Sustainable Gardening (Agricultural) Practices

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Introduction

❑ What is Sustainable Agriculture?

- ➢ **Sustainable Agriculture** is defined as an integrated system of plant and animal production practices having a site-specific application that will over the long-term:

- ❖ Satisfy human food and fiber needs.

- ❖ Enhance environmental quality and the natural resource base upon which the agriculture economy depends.

Introduction

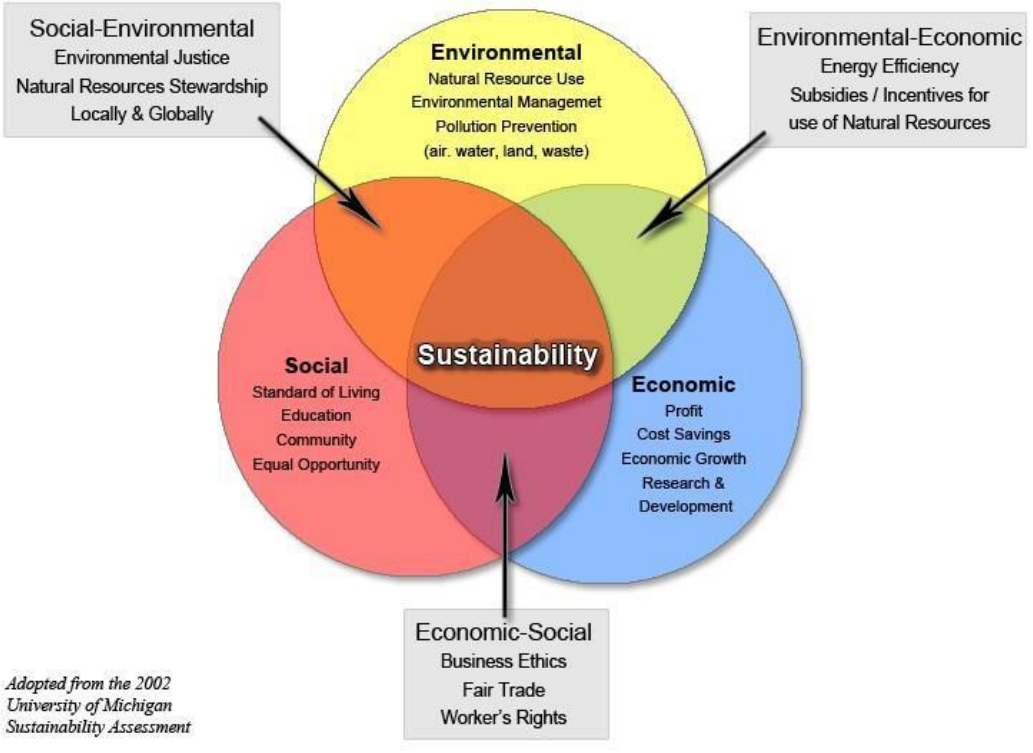
❑ What is Sustainable Agriculture?

- ❖ Make the most efficient use of nonrenewable resources and on-farm resources.
- ❖ Integrate, where appropriate, natural biological cycles and controls.
- ❖ Sustain the economic viability of farm operations.
- ❖ Enhance the quality of life for farmers and society as a whole.

(U.S. Code Title 7, Section 3103)

Introduction

❑ Spheres of Influence for Sustainable Agriculture



Introduction

❑ Sustainable vs Industrial Agriculture

➢ Sustainable agriculture is in stark contrast to industrial agriculture.

➢ Industrial agriculture generally relies upon monocropping, application of commercial fertilizers, heavy use of pesticides, and in some instances genetically modifies organisms (GMOs).

Introduction

❑ Sustainable vs Industrial Agriculture

➢ Sustainable agriculture on the other hand relies on practices that enhance the environment, communities, and people's welfare. Examples:

❖ Relying on natural biological cycles, and

❖ Enhancing the quality of life for farmers and the society.

