



## Sustainable Gardening Practices

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# Introduction

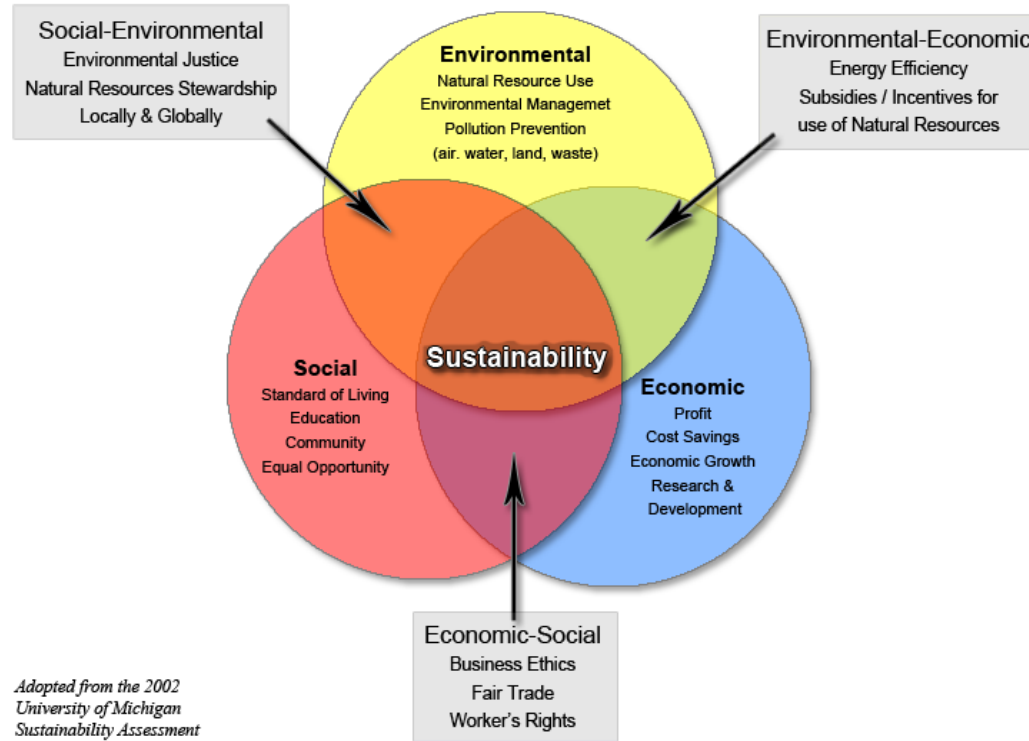
## □ What is sustainable gardening?

➤ Gardening practices that:

- ◆ do not harm the environment,
- ◆ do provide fair treatment of farm /garden workers, and
- ◆ do support and sustain local communities.

# Introduction

## □ Spheres of Influence in Sustainable Production



# Introduction

## □ Sustainable vs industrial crop production

- Sustainable crop production is in contrast to industrial crop production.
- Industrial crop production generally relies upon monocropping, application of commercial fertilizers, heavy use of pesticides.

# Introduction

## □ Sustainable vs industrial crop production

- Sustainable crop production relies on inputs that enhance the environment, communities, and welfare of farm workers.

# Introduction

## □ What sustainable production can achieve

- Sustainable crop production practices can lead to
  - ◆ higher yields over time, and
  - ◆ lesser need for expensive and environmentally damaging inputs.

# Principles of sustainable production

- Multicropping
- Use of beneficial organisms
- Integration
- Natural soil fertility management
- Less dependence on chemical weed control methods
- Soil water conservation practices

# Principles of sustainable production

## □ **Multicropping**

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

◆ during the same growing season or

◆ in successive growing seasons.



# Principles of sustainable production

## ❑ Multicropping vs Monocropping

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
Decrease dependency on chemical pesticides, fertilizers, and GMOs	Increases dependency on chemical pesticides, fertilizers, and GMOs

# Principles of sustainable production

## □ Multicropping

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

# Principles of sustainable production

➤ **Intercropping:** a method of planting two or more crops of differing characteristics in close proximity to:

- ◆ reduce weeds
- ◆ avoid pest infestation
- ◆ provide shade
- ◆ provide nitrogen through N-fixation.

