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The Journey to Sustainability Begins with Education

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Organic Vegetable Gardening

Companion Planting

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OUTLINE

- Overview of topics of noontime talks on organic vegetable gardening
- Introduction to organic vegetable gardening
- Companion planting: concepts and applications

Topics of Noontime Talks for Organic Vegetable Gardening

- Introduction (Nov 23, 2011)
- Edible Flowers (Dec 7, 2011)
- Container Gardening (Dec 21, 2011)
- Worm Composting (Jan 4, 2012)
- Frost Protection (Jan 11, 2012)
- Composting – Part 1 (Jan 25, 2012)
- Transplants (Feb 8,2012)

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Topics of Noontime Talks for Organic Vegetable Gardening

- Composting – Part 2 (Feb 22, 2012)
- Irrigation (March 14, 2012)
- Raising Honey Bees (March 28, 2012)
- Companion Planting (April 11, 2012) ←
- Cover Crops (April 22, 2012)

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Goals for Noontime Talks on Organic Vegetable Gardening

- Food for your freshest nutrition
- Food for expanding benefits of backyard vegetable gardening
- Food for thought
- Food for your soul

Approach of Noontime Talks on Organic Vegetable Gardening

- Promote the practice of the guidelines in the reference "Vegetable Gardening in Florida" by James M. Stephens. 1999. Univ. of FL, IFAS
- Provide background information on the science and principles from agroecology for successful organic vegetable gardening
- Provide additional resources available for successful organic vegetable gardening

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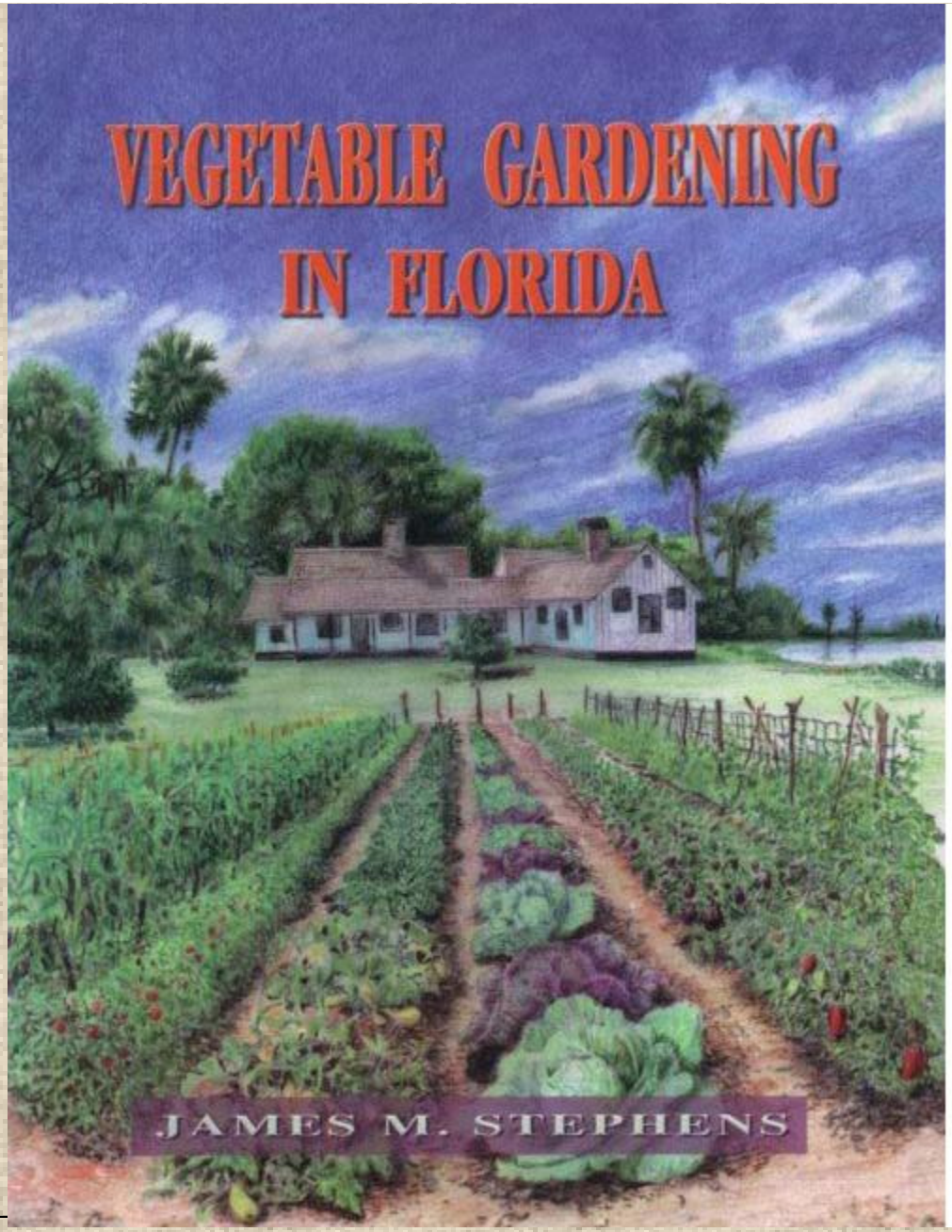