Introduction

❑ What Sustainable Agriculture Can Achieve

- ➢ Sustainable agricultural practices can lead to:
  - ❖ Higher yields over time, and
  - ❖ Lesser need for expensive and environmentally damaging inputs.

Sustainable Agricultural Practices

- ❑ Multicropping systems
- ❑ Use of beneficial organisms
- ❑ Integration of plants and animals
- ❑ Natural soil fertility management
- ❑ Less dependence on chemical pest control methods
- ❑ Soil water conservation practices

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❑ Multicropping Systems

➢ Multicropping is practice of planting multiple species on one piece of land, either:

❖ During the same growing season; or

❖ In successive growing seasons.

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❑ Multicropping vs Monocropping Systems

Multicropping	Monocropping
Increased yields due to reduced pests and improved soil health	Decreased yields over time, due to pest and disease susceptibility
High genetic diversity	Little or no genetic diversity
Enhanced soil ecology through nutrient cycling	Damaged soil ecology by depleting soil nutrients
Decreased dependency on chemical pesticides, fertilizers and GMOs	Increased dependency on chemical pesticides, fertilizers and GMOs

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- **Multicropping**
  - Multicropping involves:
    - Intercropping,
    - Companion planting, and
    - Crop rotation.

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- **Intercropping (polyculture)**: a method of planting two or more crops of differing characteristics in close proximity to:
  - Reduce weeds
  - Reduce diseases and insect pest infestation
  - Provide shade
  - Provide NO_3^- through biological nitrogen fixation (BNF).

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- **Intercropping (polyculture) systems:**

  - Row intercropping - growing two or more crops at the same time with at least one crop planted in rows.

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- **Intercropping (polyculture) systems:**
  - Strip intercropping – growing two or more crops together in strips wide enough to permit separate crop production using machines but close enough for the crops to interact.

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- **Intercropping (polyculture) systems:**

  - 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.

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- **Intercropping (polyculture) systems:**

  - Mixed intercropping - growing two or more crops together in no distinct row arrangement.

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- **Companion planting:** the planting of different crops in close proximity for:
  - Pest control,
  - Pollination,
  - Providing habitat for beneficial organisms, and
  - Maximizing use of space.

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- **Companion planting and allelopathy:**
  - **Allelopathy** refers to the **beneficial** or **harmful** effects on one type of plant, by a biochemical produced by another type of plant.
  - The biochemicals released are referred to as **allelochemicals**.

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- Allelochemicals originate from plant parts by:
  - Leaching,
  - Root exudation,
  - Volatilization, and
  - Residue decomposition.

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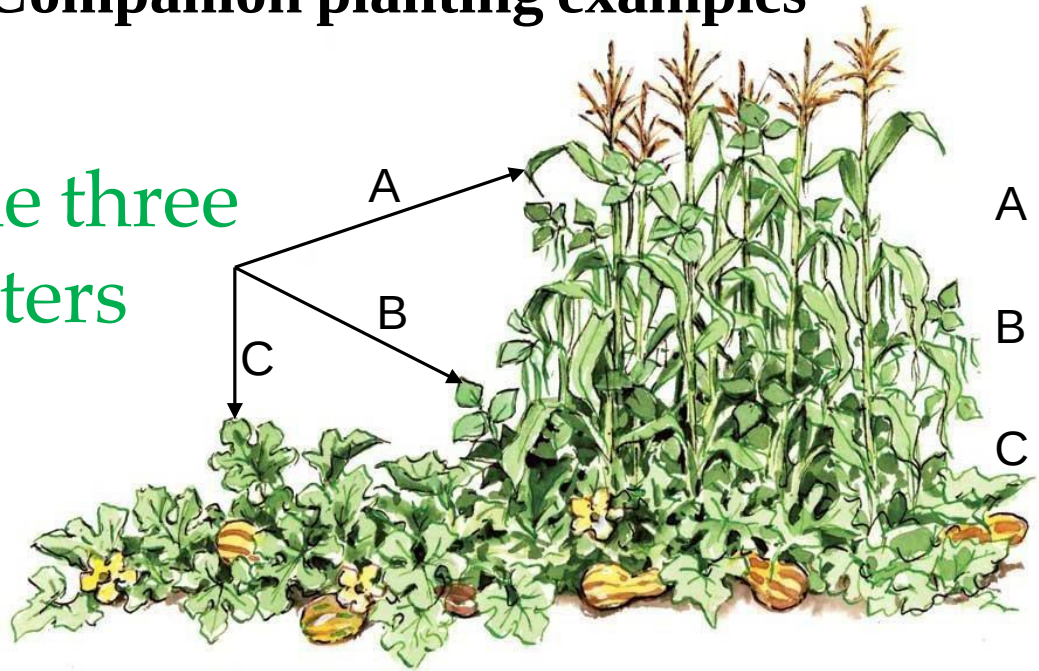
- **Companion planting examples**

