

# Primary Tillage



# Objectives

This presentation will outline

- ❖ Tillage solutions for **permaculture and organic farms**
- ❖ Definitions of tillage and cultivation
- ❖ Positive and negative effects of tillage on physical and biological properties of the soil
- ❖ Conditions for tillage depending on soil types
- ❖ Seasonal consideration
- ❖ Types of tillage equipment
- ❖ Common soil preparation sequence used in primary tillage

# Terms and Definitions

- ❖ **Cultivation:** The total assemblage of tools and techniques used to develop and maintain soil fertility and crop production in garden and farm systems
- ❖ **Tillage:** Mechanical manipulation of the soil to prepare seedbeds



# Tillage in permaculture

Permaculture farms attempt to maintain natural soil structures as much as possible. Considerations for permaculture:

- ❖ How does nature regenerate healthy soil? (Leaves and other organic matter decay on the soil surface.)
- ❖ Is tillage necessary in all cases? (See slides [No Till Methods for Permaculture](#))
- ❖ Are there ways to lay out your farm that minimize tillage? (Perennials help minimize a farm's tillage requirements.)

# Terms and Definitions

## **Primary Tillage:**

Course and deep tillage that cuts, fractures, and mixes the soil. It creates a soil condition from which a seed bed can be prepared.

## **Secondary Tillage:**

Tilling which reduces the surface soil particle size; helpful for seed bed preparation

## **Land shaping:**

Forming vegetable beds, concerns land height of 6 to 8 inches, and may apply plasticulture .

## **Cultivation:**

The mechanical management of weeds and residues

# Purposes for Tillage

- ❖ **Maintain good soil structure**

Opens up compacted soil, allows for vertical transfer of organic matter, creates soil aggregates, and decreases soil particles in order to create a good seedbed

- ❖ **Aerate the Soil**

Increases soil/air exchange and increases water infiltration

- ❖ **Increase the temperature of cold soils**

- ❖ **Incorporate organic matter, cover crops, or crop residues**

- ❖ **Break up soil pans**

- ❖ **Control weeds**

- ❖ **Dry the soil before seeding**

# Negative Effects of Tillage

Compaction of soil below the depth of tillage (hard pan)

Soil loses nutrients and organic matter

Reduced biological activity and loss of earthworm activity

Destruction of soil aggregates

Soil loses ability to store water and soil loses ability to drain well

Loss of soil pore space

Erosion of the soil

Cost of tillage equipment and energy costs of tillage operation

# Types of Soil

## **Clay soil -**

Avoid tilling soil that is too wet . Clay soil that is too dry will be too hard to till. Optimal time to till is early spring, after rainfall but not when soil has dried out

## **Sandy soil-**

Till when moisture content is high. This allows soil particles to stick together so the wind will not blow soil away. Higher moisture content will help to avoid powdering of the soil.



# Seasonal Considerations

(Temperate Climate – Outdoors)

## **Spring Till**

Incorporate cover crops, warm cold soils, aerate, incorporate organic matter, create planting beds