# Principles of sustainable production

## ➤ Intercropping (polyculture) systems:

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



# Principles of sustainable production

## ➤ 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.



# Principles of sustainable production

## ➤ 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.



# Principles of sustainable production

## ➤ Intercropping (polyculture) systems:

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



# Principles of sustainable production

- **Companion planting:** the planting of different crops in close proximity for:
  - ◆ pest control,
  - ◆ pollination,
  - ◆ providing habitat for beneficial organisms, and
  - ◆ maximizing use of space.



# Principles of sustainable production

## ➤ Companion planting and allelopathy:

◆ **Allelopathy** refers to the **beneficial** or **harmful** effects of one plant on another plant, both crop and weed species, from the release of biochemicals, known as **allelochemicals**.

# Principles of sustainable production

◆ Allelochemicals originate from plant parts by:

- leaching
- root exudation
- volatilization and
- residue decomposition



# Principles of sustainable production

## ◆ Companion planting examples

The three sisters



# Principles of sustainable production

## ◆ Companion planting examples

### Radish and squash

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

# Principles of sustainable production

## ◆ Companion planting examples

### Basil and tomatoes

- Basil plants help tomato plants overcome insects and disease;
  - ❖ Repels thrips, flies, hornworms, aphids.
  - ❖ Also acts as a natural fungicide.
- Basil improves the growth rate and flavor of tomatoes.

# Principles of sustainable production

## ◆ Companions vs incompatibles

Crop	Companions	Incompatibles
Broccoli	Celery, beets, onions, spinach, chard	dill, strawberries, tomato
Cabbage		
Cantaloupe	Corn, nasturtium	potatoes
Carrots	Pea, lettuce, onion, rosemary, tomato	dill, parsnip, radish
Cilantro	Tomato, spinach, basil	fennel
Collards	Celery, beets, onions, spinach, chard	dill, strawberries, tomato
Corn	Irish potato, beans, pea, cucumber, squash	tomatoes

# Principles of sustainable production

## ◆ Companions vs incompatibles

Crop	Companions	Incompatibles
Kale	Celery, beets, onions, spinach, chard	dill, strawberries, tomato
Lettuce	Carrot, radish, strawberry, cucumber	None
Okra	Peppers, eggplants, basil, cucumbers,	
Onions	Beets, carrot, lettuce, cabbage family	beans, English peas
Oregano	Cabbage, cucumbers, grapes	
Parsley	Tomato, asparagus	
Peas	Carrots, radish, cucumber, corn, beans	onion, gladiolus, Irish potato

# Principles of sustainable production

## ◆ Companions vs incompatibles

Crop	Companions	Incompatibles
Peppers	Tomatoes, parsley, basil, carrots	fennel
I. Potatoes	Beans, corn, cabbage family, marigolds	squash, tomato, cucumber,
Squash	Nasturtium, corn, marigold	Irish potato
S. potatoes	dill, thyme, oregano, bush beans	squash
Tomatoes	Basil, onions, carrot, parsley, cucumber,	Irish potato, fennel, cabbage
Turnips	English peas	Irish potato



# Principles of sustainable production

➤ **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.

# Principles of sustainable production

## ◆ 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.

# Principles of sustainable production

## ◆ 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.

# Principles of sustainable production

## ◆ Crop rotation for balancing soil fertility

Crop Family	Nutrient extraction level	Suggested rotation sequence
Onion Family	Light feeders	Plant after heavy feeders. Follow with legumes
Cabbage Family	Heavy feeders	Plant after legumes. Then go fallow for a season or plant a cover crop
Lettuce Family	Heavy feeders	Follow with legumes
Beet Family		

# Principles of sustainable production

## ◆ Crop rotation for balancing soil fertility

Crop Family	Nutrient extraction	Suggested rotation sequence
Bean Family	Enrich the soil	Plant before or after any other crop family
Tomato Family	Heavy feeders	Follow these crops with legumes
Squash Family	Heavy feeders	Plant after members of the grass family. Follow these crops with legumes
Carrot Family	Light to medium feeders	Can follow any other group. Follow these crops with legumes, onions.

# Principles of sustainable production

## ◆ Crop rotation for disease and pest prevention

- If you have a large home garden, 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 pest overwinter in the soil. Same case for bacterial and fungal diseases that overwinter in plant debris in the soil.

