Miami-Dade County Agriculture and Plant Oxygen Stress

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10-15-15

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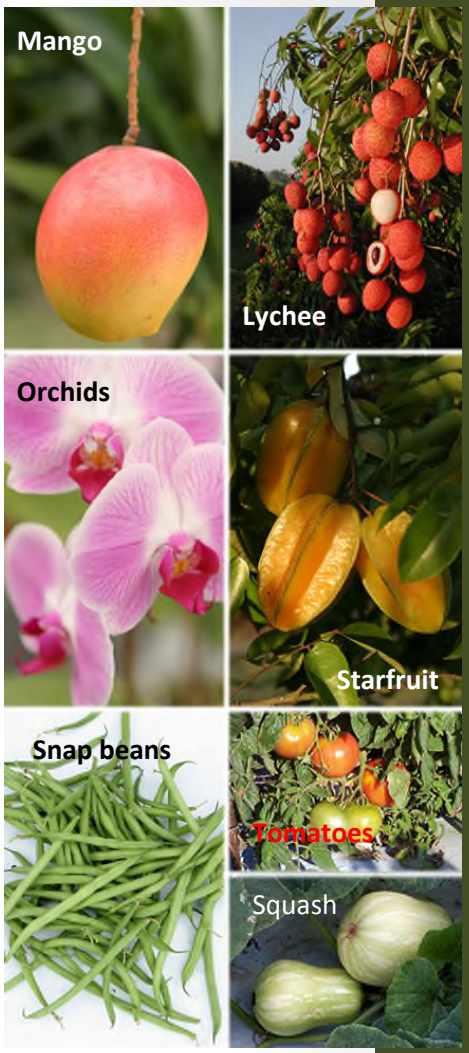
Agricultural Industries

- The agricultural industry has an annual farm gate value to the local/regional economy of over $850 million.
- Multiplier effects make agriculture's impact on the local economy worth over $1 billion annually.
- Out of Florida's 67 counties Miami-Dade County is no. 2 in agricultural value.
- Provides in excess of 25,000 jobs.



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So why is agriculture in south Florida?

- Climate – marine warm subtropical
- Economic opportunities due to climate
- Vegetable crops – market windows and demand
  - For many crops – fall-winter period is best
    - because very few other locations in the US can grow and supply consumers with fresh vegetables
    - disease problems are decreased during the dry season
    - Local, regional, and national ethnic market demand due to demographic diversity (e.g., Hispanic- and Asian American populations)

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So why is agriculture in south Florida?

- Fruit and ornamental crops – market windows and demand
  - Many of the crops grown in Miami-Dade County cannot be grown anywhere in the continental US (e.g., specific palm and orchid species, tropical fruits – mamey sapote, tropical-avocados, papaya, etc.)
  - Local, regional, and national ethnic market demand due to demographic diversity (e.g., Hispanic- and Asian American populations)

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Soils – two main types

Rockland types

- Krome very gravelly loam
- Chekika very gravelly loam
- Hard porous oolitic limestone bedrock
- Rock-plowed/trenched
  - Calcium carbonate rock fragments mixed with sand, silt, clay, organic matter

Marl types

- Biscayne marl
- Biscayne gravelly marl*
- Pennsuco marl
- Perrine marl
  - ➢ Very fine calcium carbonate – silt-loam texture

