IRRIGATION SYSTEMS AND METHODS

JOHNNY'S RESEARCH FARM

Original farm was purchased in 1976 and still functions as our "home farm."

Dedicated to:

- *Breeding* – development of new vegetable and flower varieties
- *Seed production* – foundation, stock, and commercial seed productions
- *Product trialing* – field and high tunnel trials of Johnny's and partner products
- *Every product* in the Johnny's catalog is field tested on the research farm.

THE FARM

Consists of:

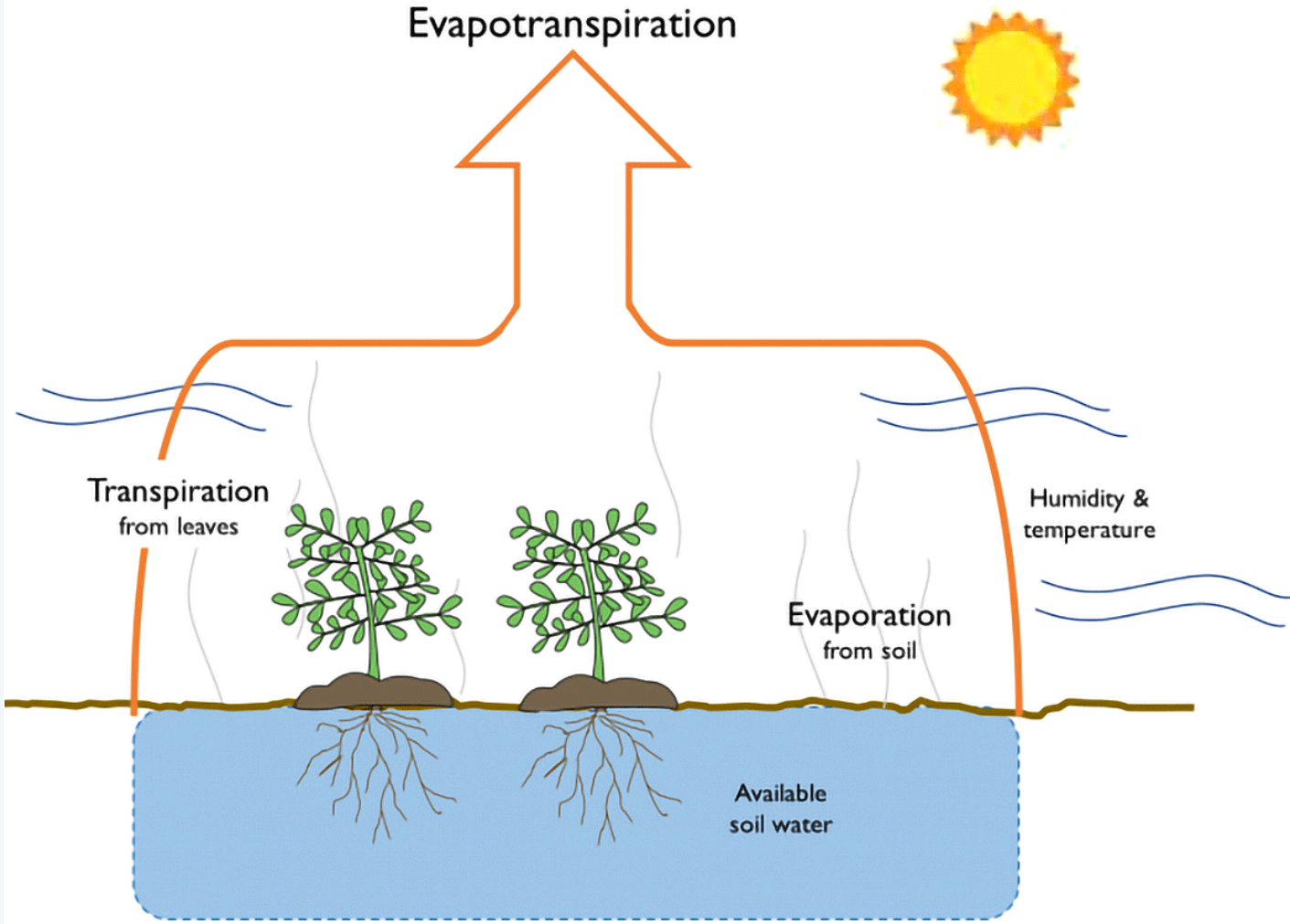
- 31 Farm Operations Staff
- Nine farm locations (3 owned, 6 leased)
- 203 acres total, 50-75 in active production
- 50% or more of acreage in cover crops annually

SESSION OVERVIEW

- Irrigation Terminology
- Basic Irrigation System Components
- Factors Affecting Irrigation Decisions
- Irrigation Scheduling

