CHAPTER 9

TRANSPLANT PRODUCTION

INTRODUCTION

***Transplants**: Young plants produced specifically for transplant into pots (houseplants), the ground (field production), hydroponic systems (greenhouse hydroponics), etc.

*The production of transplants has become an industry in and of itself.

*In the case of greenhouse hydroponic tomatoes, the separation of transplant production and the growing of the mature plants for tomato harvest means that each grower can tailor the growing conditions for their plant's life stage needs.

*Separate production of transplants is also advantageous for the tomato producer. Precious greenhouse space does not have to be used for seeding and grow out.

*In deciding whether or not to go into transplant production, a grower should consider:
- *The overall operation. Would transplant production fit the business scheme?
- *Can the required number of transplants be grown successfully?
- *Resident management skills and knowledge of transplant production for the specific crop desired. Remember, the transplant grower may be held responsible for weak or failed crops! So the best possible transplants are desired.
- *Availability of the money needed to establish such an operation.
- *Is there a market for the transplants and will the operation be profitable?
- *The time and resources need for such an operation.

*Greenhouse transplant growers are usually growing transplants
- *For commercial sale only
- *For personal use only
- *For both commercial sale and personal use

*Transplants can be started from seeds, or vegetatively using cuttings, grafting, or micro-propagation (tissue culture) methods. However, even with cuttings or grafting the original material will still come from seed.

TRANSPLANTS FROM SEEDS

*Most vegetable transplants are produced from seed.

*The choice of seed is one of the most important initial decisions a grower can make.

*As mentioned previously, most varieties used in commercial greenhouse hydroponic production are F1 hybrids (see Chapter 2).
The pollen from one parent plant is transferred to a second parent plant. The resulting fruits contain the F1 (first filial) seeds that are then sold.
F1 hybrid seed is preferred because most of the plants will have the same characteristics and produce the same quality and quantity of fruit.
Also note that the seeds in fruit from plants grown from the F1 hybrid seed will NOT produce the same type of plant/fruit as the F1 seed.

*Make sure the seed comes from a reputable company. A less well known company may have a "bargain" product… full of problems (diseases, weed seeds, etc.)!
Companies with good reputations include (but are not limited to):
Burpee Seeds, 300 Park Ave. Warminster, PA 18974
1-800-888-1447
Carolina Seeds, PO Box 2658, HWY 105 Bypass, Boone, NC 28607, www.carolinaseeds.com
DeRuiter Seeds, Inc. PO Box 20228 Columbus OH 43220
www.deruiterusa.com
Johnny's Selected Seeds, 1 Foss Hill Rd. RR1 Box 2580, Albion, ME, 04910-9731, www.johnnyseeds.com
Novartis Seeds, Inc., PO Box 4188 Boise ID 83711-4188
208-322-7272
Rijk Zwaan, PO Box 40, 2678 ZG DE LIER, The Netherlands
Email: export@rijkzwaan.nl

*Make sure the seed is disease-free. Reputable companies should guarantee this.

***Seeds** can be sown in a variety of ways depending upon the ultimate use:
Into individual plant containers or plastic flats filled with various types of sterile growing media (soil, sand, peat moss, vermiculite, perlite, rock wool, rice hulls, coconut coir, compost, etc.). Sterilization excludes insects, disease, nematodes and weed seeds…. OR
Typically for tomatoes in greenhouse hydroponics, into "grow cubes" such as rock wool, Oasis cubes, foam cubes, peat pellets, etc….. OR
For research or classroom purposes, in moist paper towels or filter paper in petri dishes or other containers with loose-fitting lids. Make sure the paper toweling or filter paper is not too wet or too dry.
NOTE: Mechanical seeders are available for commercial operations.

***Containers** include a variety of forms.
Individual containers may be more appropriate for foliage plants and come in paper, plastic, clay, peat moss, Styrofoam, etc.
Individual plastic containers called net pots or web pots, filled with perlite, clay pellets, rock wool, etc. are routinely used in air gap, floating or NFT hydroponic systems (see Chapter 5).

Molded plastic or Styrofoam "plug" or cavity trays, in various sizes and containing tens to hundreds of cavities, can be filled with growing medium or cubes for production of multiple seedlings per tray.

Plastic flats can be filled with growing medium or, typically for greenhouse hydroponic tomatoes, pads of rock wool or foam are used that are sized to fit these trays and divided into small cubes (1"x 1" or even smaller plugs called "sugar cubes") which are connected at the top but partially separated at the bottom to keep roots from mingling and reduce root breakage at transplant.

