

# Agricultural Strategies

Soil Management

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# Soil Health

Soil is the foundation for all healthy farms. The soil is a living ecosystems with billions of living microorganisms in one handful of healthy soil.

“Bear in mind that there is no unproductive land, only unproductive farmers.”



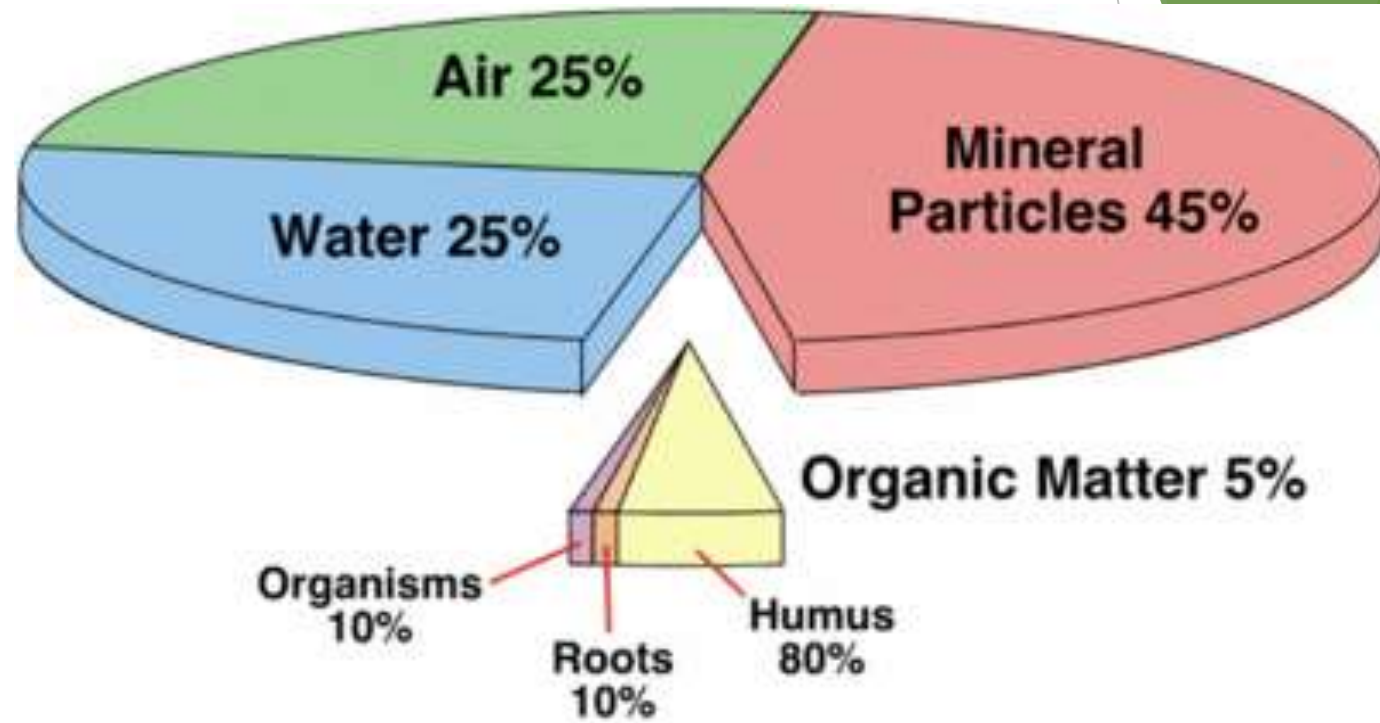
# Soil Health (Components of Soil) 土壤的构成

Soil is a key component to maintain a healthy farm. 土壤是一切健康养植的基础，它是由数十亿微生物共同生活在一起的一个活的生态系统。

Soil is composed of: 土壤的组成

- ▶ Weathered rock (minerals) 风化岩石 (矿物质)
- ▶ Organic material (Bio Life) 有机物 (活的生物)
- ▶ Water 水
- ▶ Air. 空气

If any of these components are missing you will not be able to grow healthy crops. 如果这些构成有缺失将抑制作物健康生长。



Soil PH - Another important factor is the soil pH. The pH level of your soil indicates its relative acidity or alkalinity

Most essential plant nutrients are soluble at pH levels of 6.5 to 6.8, which is why most plants grow best in this range.