• Available from UF/IFAS bookstore, see http://ifasbooks.ufl.edu/merchant2/
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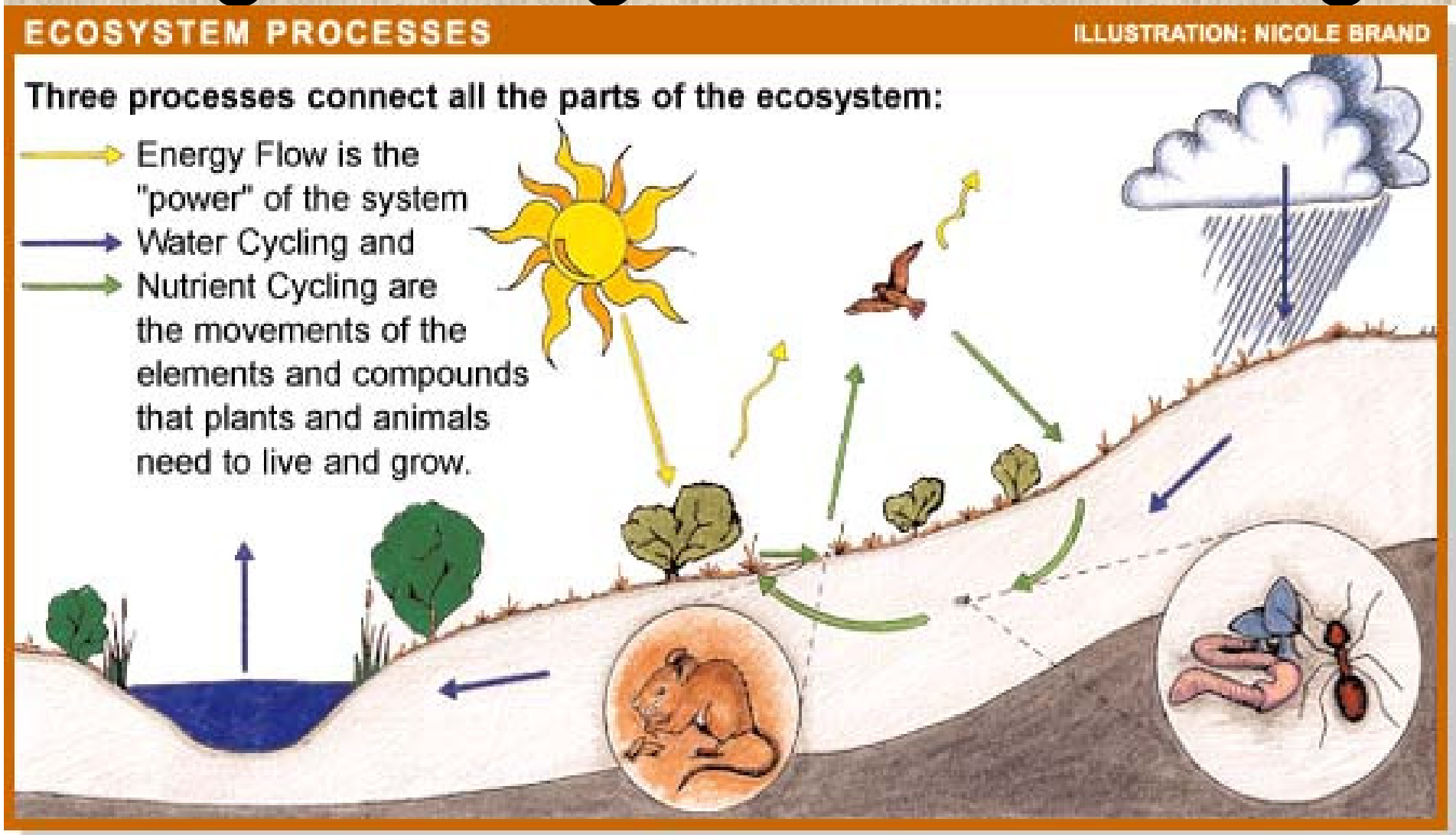
Agroecosystem Concept

- An approach that looks at your vegetable garden as a functional whole of interacting living and non living components, i.e. “whole is more than sum of parts”