*, transition type

Potentially well-drained

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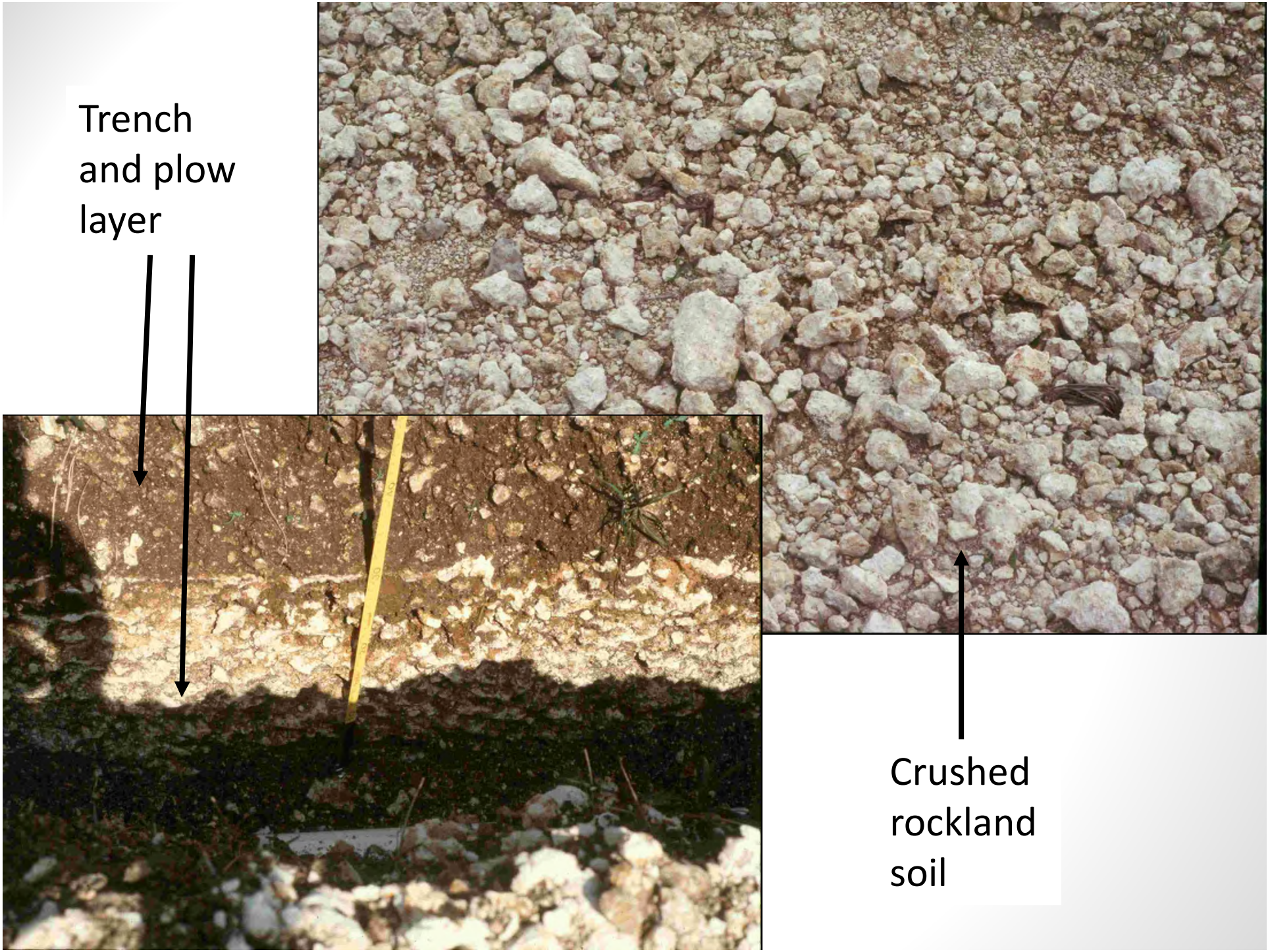
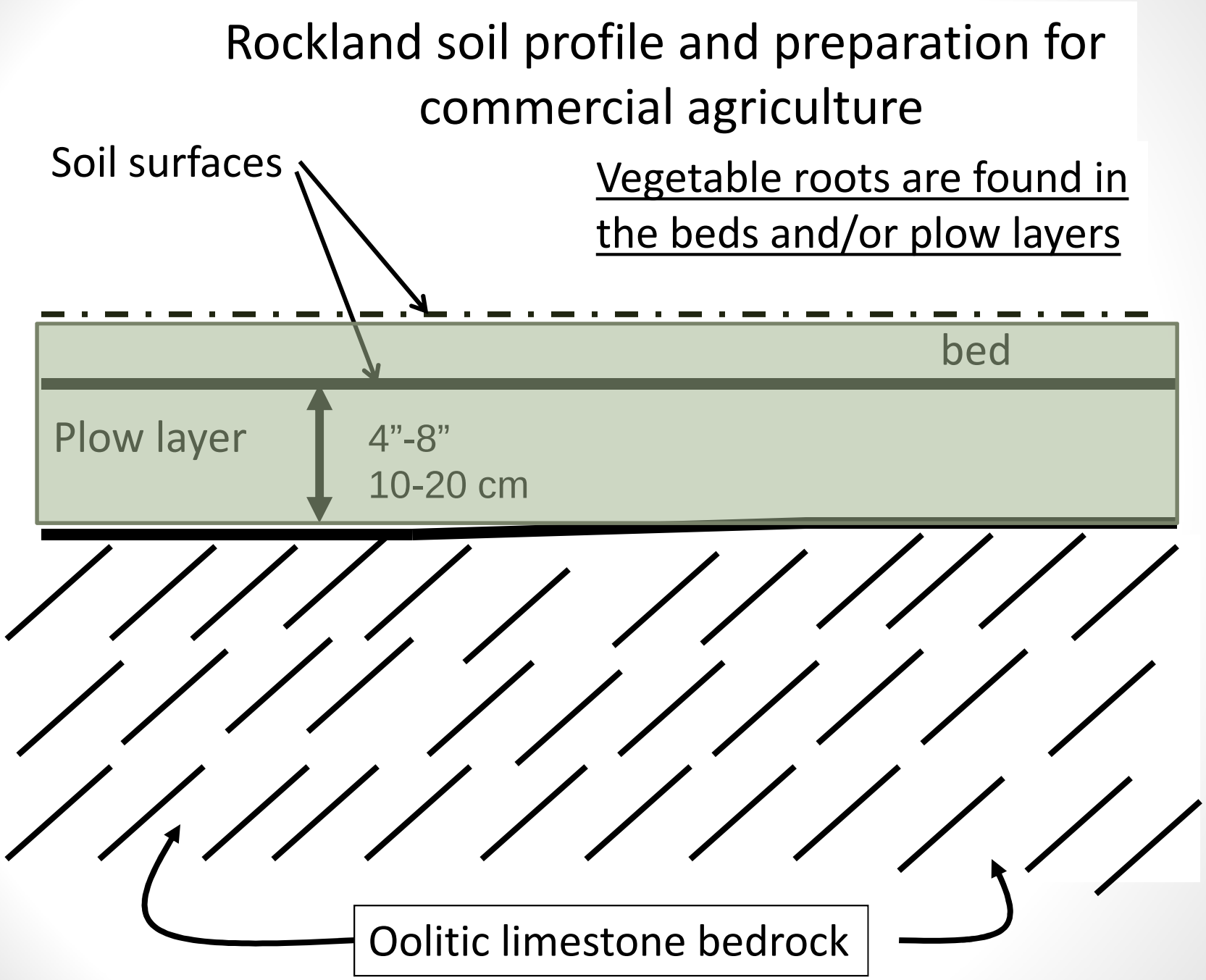
Land preparation for groves and vegetable fields