## **Summer Till**

Surface tillage for successive planting

## **Fall Till**

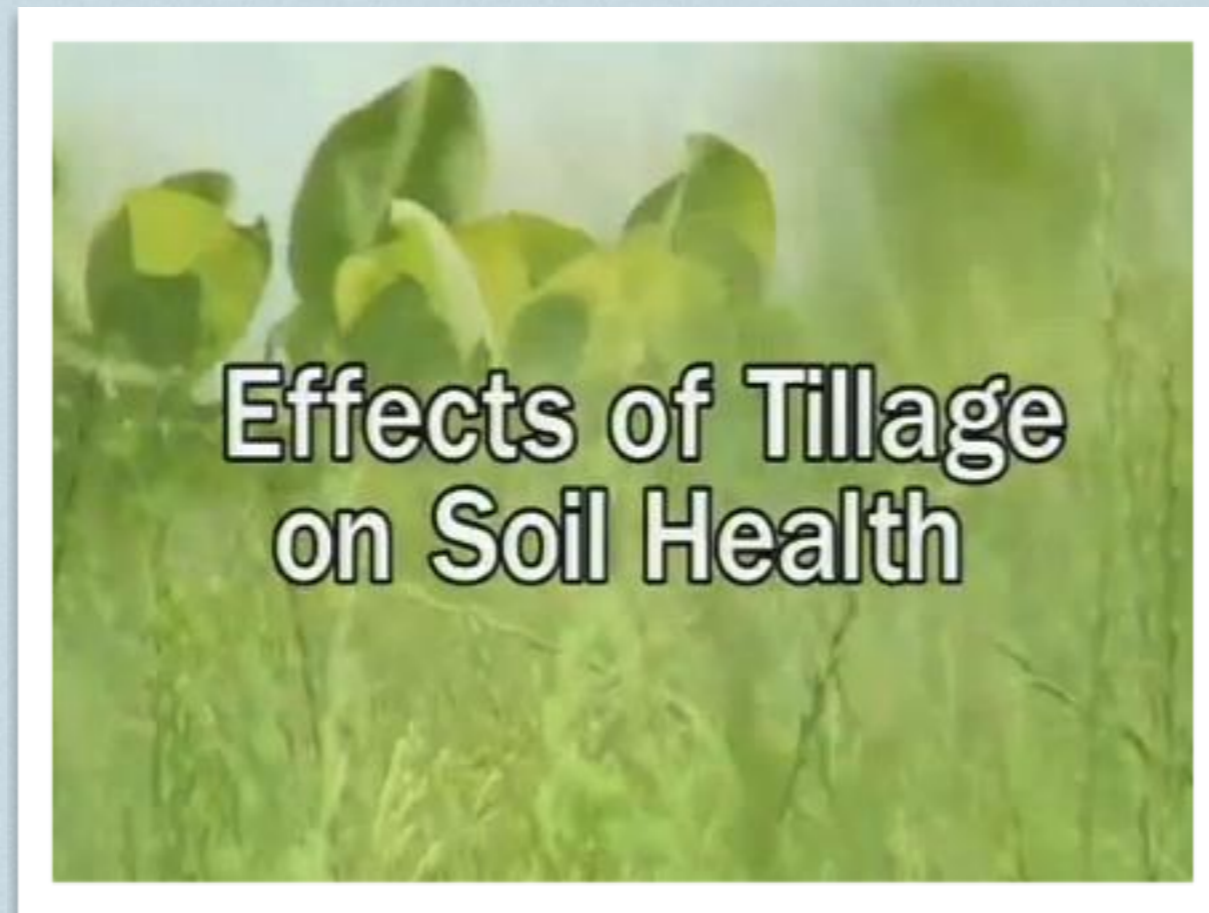
Prepare soil for fall and overwinter crops, incorporate minerals and organic matter, shape raised beds and compost the tops of raised beds

## **Winter Till**

No cultivation except in greenhouses. When warm enough, till top of raised beds

# Tillage and Soil Health

Video: Effects of Tillage on Soil Health



<http://youtu.be/pCj58isK1xE>

# Primary Tillage Equipment

- ❖ Flail Mower
- ❖ Moldboard Plow
- ❖ Chisel Plow
- ❖ Disk Plow
- ❖ Subsoiler

# Secondary Tillage Equipment

- ❖ Spader and Harrow
- ❖ Bedshaper

# Flail Mower

Video: Flail Mower

- ❖ To prepare beds for plowing
- ❖ Mow cover crop



<http://youtu.be/HJOYZQiP4Wg>

# Moldboard Plow

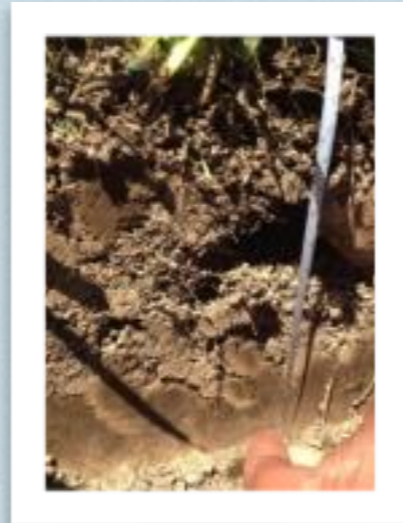
- ❖ Inverts soil in a plow layer
- ❖ Breaks up turf
- ❖ Incorporates cover crops
- ❖ Buries crop residues
- ❖ Can cause a tillage pan