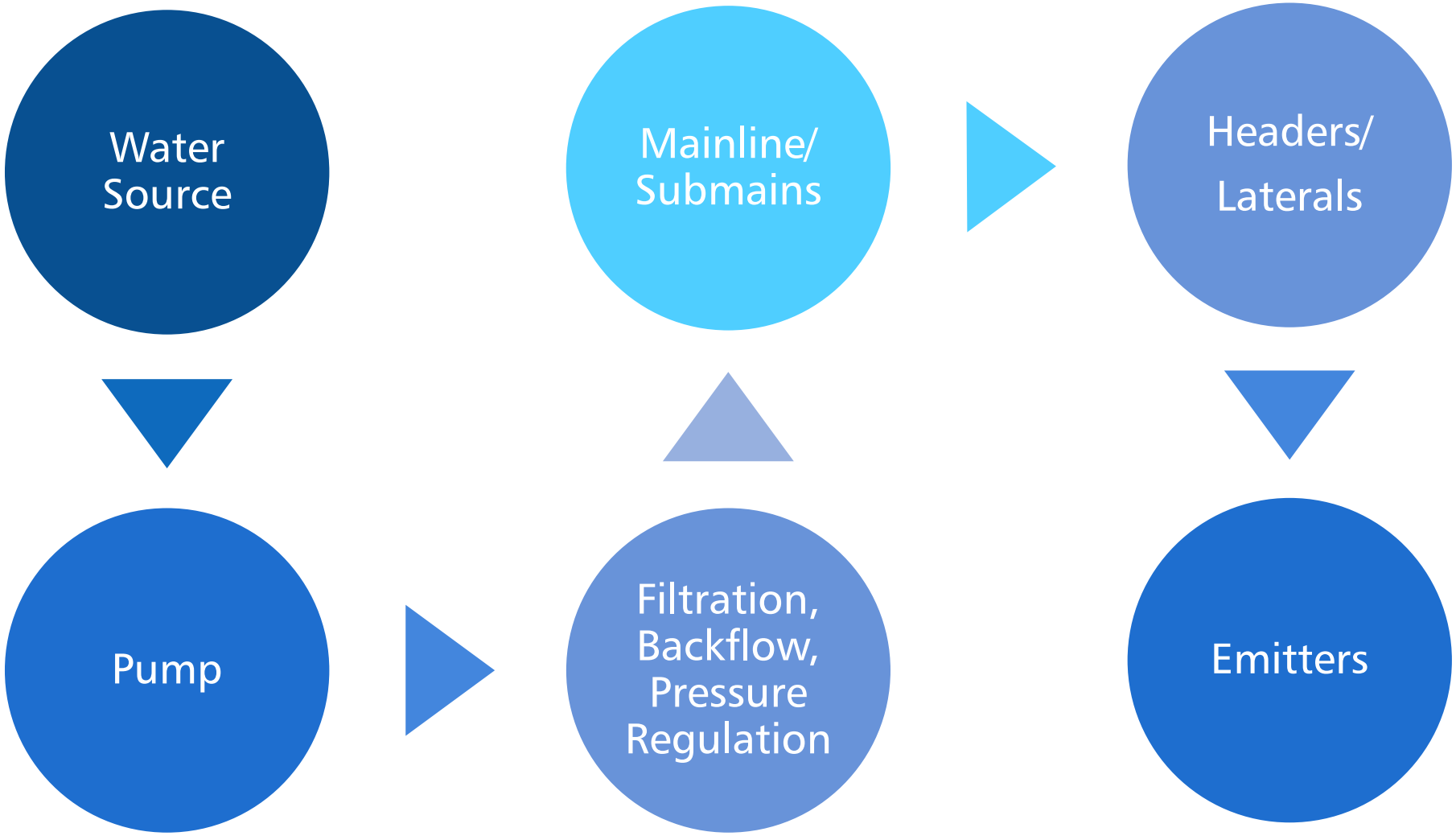
WATER CYCLING TERMINOLOGY

- **Transpiration:** Loss of water from plant tissues to air
- **Evaporation:** Loss of surface water to air via phase change (liquid to vapor)
- **Evapotranspiration:** Loss of water to the atmosphere through the combined processes of evaporation and transpiration



Gigi Richard, adapted from Bates, R.L. ; J.A.Jackson, Glossary of Geology, Second Edition, American Geology Institute, 1980