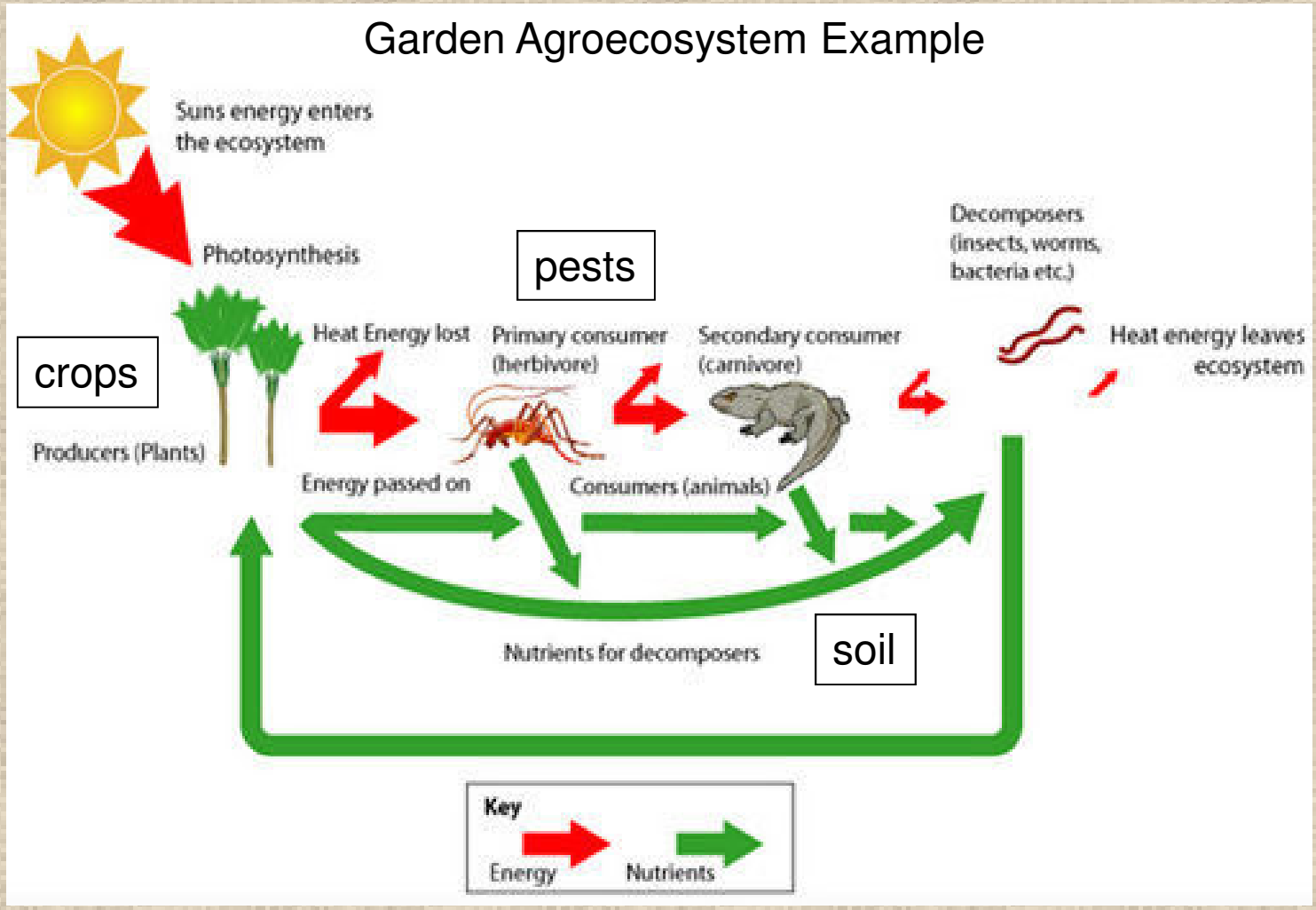
- A science-based management using models from natural ecosystems

Gliessman, S., 1999. Agroecology: Ecological Processes in Sustainable Agriculture

Nature Model for Organic Vegetable Gardening



Organic Vegetable Garden Ecology



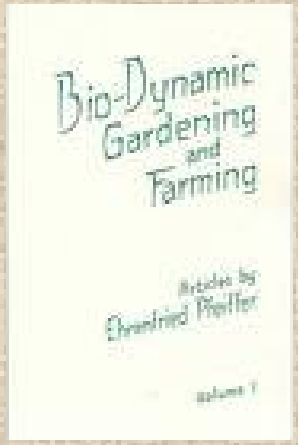
- Garden agroecosystems have functional properties & subsystems from **biodiversity management**

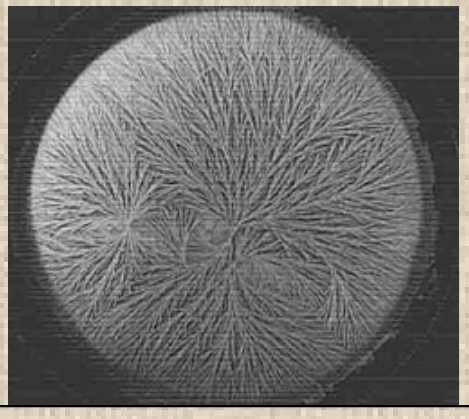
What is Companion Planting?

- It's the establishment of two or more plant species in close proximity so that some cultural benefit that results in higher yields is derived.
- Groups of plants which grow well together are called "companions."

Companion Planting Origins

- Traditional recommendations used by gardeners have evolved from an interesting combination of
  - historical observation
  - horticultural science, and
  - a few unconventional sources (e.g., sensitive crystallization tests by Biodynamic practitioners using solution mixtures of potential companion plants)





Crystallization example

Why Companion Planting?

- Naturalists have known about the interactions among plants for thousands of years
  - For example, about 2,000 years ago the Roman agriculturalist, Varro, declared "Large walnut trees close by, make the border of the farm sterile."
  - Some pest control potential is based on insecticides derived from plants, e.g., rotenone, sabadilla and ryania.
  - Certain trees move groundwater to the soil surface where shallow-rooted plants can grow even under droughty conditions.

