1.4 Transplanting and Direct Seeding

Introduction: Transplanting and Direct Seeding

UNIT OVERVIEW

In this unit, two demonstrations introduce students to the basic skills and concepts associated with direct seeding and transplanting techniques used in traditional French-intensive gardening, and small- to medium-scale field production. Note that there is no lecture outline associated with this unit; it uses garden and field demonstrations and a set of step-by-step instructions to convey the material. Refer to Unit 1.3, Propagating Crops from Seed and Greenhouse Management, for additional information relevant to the material presented here.

MODES OF INSTRUCTION

> GARDEN-SCALE TRANSPLANTING DEMONSTRATION (1–1.5 HOURS)

The garden-scale demonstration outline details the basic skills and concepts for direct seeding annual crops and transplanting both annual and perennial container-grown plants. Following the outline is a set of step-by-step instructions for students on seedling and soil preparation, direct seeding, and transplanting techniques.

> TRACTOR-MOUNTED SEEDING AND TRANSPLANTING EQUIPMENT DEMONSTRATION (1 HOUR)

The demonstration outline for field-scale transplanting and direct seeding details how to use tractor-mounted equipment for planting on a larger scale.

> ASSESSMENT QUESTIONS (0.5 HOUR)

Assessment questions reinforce key unit concepts and skills.

LEARNING OBJECTIVES

CONCEPTS

- The optimal physical environment conditions favorable for successful transplanting
- The optimal soil moisture conditions favorable for successful transplanting
- The optimal seedling development and pre-treatments necessary for successful transplanting

SKILLS

- How to sow small- and large-seeded crops using hand methods and push seeders
- How to transplant from a cell tray and flat format
- How to water-in/irrigate recently transplanted seedlings
- How to irrigate seed beds for optimal germination

Demonstration 1: Garden-Scale Transplanting and Direct Sowing

for the instructor

OVERVIEW

The demonstration outline covers the basic skills and concepts used to direct seed and transplant crops for garden-scale production. Following the outline below, discuss and demonstrate the tools and techniques used in garden-scale transplanting and direct seeding.

PREPARATIONS AND MATERIALS

- Recently prepared garden bed at 50%–75% of field capacity, including a 4-foot section prepared as a seed bed and a 4-foot section prepared using coarse secondary tillage
- Flat of plants at seedling maturity (allium and broad-leaf crops)
- Cell tray at seedling maturity and immaturity
- Hand trowel and hand fork
- Watering wand
- Dibble
- Measuring tape
- Ross and hose
- Mist system/micro-sprinklers
- String and stakes
- Large and small seed (e.g., squash and carrots)
- Push seeder
- Bed end markers and indelible marker
- Appendix 10, Propagation and Crop Performance Record Sheet, from Unit 1.3, Propagating Crops from Seed and Greenhouse Management

PREPARATION TIME

1.5 hours

DEMONSTRATION TIME

1.5 hours

DEMONSTRATION OUTLINE

A. Discuss Transplanting versus Direct Sowing

Ask students to explain why certain crops are transplanted and others directly sown

1. Transplanted crops
   a) Greenhouse advantages
      i. Greater climate control
      ii. Greater season extension
      iii. Intensive rather than extensive management of seedlings
      iv. Rapid crop successions (e.g., from cover crops to cropping and from one crop to another)
   b) Root nature of transplanted crops: Fibrous
   c) May allow for greater control over specific density of crops
2. Direct-sown crops
   a) Root nature of direct-sown crops: Often tap rooted
   b) Intended density of crop: Direct-seeded crops require sowing at high density and eventual thinning
   c) Scale of production: Many crops are direct seeded on a large scale to avoid additional production costs
   d) Exceptions: Many, if not all crops, including tap-rooted crops, may be transplanted if sown and transplanted in clusters

B. Review Assessments of Plant, Soil, and Environmental Conditions *Prior* to Transplanting

Ask students to assess the compatibility of the following environmental conditions and seedling maturity with the planned tasks, then discuss and demonstrate the following:

1. Seedling development necessary for successful transplanting
   a) Shoot development
   b) Root development
2. Seedling pre-treatments necessary for successful transplanting
   a) Soil/mix moisture
      i. Cell-grown seedlings at field capacity
      ii. Flat-grown seedlings at 50%–75% of field capacity
   b) Hardening-off period: A minimum of three days of full exposure to field conditions
3. Soil conditions favorable for successful transplanting or direct sowing