BASIC IRRIGATION SYSTEM COMPONENTS



DRIP IRRIGATION LAYOUT

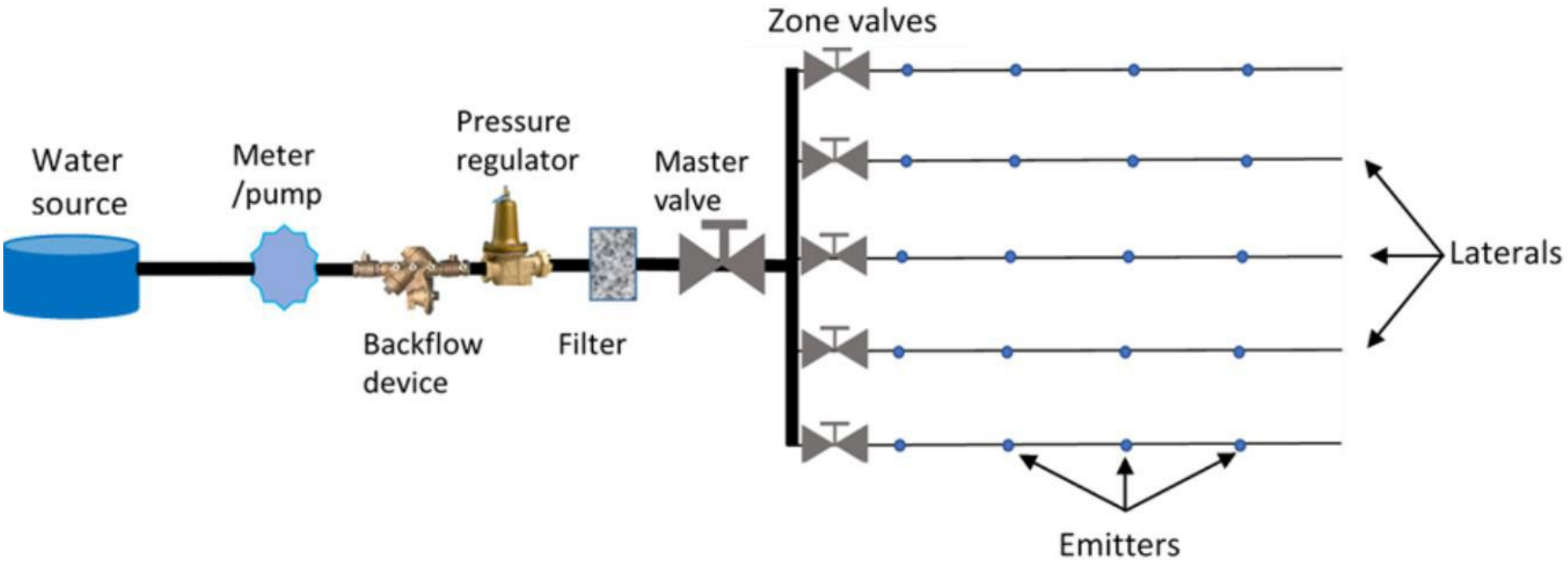
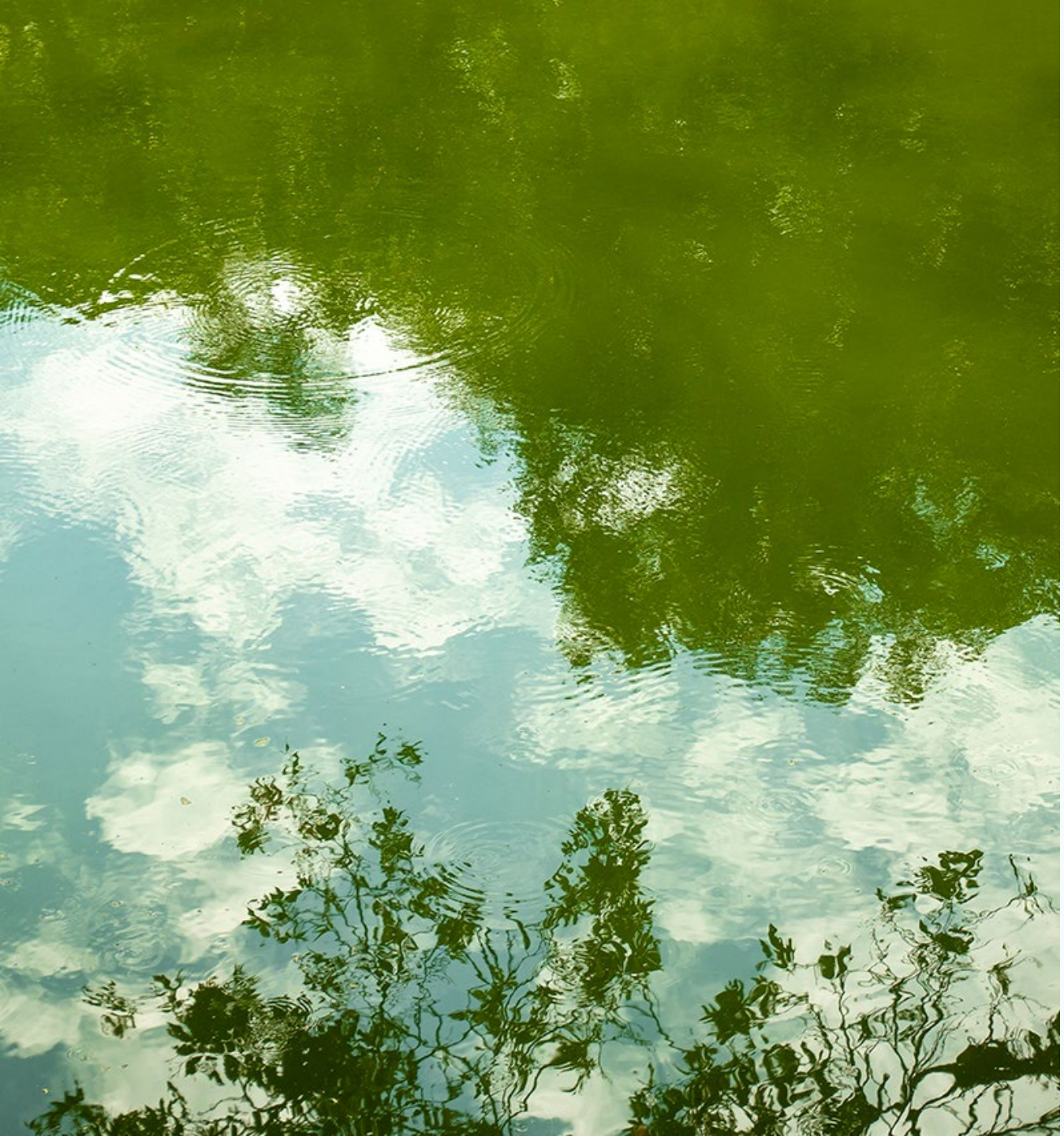