Companion Planting Examples

Table 1. COMPANION PLANTING CHART FOR HOME & MARKET GARDENING (compiled from traditional literature on companion planting)

CROP	COMPANIONS	INCOMPATIBLE
Asparagus	Tomato, Parsley, Basil	
Beans	Most Vegetables & Herbs	
Beans, Bush	Irish Potato, Cucumber, Corn, Strawberry, Celery, Summer Savoury	Onion

Beans, Pole	Corn, Summer Savoury, Radish	Onion, Beets, Kohlrabi, Sunflower
Cabbage Family	Aromatic Herbs, Celery, Beets, Onion Family, Chamomile, Spinach, Chard	Dill, Strawberries, Pole Beans, Tomato
Carrots	English Pea, Lettuce, Rosemary, Onion Family, Sage, Tomato	Dill
Celery	Onion & Cabbage Families, Tomato, Bush Beans, Nasturtium	

Corn	Irish Potato, Beans, English Pea, Pumpkin, Cucumber, Squash	Tomato
Cucumber	Beans, Corn, English Pea, Sunflowers, Radish	Irish Potato, Aromatic Herbs
Eggplant	Beans, Marigold	
Lettuce	Carrot, Radish, Strawberry, Cucumber	

Onion Family	Beets, Carrot, Lettuce, Cabbage Family, Summer Savory	Beans, English Peas
Parsley	Tomato, Asparagus	
Pea, English	Carrots, Radish, Turnip, Cucumber, Corn, Beans	Onion Family, Gladiolus, Irish Potato
Potato, Irish	Beans, Corn, Cabbage Family, Marigolds, Horseradish	Pumpkin, Squash, Tomato, Cucumber, Sunflower

Pumpkins	Corn, Marigold	Irish Potato
Radish	English Pea, Nasturtium, Lettuce, Cucumber	Hyssop
Spinach	Strawberry, Faba Bean	
Squash	Nasturtium, Corn, Marigold	Irish Potato

Tomato	Onion Family, Nasturtium, Marigold, Asparagus, Carrot, Parsley, Cucumber	Irish Potato, Fennel, Cabbage Family
Turnip	English Pea	Irish Potato

Does Companion Planting Work?

- While companion planting has a long history, the mechanisms of beneficial plant interaction have not always been well understood.
- Recently dentified mechanisms for higher yields include
  - Pest control
  - Nutrient uptake
  - Physical spatial interactions

Why Companion Planting?

- The concept provides strategies that increase the biodiversity of garden agroecosystems by mimicing the non-negative examples of biodiversity of natural ecosystems.

- A key to success is experimentation and observation of plant to plant interactions in your garden agroecosystem

Ecosystem Biodiversity Examples

TABLE 16.2 Dimensions of ecological diversity in an ecosystem

Dimension	Description
Species	Number of different species in the system
Genetic	Degree of variability of genetic information in the system (within each species and among different species)
Vertical	Number of distinct horizontal layers or levels in the system
Horizontal	Pattern of spatial distribution of organisms in the system
Structural	Number of locations (niches, trophic roles) in the system organization
Functional	Complexity of interaction, energy flow, and material cycling among system components
Temporal	Degree of heterogeneity of cyclical changes (daily, seasonal, etc.) in the system

Ecosystem Biodiversity Interactions

TABLE 11.2 Summary of interference interactions

	Creator of interference (A)	Receiver(s) of interference (B)	Type & identity of interference	Location of interference	Effect on A*	Effect on B*
Competition	Roles inter-changeable	Roles inter-changeable	Removal of resources	Shared habitat	—	—
Parasitism	Parasite	Host	Removal of nutrients	Body of host	+	–
Herbivory	Herbivore	Consumee	Removal of biomass	Body of consumee; shared habitat	+	– or +
Epiphytism	Host	Epiphyte	Addition of habitat surface	Body of host	0	+
Proto-cooperation	Roles inter-changeable	Roles inter-changeable	Addition of material or structure	Shared habitat or body of A/B	+ (0)	+ (0)
Mutualism	Roles inter-changeable	Roles inter-changeable	Addition of material or structure	Shared habitat or body of A/B	+ (–)	+ (–)
Allelopathy	Allelopathic plant	Potential habitat associates	Addition of active compound	Habitat of organism A	+ or 0	+, –, or 0

*Symbols in parentheses refer to effect when the organisms are not interacting

Agroecosystem Biodiversity

TABLE 16.3 Methods of increasing ecological diversity in an agroecosystem

Dimensions of ecological diversity affected

Method	Species	Genetic	Vertical	Horizontal	Structural	Functional	Temporal
* Intercropping	■		■	■	■	■	
* Strip cropping	■			■			
* Hedgerows & buffers	■		■	■			■
Cover-cropping	■		■	■	■	■	
Rotations							■
Fallows							■
Minimum tillage	■					■	
High inputs of organic matter	■					■	
Reduction of chemical use						■	

■ Direct or primary effect

Indirect, secondary, or potential effect

Little or no effect

* = forms of companion planting

Companion Planting Practices

"Trap cropping"

- - a neighbouring crop may be selected because it is more attractive to pests and serves to distract them from the main crop

Collards (trap crop) and cabbage (food crop) to draw the diamond back moth away from cabbage

Companion Planting Practices

"Biochemical Pest Suppression"

- some plants exude chemicals from roots or aerial parts that suppress or repel pests and protect neighbouring plants.