The three sisters



A is the supportive sister

B is the giving sister

C is the protective sister

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- **Companion planting examples**

  <u>Radish and squash</u>

- Radishes and squash or zucchini plants are easily interplanted.
- The companion repels common cucurbits pests such as aphids, squash bugs, and cucumber beetles.

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❖ **Companion planting examples <u>Basil and tomatoes</u>**

- Basil benefits tomato plants as follows:
  - Repels thrips, hornworms, aphids.
  - Also acts as a natural fungicide.
  - Basil improves the growth rate and flavor of tomatoes.

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- **Compatible vs Incompatibles Companions**

Crop	Compatible Companions	Incompatible Companions
Broccoli	Celery, beets, onions, spinach, chard	Dill, strawberries, tomato
Cabbage		
Corn / Maize	Irish potato, beans, pea, squash	Tomatoes
Okra	Peppers, eggplants, basil, cucumbers	None
Onions	Beets, carrot, lettuce, cabbage family	Beans, English peas
White Potatoes	Beans, corn, cabbage family	Squash, tomato, cucumber,
Tomatoes	Basil, onions, carrot, parsley,	Irish potato, fennel, cabbage

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➢ **Crop rotation**: the practice of changing what is planted in a particular location on a farm from season to season.

The goals are to:

- ❖ Manage soil fertility and
- ❖ Avoid or reduce pests and diseases.

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- **Crop rotation for balancing soil fertility**

  - Different crops have different nutrient requirements and affect soil balance differently.

  - Example: corn and tomatoes are heavy feeders that quickly deplete soil nitrogen and phosphorus.

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- **Crop rotation for balancing soil fertility**
  - Leafy crops such as lettuce and cabbage also use up N rapidly.
  - The general rule of thumb is to avoid planting the same general category of crop successively in the same place.
  - Follow N-fixing legumes with N-loving crops.
  - Follow the heavy feeding crops with light-feeding crops.

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♦ **Crop rotation for balancing soil fertility**

Crop Family	Nutrient extraction level	Suggested rotation sequence
Onion Family	Light feeders	Plant after heavy feeders. Then follow with legumes
Cabbage Family	Heavy feeders	Plant after legumes. Then go fallow for a season or plant a cover crop
Bean Family	Enrich the soil	Plant before or after any other crop family
Carrot Family	Light to medium feeders	Can follow any other group. Follow these crops with legumes, onions.

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♦ **Crop rotation for disease and pest prevention**

❖ If you have a large farm, you may want to plan your crop rotation on the basis of plant families rather than on nutrient needs.

❖ This can help in your overall program of avoiding diseases and pests.

❖ Remember some insect pests and diseases (bacterial and fungal) can persist in plant debris in the soil.

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- **Crop rotation for disease and pest prevention**

  - Lengthy rotations are sometimes necessary to control chronic soilborne problems such as bean anthracnose fungus, Fusarium and Verticillium wilt.

  - Other diseases such as club root persist in the soil for even longer, so rotation is less useful for controlling them.

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♦ **Crop rotation for disease and pest prevention**

❖ Cover crops can be included in a rotation plan to discourage specific types of pests and to improve soil.