Photo credit: Haimanote K. Bayabil, UF/IFAS



A NOTE ON WATER SOURCES

- Well water tends to be cleanest, though sediment and contamination can still be issues.
- Surface water is often plentiful but can have withdrawal restrictions.
- Your filtration, pumping, and application decisions will largely be determined by what type and volume of water you have access to.

APPLICATION METHODS

OVERHEAD:

- Good for general wetting and bare ground plantings.
- Less efficient application of water due to evaporation and wind loss.
- Generally requires more pressure/flow.
- Several types of sprinklers, guns, etc. that vary based on flow rate, pressure requirements, wetted pattern/diameter, and droplet size

DRIP:

- Precise application at root zone = more efficient water use.
- Not great for wetting across entire bed, especially on sandy soils.
- Multiple options for emitter spacing, flow rate, wall thickness
- Pressure compensating/flow control vs. standard

SOIL MOISTURE TERMS

Soil Saturation – all soil pores are filled with water

Gravitational Water – water that drains from saturated soil (not available to plants)

Plant Available Water – water content between permanent wilting point and field capacity that can be used by plants

100% Field Capacity – point after all gravitational water has drained - macropores hold water, micropores hold air

Permanent Wilting Point – soil moisture has been lost to a point where the plant cannot sustain growth/life

