30 in) beds and 30 cm (12 in) pathways. Cucumbers are trellised on a single wire running parallel to the bed center, at a height of approximately 2 m (7 feet).
- **Soil Temperature:** Ensure soil temperatures are above 17°C and ambient temperatures are above 16°C before transplanting. Cold conditions can stress plants and increase the risk of soil-borne diseases.
- **Soil Preparation:** Two weeks before transplanting, flood the soil with 2-3 cm (1-2 in) of water to flush out salts and improve soil conductivity.

Climate management

- **Temperature:** Maintain a constant temperature of 23-25°C for the first week after transplanting. After the first week, lower nighttime temperatures to 21-23°C. During harvest, maintain daytime temperatures between 21-24°C and nighttime temperatures between 17-20°C.
- **Humidity:** Optimal humidity levels are between 65-80%. Excess humidity can lead to fungal diseases, while low humidity can reduce productivity. Use heating and ventilation to control humidity levels.

Pruning and trellising

- **Pruning:** Prune cucumber plants at least once a week to prevent overloading the plant with fruits. For English cucumbers, leave one fruit every two nodes and remove all tendrils and suckers. For pickling cucumbers, leave all fruits but remove tendrils and suckers.
- **Trellising:** Train the plants to grow along the trellis wire. Once the main stem reaches the wire, allow suckers to grow downward. Prune the lower leaves to improve airflow and reduce disease risk.

Figure 4. Trellising of young cucumber plants

Harvesting

- **Harvest Frequency:** Harvest cucumbers a few times a week during production, and daily during peak production. Use clippers to harvest English cucumbers, ensuring they are 30 cm (12-13 in) long. We usually use small clippers for our pickling cukes as well.
- **Storage:** Store cucumbers in a cold room at 8-12°C. Label the harvest date for proper stock rotation.

Pest management

- **Prevention:** Remove plant debris at the end of the season and disinfect the greenhouse. Use yellow sticky traps to monitor pests like whiteflies and thrips. Regularly inspect plants for signs of pests and diseases.
- **Beneficial Insects:** Introduce beneficial insects like parasitoid wasps to control aphids and other pests.

Soil and fertilizer management

- **Soil Health:** Organic fertilizers like compost, chicken manure, and alfalfa meal are essential for soil health. Ensure the soil remains moist and dark to support the activity of soil fauna and flora, which help release nutrients for plant uptake.
- **Fertilizer Application:** Apply fertilizers in a way that avoids over-mineralizing the soil. Use a concrete mixer to mix fertilizers and apply them uniformly along the bed, avoiding the stem zone.

Peppers

Peppers are another Indigenous crop and one of the oldest cultivated crops in the world. They have a long history of food and medicinal use across the warmer regions of the Americas.

To grow peppers successfully, you need to control the growing conditions to get the best harvest and keep the plants healthy. The following are best practices for growing greenhouse peppers, focusing on heated greenhouse production.

Crop overview

Family: Solanaceae

Cultivars: Hybrid varieties that are specially bred for greenhouse growing are highly recommended. However, all peppers will benefit from being grown in protected culture. Feel free to experiment!

Growing Season: One generation per year, with a productive lifespan of 6 months or more.

Crop planning

- **Seeding:** Start seeds in January, about 8 to 10 weeks before transplanting.
- **Transplanting:** Transplant seedlings at the same time as greenhouse tomatoes, typically in early spring.
- **Harvest:** Harvest throughout the summer and early fall. Remove plants in late fall when productivity declines and heating costs outweigh yields.

Seed starting

- **Sowing:** Plant seeds in 128-cell flats using a low-fertility soil mix. Place one seed per cell.
- **Germination:** Use heating mats to maintain a soil temperature of 27°C until emergence. Cover trays with a plastic dome to retain heat and humidity, removing it after germination.
- **Seedling Care:** After emergence, maintain nursery temperatures at 21-24°C during the day and 20-21°C at night. Keep the soil moist.
- **Potting Up:** Transplant seedlings into 15 cm (6 in) pots with high-fertility potting soil when they develop 2 true leaves (3-4 weeks after sowing). Add a small amount of fertilizer (i.e. alfalfa meal or chicken manure).
- **Light Management:** Reduce plant density by half at weeks 5-6 to ensure adequate light exposure.
- **Transplanting:** Seedlings are ready for transplanting at 8-10 weeks old, when they reach 35-45 cm (14-18 in) in height. Remove the first flower (king flower) to encourage strong vegetative growth.