❖ Example: beetle grubs thrive among most vegetables, but not in soil planted with buckwheat or clover.

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- **Use of beneficial organisms**
  - Pollinators

Sustainable Agricultural Practices

❑ Use of beneficial organisms

➢ Natural enemies of garden pests

- ♦ **Parasites**: organisms that live and feeds in or on a host.
- ♦ **Pathogens**: microorganisms such as bacteria, fungi, nematodes, protozoa, and viruses that can infect and kill the host.
- ♦ **Predators**: kill and feed on several to many individual prey during their lifetimes.

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- **Use of beneficial organisms**
  - **Natural enemies of garden pests**

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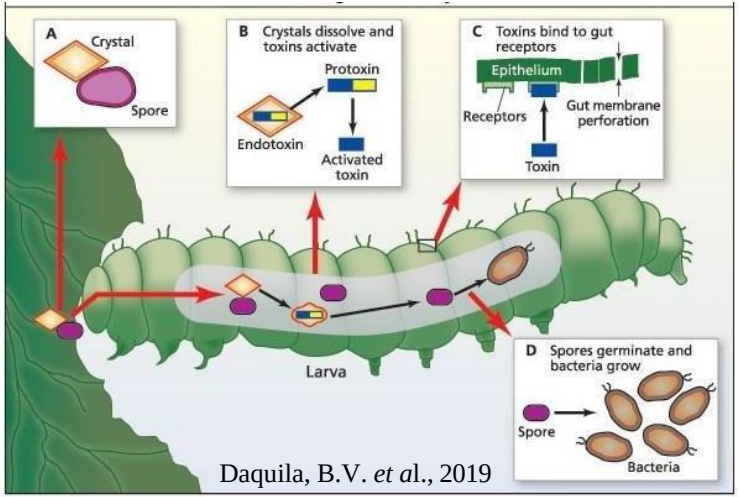
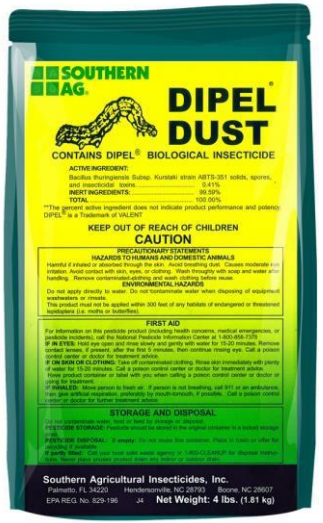
❑ Use of beneficial organisms

➢ Natural enemies of garden pests



Daquila, B.V. *et al*., 2019



Bacillus thuringiensis (Bt)

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- **Use of beneficial organisms**
  - **Natural enemies of garden pests**

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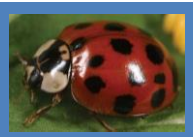
PESTS	 Lacewings	 Lady beetles	 Parasitic flies	 Parasitic wasps	 Predatory mites
Aphids	X	X		X	
Caterpillars	X		X	X	
Mealybugs	X	X		X	
Scales	X	X		X	X
Spider mites	X	X			X
Thrips	X			X	X
Whiteflies	X	X		X	

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❑ Integration

- Sustainable practices integrate their various enterprises.
- Benefits of integration:
  - Economic and
  - Environmental benefits.

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- **Natural soil fertility management**
  - Cover crops,
  - Green manure, and
  - Compost.

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- **Cover Crops and Green Manures**

  - Cover crops are grown for covering the soil to protect it from forces of erosion.
  - Cover crops provide continuous living vegetation in the field.
  - Green manures are grown for incorporating their biomass into the soil.

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Winter cover crops:

- Planted in late summer or fall to provide soil cover during the winter.
- Cool-season legumes include: clovers, vetches, and field peas.
- They are sometimes planting in a mix with winter cereals such as rye or wheat.

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Summer cover crops:

- Included in crop rotations to improve the condition of poor soils.
- Legumes: cowpeas, soybeans, Sunn hemp, may be grown to add nitrogen.
- Non-legumes such as sorghum-sudan grass, millet, buckwheat, radish, may be added to provide biomass.

