UF/IFAS Extension
The Journey to Sustainability Begins with Education

UF/IFAS Sarasota County Extension
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Organic Food Gardening
*Vegetable Crops, Cultivars and Ecology*

Robert Kluson
Ag/NR Extension Agent
UF/IFAS Sarasota County Extension
Introduction

• Objectives of Presentation Series
  – Food for your freshest nutrition
  – Food for expanded community benefits
  – Food for thought
  – Food for your soul
Syllabus of Presentation Series

• Introduction to Organic Vegetable Gardening
• Soil Management
• Crop Management
• Pest Management
• Water Management
• Cover Crops
• Advanced Composting
Introduction

• Objectives of this presentation
  – Provide the concepts, and science from agroecology of crop management practices used in organic vegetable gardening
  – Provide resources in the management practices of crops, in addition to our text “Vegetable Gardening in Florida” by James Stephens, UF/IFAS
    • 3 seasons are possible (fall, spring, summer)
    • Large variety of crops are possible
Today’s Outline

• Vegetable Crops & Cultivars
  – Domestication history
  – Categories
  – Growing requirements

• Biology & Ecology
  – Organic Vegetable Gardens as an Agroecosystem
First, Some ‘Food For The Soul’ About Vegetable Crops

The first gatherings of the garden in May of salads, radishes and herbs made me feel like a mother about her baby – how could anything so beautiful be mine? And this emotion of wonder filled me for each vegetable as it was gathered every year. There is nothing that is comparable to it, as satisfactory or as thrilling as gathering the vegetables one has grown.

- Alice B. Toklas
Vegetable Crop Diversity
Food Crop Diversity

- Plant parts as vegetables
  - Leaf
  - Stem
  - Root
  - Seed
- Herbs (culinary)
- Fruits
- Medicinal
- Flowers (nursery & edible)
Vegetable Crop Diversity

Peppers

Watermelon

Calabaza

Pumpkins
Crop Diversity & Seasonality in Florida

<table>
<thead>
<tr>
<th>Crop</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
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www.Florida-Agriculture.com
Vegetable Categories that Can be Grown Successfully in Southcentral Florida

- **Temperate**
  - Broccoli

- **Subtropical**
  - Sweet Potato

- **Tropical**
  - Amaranth
Vegetable Crop Variety Information

✓ EDIS Publications (http://edis.ifas.ufl.edu/)
✓ UF/IFAS Research & Education Centers - Food Crop Trials Reports & Publications
✓ E.C.H.O., North Ft. Myers, FL (http://www.echonet.org/)
Vegetable Crop Variety Information

• Seed Company Examples
  – SE USA Region
    • E.O.N.S. (http://www.eonseed.com/)
    • FL Tomato Growers Supply Company (http://www.tomatogrowers.com/)
    • Southern Exposure See Exchange (http://www.southernexposure.com/index.html)
    • E.C.H.O. (http://www.echonet.org/)
  – USA Region
    • Seed Savers Exchange (http://www.seedsavers.org/)
    • Johnny’s Selected Seeds (http://www.johnnyseeds.com/default.aspx)
    • Seeds of Change (http://www.seedsofchange.com/default.aspx)
Vegetable Crop Diversity

- **How Did Crops & Cultivars Originate?**
- Crop domestication = human-induced plant adaptation
- Centers of crop origin have wild relatives of the crop.
- Hybridization and polyploid formation are important driving forces in crop evolution
- In each *center of origin* numerous crops were domesticated
- Genetic diversity can be measured at the molecular level
- Genetic diversity was lost as a result of domestication
- Loss of genetic diversity may allow disease epidemics
Hybridization and polyploidization of weeds produced crops!