# Soil Health (Components of Soil)

**Organic Material**- 5% of your soil is made up of organic material. Organic matter is the partially decomposed remains of soil organisms and plant life including lichens and mosses, grasses and leaves, trees, and all other kinds of vegetative matter. 有机质是土壤生物和植物的生命，它占土壤的5%，包括地衣和苔藓、草和树叶、树和其他各种营养物质具部份已腐烂的尸体。

- ▶ Binds together soil particles into porous crumbs (aeration and water flow) 连接土壤微粒（利于通风透水）
- ▶ Provides food for organisms 提供营养和有机物
- ▶ Absorbs nutrients 吸收营养

**Soil Life** - The organic material also contains living organisms such as bacteria and fungi, protozoa and nematodes, mites, springtails, earthworms and other tiny creatures. 土壤生命：有机物质还包含了活的有机体，如细菌、真菌、原生动物和线虫、螨虫、跳虫、蚯蚓和其他小生物

- ▶ Convert material to minerals, vitamins, hormones and disease suppressing compounds. 将物料转换为矿物质、维生素、激素和抑制化合物疾病
- ▶ Help loosen soil 帮助松软土壤



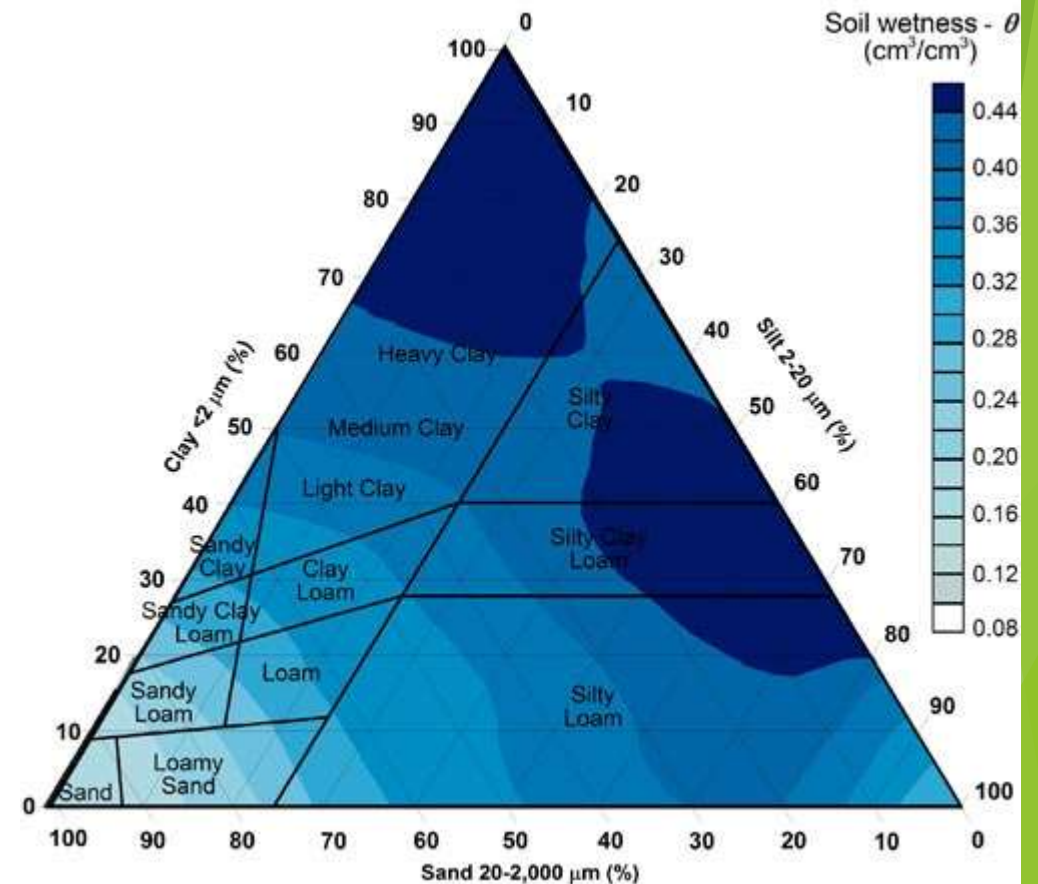
# Soil Health (Components of Soil) 土壤构成

**Water-** 25% of your soil is made up of water. Water is held in the pore spaces between soil particles. Large pore spaces allow rain and irrigation water to move down to the root zone and into the subsoil.