   Determine soil moisture with students
   a) Soil moisture (see appendix 1, Estimating Soil Moisture By Feel):50%–75% of field capacity
   b) Degree of secondary cultivation: Smaller seeds require greater secondary cultivation
4. Optimal physical environment conditions favorable for successful transplanting of flat-grown seedlings
   a) Low light levels
   b) Low temperature
   c) Low wind speed
   d) High humidity
   e) Steps to take if environmental conditions are not optimal

C. Discuss and Demonstrate Transplanting

1. Plant spacing considerations: Ask students to consider how the following factors influence crop spacing
   a) Irrigation and cultivation considerations
   b) Soil fertility/soil development considerations: Low fertility may require reduced density or supplemental fertility
   c) Root and shoot size at maturity
   d) Disease prevention/air circulation
   e) Stem length or stem number for cut flowers
   f) References: Crop-spacing chart in *Knott's Handbook for Vegetable Growers*, and in *How to Grow More Vegetables*, by John Jeavons; seed catalogues (see Resources section of Unit 1.3, Propagating Crops from Seed and Greenhouse Management)
2. Tool uses to assure uniform plant spacing: Discuss and demonstrate tools used to guide planting
   a) String lines
   b) Dibbles
   c) Triangulation
   d) One's hand
3. How to plant: Discuss and demonstrate the following
   a) The importance of a knowledge of crop being planted
   b) Plant selection criteria (development and vigor of seedling)
   c) Plant handling technique
   d) Depth of planting
4. Watering in: Discuss and demonstrate why, how, and irrigation options
   a) Why? To assure even soil moisture between transplant and surrounding soil in order to assure uninterruped regrowth
   b) Options on how to water in
      i. Basal with watering wand
      ii. Overhead sprinkler and considerations of scale
      iii. Overhead sprinkler, transition to drip
5. Documenting
   a) Documenting as learning tool
   b) Where to document?
      i. Bed end stake
      ii. Garden log book with crop seeding dates and seed company (see appendix 10 in Unit 1.3)
6. Post-transplant follow up
   a) Irrigation
      i. Method of irrigation
      ii. Monitoring root zone for 50% of field capacity (see appendix 1 in this unit, and Unit 1.5, Irrigation, for discussion of field capacity)
   b) Observations of subsequent growth
      i. Predation: Watch seedlings for insect or pest damage. Replace as needed.
      ii. Nutrient needs: In spring, heat-loving crops growing in poorly developed soils may require supplemental fertility
      iii. Root development: Carefully digging up seedlings to observe root development provides infomation for depth of irrigation requirements

c) Remainder/replacement seedlings
    i. Replacement in propagation area
    ii. Treatment: Supplemental fertility may be required to sustain replacement seedlings

D. Discuss and Demonstrate Direct-Sowing Techniques

1. Briefly review optimal environmental considerations for seed germination. Ask students to consider the optimal environmental conditions for seed germination in terms of:
    a) Soil moisture
    b) Degree of secondary cultivation
    c) Soil temperature
2. Demonstrate and discuss the pros/cons of the various direct-sowing techniques
    a) Drills/sowing into furrows by hand
    b) Push seeder
    c) Broadcast sowing
3. Irrigation
    a) Objective
    b) Techniques used
        i. Mist systems
        ii. Overhead
        iii. Drip
4. Thinning established stand
    a) Stage of development
    b) Density: see crop-spacing charts in Resources section in Unit 1.3
5. Questions and answers