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- **Composting**
  - Refers to the decomposition of organic waste or material into organic fertilizer which can be utilized by plants on gardens.
  - Involves spontaneous biological decomposition process of organic material in predominantly aerobic (oxygen rich) conditions.

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- **Composting**

  ♦ "Team Compost" consists of micro and macro-organisms choreographed to take advantage of changing

  - temperatures
  - moisture
  - oxygen and
  - pH.

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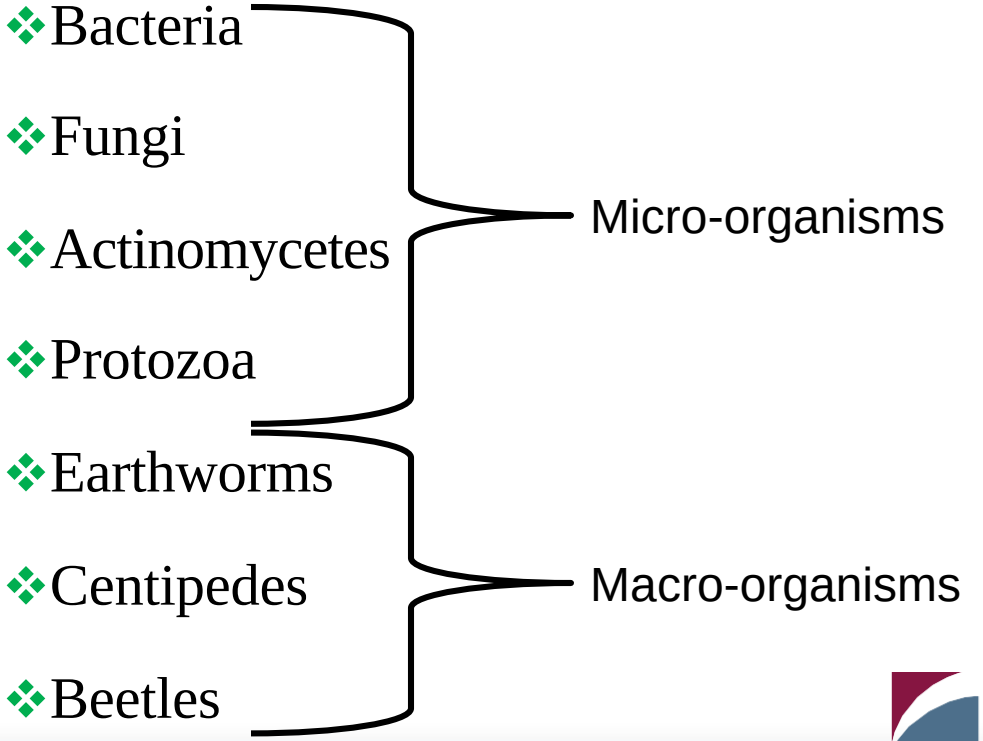
Compost team:



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Compost input: good balance of these basic four ingredients:

- Greens
- Browns
- Moisture
- Air

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- **Less dependence on chemical weed control methods**
  - Use of cover crops
  - Mulching
  - Flame weeding.

Sustainable Agricultural Practices

- **Less dependence on chemical weed control methods**
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Sustainable Agricultural Practices

- **Less dependence on chemical weed control methods**

  - Flame weeding

Sustainable Agricultural Practices

❑ Soil water conservation practices

➢ Water conservation measures should restrict runoff and erosion, and hence minimizes nutrient losses and sustains soil productivity.

- ♦ Practice reduced tillage or no-till
- ♦ Maximizes residue coverage
- ♦Use low head drip system and mulching.

Conclusion on Sustainable Agricultural Practices

- **Use practices that:**
  - Enhance biodiversity
  - Minimize or eliminate the use of external inputs
  - Minimize or eliminate wastage
  - Leave the environment better if not the way you found it.

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