- **B. campestris**: turnip
  - $2n = 2x = 20$
  - AA

- **B. juncea**: brown mustard
  - $2n = 4x = 36$
  - AA BB

- **B. nigra**: black mustard
  - $2n = 2x = 16$
  - BB

- **B. napus**: rapes, swedes
  - $2n = 4x = 38$
  - AACC

- **B. oleracea**: cabbages, kale
  - $2n = 2x = 18$
  - CC

- **B. carinata**: Ethiopian mustard
  - $2n = 2x = 34$
  - BBCC

Rapeseed/canola
Just a few mutations produced these different crops from one ancestor of *Brassica oleracea*.
A number of plants (corn, beans, peppers) were domesticated in the cool tropical highlands of Mexico. Many species of teosinte - the progenitor of modern corn - grow wild in Mexico, often in close proximity to corn fields (see below). Teosinte is a wild grass with nutritious seeds but seeds that readily disperse (brittle rachis) and are encased in a hard fruit (casing).
Origin of corn (Zea mays)
Modern maize has genes from two different species of teosinte (parviglumis and mexicana)

Corn evolved from small forms (< 2 cm, 4 rows) to larger, multi-row forms (> 13 cm, >8 rows) by A.D. 1500.
Vegetable Crop Agriculture

## Historical perspectives

<table>
<thead>
<tr>
<th>Time-line (yrs)</th>
<th>Archaic  - 250,000</th>
<th>hunting-gathering, nomadic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prehistoric</td>
<td>15,000</td>
<td>domesticated plants and grazers</td>
</tr>
<tr>
<td>Ancient</td>
<td>5,000</td>
<td>soil cultivation, irrigation</td>
</tr>
<tr>
<td>Medieval</td>
<td>1,500</td>
<td>deep plowing, manure, selection, profit</td>
</tr>
<tr>
<td>Modern</td>
<td>200</td>
<td>scientific approach</td>
</tr>
<tr>
<td>Contemporary</td>
<td>50</td>
<td>industrialization, ecological sustainability (?)</td>
</tr>
</tbody>
</table>
Centers of origin of selected crops

Note: The pointer locations indicate general regions where crops are believed to have first been domesticated. In some cases, the center of origin is uncertain. Other geographic regions also harbor important genetic diversity for these crops.

Source: This map was developed by the General Accounting Office using data provided by the National Plant Germplasm System's Plant Exchange Office.
Facts from Crop Origins

- Crops have been moved globally from their centers of origin in the course of agriculture development.
- Crops have been selected by farmers & gardeners for adaptation to local conditions.
- ‘Heirloom’ cultivars are not necessarily adapted to your local conditions and need to be evaluated for successful cultivation.
Short History of Crop Breeding

• Domestication
  – Traditional selection
  – Open pollination
  – Land races; Heirloom cultivars

• Classical Breeding
  – Hybrid cultivars

• Modern Breeding
  – Plant tissue culture
  – Induced mutations

• Molecular Breeding
Loss of genetic diversity as a result of domestication and selection

Wild species  --  Early domesticates  --  Modern varieties
Land races

Relative reproductive isolation and differing conditions of soil, nutrients, diseases, insects, water, day length etc created numerous landraces of our crops. However, subsistence farmers are always trading seeds, so land races are not static entities, but their genetic make-up changes. All land races of one species have the same genes (unless deletions occurred), but many different alleles.
Hybrid Crop Breeding Example

Hybrid Crop Varieties Are Allowed in Organic Gardening
Molecular Crop Breeding Example

“GMO” Crop Varieties Are **Not** Allowed in Organic Gardening
Alternative Crop Variety Information

- Cornell Univ. Horticulture Department’s Vegetable Varieties for Gardeners Project
  - a ‘Citizen Science’ Program
  - Review and participate in online feedback of experience with specific cultivars
  - see http://vegvariety.cce.cornell.edu/
Participatory Plant Breeding

• Why not depend on conventional crop breeding programs?
  – Trials not done on sustainable and diversified agroecosystems
  – “Minor crops” not covered
  – Costs and patent restrictions of commercial cultivars
  – Concentration of crop seed industry
  – Site specific conditions
• **Organic Seed Partnership**
  – Originated from “Public Seed Initiative” Project
  – National trialing network
  – Farmers as breeders, selectors and evaluators
  – Supported by regional research centers in 6 states (FL initiated in 2010!)
  – Germplasm originates from local small businesses
  – Marketed with partner small seed companies
Participatory Plant Breeding Example Program