土壤的25%由水组成，水充满了土壤颗粒的空隙，土壤空隙大对于水由上而下流动直至底部。

Ideally, your soil should have a combination of large and small pore spaces. Organic matter is the key, because it encourages the formation of aggregate, or crumbs, or soil. Organic matter also absorbs water and retains it until it is needed by plant roots.

理想的情况是土壤间大小空隙相间，这一点有机物起关键作用，有机物帮助聚合土壤颗粒也吸收和释放植物根系所需水份。



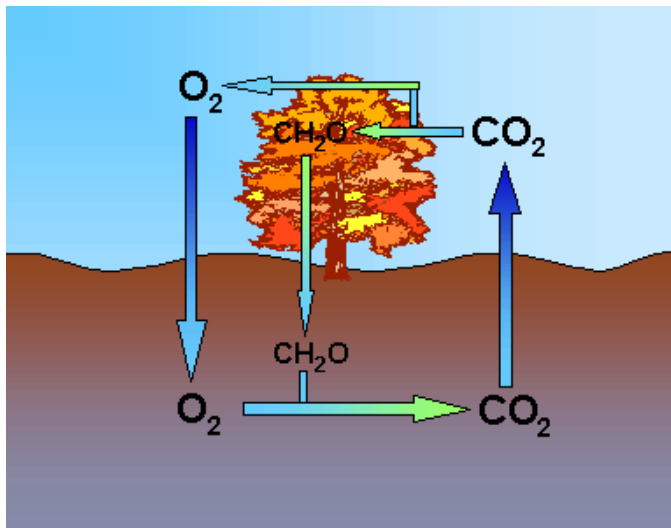
# Soil Health (Components of Soil)

**Air-** 25% of your soil is made up of air. Insects microbes, earthworms and soil life require this much air to live. The air in soil is also an important source of the atmospheric nitrogen that is utilized by plants.

空气-土壤有25%的空气组成，土里有蚯蚓、土壤生物等它们都需要空气另一个重要原因就是植物生长所需的大量氮肥就存在于空气中。

To ensure that there is a balanced supply of air in your soil, add plenty of organic matter, avoid stepping in the growing beds or compacting the soil with heavy equipment and never work the soil when it is very wet.

确保土壤构成的平衡增加大量有机物是关键，还要避免土地受重压和太湿。



# Soil Health (Components of Soil) 土壤构成

**Weathered Rock (Minerals)** - 45% of your soil is made up of weathered rock. Soil is classified by size of these particles. There are three type; sand, silt or clay.

土壤的 45%由风化岩石组成。土壤粒子分类大小不等。有三种类型；砂、淤泥或粘土。

- ▶ Sand - Large Particles 沙子 — — 大颗粒
- ▶ Silt - Medium Sized Particles 淤泥 — — 中型颗粒
- ▶ Clay - Very Small Particles 粘土 — — 很细小的颗粒