Demonstration 1: Garden-Scale Transplanting and Direct Sowing

step-by-step instructions for students

A. Assess Plant, Soil, and Environmental Conditions *Prior* to Sowing or Transplanting

1. Seedling development
   a) Shoot development
      i. Second set of true leaves (cell format)
      ii. Filling out allotted space (flat format)
   b) Root development
      i. Root knit (cell format)
      ii. Filling out allotted space (flat format)
2. Seedling pre-treatments
   a) Soil/mix moisture
      i. Field capacity (cell format)
      ii. 50%–75% of field capacity (flat format)
   b) Hardened-off
      i. 3–21 day range (minimum of 3 days with 24 hours at field conditions)
      ii. Hardening-off period increases in length with increased differential between field and greenhouse conditions
3. Field or garden soil conditions
   a) Soil moisture
      i. 50%–75% of field capacity
   b) Degree of secondary cultivation
      i. Extensive secondary cultivation for small-seeded, direct-sown crops and transplants with small, weak, or inefficient root systems
      ii. Course secondary tillage for large, vigorous, and resilient transplants
4. Optimal physical environment conditions favorable to successful transplanting from flat format
   a) Low light levels
   b) Low temperature
   c) Calm winds
   d) High relative humidity
   e) Late afternoon and early evening

B. Transplanting

1. Gather necessary tools and materials
   a) Seedlings at transplant maturity
   b) Hand trowel and hand fork
   c) Watering wand
   d) Dibble
   e) Measuring tape
   f) Ross and hose

g) Mist system/micro-sprinklers
h) String and stakes
i) Seed
j) Push seeder

2. Plant spacing considerations: Consider how the following factors influence crop spacing
   a) Irrigation and cultivation considerations
      i. Rows should be straight and between-row crop spacing should be large enough to accommodate drip irrigation ribbon and cultivation tools
   b) Soil fertility/soil development considerations
      i. In infertile or degraded soil, plant densities should be low and increased as soil fertility develops over time
   c) Root and shoot size
      i. How large is the root system and vegetative portion of the plant at maturity?
   d) Disease prevention considerations
      i. Is the crop susceptible to certain plant pathogens?
      ii. Increasing the plant spacing may help to assure adequate air circulation and prevent the development and spread of fungal plant pathogens in certain climates
   e) Stem length and stem number in cut flowers
      i. By increasing crop density in certain cut flowers, the bloom shaft length may be increased. Decreasing plant densities often results in greater numbers of shorter bloom shafts.
   f) References: Crop-spacing chart in *Knott's Handbook for Vegetable Growers*, and *How to Grow More Vegetables*, by John Jeavons; seed packages and catalogues
3. How to plant
   a) Know the crop being planted
      i. Review the crop culture information on the back of the seed package, in seed catalogues, or books on crop culture
   b) Plant selection criteria (seedling vigor): Select for bigger size and color
   c) Plant handling
      i. Crops grown in a flat format should be handled carefully by the rootball, attempting to disturb the root system as little as possible during the transplanting process. Crops grown in a flat format should only be transplanted during the early evening.
      ii. Crops grown in a cell tray format may be planted throughout the day and with less concern for disturbance of the root system during planting
   d) Depth of planting
      i. Most crops should be planted to the depth of the cotyledons
      ii. Crops in the Solanaceae family (tomatoes, peppers, eggplants, etc.) and Brassicaceae family (broccoli, cabbage, cauliflower, etc.) are adventitious rooters and may be buried to the bottom of the first set of true leaves
4. Watering in
   a) Seedlings should be immediately irrigated following transplanting
   b) Bring the root zone of the crop to field capacity using drip irrigation, overhead sprinkler, or basal soaking
5. Documenting
   a) Transcribe the information on the horticultural label (including the transplanting date) to a bed-end stake *and* the garden record log book (see appendix 10, Unit 1.3)

6. Follow-up
    a) Determine the type of irrigation to be used and set up any necessary irrigation equipment at this time
    b) Return remaining seedlings to the propagation area. Refill flats with propagation mix and water thoroughly.
    c) Over the following approximately 2–5 days, monitor soil moisture in the root zone of the recently transplanted crop. Irrigate once the soil in the root zone has reached 50% of field capacity.
    d) Periodic, light overhead irrigation will raise the relative humidity around the seedlings, reduce the rate of evapotransporation, and help minimize transplant shock
    e) Observe the growth and development of the roots and shoots of the seedlings, noting the following: Rates of growth, changes in color, and damage due to predation
    f) Replace seedlings lost to predation