Rock plowing

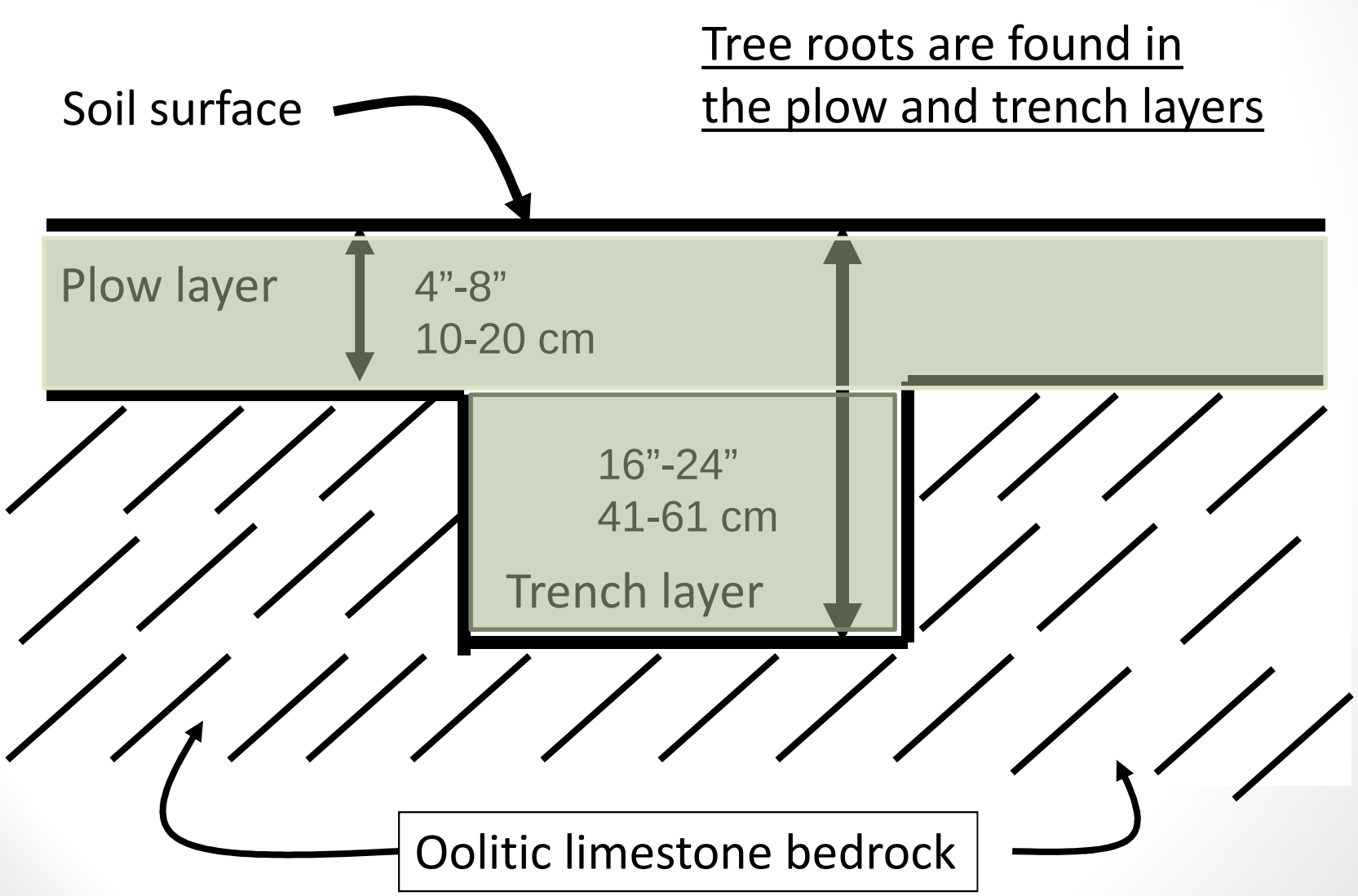
Rock trenching for groves


Trench and plow layer
Crushed rockland soil

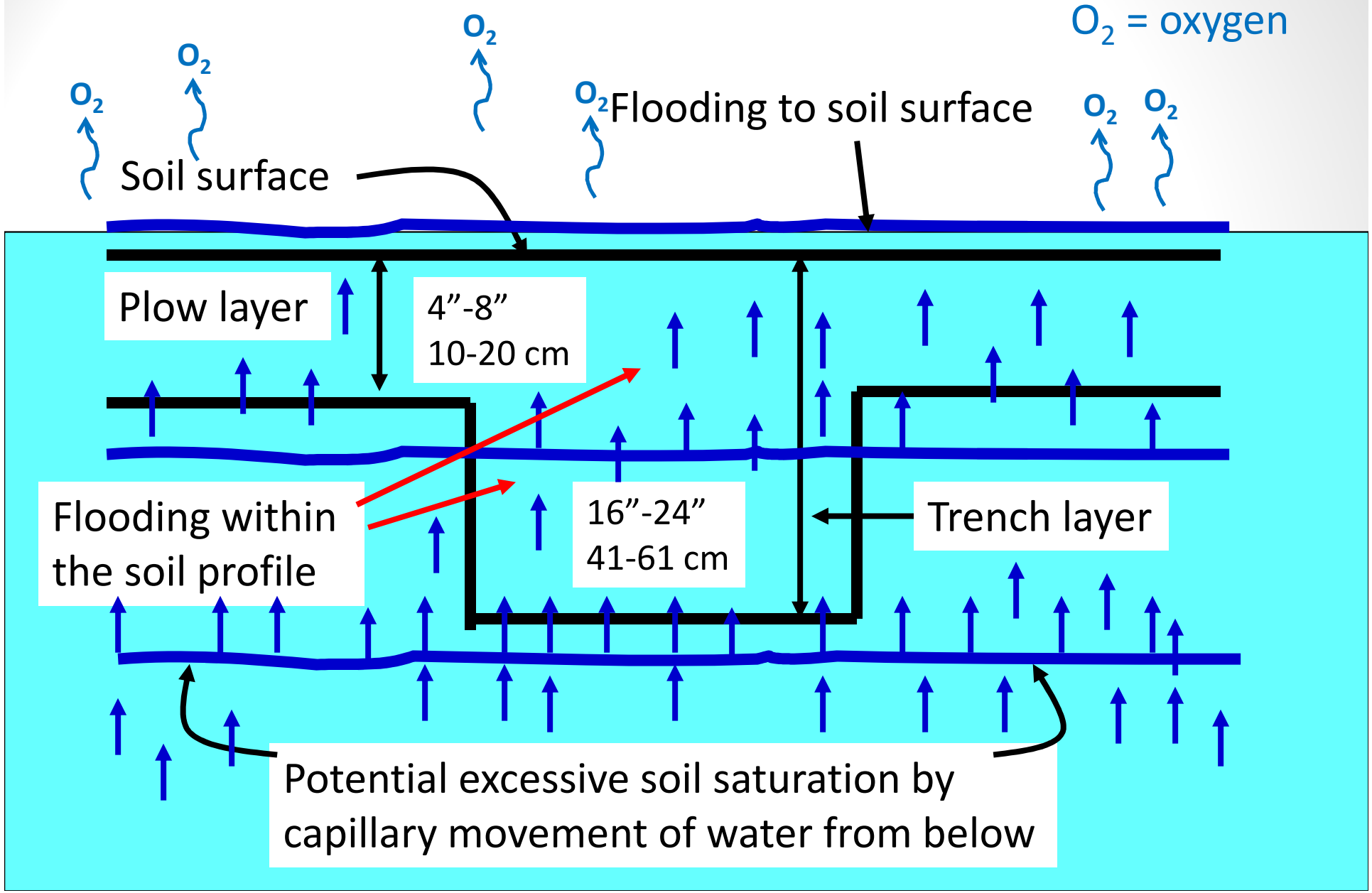
Rockland soil profile and preparation for commercial agriculture



Rockland soil profile and preparation for commercial agriculture



Flooding from below – water table and capillary rise



Factors involved in flooding stress of plants

- Climate and weather
  - Season
  - Temperatures, vapor pressure deficit
  - Cloudiness and rainfall frequency and amount
- Plant species
  - Physiological, biochemical, and morphological adaptations
- Soil type
  - Soil texture
  - Soil depth
  - Soil moisture holding capacity
- Duration of flooding or excessive soil moisture

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Basic effects of flooding

Soils

- Loss of oxygen
  - Hypoxic conditions
  - Anaerobic conditions
- Increased carbon dioxide
- Changes in chemical state of soil elements
- Drastic change in microbial populations

Plants

- Root oxygen starvation
  - Root die-off
- Metabolism changes from aerobic to fermentation pathways (energy starvation)
- Gas exchange (no growth)
  - Stomatal closure
  - Carbon assimilation ceases
  - Water uptake ceases
  - Nutrient uptake ceases
- Fungal pathogens colonize root system
- Plant decline > death

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Flood tolerance - definitions

- Tolerant – Flood tolerant crops will survive excessively wet (high water table) and flooded conditions for several days to a few weeks. However, the stress of wet soil conditions reduces growth and production. In addition, root disease may develop resulting in plant damage or death.
- Moderately tolerant – Moderately flood tolerant crops will survive several days of excessively wet or flooded soil conditions. However, the stress of wet conditions reduces tree growth and production. In addition, root disease may develop resulting in tree damage or death.