# Moldboard Plow

- ❖ Moldboard Plow
- ❖ In clay soil, till above the clay line (depth of around 4 inches)

Video: Moldboard Plow



<http://youtu.be/cNCqkmlk5FI>

# Moldboard Plow

Field after plowing





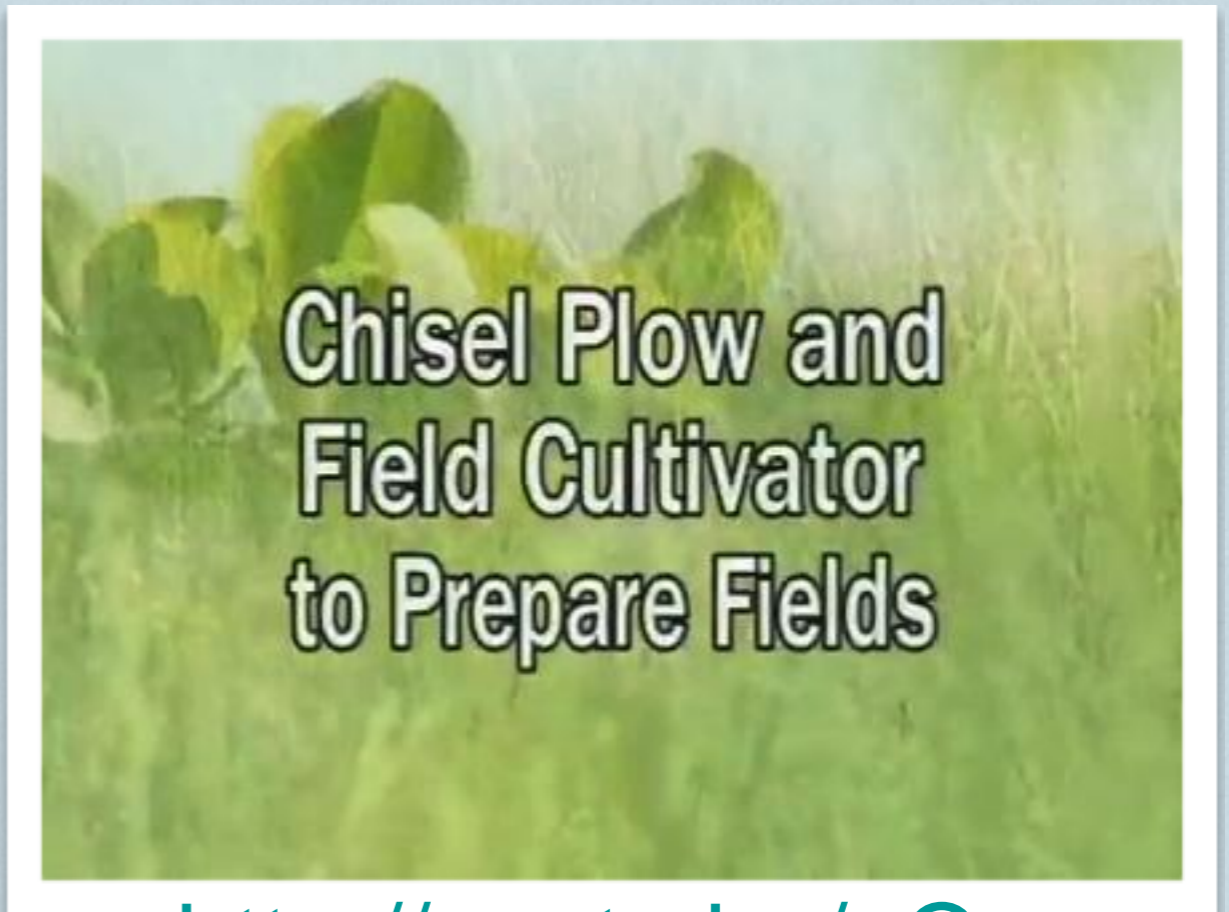
# Chisel Plow

- ❖ Fractures the soil
- ❖ Does not invert soil
- ❖ Mixes soil and surface residue
- ❖ Not effective for weed control