C. Direct Sowing

1. Consider the optimal environmental conditions for seed germination in terms of:
    a) Soil moisture
        i. 50%–75% of field capacity
    b) Degree of secondary cultivation
        i. Extensive secondary cultivation is necessary for small-seeded direct-sown crops and transplants with small, weak, or inefficient root systems
    c) Soil temperature
        i. Compare the existing soil temperatures with the optimal germination temperatures found on the back of the seed package, in *Knott's Handbook for Vegetable Growers*, or in appendix 2, Unit 1.3, Propagating Crops from Seed and Greenhouse Management
2. Direct-sowing techniques
    a) Sowing into furrows with hands
        i. Open furrow with fingers or hand tool to a depth of approximately 2 times the diameter of the seed to be sown
        ii. Sow seed at 2–3 times the density desired at maturity (seedlings are later thinned to desired spacing when the first set of true leaves have developed)
        iii. Cover seed by pinching furrow together
        iv. Gently tamp soil with head of rake to assure soil-to-seed contact
    b) Sowing into furrows with push seeder
        i. Consult the seed plate chart for use of push seeder
        ii. Test seeder output on hard, flat surface to confirm desired seed rate
        iii. Periodically check to assure seed output and seed supply in hopper
    c) Broadcast sowing
        i. Determine application rate using references such as crop-spacing chart in *Knott's Handbook for Vegetable Growers*, and in *How to Grow More Vegetables*, by John Jeavons; seed packages and catalogues
        ii. Broadcast evenly over surface of soil
        iii. Cover lightly with a mixture of 50% garden soil and 50% mature compost
3. Irrigating seed beds
    a) Using Ross, oscillator, or mist/micro-sprinklers, maintain surface soil moisture with light, frequent applications of water each time 50% of the surface of the soil has dried and discolored (see appendix 4, Garden-Scale Seed Bed Irrigation)

4. Thinning direct-sown crops
    a) Thin directly seeded crops to desired spacing, if necessary, once the first set of true leaves has developed

Demonstration 2: Tractor-Mounted Seeding and Transplanting Equipment

for the instructor

INSTRUCTOR OVERVIEW

This demonstration outline introduces the tractor-mounted equipment and skills used to transplant and direct seed crops. It first covers the sequence of techniques and equipment used to prepare the soil for both transplanting and direct seeding. The outline then introduces the range of equipment and techniques used to transplant and direct seed crops, followed by irrigation techniques.

PREPARATION AND MATERIALS

- Bed shaper/marker
- Tractor-mounted seeder
- Push seeder
- Plate planter
- Tractor-mounted transplanting equipment
- Hand trowels
- Irrigation equipment: drip and sprinkler
- Record book for recording crops planted, sown
- Labels for marking bed
- Shovels for single row plantings

GROUND PREPARATION

This demonstration requires access to an area of ground that has received primary and secondary tillage, pre-irrigation, and weed cultivation. These techniques should be included in the demonstration if not covered previously in Unit 1.2, Garden and Field Tillage and Cultivation.

PREPARATION TIME

1 hour

DEMONSTRATION TIME

1 hour

DEMONSTRATION OUTLINE

A. Review and Discuss Tools and Sequence Used to Prepare Ground

1. Review field soil conditions prior to tillage
   a) Soil moisture range: 50%–75% of field capacity (see appendix 1 in this unit, and Unit 1.5, Irrigation, for discussion of field capacity)
2. Incorporation of cover crop residue through primary tillage
   a) Mowing (flail or rotary)
   b) Apply compost prior to residue incorporation, if necessary
   c) Incorporate cover crop residue with spader or off-set wheel disc
3. Establishment of seedbed thorugh secondary tillage techniques
   a) Rototill or disc field to improve surface uniformity following residue breakdown
4. Planting bed formation
   a) Form beds with lister bar and shovels or rolling cultivator
   b) Shape bed with bed shaper
   c) Pre-irrigate to germinate weed seed
   d) Cultivate unplanted beds with sweeps, knives, or rolling cultivator to minimize weed pressure and exhaust seed bank
   e) Plant beds with seeder, transplanter, or by hand

B. Demonstrate Bed Shaper/Seeder for Direct-Sown Crops

1. Review attachment of implement(s)
2. Demonstrate adjustment of bed shaper height
3. Demonstrate adjustment of seeder shovels' height for seeding various crops
4. Review examples of crops that are directly sown and why