- **Organic Seed Partnership**
  - Cornell University
  - Several small seed companies
  - Organic farmers

- **Results**
  - Since 2001, released 15 vegetable cvs
    - Squash, arrugula, potatoes, tomatoes, peppers
    - Example: Bush Delicata – powdery mildew resistant “sweet potato” squash (now sold by Johnny’s Select Seeds)
Participatory Plant Breeding
Example Program

• **Organic Seed Partnership**
• **Available cvs & training for trails**
  – Cucumber, melon, onion, pepper, summer squash, tomato, winter squash
• **Requires signed Materials Transfer Agreement by each grower**
• **An excellent opportunity for a cooperative project with Sarasota County Community Gardeners ?!**
## Crop Biology

<table>
<thead>
<tr>
<th>MONOCOTS</th>
<th>DICOTS</th>
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<tbody>
<tr>
<td><strong>Cotyledons</strong></td>
<td><strong>Two cotyledons</strong></td>
</tr>
<tr>
<td><strong>Veins in leaves</strong></td>
<td><strong>Usually netlike</strong></td>
</tr>
<tr>
<td><strong>Flower parts</strong></td>
<td><strong>Usually in fours or fives</strong></td>
</tr>
<tr>
<td><strong>Arrangement of primary vascular bundles in stem</strong></td>
<td><strong>In a ring</strong></td>
</tr>
</tbody>
</table>

- **MONOCOTS**
  - Cotyledons: One cotyledon
  - Veins in leaves: Usually parallel
  - Flower parts: Usually in multiples of three
  - Arrangement of primary vascular bundles in stem: Scattered

- **DICOTS**
  - Cotyledons: Two cotyledons
  - Veins in leaves: Usually netlike
  - Flower parts: Usually in fours or fives
  - Arrangement of primary vascular bundles in stem: In a ring
• Is a Potato a Root Crop?
NO! Its anatomy shows that it’s a stem.
Crop Biology Example

• Is a Sweet Potato a Root Crop?