SOIL TEXTURE

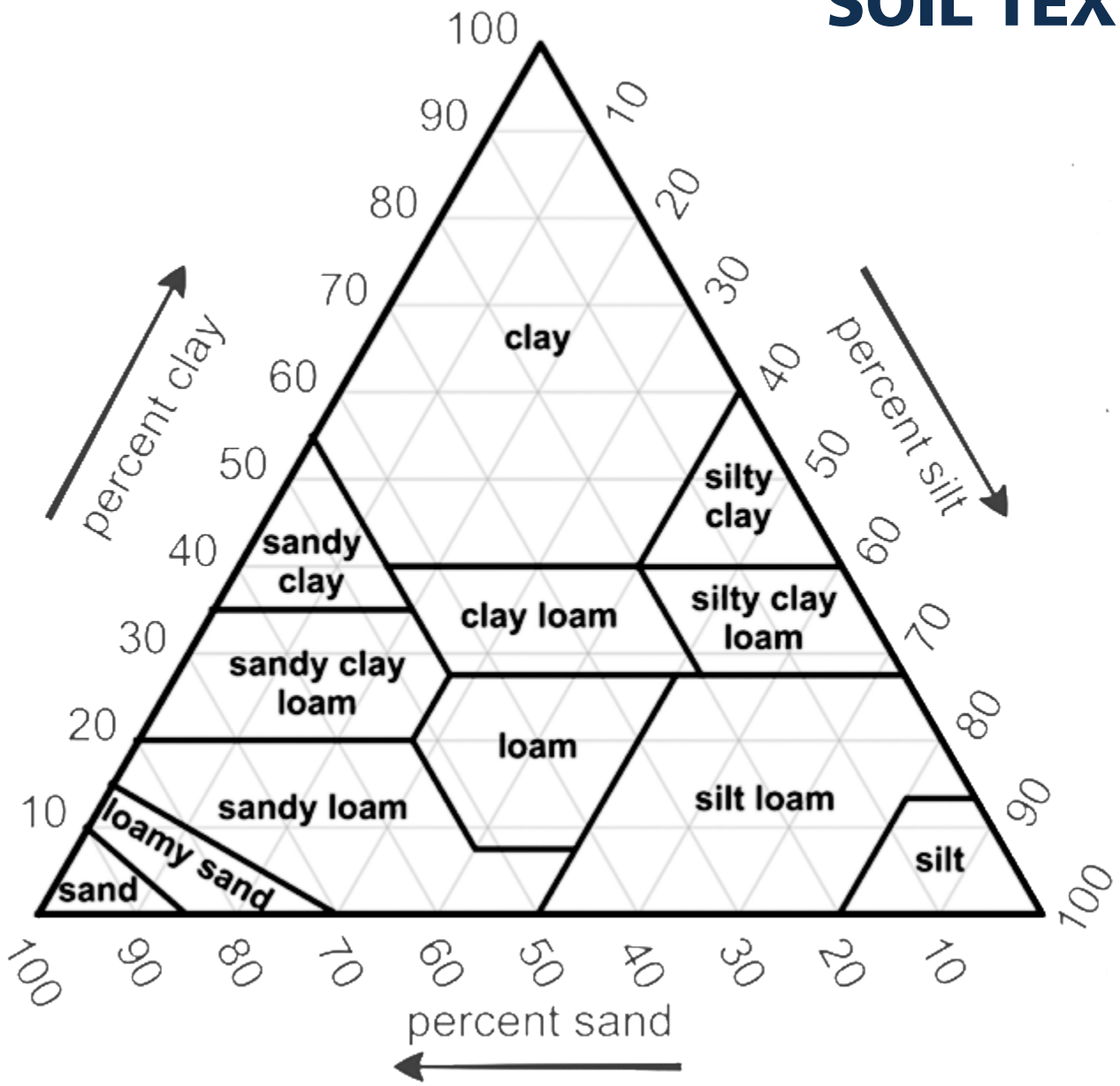
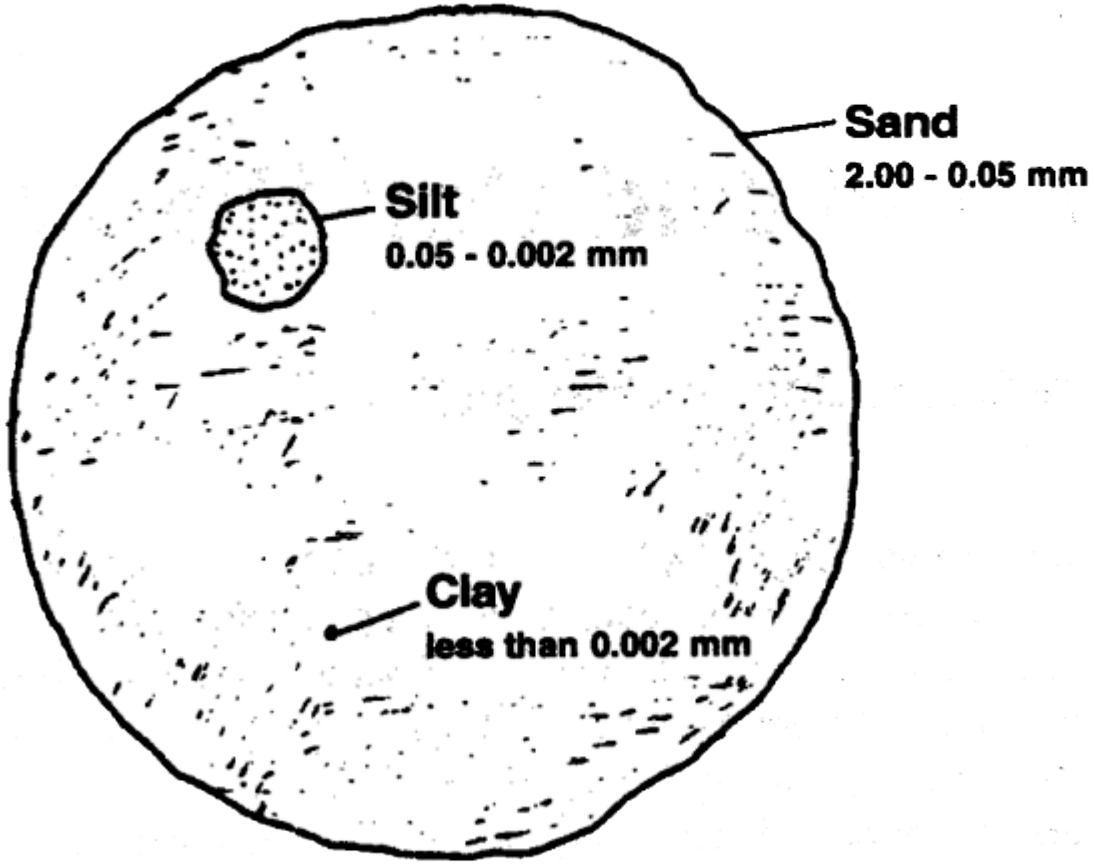