Photo from [www.bucktraco.com](http://www.bucktraco.com)

Video: Chisel Plow and Field Cultivator to Prepare Fields



[http://youtu.be/eOrzuu5l\\_gc](http://youtu.be/eOrzuu5l_gc)

# Disk Plow

- ❖ Inverts the soil
- ❖ Breaks up large clumps
- ❖ Levels the surface



# Disk Plow Videos



<http://youtu.be/6a398x22I9s>



<http://youtu.be/FgnLyfpqvda>

# Subsoiler

- ❖ Used to break up hard pans
- ❖ Fractures the soil but does not invert soil
- ❖ Can reach depths of 12 to 24 inches



# Spader and Harrow

Video: Soil Spader to Incorporate  
Cover Crops and Compost

- ❖ Used for seedbed preparation
- ❖ Does not invert soil
- ❖ Levels the surface



<http://youtu.be/ycadZjZ1Vnw>

# Rotary Tiller

- ❖ Used for seedbed preparation
- ❖ Breaks up large clumps
- ❖ Levels the surface



# Bedshaper

Video: Bedshaper

- ❖ Used for seedbed preparation
- ❖ Creates a raised bed for seeds and transplants



<http://youtu.be/5EJ0YfVxsLU>

# Tillage Sequence

- ❖ Mowing Plow
- ❖ Moldboard plow
- ❖ Disk
- ❖ Rotary Tiller
- ❖ Bedshaper



# No Till Methods (for permaculture)

I am always impressed when I remove a straw mulch that has been down for a few months. The improved soil structure from the extra earthworm activity emphasizes how effective nature can be when I don't interfere.

-Eliot Coleman

# No Till Methods

- ❖ Use disk or chisel plow to prepare for seeding.
- ❖ Does not turn over the soil.
- ❖ Creates narrow furrow for planting.
- ❖ Use cover crops during non-growing seasons.
- ❖ Flail mowers cut and chop cover crops and leave residue on the field.
- ❖ Planting is done through the residue that is left on the field.

# No Till Methods

Video: Small Scale No Till Using Compost as Mulch

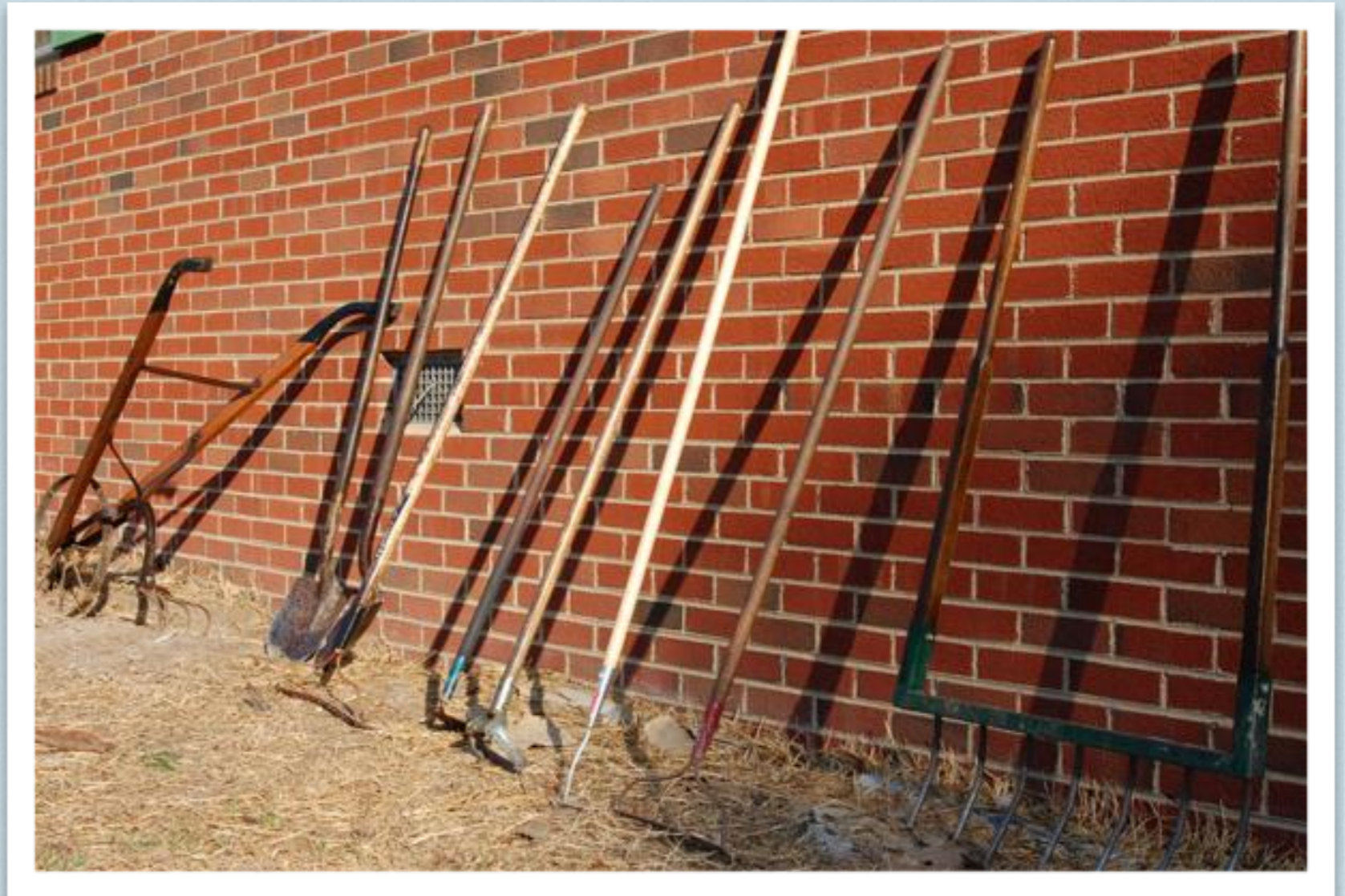
- ❖ Used for seedbed preparation
- ❖ Does not invert soil
- ❖ Levels the surface