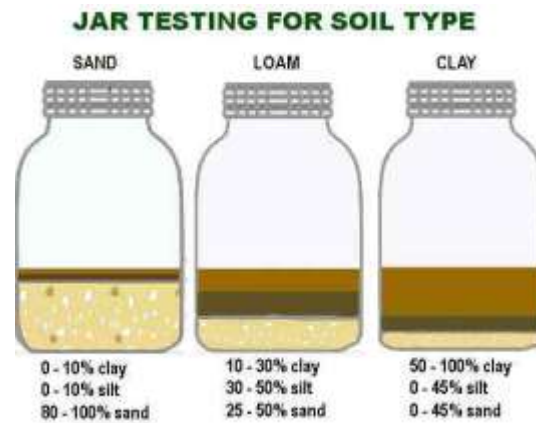
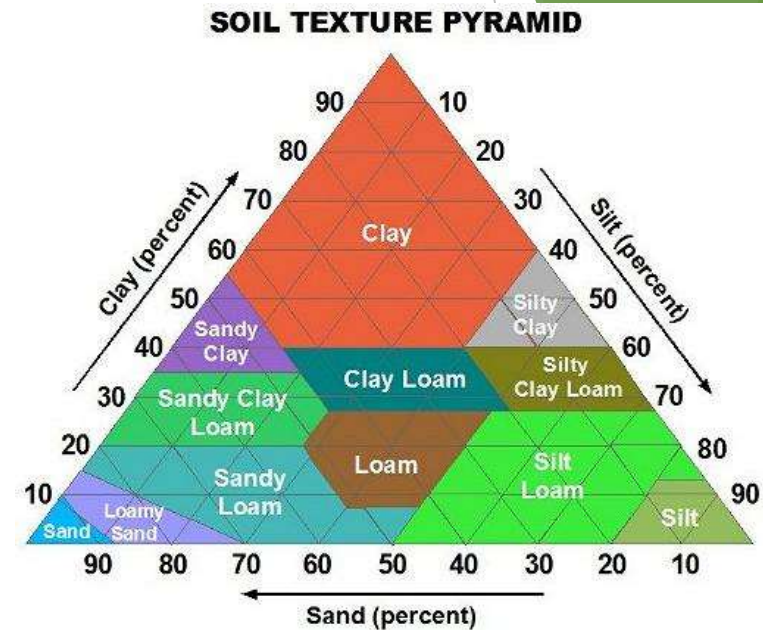
The proportion of sand, silt and clay particles determines the texture of your soil and affects drainage and nutrient availability, which in turn influence how well your plants will grow.

沙子、淤泥和粘土颗粒的比重决定了你的土壤质地和影响排水与养分的有效性，这反过来又会影响你的植物如何生长。



# Soil Health (Type of soil test) 不同类型土壤测试

- ▶ Fill a liter jar about one-third full with topsoil and add water until the jar is almost full. 用1升的容器装满浅层地表土，然后加水至满。
- ▶ Screw on the lid and shake the mixture vigorously, until all the clumps of soil have dissolved. 拧上盖子使劲摇动混合物，直到所有的块状土壤已散
- ▶ Now set the jar on a windowsill and watch as the larger particles begin to sink to the bottom. 放在窗台，看容器中较大的颗粒开始沉到水底
- ▶ In a minute or two the sand portion of the soil will have settled to the bottom of the jar (see illustration). Mark the level of sand on the side of the jar. 一两分钟后，土中的砂子先沉到底部，标记下位置。
- ▶ Leave the jar undisturbed for several hours. The finer silt particles will gradually settle onto the sand. You will find the layers are slightly different colors, indicating various types of particles. 几小时后细微砂粒会落在底部砂子上，你会发现有几种不同的颜色，也就包括几种不同的粒子。
- ▶ Leave the jar overnight. The next layer above the silt will be clay. Mark the thickness of that layer. On top of the clay will be a thin layer of organic matter. Some of this organic matter may still be floating in the water. In fact, the jar should be murky and full of floating organic sediments. If not, you probably need to add organic matter to improve the soil's fertility and structure. 过一夜后，底层是砂子，砂子以上是粘土。标记厚度，粘土以上会有一层薄薄的有机质，还有一些有机质会漂浮在水面上。而容器整体观看是暗色的，也会有一些微粒漂浮在水中，如果不是这样的，那就需要增加有机质以提高肥力和构成。





# Soil Health (Restore Health) 恢复健康

- ▶ Adding Organic Matter 增加有机质
  - ▶ Carbonized rice hulls 炭化米壳
  - ▶ Compost or organic material 堆肥和有机肥
  - ▶ Manure 动物粪便
- ▶ Introduction of Indigenous Microbes 引入土著微生物
- ▶ Retaining water/air and organisms 保持水空气和生物体
  - ▶ Mulching 地面覆盖
  - ▶ Minimal Tillage 少耕
  - ▶ Cover Cropping 覆盖作物
- ▶ Vermiculture 蚯蚓培养