Plastic and Styrofoam containers can be sterilized using 10% bleach. Rinse containers thoroughly to avoid chlorine toxicity.

***Sowing of seeds**

In growing media (like perlite): follow package instructions for depth.

In rock wool or foam cubes, Oasis cubes or other preformed material: these usually have a small hole in the top of each cube into which the seed is placed. Vermiculite can then be sprinkled over the top to maintain moist conditions around the seed.

Time the sowing of seeds so that the resulting transplants are beyond the first true leaf stage but have not yet reached much flowering or any fruiting.

Ex: Most beef type tomato varieties and colored peppers take 4 weeks from seed to final transplant, whereas long cucumbers only take 2 weeks from seed to final transplant!

***Watering and fertilization:**

After sowing, seeds should receive water only, no fertilizer.

Apply by hand. Use a watering can or hose. Round sprinkler heads (give more water with less plant damage) are preferred to fan types.

Apply by overhead misters, sprinklers or programmable traveling irrigation booms (if for foliage plants, or in areas with cool, humid conditions make sure last watering is early enough so that the leaves dry before dark to avoid foliar disease).

Apply by flooding the plant trays or water-tight floor (concrete, plastic, etc.) then draining the excess "to waste" or to a tank for recycling. (Caution: recycling can cause spread of disease – See Chapter 4.)

After the cotyledons have opened and the first true leaf is expanded:

Apply liquid fertilizer in dilute form with every watering:

Ex: 110-175 g of a 20-20-20 fertilizer per 200 liters over a 20 square meter area.

Ex: ¼-½ strength hydroponic nutrient solution…. OR

Apply liquid fertilizer at a stronger rate every 2 weeks:

Ex: 500-700 g of a 20-20-20 fertilizer per 200 liters over a 20 square meter area.

Ex: 3-4 times full strength hydroponic nutrient solution.

NOTE: To avoid leaf burn, rinse leaves with pure water after each concentrated feeding.

***Boosting seedlings to larger containers/cubes/etc.:**

For tomato seedling production:

If seeds are planted in small plugs or 1-1 ½ rockwool cubes, the seedlings will need to be transplanted into larger blocks (3" with one hole or larger blocks with 2 holes) at least 2 weeks after seeding (sooner, if roots begin emerging from cube to prevent root damage). Plants will be ready for planting onto rock wool slabs or perlite bags, etc. in another 2 weeks. Plants may have a couple of flowers open on the first truss but should not have any set fruit at transplant.

If seeds are planted as above, but the grower (or this is especially good for schools on a limited budget) does not want the expense of larger blocks, the smaller seedlings in their cubes can be placed directly onto rock wool slabs or into perlite bags.

For other types of crops – general criteria:

Seedlings should be boosted to larger containers/cubes/etc. when leaves from neighboring plants overlap and shade each other or when roots begin to protrude from the current container/cube/etc.

***Structures for seed-generated transplant production:**

Most vegetable transplant production occurs in some type of controlled environment structure so that the environment can be tailored for the crop being grown.

Cold frames: low plastic covered structures without heat

Hot beds: similar to cold frames but with heat

Greenhouses: transparent enclosed structures with environmental control utilizing light directly from the sun (can be supplemented with artificial lights)

Growth chambers or rooms: opaque enclosed structures with environmental control using artificial light (can use solar light via fiber optic light pipes).

TRANSPLANTS FROM CUTTINGS:

***Cuttings** are portions of the stem, root, leaf or leaf bud removed from a "parent plant".

These portions are then induced to form roots and shoots by chemical, mechanical and/or environmental means.

The resulting plants will be "clones" of the parent plant with exactly the same genetic makeup.

Ex: Tomato plant suckers can be removed, the severed ends placed in water (no nutrients until roots form) and within a few days to a week roots will form.

Parent plant stock material must be free of disease and insect pests.

Material selected for cuttings needs to be in the proper physiological state so that roots and shoots develop readily.

This method is used mainly to propagate ornamental shrubs, evergreens, floral and foliage crops, as well as various fruit species.

***Typical uses for cuttings:**

Commercial: transplants from cuttings can be grown either in the ground or by using an aggregate medium or soil mix for rooting in plug trays, flats, etc.

When vegetable crops (including tomatoes, pepper and cucumbers) are grown from cuttings they are usually produced by small-scale farmers for retail/wholesale or by individuals for home use.

NOTE: Cutting production of vegetable crops is very labor intensive, which is why seeds are usually used.

Educational/school: cuttings can be used in the classroom and easily rooted using

*Aeroponic type hydroponic systems in which the severed ends of, for example, tomato suckers can be bathed in water until they root.