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Definitions for flood tolerance

- Not tolerant – Trees not tolerant of wet or flooded soil conditions may sustain heavy damage or be killed by a day or few days of wet soil conditions.

Note 1: Soil borne diseases will greatly influence plant reaction to and recovery from flooding.

Note 2: Even with flood tolerant crops, the performance of cultural practices under excessively wet/flooded conditions is impossible (e.g., access and weed control).

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Flood tolerance vegetable crops

- Most vegetable crops have little to no flood tolerance (e.g., tomato, corn, and squash and root crops).
- Even those plants termed tolerant when exposed to short duration (hours/days) of flooding under disease-free environments lose potential yield (i.e., never reach their potential) such as some bean crops and some pepper.
  - However, in-field conditions, fungal pathogens attack roots and stems and result in plant decline and death

Tomato	**1-2 days**	**Eggplant**	**2 days**
Green beans	1 day	Corn	2 days
Squash	1-2 days	Root crops	rot

Flood tolerance rating of tropical fruit crops

Tolerant	Moderately tolerant
• *Annona* sp. grafted on *A. glabra (not available)*	• 'Tahiti' lime (rootstock dependent)
• Guava	• Canistel
• Sapodilla	• Mango
• Caimito	• Banana
• Coconut	• Lychee
• Grafted citrus (rootstock dependent)	• Longan

However, not even flood tolerant fruit crops will be productive if consistently exposed to prolonged excessively wet soil conditions or periodic flooding.

Flood tolerance rating of tropical fruit crops

Not tolerant

- Avocado*
- Papaya*
- Mamey sapote
- Sugar apple*
- Atemoya
- Passion fruit*
- Jackfruit

Variables involved in tolerance

- Flooding duration
- Flooding depth
- Temperatures
- Tree health
- Stage of growth (e.g., with/without fruit)
- Disease susceptibility

*, key indicator plants of flood damage

Symptoms of flooding stress

- Leaf wilting
- Reduce leaf size
- Chlorosis/nutrient deficiencies
- Leaf abscission
- Stem dieback
- Reduced flowering and fruit set
- Reduced fruit size
- Fruit abscission
- Reduced crop yields
- Reduced fruit quality
- Greater “alternate bearing”
- Increased susceptibility to damage from other stresses and diseases
- Tree death

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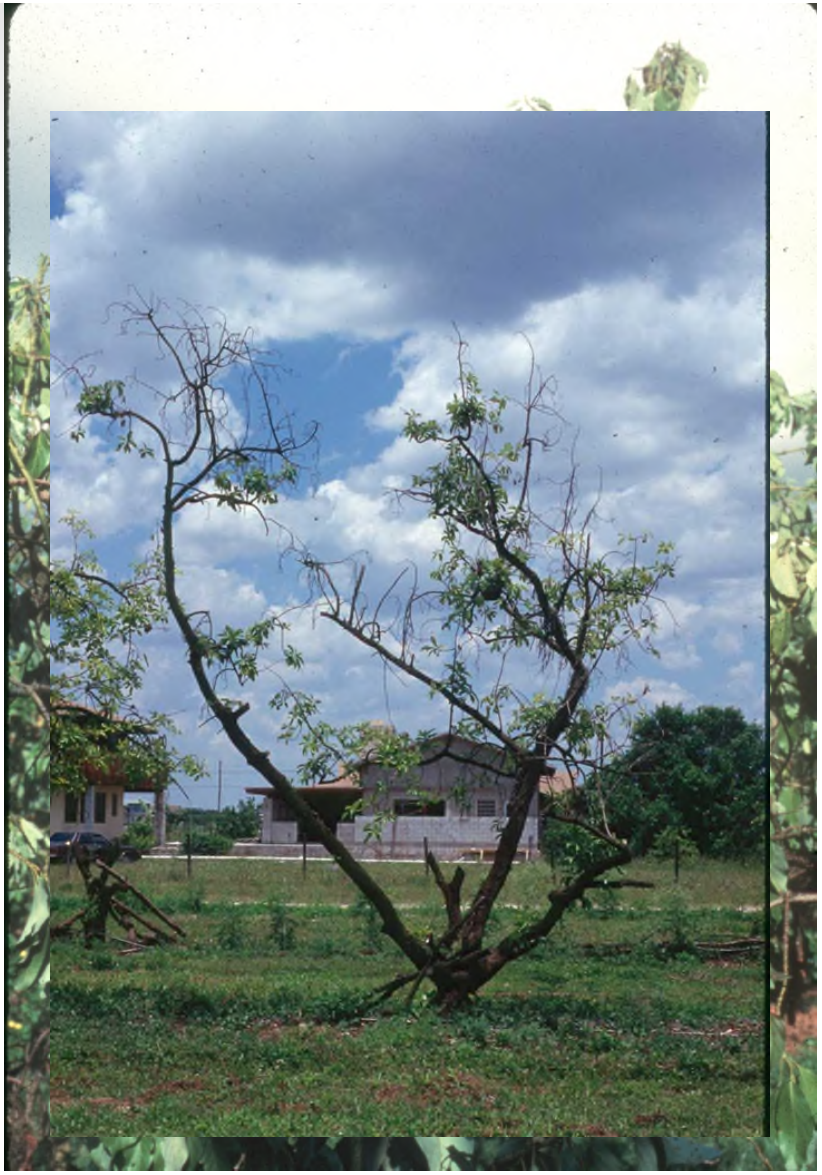