# Principles of sustainable production

## ◆ Crop rotation for disease and pest prevention

- Lengthy rotations are sometimes necessary to control chronic soilborne problems such as bean anthracnose fungus. Also, fungal diseases as Fusarium wilt and Verticillium wilt.
- A few problems, such as club root, persist in the soil for even longer, so rotation is less useful for controlling them.

# Principles of sustainable production

## ◆ 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 in buckwheat or clover.



# Principles of sustainable production

## □ Use of beneficial organisms

### ➤ Pollinators



# Principles of sustainable production

## □ 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.

# Principles of sustainable production

## □ Use of beneficial organisms

### ➤ Natural enemies of garden pests



# Principles of sustainable production






## □ Use of beneficial organisms

### ➤ Natural enemies of garden pests



# Principles of sustainable production

## Natural enemies of garden pests

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	

# Principles of sustainable production

## □ Use of beneficial organisms

### Beneficial Soil microbes

➤ Beneficial soil microbes help in:

- ◆ nutrients cycling
- ◆ nitrogen fixation
- ◆ disease suppression.

# Principles of sustainable production

## □ Integration

- Sustainable practices integrate their various enterprises.
- Benefits of integration:
  - ◆ economic
  - ◆ environmental benefits.



# Principles of sustainable production

## □ Natural soil fertility management

- Crop rotation
- Use of cover crops and green manure
- Use of compost.



# Principles of sustainable production

## ➤ 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.

# Principles of sustainable production

## *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.



# Principles of sustainable production

## *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.



# Principles of sustainable production

## ➤ 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.

# Principles of sustainable production

## ➤ Composting

- ◆ "Team Compost" consists of microorganisms and macroorganisms choreographed to take advantage of changing
  - temperatures
  - moisture
  - oxygen and
  - pH.

# Principles of sustainable production

## *Compost team:*

- ❖ Bacteria
- ❖ Fungi
- ❖ Actinomycetes
- ❖ Protozoa
- ❖ Earthworms

# Principles of sustainable production

*Compost input:* good balance of these basic four ingredients:

- Greens
- Browns
- Moisture
- Air



# Principles of sustainable production

## □ Less dependence on chemical weed control methods

- Use of cover crops

- Mulching

- Flame weeding.



# Principles of sustainable production

## ❑ Less dependence on chemical weed control methods

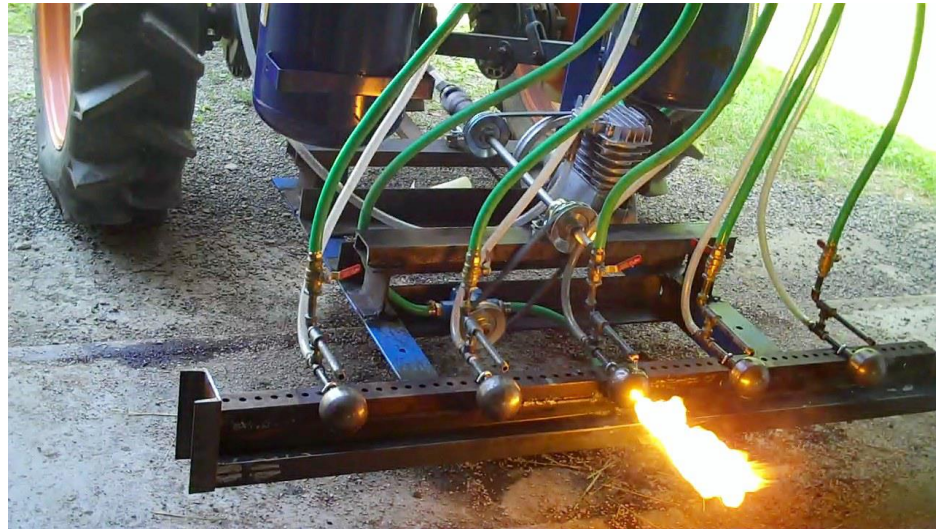
### ➤ Mulching



# Principles of sustainable production

## ❑ Less dependence on chemical weed control methods

➤ Flame weeding



# Principles of sustainable production

## □ 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 Production

## □ Use practices that:

- Enhance biodiversity
- Minimize or eliminate the use of external inputs
- Minimize or eliminate wastage
- Leave the environmental better if not the way you found it.

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