<http://youtu.be/XSvLkh5oOsY>

# Small Scale

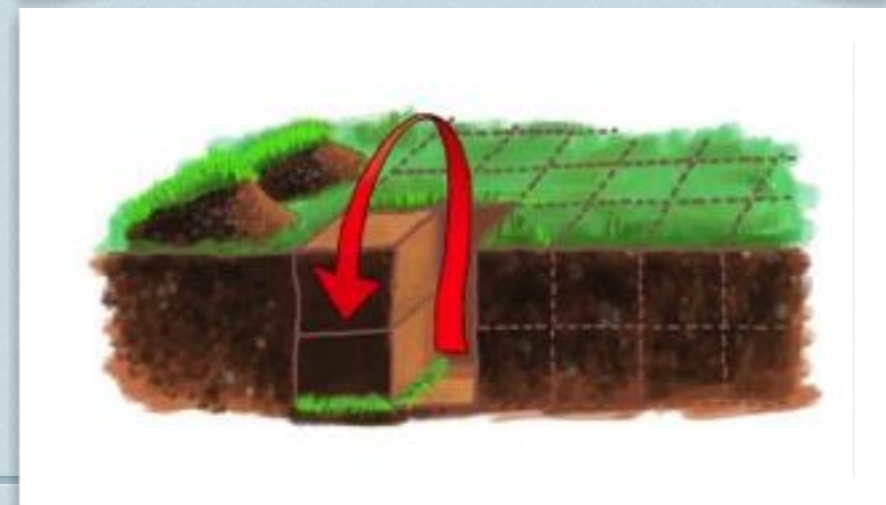
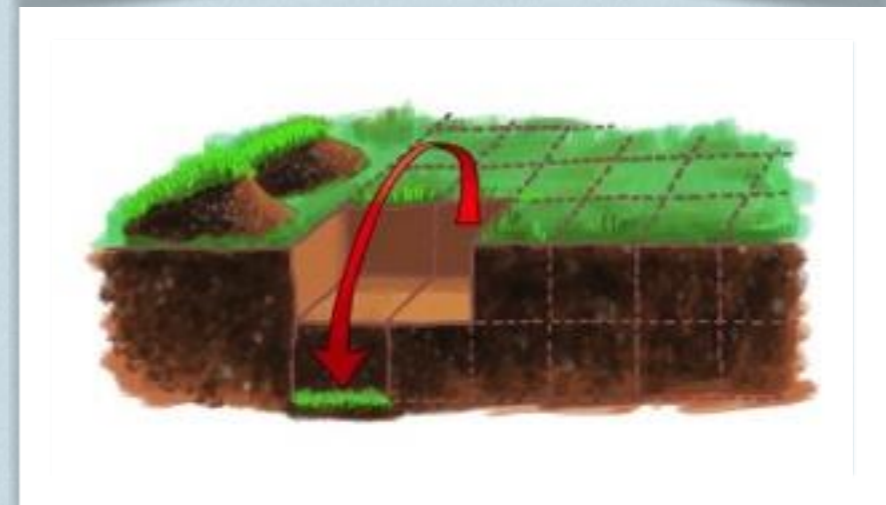
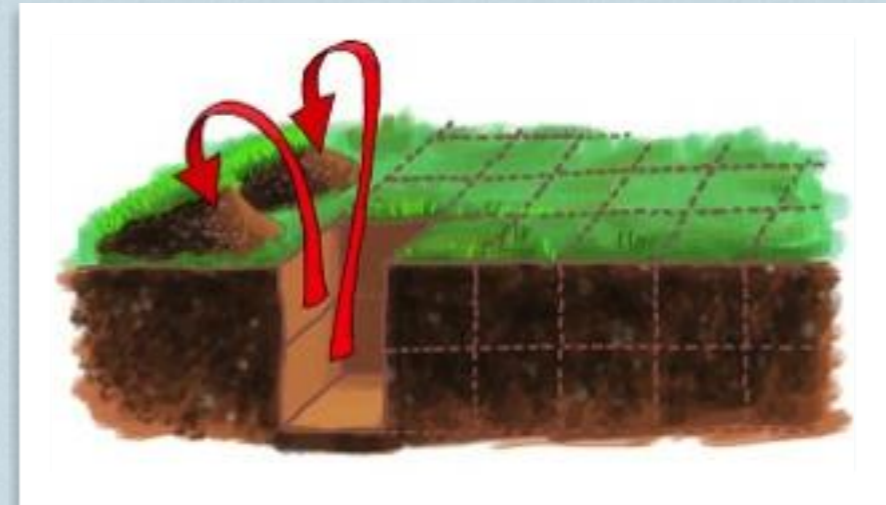
- ❖ Push Plows
- ❖ Rotary Plow
- ❖ Broadfork