Avocado flooded, note wilting; within of 24 h flooding

Papaya within 24 h of flooding

‘Arkin’ carambola leaf chlorosis

Mamey sapote tree death

Occasional flooding of mango

Flooded green bean field

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Pros-cons possibilities to prevent and/or ameliorate flood damage

- Bedding: potential for some of root mass to be above saturated/flooded conditions
  - If standing water in row-middles and/or high water table, capillary rise of water saturates bed - hypoxia
  - Root diseases, root death, plant decline , plant death
  - Weed control difficult to impossible when constantly saturated
  - Vehicle access difficult to impossible when saturated and/or flooded
  - Harvesting and food safety issues – you cannot harvest flooded crops

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Pros-cons possibilities to prevent and/or ameliorate flood damage

- Fungicides
  - Must be applied prophylactically (i.e., before flooding or soil saturation) to protect roots and stems
  - Very costly to purchase and apply
  - Availability issues (i.e., limited or no products registered)
  - Disease resistance issues
  - Pre-harvest interval issues
- Foliar nutrients (primarily KNO_3)
  - Experimental on some crops – inconsistent results
  - Access to planting difficult (i.e., it's flooded or saturated)
  - Does not prevent root pathogens (root rot)

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Pros-cons possibilities to prevent and/or ameliorate flood damage

- Oxygen fertilizer
  - Experimental – inconsistent results, pH issues, cost, not available
- Foliar application of plant growth regulators (PGRs)
  - Cytokinins, abscisic acid, aliphatic alcohols
  - Experimental on some crops – inconsistent results
  - Access to planting difficult (i.e., it's flooded or saturated)
  - Does not prevent root pathogens (root rot)
  - Expensive to purchase and apply

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Pros-cons possibilities to prevent and/or ameliorate flood damage

- Use of flood tolerant rootstocks
  - Some available for some fruit crops (in Florida primarily citrus)
  - Some experimental work for tropical fruit crops – inconsistent results (e.g., pond apple)
  - None available for most fruit crops (e.g., avocado, lychee, *Annona*) and vegetable crops
  - Some experimental work with vegetables – inconsistent results and the rootstocks caused other physiological problems
  - Cost considerations – may be uneconomic

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Questions?

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South Florida's marine subtropical climate

- Surrounded by water on 3 sides results in generally less extreme cold and warmer temperatures than mid- and north in the state.
- The closer to the coast the warmer and less variation in temperatures throughout the year.
- Mean annual temperature is 74°F.
- Mean annual rainfall is 65 inch but varies from year to year and has ranged from 38-95 inches.
- Tendency for 2 rainfall peaks, late June-July and late Sept.-Oct.