C. Demonstrate Implements Used to Prepare Beds for Single-Line Plantings

1. Review attachment and adjustment of implement(s) used
2. Review examples of single-line crops

D. Demonstrate the Use of Mechanical Transplanter

1. Review attachment of implement(s)
2. Demonstrate adjustment of transplanter
3. Transplant preparations: Irrigation and hardening off (see Unit 1.3, Propagating Crops from Seed and Greenhouse Management)
4. Handling and placement of transplants
5. Review examples of crops that are mechanically transplanted and why

E. Review Hand Transplanting Techniques

1. Transplant preparations: Irrigation and hardening off (see Unit 1.5, Irrigation)
2. Handling and placement
3. Review of transplanted crops
   a) Single line crops
   b) Double line crops

F. Review Irrigation Techniques Used Immediately Following Transplanting and Direct Seeding

1. Drip irrigation
2. Sprinkler irrigation

Assessment Questions

1) List three physical environmental conditions favorable for successful transplanting of flat-grown seedlings.

2) What is the optimal range of soil moisture for transplanting or direct seeding of crops?

3) Describe how the size, root nature, and vigor of transplants and the size of seeds influence the degree of secondary cultivation needed.

4) List two characteristics of seedlings at transplanting maturity.

5) List two necessary steps in preparing seedlings for transplanting.

Assessment Questions Key

1) List three physical environmental conditions favorable for successful transplanting of flat-grown seedlings
   - *Low light levels*
   - *Low temperature*
   - *High relative humidity*
   - *Calm winds*

2) What is the optimal range of soil moisture for transplanting or direct seeding of crops?
   - *Between 50%–75% of field capacity*

3) Describe how the size, root nature, and vigor of transplants and the size of seeds influence the degree of secondary cultivation needed
   - *Directly sown crops (especially small-seeded crops) require extensive secondary cultivation in order to reduce the surface soil particle size and produce a quality seed bed. Small, inefficient, weak, or shallow-rooted crops (e.g., onions, leeks, lettuce) also respond favorably to being transplanted into soils having received extensive secondary cultivation.*
   - *Large, vigorous transplants may be transplanted into more coarsely tilled soils*

4) List two characteristics of seedlings at transplanting maturity.
   - *Second set of true leaves initiated*
   - *Root knit*

5) List two necessary steps in preparing seedlings for transplanting.
   - *Pre-moistened to 50–75% and 100% of field capacity (flats and cell tray transplants respectively)*
   - *Hardened-off for 3–21 days*

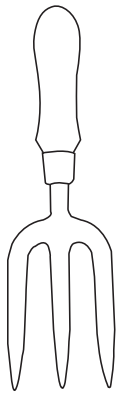
Appendix 1: Estimating Soil Moisture by Feel

SOIL MOISTURE LEVEL (% OF FIELD CAPACITY)	COARSE (SAND)	LIGHT (LOAMY SAND, SANDY LOAM)	MEDIUM (FINE, SANDY LOAM, SILT LOAM)	HEAVY (CLAY LOAM, CLAY)
0–25% No available soil moisture. Plants wilt. Irrigation required. (1st range)	Dry, loose, single grained, flows through fingers. No stain or smear on fingers.	Dry, loose, clods easily crushed and will flow through fingers. No stain or smear on fingers.	Crumbly, dry, powdery, will barely maintain shape. Clods, breaks down easily. May leave slight smear or stain when worked with hands or fingers.	Hard, firm baked, cracked. Usually too stiff or tough to work or ribbon[1] by squeezing between thumb or forefinger. May leave slight smear or stain.
25–50% Moisture is available, but level is low. Irrigation needed. (2nd range)	Appears dry; will not retain shape when squeezed in hand.	Appears dry; may tend to make a cast[2] when squeezed in hand, but seldom will hold together.	May form a weak ball[2] under pressure but will still be crumbly. Color is pale with no obvious moisture.	Pliable, forms a ball; will ribbon but usually breaks or is crumbly. May leave slight stain or smear.
50–75% Moisture is available. Level is high. Irrigation not yet needed. (3rd range)	Color is darkened with obvious moisture. Soil may stick together in very weak cast or ball.	Color is darkened with obvious moisture. Soil forms weak ball or cast under pressure. Slight finger stain, but no ribbon when squeezed between thumb and forefinger.	Color is darkened from obvious moisture. Forms a ball. Works easily, clods are soft with mellow feel. Will stain finger and have slick feel when squeezed.	Color is darkened with obvious moisture. Forms good ball. Ribbons easily, has slick feel. Leaves stain on fingers.
75% to field capacity (100%) Soil moisture level following an irrigation. (4th range)	Appears and feels moist. Color is darkened. May form weak cast or ball. Will leave wet outline or slight smear on hand.	Appears and feels moist. Color is darkened. Forms cast or ball. Will not ribbon, but will show smear or stain and leave wet outline on hand.	Appears and feels moist. Color is darkened. Has a smooth, mellow feel. Forms ball and will ribbon when squeezed. Stains and smears. Leaves wet outline on hand.	Color is darkened. Appears moist; may feel sticky. Ribbons out easily, smears and stains hand, leaves wet outline. Forms good ball.