# Soil Health (Carbonized Rice Hulls) 炭化米壳

Carbonized Rice Hulls - Carbonized rice hull is made from incomplete or partial burning of rice hull. It undergoes a controlled burning process with low oxygen where the dried rice hull is heated until they are carbonized. 碳化的稻壳-炭化的稻壳是由不完全或部分燃烧的稻壳。它经历了一个控制的燃烧过程，处于低氧状态下的干稻壳被加热直到他们被炭化

## Benefits of CRH 炭化稻壳的益处

- ▶ Soil fertilizer and conditioner 土壤肥料和调解剂
- ▶ Contains phosphorous(P), potassium (K), Calcium (Ca), Magnesium (Mg) and micronutrients. 含有磷、钾 (K)、钙 (Ca)、镁 (Mg) 和微量元素
- ▶ Retains water 保水
- ▶ Houses beneficial bacteria 有益菌的滋生地
- ▶ Brings up the pH of acidic soils, reducing the need for Lime 提高酸性土的PH，减少石灰的使用



# Soil Health (Carbonized Rice Hulls)

Right green bean plants, 3 weeks old, untreated (left) versus biochar-treated. 使用和未使用炭化稻壳绿豆对比, 3周龄



Right, bok choy plants, 2 weeks old, untreated (left) versus biochar-treated.. 使用和未使用炭化稻壳白菜对比, 2周龄



University of Hawaii

# Soil Health (Carbonized Rice Hulls)

## Materials: 材料

- Fire wood 木柴
- Shovel 铁铲
- Dried rice hulls 干稻壳
- Carbonizer 炭化装置
  - Metal Can 铁皮筒
  - Metal Chimney 铁皮烟囱



# Soil Health (Carbonized Rice Hulls)

1. Start a fire using the lighter and firewood and let it kindle 用打火机和木柴生火，让它燃烧
2. Make sure that the fire won't die out before covering it with the Carbonizer 进行覆盖炭化前确保火不会熄灭
3. Pour and stack the dried rice hull around the carbonizer. 堆好周围干稻壳。
4. When the rice hull at the top are carbonized, use the shovel to cover it with the dried rice hull from the bottom 当顶部稻壳被炭化，用铲子把底部的干稻壳再撒在上面
5. When the rice hull is almost carbonized (80%). Remove the carbonizer by tipping it over to the side using the long shovel. Extra caution is exercised for the carbonizer is extremely hot 当稻壳几乎炭化 (80%)，用长铲把未炭化稻壳撒离，要格外小心，炭火非常热
6. Mix the rice hull and let the remaining embers to carbonize the rest of the mixture until all of it (100%) are carbonized 混合稻壳并让剩余的灰烬炭化该混合物的其余部分，直到全部 (100%) 被炭化
7. When all of the rice hull are carbonized, sprinkle water/IMO onto the CRH using the watering pale to extinguish the remaining embers 当所有的稻壳炭化，用喷壶用水或IMO扑灭余火。
8. Lay the CRH thinly and make sure that the embers have completely died out to prevent the carbonized rice hull turning into ash 把炭化稻壳铺成薄薄的一层并确保余火已经完全熄灭，以防止炭化稻壳烧成灰。
9. When its dry, collect and store the CRH into sacks. After that, its ready to be used or sold 干透装袋，等待用在地里。



Figure 3.3: The steps of rice hull carbonization. Starting the fire and installing the carbonizer (a), adding hulls to the carbonizer (b), the appearance of carbonized areas on the rice hull pile (arrow) (c), the progression of carbonization (d), the appearance of the pile when approximately 90% of the carbonization has occurred (e), stirring the rice hulls during the final stage of carbonization (f) and spreading out the carbonized rice hulls and halting the carbonization (g).