*Floater or air-gap systems where the cutting ends are kept moist by water wicked up into perlite, etc. from the reservoir below.

When roots form, nutrient solution can be added to the reservoir.

NOTE: See Chapter 5 for system descriptions.

***Facilities and special considerations:**

Most cuttings are produced in some type of protected structure (cold frames, hot beds, greenhouses or growth rooms), though some hardwood cuttings (willow, poplar, rose, etc.) are planted directed into the soil outside.

Because cutting material initially has no roots, misting is typically used in greenhouses to maintain a humid environment around the cutting and reduce water loss while roots are forming.

NOTE: For a small number of cuttings (home or school use) even a simple plastic dome over the cuttings will help maintain a moist environment.

Also, to reduce water loss, all but the uppermost 4-5 leaves should be removed.

Research in the physiology of plant growth has shown that auxin-type plant hormones, including the naturally occurring IAA (indoleacetic acid) and the synthetic chemicals, IBA (indolebutyric acid) and NAA (naphthaleneacetic acid) promote root growth. Therefore, treating the cut ends increases the number and hastens the development of roots.

The use of "bottom heat" will also help to induce faster root growth. This is achieved by electric cables, electric mats or hot water tubes running beneath the beds or trays containing the cuttings.

TRANSPLANTS FROM GRAFTING

***Grafting**

A technique for connecting two previously separate plant parts such that the resulting plant will live and grow as one.

Stock = the lower part of the graft including the roots.

Scion = the upper part of the graft including the shoot and dormant buds from which new stems, leaves, etc., will grow.

Although this technique is very labor intensive it has become widely used over the last year or so in vegetable production.

***Why use grafting?**

There are several reasons to use grafting including to maintain clones that can not be easily maintained by other asexual methods, to repair damaged parts of trees, or to create specialized growth forms.

Vegetable growers, in Europe, have been using root stocks with resistance to such root pathogens as *Fusarium* and *Verticillium* wilt with soil agriculture.

Hydroponic vegetable growers are also now using grafted plants, not necessarily for pathogen protection (plants are grown in sterile media) but to increase yields of many greenhouse vegetable crops, including tomatoes.

***Special considerations:**

The root stock and scion must be compatible.

The cambium (new cell generating tissue) of the root stock and scion must be in direct contact with each other.

Both the root stock and scion must be in the proper physiological stage to promote the fusion of the two parts into one.

Cut surfaces must be wrapped after joining to prevent water loss.

As the new plant heals, care must be taken to promote the desired growth habit.

Once the graft has healed the plant can be treated as any other plant.

TRANSPLANTS USING MICRO-PROPAGATION (TISSUE CULTURE)

***Micro-propagation:** The use of sterile tissue culture methods to propagate important crops including woody plants, orchids, palms, ferns, bulbs and ornamentals.

***This technique is used:**

For mass propagation of important clones.

To produce pathogen-free plants.

Potentially, to provide plants year-around for nursery sale.

Specifically for tomatoes and other vegetable crops, micro-propagation has the potential to produce mass numbers of clones for hybrid seed production.
NOTE: This is already being done for some hybrid seed.

***Special considerations:**

Micro-propagation requires a large monetary input for facilities and labor.
Specialized laboratories, growth chambers, high-tech equipment as well as trained personnel are required.

A large storage facility will also be required for the transplants produced.

Precautions must be taken to prevent contamination and the occurrence of "off-type" plants.

Since plants are started from various tissue masses in agar, special methods are required to acclimate the new plant to the greenhouse or the out-of-doors.

Agar	→	Growing medium	→	Growing conditions
(callus formation)		(root development)		(GH or outside)

REFERENCE MATERIAL:

1. **Commercial Production of Vegetable Transplants.** 1997. D.M. Granberry. Published by The Cooperative Extension, The University of Georgia, Athens, GA. Bulletin #1144.
2. **Hydroponic Food Production.** 2001. H.M. Resh. Woodbridge Press Publishing Company, P.O. Box 209, Santa Barbara, CA, 93160. ISBN 0-88007-222-9
3. **Plant Propagation: Principles and Practices.** 1990. H.T. Hartmann, D. E. Kester and F.T. Davies. Fifth Edition. Prentice Hall, Englewood Cliffs, NJ, 07632. ISBN 0-13-681016-0
4. **Protected Agriculture: A Global Review. Part 3: Production Aspects.** 1995. M.H. Jensen and A.J. Malter. The International Bank for Reconstruction and Development/The World Bank. 1818 H Street, N.W., Washington, D.C. 20433. World Bank Technical Paper. ISBN 0-8213-2930-8