Marigold with cabbages to repel nematodes

Companion Planting Practices

Herb Companion Planting for Repelling Pests

- Some of the earliest written documents on gardening discuss herbs as companion plants for deterring pests.

- When selecting your companion plants you will need to consider more than which pests are deterred, e.g., what effect the proximity of strong herbs may have on the flavour of your vegetables.

Insect	Crop and Herb Plants that Repels
Ants	Onions, Tansy, Mint family
Aphids	Chives, Garlic, Marigolds, Mint family, Dried and crushed chrysanthemum flowers, Coriander, Onions, Oregano
Cabbage Moths	Rosemary, Sage, Thyme
Cabbage Worms	Tomatoes, Celery
Carrot Flies	Leeks, Sage, Rosemary
Colorado Potato Beetles	Marigolds, Nasturtiums, Flax
Cucumber Beetles	Nasturtiums, Radishes, Tansy
Flea Beetles	Catnip, Garlic
Flies	Basil, Tansy
Leafhoppers	Dried and crushed chrysanthemum flowers
Mosquitoes	Basil, Garlic, Geranium (citrosa)
Onion Flies	Garlic
Ticks	Garlic
Tomato Worms	Borage

Companion Planting Practices

- **"Symbiotic nitrogen fixation"**

  - legumes have the ability to fix atmospheric nitrogen for their own use and for the benefit of neighbouring plants via symbiotic relationship with Rhizobium bacteria

Bush beans intercropped with Chinese vegetables

Symbiotic Nitrogen Fixation

Nodules on legume roots, e.g., peas, beans, etc

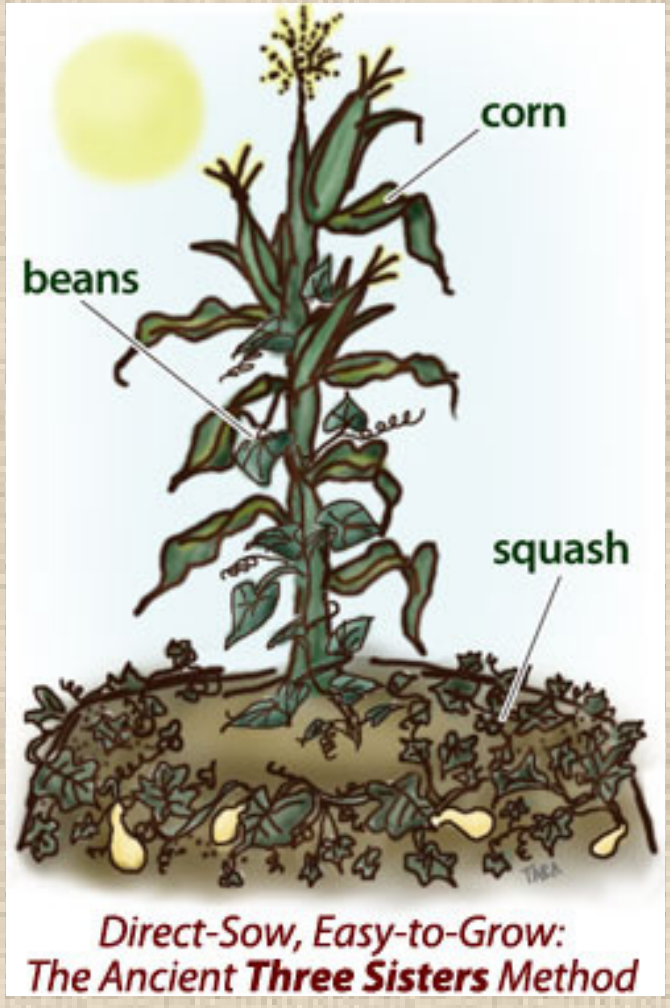
Nodules with good N fixation activity have an internal red color due to leghaemoglobin.

- N-fixing bacteria (*e.g., Rhizobium* species) infect roots of legumes & induce formation of specialized nodules
- Benefit of this process is the transformation of atmospheric N to plant N, e.g., protein
- Correlates with 'high protein' content of legumes

Companion Planting Practices

"Physical Spatial Interactions"

- for example, tall-growing, sun-loving plants may share space with lower-growing, shade-tolerant species, resulting in higher total yields from the land.



"3 Sisters" of corn/bean/squash

Companion Planting Practices

"Physical Spatial Interactions" (cont.)

"Nurse crops"

– for example, tall or dense-canopied plants may protect more vulnerable species through by providing a windbreak.

Taller grain crop protecting shorter transplanted crop from wind damage

Companion Planting Practices

"Beneficial Habitats"

– provide a desirable environment for beneficial insects and other arthropods—especially those predatory and parasitic species which help to keep pest populations in check.

Companion Planting Management

- Success Factors Include:
  - *Spatial arrangement*
  - *Plant density*
  - *Maturity dates*
  - *Plant structure*
- However, most recommendations do not specify them. Therefore, experimentation is required.

COMPARISON OF COMPANION PLANTING GUIDES FOR MOST COMMON GARDEN VEGETABLES

- ✓ Differences among recommendations demonstrate the importance of management factors

OBJECTIVE: This guide surveys four companion planting guides to reveal the relative degrees of agreement among four selected gardening book authors (see references). **However, regardless of consensus, companion planting recommendations are not always effective due many influences on a vegetable garden.** Record your own observations to determine the best companions in your garden!