Image credit: USDA-NRCS



WATER MOVEMENT & SOIL TYPE

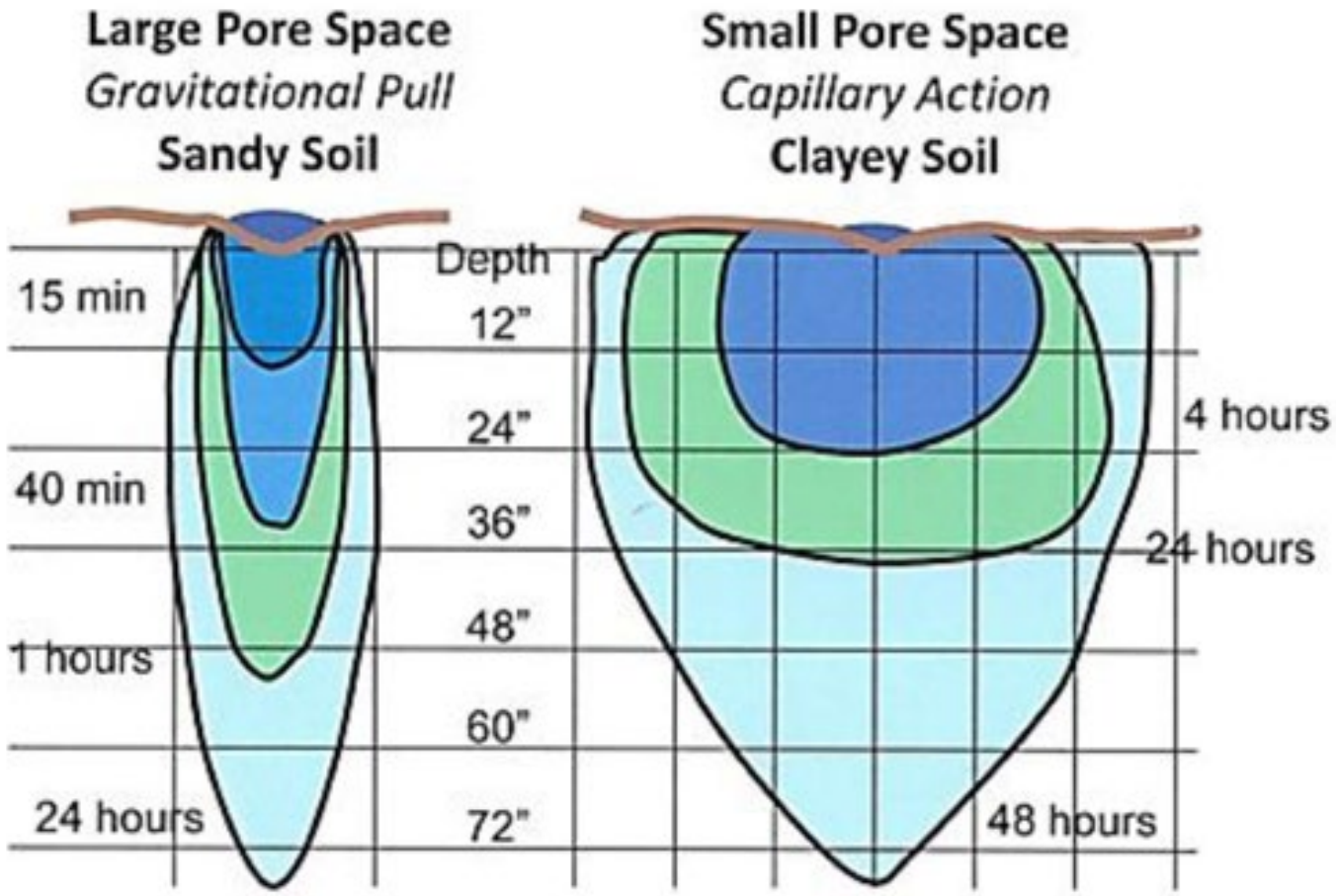


Photo credit: Colorado State University Extension

ASSESSING SOIL MOISTURE

- **Feel approach:**
  Using visual and tactile clues to determine general soil moisture
    - Easy, but subjective

- **Water Budget Approach:**
  Calculate water loss to ET and schedule irrigation accordingly
    - Informative, but general

- **Measured Approach:**
  Using tools, such as a tensiometer, to understand soil moisture
    - Precise, but requires equipment

UNITS OF WATER MEASUREMENT

Acre-inch – Volume of water required to cover one acre of land with one inch of water (equivalent to 27,154 gallons)

Gallons per Minute (gpm) - The number of gallons distributed through a system in one minute. Measure of *flow.*

Pounds per Square Inch (psi) - Common unit of *pressure* in an irrigation system.