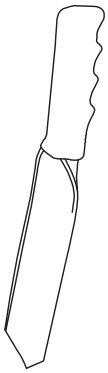
[1] Ribbon is formed by squeezing and working soil between thumb and forefinger

[2] Cast or ball is formed by squeezing soil in hand

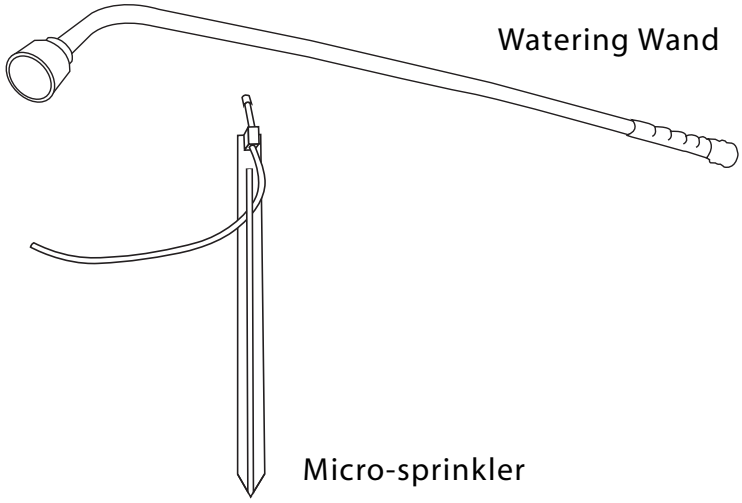
Appendix 2: Transplanting and Irrigation Equipment