Plant spacing and density

- **Spacing:** Plant peppers in rows spaced 25 cm (10 in) apart, with two heads per plant.

Fertilization

- **Fertilizers:** Use a mix of compost, alfalfa meal, feather meal, Sul-Po-Mag, hen manure, and potassium sulfate. Apply every two weeks.
- **EC Testing:** Monitor soil electrical conductivity (EC) every two weeks to determine fertilization needs. Fertilize between different rows each time to prevent using too much fertilizer.

Irrigation

- **System:** Use drip irrigation with four lines per bed, placed under black-and-white tarps (white side up).
- Management:
  - Maintain consistent moisture levels, allowing the soil to dry slightly between waterings.
  - Adjust irrigation based on light, temperature, and growth stage. Schedule 1- 6 irrigation cycles per day, starting 2-3 hours after sunrise and ending 5-6 hours before sunset.
  - Use separate irrigation schedules for sunny, partially sunny, and cloudy days.

Transplanting and bed preparation pre-transplant

- Install steel support wires at least 2m (7 feet) high, spaced 50 cm (20 in) apart.
- Ensure soil temperatures are above 16°(, ideally 20°c. Use clear plastic or radiant floor heating to warm the soil if necessary.
- Flood the soil with 2-3 cm (1-2 in) of water to flush out salts and improve conductivity.

Transplanting

- Dig a 20 cm (8 in) trench in the center of each bed. Add compost and amendments, then fill the trench with water.
- Transplant seedlings, spacing them 25 cm (10 in) apart. Tie each plant to the support wire using clips.

- Install drip irrigation lines and cover the bed with black-and-white tarps, securing them with staples.
- Maintain greenhouse temperatures at 23°C during the day and 21°C at night for the first week.

Pruning and trellising

- Select two main heads per plant and trellis them outward.
- Remove the first flower to encourage vegetative growth.
- Allow one fruit per node on the main heads and three leaves per sucker. Remove fruits from suckers.
- Trellising: Use clips to secure plants to support wires every two weeks.
- Final Pruning: Six to seven weeks before the last harvest, prune the heads above the last set of fruits to focus the plant's energy on ripening.

Climate management

- Maintain daytime temperatures of 21-24°C and nighttime temperatures of 18-20°C during vegetative growth.
- Adjust to 21-23°C during the day and 17-18°Cat night once the plant is fully loaded with fruits.
- Avoid temperatures below 16°C or above 28°C, as these can stress the plant and reduce fruit set.

Pest and disease management

- **Aphids:** Introduce ladybugs or parasitic wasps (*Aphidius colemani*). Use insecticidal soap if necessary.
- **Tarnished Plant Bug:** Monitor for this pest, which can reduce fruit set. Use biopesticides if infestations occur.
- **Blossom-End Rot:** Prevent this calcium deficiency disorder by maintaining consistent irrigation and applying calcium chloride sprays or fertigation.

Pollination

- While peppers are self-fertile, bumblebees can improve pollination and fruit size.

Harvesting

- **Timing:** Begin harvesting 2-2.5 months after transplanting, when plants have set 5 fruits per head.
- **Method:** Use pruners to cut fruit peduncles close to the stem. Harvest peppers when they are firm, large, and 80% ripe (fully colored).
- **Quality Control:** Discard blemished or diseased fruits to prevent energy drain on the plant

Post-harvest handling

- **Cleaning:** Wipe peppers clean if necessary. Wash only if aphids or whiteflies are present.
- **Storage:** Store peppers at 12°C.

Other common greenhouse crops:

- Hot Peppers
- Eggplants
- Leafy Greens
- Ginger
- Celery
- Winter/Shoulder Season Spinach
- Runner Beans
- Melons
- Basil
- Any other crop requiring more heat than naturally available, or that you want to grow earlier or later in the season

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