Appendix 4: 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.	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.	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 moderate to high.	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.	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.

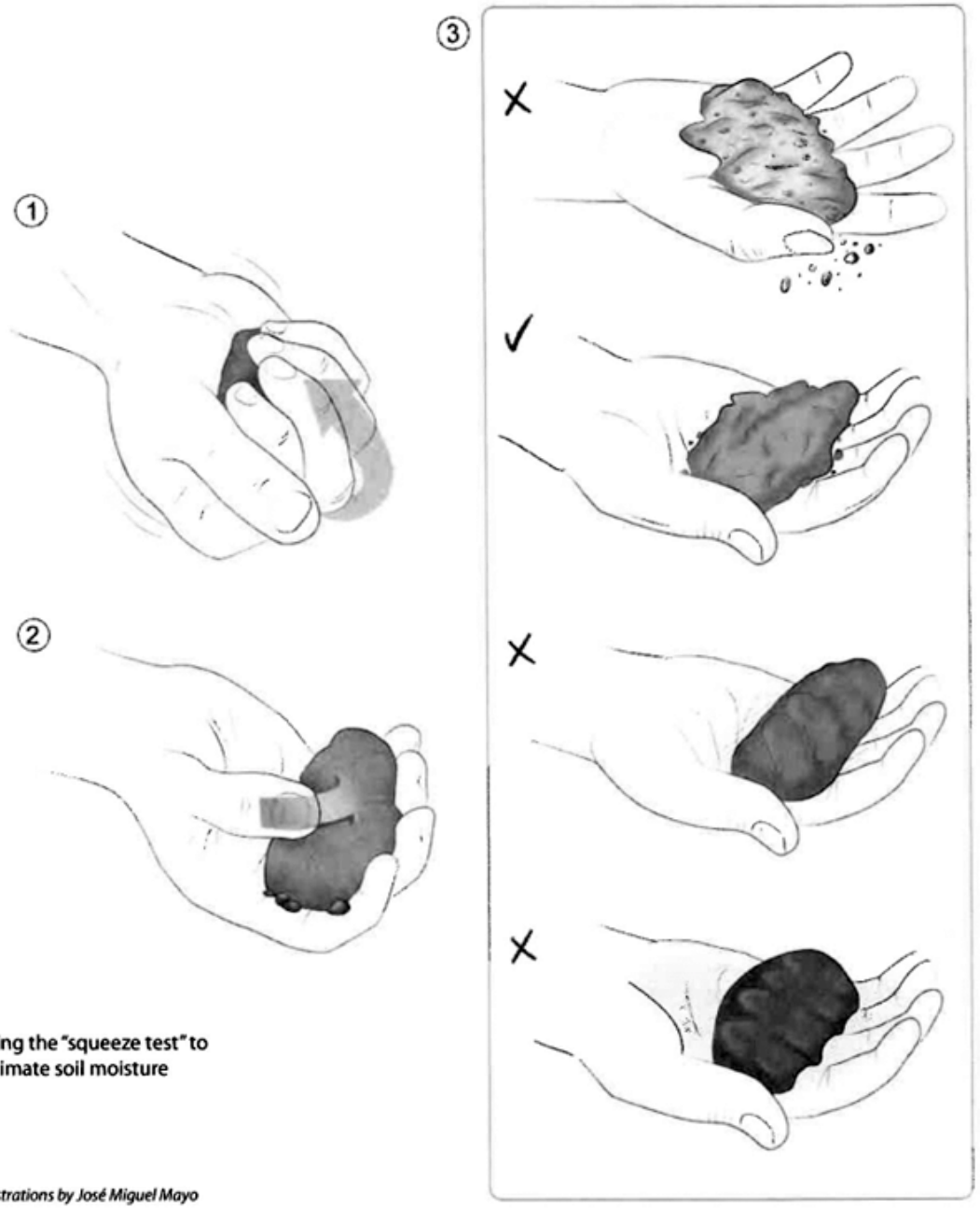
[1] Ribbon is formed by squeezing and working soil between thumb and forefinger

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

See also:

USDA, Natural Resources Conservation Service. 1998. Estimating Soil Moisture by Feel and Appearance. Program Aid Number 1619. *www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/newsroom/?cid=nrcs144p2_056492*

Table credit: UC Santa Cruz



Using the "squeeze test" to estimate soil moisture

Illustrations by José Miguel Mayo

WATER BUDGET APPROACH

- Determine ET Rate
  - July avg = 1.02”/week for Bangor, ME
  - 1 acre-inch = 27,154 gallons
  - Accounting for ET, 1.02 * 27,154 = **27,697 gallons/acre**

- Example field: 20 beds @ 300’, two drip lines
  - Bed width is 6’, so one bed is 1800 sq ft, or .04 acres
  - 20 beds = **0.82 acres**

- 0.82 acres * 27,697 gallons/acre = **22,711 gallons needed per week**

- Calculate run time
  - Drip tape flow rate is 0.45 gpm/100’
  - One bed has 600’ of tape – 0.45 gpm x 6 = 2.7 gpm/bed
  - 2.7 gpm/bed * 20 beds = 54 gpm for entire field
  - 22,711 gal/54 gpm = ***420 minutes or 7 hours***

USING A MOISTURE METER

- Different types – tensiometer or granular matrix/digital meter
- Placed at various depths in different soil types
- Measure in centibars
- Threshold readings depend on soil type (heavier = higher)
- *Theoretically should remove guesswork and provide an accurate snapshot of current conditions*

Photos courtesy of Irrometer

IRRIGATON SCHEDULING

What do we need to know?

- Soil and plant details:
  - General plant requirements
  - Growth stage
  - Soil type
  - Production system (i.e. mulch?)
- How much water?
  - Based on soil moisture, weather, etc
- Irrigation system capacity
  - Water source
  - Pressure and Flow

IRRIGATON SCHEDULING

- Field A is planted to a **multi-acre tomato trial** that is **flowering and fruiting**. It is planted on **black plastic mulch** into a field with **silt loam soils**. Our calculations show we need to run the kit for **6 hours** to provide sufficient water. We have access to **surface water** and a **high-volume pump**.

- What schedule/type of kit is appropriate?

IRRIGATON SCHEDULING

- Tomatoes like to dry down between irrigation events. Their roots are also deeper than other vegetable varieties. They are flowering and fruiting, meaning there are more mature than a small seedling.
- Black plastic mulch will help retain water.
- Silt loam soils are heavier, meaning we should run kits longer, but less frequently.
- It is a large planting, but we have sufficient water/capacity in our system.

Recommended – one drip run at 6 hours per week, ideally timed at the end of the day

IRRIGATON SCHEDULING

- Field B has a **recently-seeded carrot** trial that is on 0.15 acres. It has sandy **loam soil** and we have access to a **pond** and a **small transfer pump.** Our calculations show that we should run our kit for **280 minutes per week** to put down **1" of water**.

- What schedule/type of kit is appropriate?

IRRIGATON SCHEDULING

- Light soils benefit from frequent, shorter applications to reduce drainage loss.
- The carrots were just seeded, so they need consistently moist soils to encourage germination. We will be thinking about evaporation, but transpiration is not a factor since there is no aboveground tissue.
- The planting is small, and we sufficient water/pressure, so a small overhead kit is best.

Recommended – 2 runs @ 20 minutes each day until the crop germinates

OTHER IMPORTANT NOTES

- Water requirements fluctuate based on stage of production and individual crop needs.
- Most crops require irrigation when soil moisture drops to 50% field capacity.
- Overapplication of water wastes time, money, and fuel, and can also lead to crop stress. Excessive water can also leach nutrients and lead to increased weed germination. Lastly, overapplication of water can prevent deep rooting, making crops more dependent on frequent irrigation.
- Water stress can increase susceptibility to pests and pathogens and reduce nutrient uptake.

Photo courtesy Alabama A&M/Auburn Cooperative Extension

IN SUMMARY

- Water is important!
- Too much or too little can cause problems.
- There are many tools to help you make management decisions. Use them to your advantage
- Knowing your soils and crop stages is the first step.

RESOURCES

Johnny's Grower's Library – Watering & Irrigation:
https://www.johnnyseeds.com/search/?fdid=watering-irrigation

Clemson Soil Texture Analysis Jar Test:
https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/

Estimating Soil Moisture by Feel:
https://www.canr.msu.edu/uploads/235/67987/lyndon/FeelSoil.pdf

USDA Web Soil Survey:
https://websoilsurvey.nrcs.usda.gov/app/

NWS Evapotranspiration - Water Management Aid:
https://www.weather.gov/ict/Evapotranspiration

Knott's Handbook for Vegetable Growers
https://www.wiley.com/en-us/Knott%27s+Handbook+for+Vegetable+Growers%2C+6th+Edition-p-9781119811176

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