Hand Fork

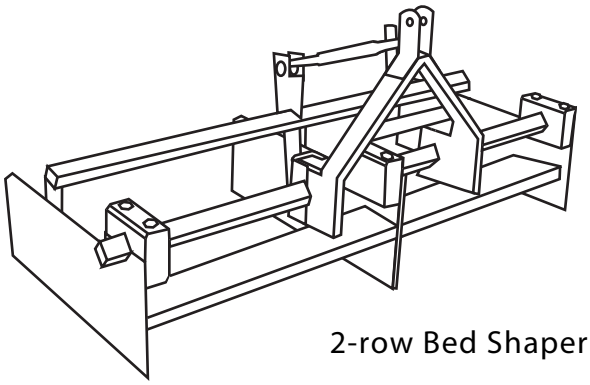


Hand Trowel

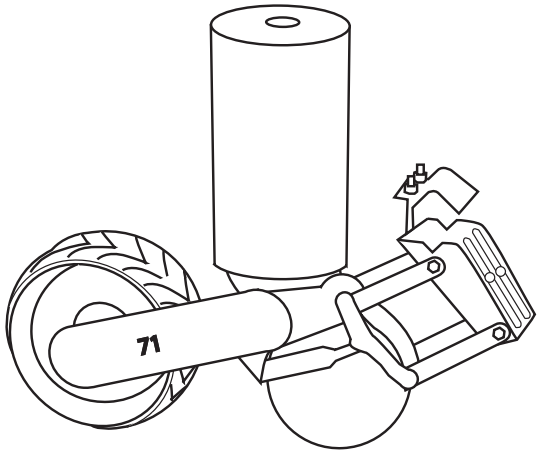


Watering Wand

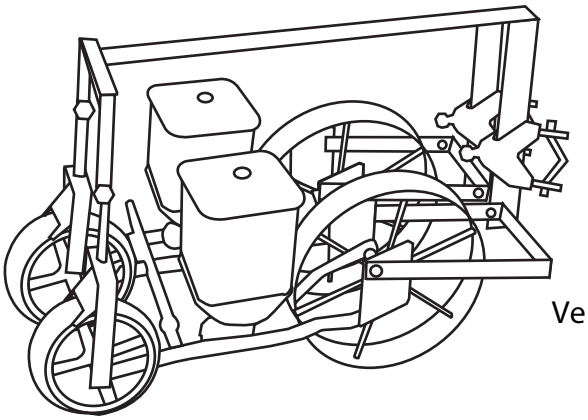
Micro-sprinkler



2-row Bed Shaper



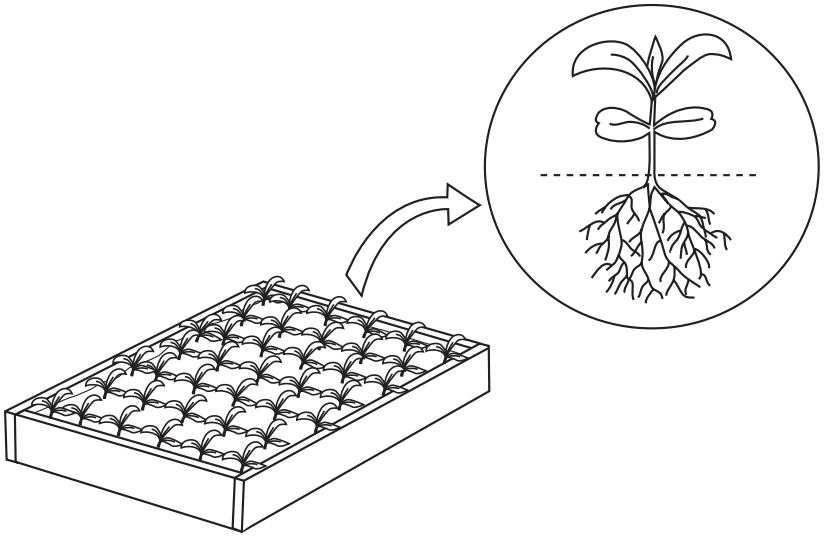
John Deere
Model 71 Plate
Planter



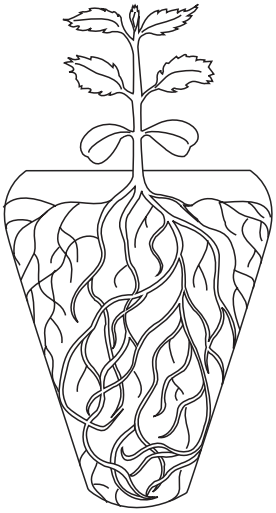
Planet Jr.
Vegetable Planter

illustrations by Cathy Genetti Reinhard; not to scale

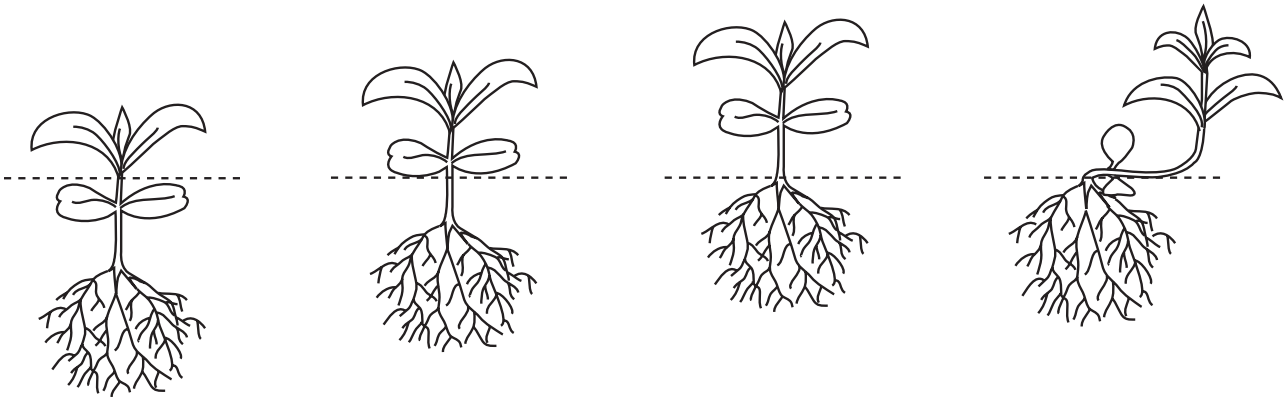
Appendix 3: Seedlings at Transplant Maturity, Planting Depths