HOW TO READ THE TABLES

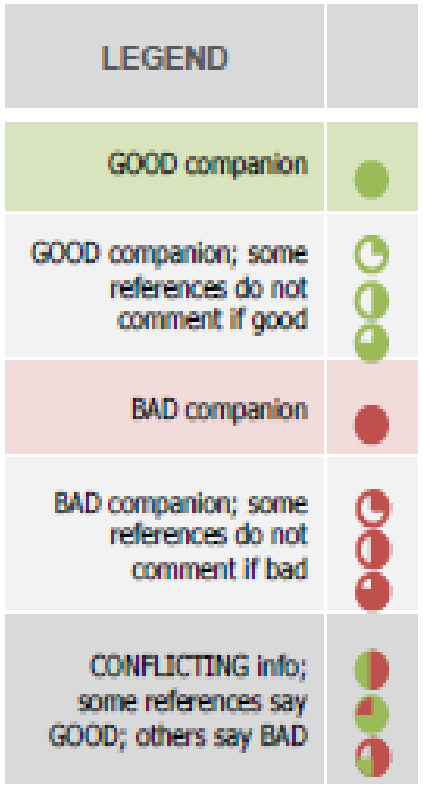


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Table I

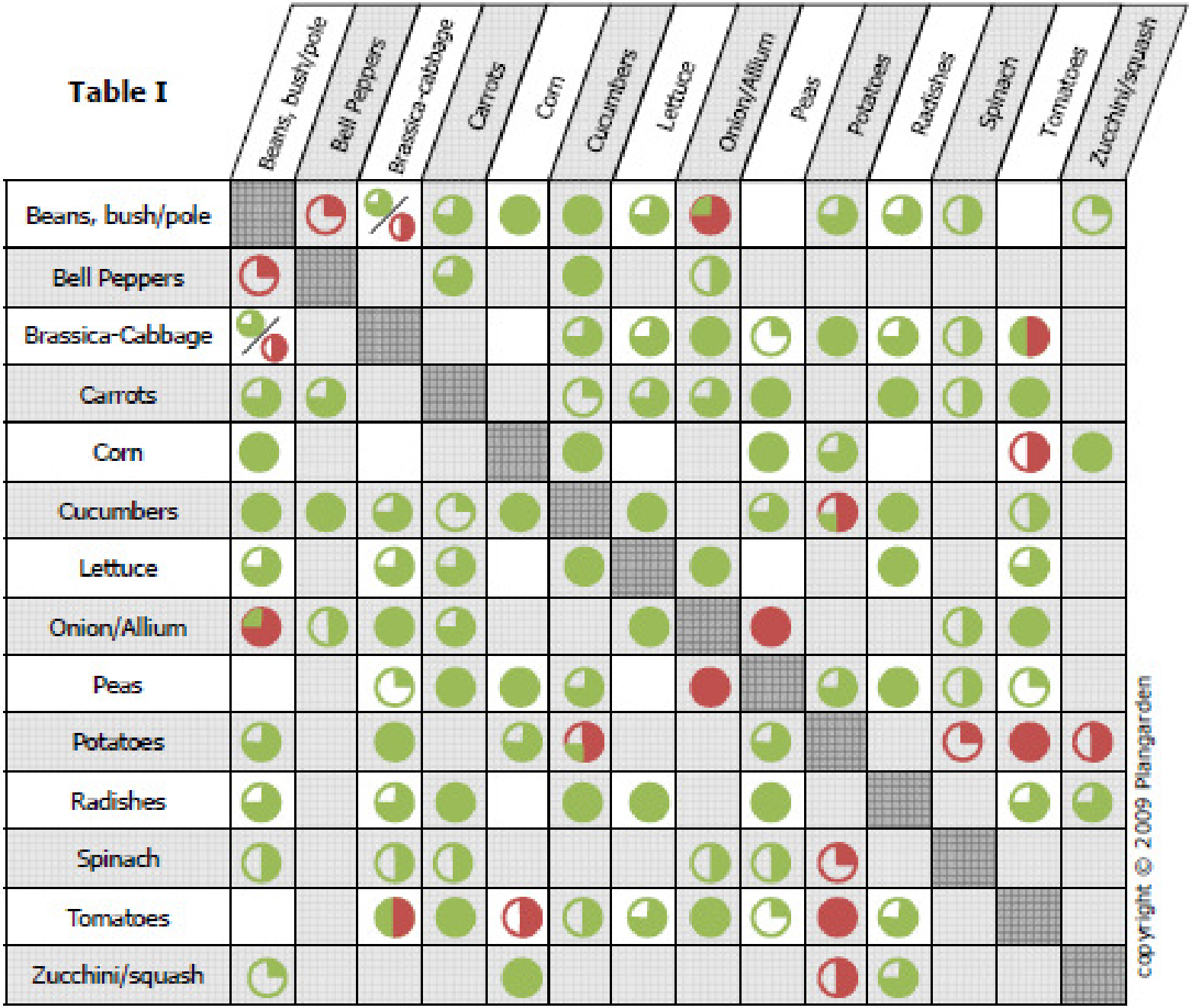
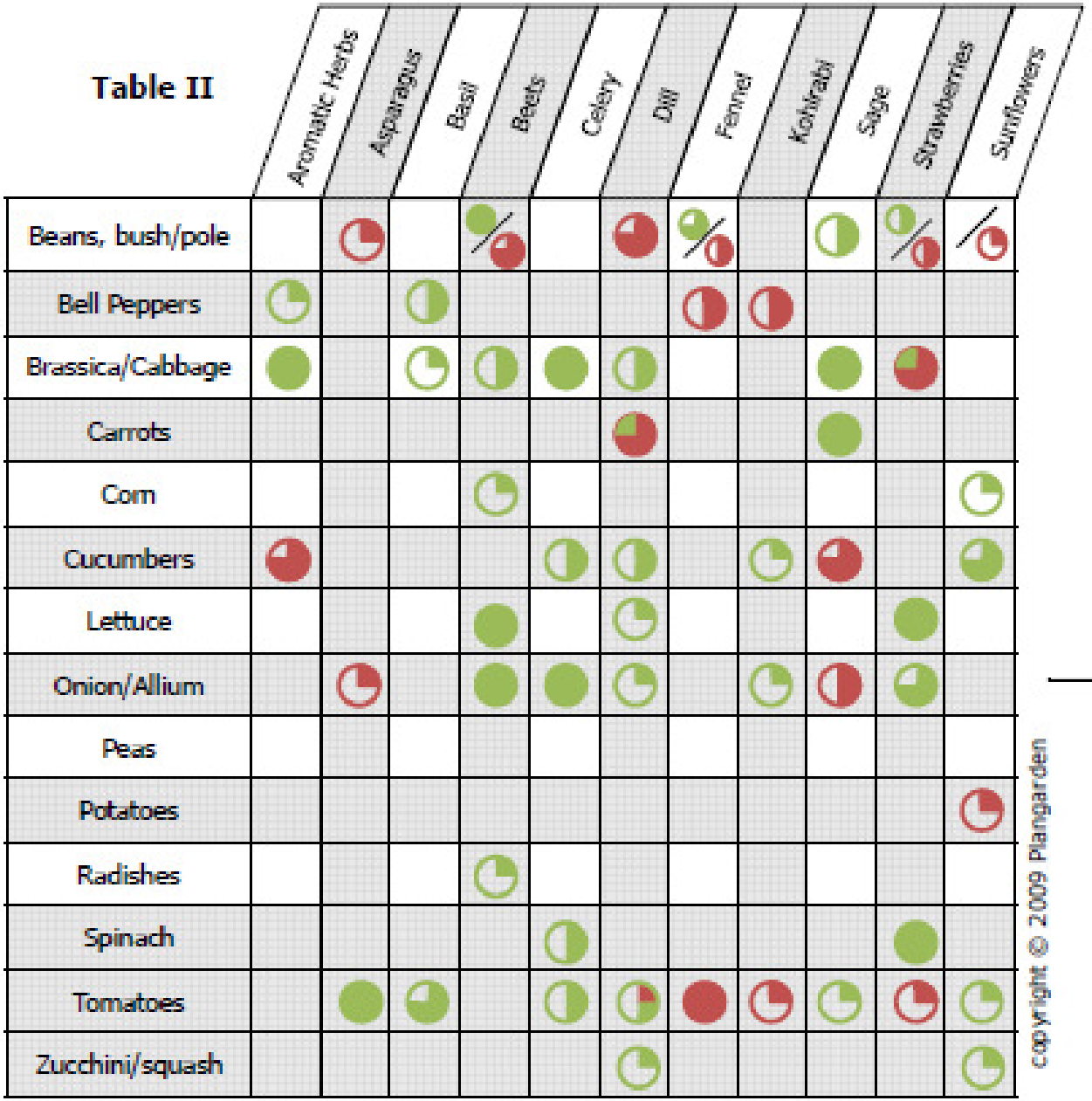


Table II shows other companions

Table II



Companion Planting Management

- Example ‘spatial arrangements’ include:
  - ***Row intercropping*** — growing two or more crops at the same time with at least one crop planted in rows.
  - ***Strip intercr****opping* — growing two or more crops together in strips wide enough to permit separate crop production but close enough for the crops to interact.
  - ***Mixed intercropping*** — growing two or more crops together in no distinct row arrangement.
  - ***Relay intercropping*** — planting a second crop into a standing crop at a time when the standing crop is at its reproductive stage but before harvesting.