YES! Its anatomy shows that it’s a root.
Vegetable Crop Diversity

Growth Requirements

• **Moisture**
  – Flooding vs drought tolerance

• **Temperature**
  – Cool vs warm season

• **Light**
  – Full sun vs partial sun vs shade
  – Photoperiod

• **Nutrients**

• **Space & Time**
  – Long vs short season
USDA Crop Hardiness Map

http://www.usna.usda.gov/Hardzone/ushzmap.html
<table>
<thead>
<tr>
<th>Zone</th>
<th>Fahrenheit</th>
<th>Celsius</th>
<th>Example Cities</th>
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<tbody>
<tr>
<td>1</td>
<td>Below -50 F</td>
<td>Below -45.6 C</td>
<td>Fairbanks, Alaska; Resolute, Northwest Territories (Canada)</td>
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<tr>
<td>2a</td>
<td>-50 to -45 F</td>
<td>-42.8 to -45.5 C</td>
<td>Prudhoe Bay, Alaska; Flin Flon, Manitoba (Canada)</td>
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<tr>
<td>2b</td>
<td>-45 to -40 F</td>
<td>-40.0 to -42.7 C</td>
<td>Unalakleet, Alaska; Pinecreek, Minnesota</td>
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<tr>
<td>3a</td>
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<td>-37.3 to -39.9 C</td>
<td>International Falls, Minnesota; St. Michael, Alaska</td>
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<td>-35 to -30 F</td>
<td>-34.5 to -37.2 C</td>
<td>Tomahawk, Wisconsin; Sidney, Montana</td>
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<td>4a</td>
<td>-30 to -25 F</td>
<td>-31.7 to -34.4 C</td>
<td>Minneapolis/St.Paul, Minnesota; Lewiston, Montana</td>
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<td>4b</td>
<td>-25 to -20 F</td>
<td>-28.9 to -31.6 C</td>
<td>Northwood, Iowa; Nebraska</td>
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<td>5a</td>
<td>-20 to -15 F</td>
<td>-26.2 to -28.8 C</td>
<td>Des Moines, Iowa; Illinois</td>
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<td>-15 to -10 F</td>
<td>-23.4 to -26.1 C</td>
<td>Columbia, Missouri; Mansfield, Pennsylvania</td>
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<td>-10 to -5 F</td>
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<td>-15.0 to -17.7 C</td>
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<td>Tifton, Georgia; Dallas, Texas</td>
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<td>-6.7 to -9.4 C</td>
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<td>Brownsville, Texas; Fort Pierce, Florida</td>
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<td>10a</td>
<td>30 to 35 F</td>
<td>1.6 to -1.1 C</td>
<td>Naples, Florida; Victorville, California</td>
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<td>10b</td>
<td>35 to 40 F</td>
<td>4.4 to 1.7 C</td>
<td>Miami, Florida; Coral Gables, Florida</td>
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<td>11</td>
<td>above 40 F</td>
<td>above 4.5 C</td>
<td>Honolulu, Hawaii; Mazatlan, Mexico</td>
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AHS Heat Zone Map
Crop ecosystems have functional properties & subsystems from biodiversity that are beneficial.
Crop Subsystems Examples

**Phyllosphere**
- Above-ground surfaces of plants
- Leaves, shoots, etc.

**Rhizosphere**
- Region immediately outside the root (2-5 mm)
- Below ground bacterial habitat
Plant Leaf Life (Phyllosphere)

Leaf surface

(diagram drawn to scale; bacterial cells are 1 μm long)
Foliar Feeding

• To be efficient and to avoid crop damage, use very dilute solutions of nutrient formulations
• Spray-solution pH should remain in the near-neutral range (5.5-8.5)
• Best effect is achieved when foliar sprays are finely atomized
• Absorption is increased when sprays also reach and coat the undersides of leaves
• Absorption is further enhanced when weather conditions are humid and moist
• Addition of a surfactant to the solution decreases surface tension on the leaf and may increase absorption.

Garden As An Agroecosystem

Hierarchical Scale

- Ecosystem: The farm in the context of its watershed
- Community: Polyculture of intercropped plants, along with other organisms
- Population: Monoculture of the crop plant
- Organism: Individual crop plant
Agroecosystem Garden Example
## Table 16.2 Dimensions of ecological diversity in an ecosystem

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
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<tbody>
<tr>
<td>Species</td>
<td>Number of different species in the system</td>
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<tr>
<td>Genetic</td>
<td>Degree of variability of genetic information in the system (within each species and among different species)</td>
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<tr>
<td>Vertical</td>
<td>Number of distinct horizontal layers or levels in the system</td>
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<tr>
<td>Horizontal</td>
<td>Pattern of spatial distribution of organisms in the system</td>
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<tr>
<td>Structural</td>
<td>Number of locations (niches, trophic roles) in the system organization</td>
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<tr>
<td>Functional</td>
<td>Complexity of interaction, energy flow, and material cycling among system components</td>
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<tr>
<td>Temporal</td>
<td>Degree of heterogeneity of cyclical changes (daily, seasonal, etc.) in the system</td>
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<tr>
<td>Method</td>
<td>Species</td>
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<td>Intercropping</td>
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<td>Strip cropping</td>
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<td>Hedgerows &amp; buffers</td>
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<td>High inputs of organic matter</td>
<td></td>
</tr>
<tr>
<td>Reduction of chemical use</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- Direct or primary effect
- Indirect, secondary, or potential effect
- Little or no effect
Planning a vegetable garden

- Intercropping
- Succession planting (double cropping)
- Relay planting
- Crop rotation
- Companion planting
- Row to row distance
Organic Vegetables

North Port Community Garden, January 2011