Flat-grown seedling at transplant maturity—note balance of roots and shoots



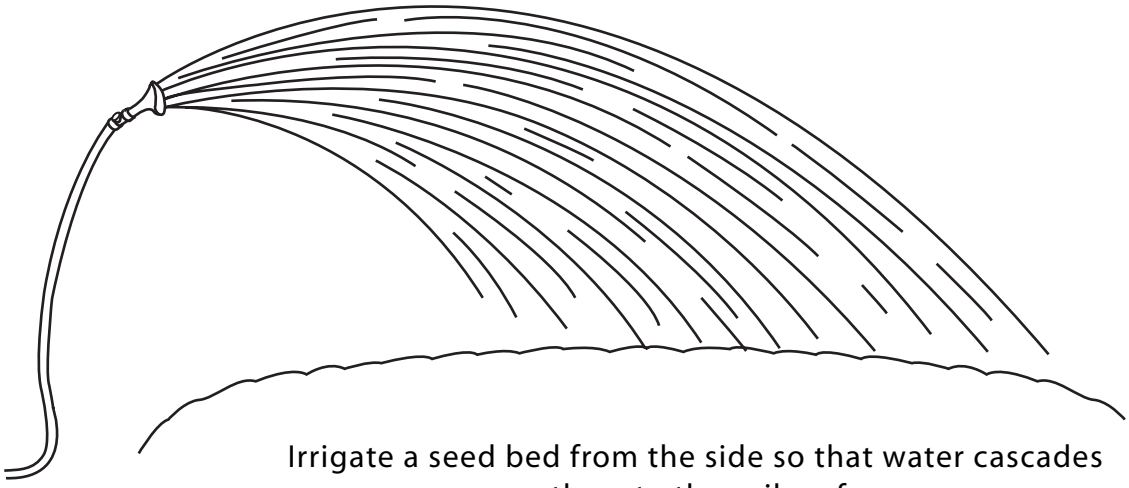
Cell-grown seedling at transplantmaturity—note balance of roots and shoots



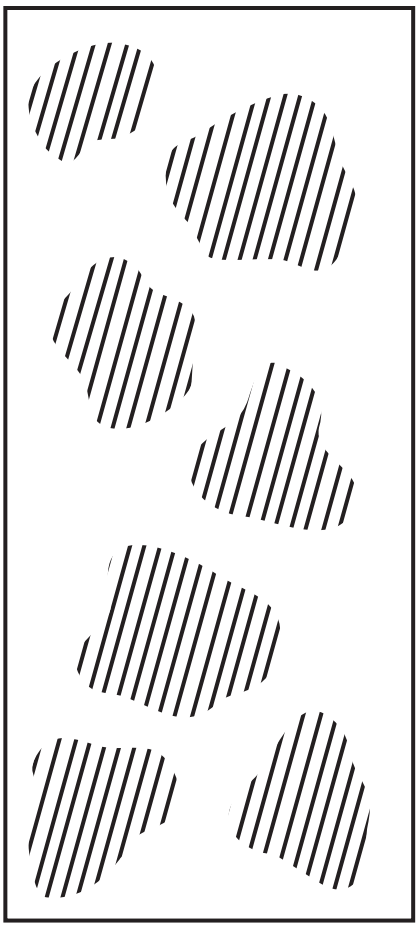
Transplanting seedlings to the proper depth

illustrations by Cathy Genetti Reinhard; not to scale

Appendix 4: Garden-Scale Seed Bed Irrigation



Irrigate a seed bed from the side so that water cascades gently onto the soil surface



Irrigate a seed bed each time 50% of the bed's surface area has dried and discolored

illustrations by Cathy Genetti Reinhard