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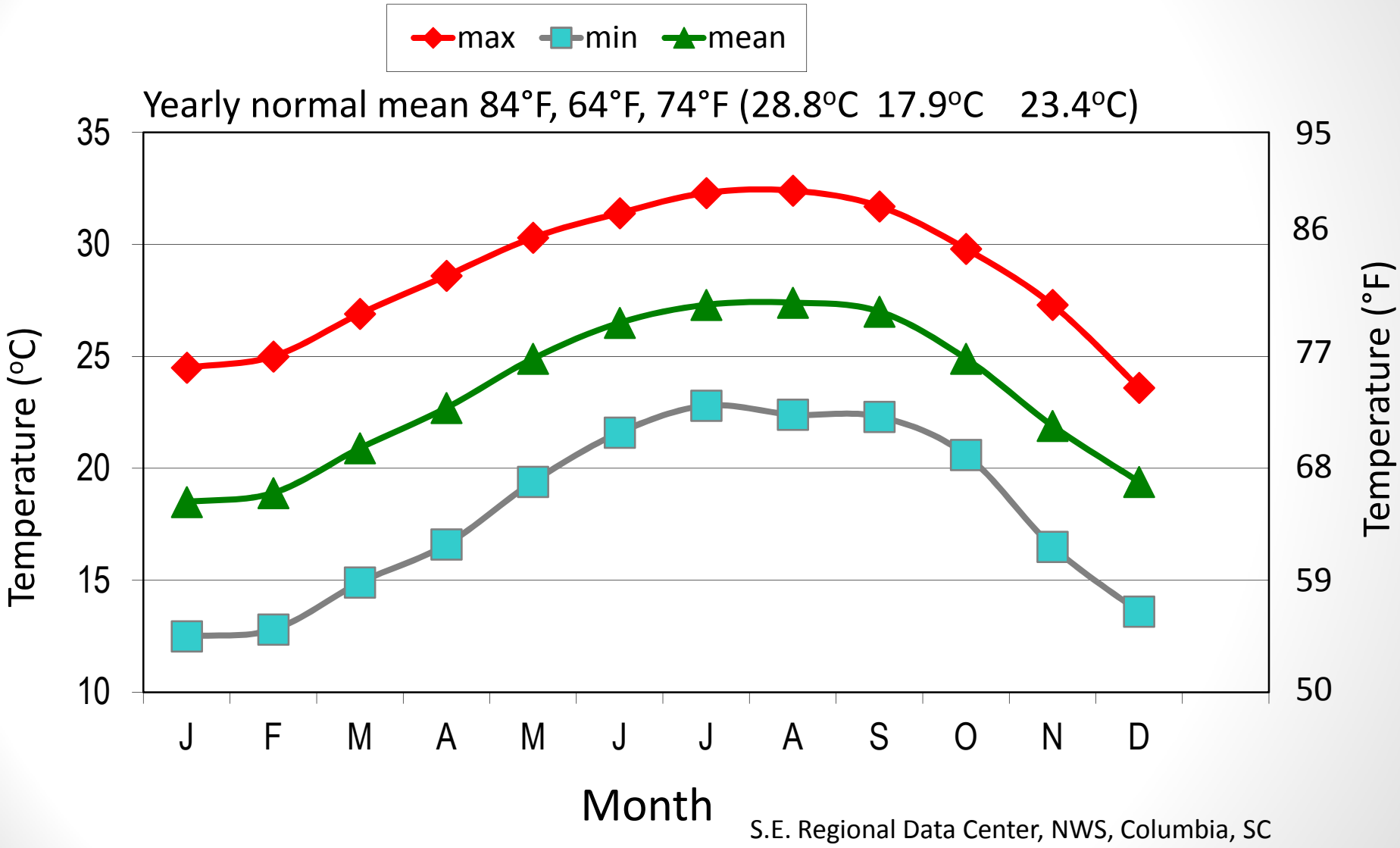
Thirty year average (1961-1990) temperatures for Homestead, Florida



S.E. Regional Data Center, NWS, Columbia, SC

Average rainfall for Homestead (60 yr average) and Miami (30 yr average), Florida