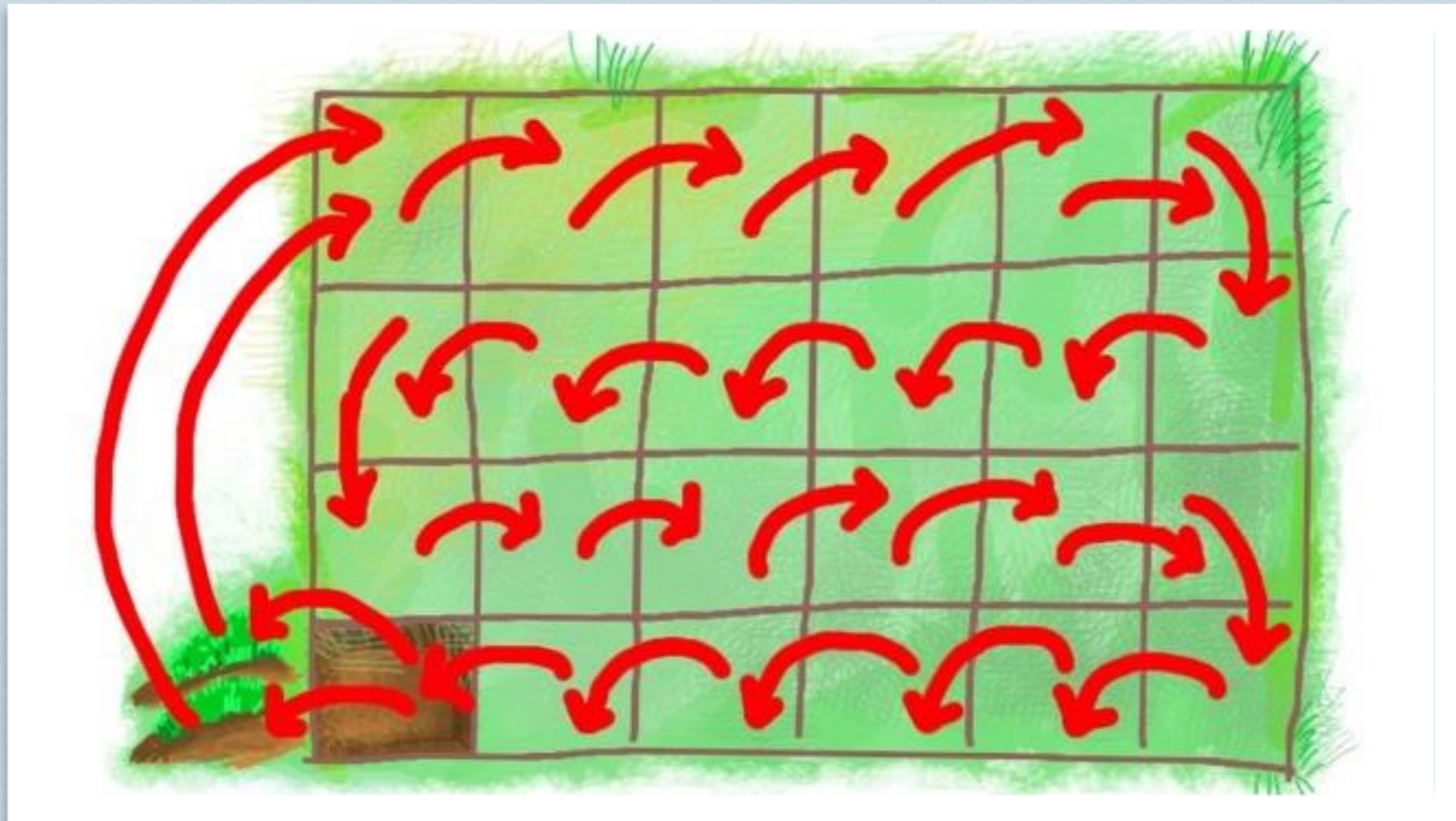
[http://broadforkfarm.files.wordpress.com/2011/01/dsc\\_0056.jpg](http://broadforkfarm.files.wordpress.com/2011/01/dsc_0056.jpg)

# Double Digging

- ❖ Dig one cubic foot of soil – set aside
- ❖ In the same hole - dig the next cubic foot of soil – set aside
- ❖ Dig a second neighboring cubic foot of soil – put turf down into the first hole.
- ❖ Dig another cubic foot of soil from neighboring hole – overturn and put into the first hole.
- ❖ Continue



# Double Digging



# Self Review Questions

- ❖ What is the purpose of tilling?
- ❖ What are the drawbacks to tilling?
- ❖ How do seasons, weather ,and water conditions affect tilling?

# Summary

- ❖ Ask yourself: Is tillage necessary?
- ❖ Avoid tillage when soil is too wet or too dry.
- ❖ Vary depth and type of tillage to minimize hardpan formation.
- ❖ Cultivate shallowly, no deeper than needed to control weeds.



# References

The New Organic Grower, Eliot Coleman

<http://campus.extension.org/course/category.php?id=31>

<http://casfs.ucsc.edu/education/instructional-resources/downloadable-pdf-files>

<http://old.huhs.org/departments/agriculture/hennes/documents/conservationtillagepractices.pdf>

<http://www.windcrestorganics.com/curriculum.html>

<http://www.bvsd.org/curriculum/CTEC/Curriculum%20Essentials%20Documents/Urban%20Agriculture.pdf>

<http://ofrf.org/education/database>

<http://www.sare.org/Learning-Center/Courses-and-Curricula>

<http://georgiaorganics.org/for-farmers/fundamentals-of-organic-farming-and-gardening-an-instructors-guide-revised-for-2009/table-of-contents/>

<http://www.extension.org/pages/18634/use-of-tillage-in-organic-farming-systems:-the-basics>

<http://extension.psu.edu/agronomy-guide/cm/sec1/sec11g>