Companion Planting Management

- Example different spatial arrangements for native American “3 sisters” companion planting (corn/bean/squash):

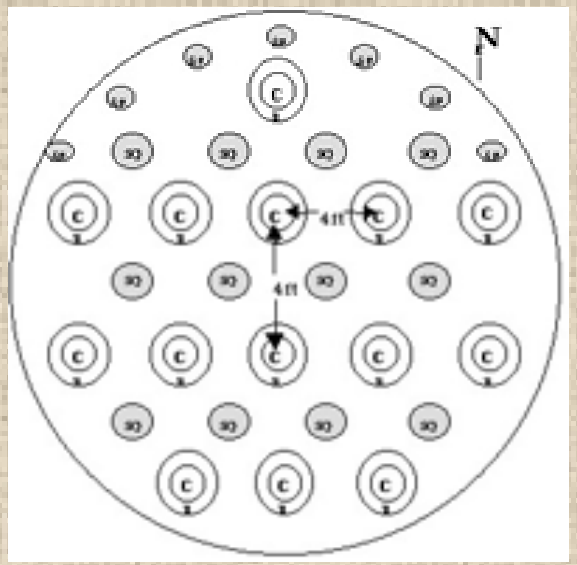


Figure 1: Circular Wampanoag Garden (Northeast & South)

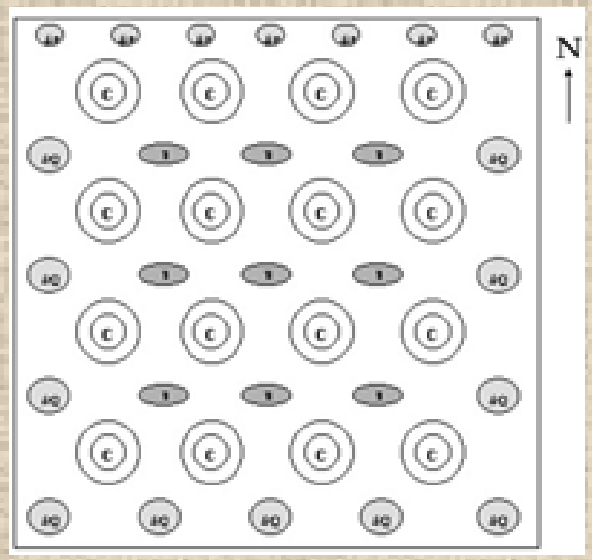


Figure 2: Hidatsa Garden Design (Northern Plains)

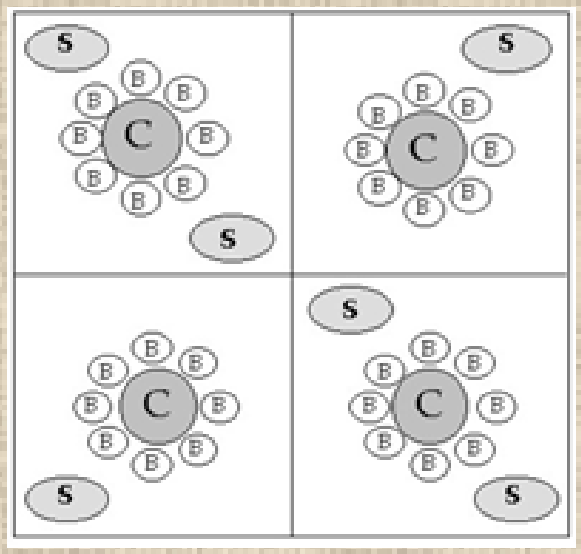


Figure 3: Zuni Waffle Garden (Southwest Desert)

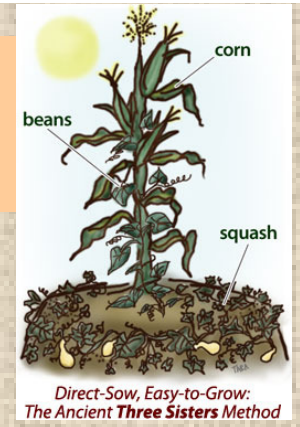
Companion Planting Research

- **Over-Yielding Assessment Factors Include:**
  - a method for assessing companion crops performance as compared to pure stand yields
  - calculated figure is called the **Land Equivalency Ratio (LER),** i.e., the yield advantage the intercrop has over the pure stand, if any.
  - for example, a corn/pea intercropping
  - measure the yields from pure corn, pure peas, and the yields from both corn and peas growing together
  - calculate the LER = (intercrop corn yield / pure corn yield) + (intercrop pea yield/ pure pea yield)
  - LER values above 1.0 show an advantage to intercropping, while numbers below 1.0 show a disadvantage

Summary

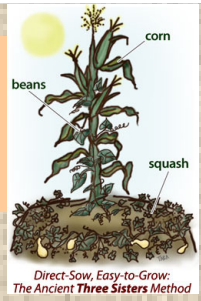
- Companion crops help develop a functional garden agroecosystem
- Choose companion crops to best fit desired purpose(s) and niche(s) for increase biodiversity
- Careful experimentation and management is needed to provide desired benefits

Food For Your Soul



- **The Legend of the Three Sisters**
- The term "Three Sisters" emerged from the Iroquois creation myth. It was said that the earth began when "Sky Woman" who lived in the upper world peered through a hole in the sky and fell through to an endless sea. The animals saw her coming, so they took the soil from the bottom of the sea and spread it onto the back of a giant turtle to provide a safe place for her to land. This "Turtle Island" is now what we call North America.

Food For Your Soul



- Sky woman had become pregnant before she fell. When she landed, she gave birth to a daughter. When the daughter grew into a young woman, she also became pregnant (by the West wind). She died while giving birth to twin boys. Sky Woman buried her daughter in the "new earth." From her grave grew three sacred plants—corn, beans, and squash. These plants provided food for her sons, and later, for all of humanity. These special gifts ensured the survival of the Iroquois people.

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