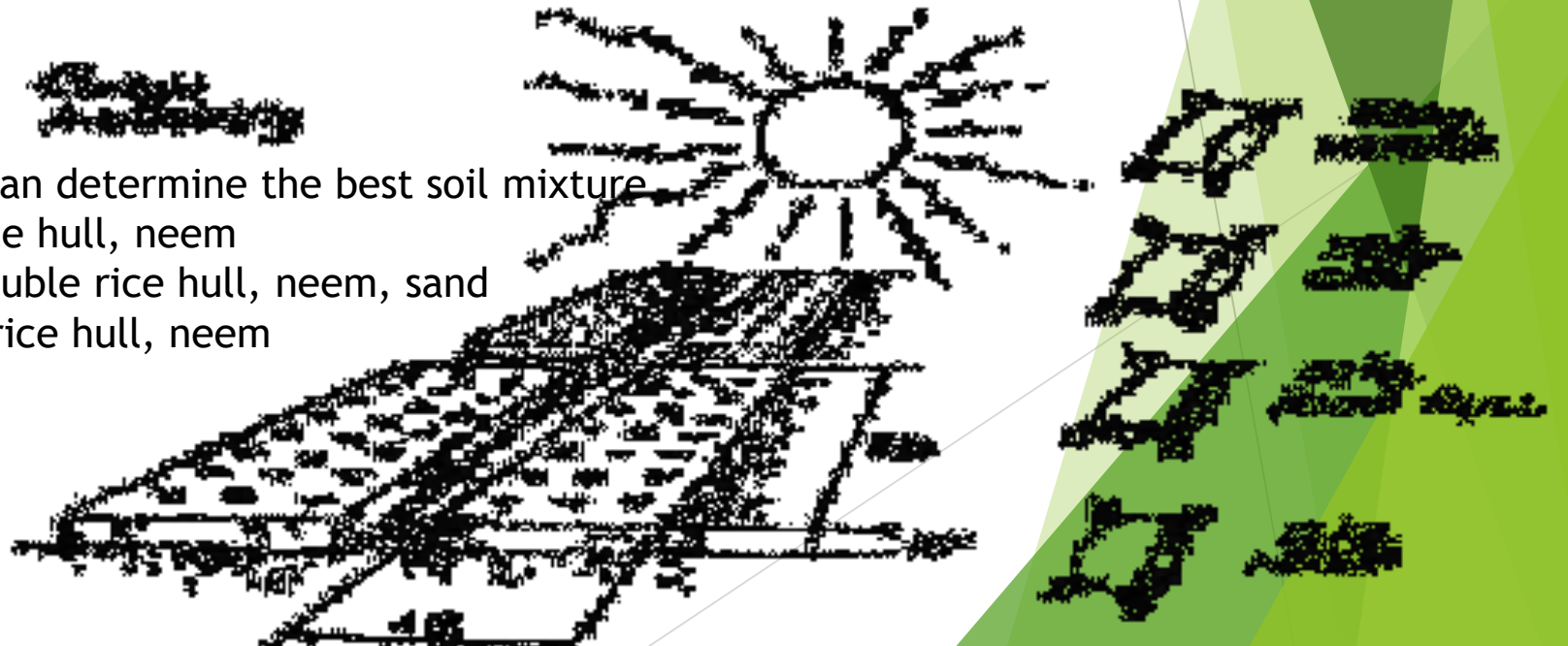
# Soil Health (Preparing Soil) 土地准备

To prepare the soil for planting we will need to prepare the following inputs: 土地种植前要做以下准备

- ▶ Rice Hulls (dried organic material) 米壳 (干的)
  - ▶ Add organic material 加入有机物
- ▶ Carbonized rice hulls 炭化稻壳
  - ▶ Feed microbes, adds nutrients, water absorption. 营养微生物、补充营养、吸收水份
- ▶ Manure 动物粪便
  - ▶ Organic materiel, nutrients 有机物、营养
- ▶ Neem Leaves or other bitter leave 苦楝树或其它苦叶子
  - ▶ Protects soil from non beneficial insects or bacteria. 保护土壤免受有害昆虫和有害细菌的伤害

By knowing the different kinds of soil, we can determine the best soil mixture

- Sandy - double manure, carbonized rice hull, neem
- Clay - manure, carbonized rice hull, double rice hull, neem, sand
- Loam - manure, carbonized rice hull, rice hull, neem



# Soil Health (Preparing Soil)

Row Size 1M x 5M

- ▶ Clear the land of weeds, big stones/rocks, and other garbage. 清除杂草、大石头、岩石和其他垃圾
- ▶ Spread one sack dried animal manure, carbonized rice hull (CRH)(1-3kg), rice hull, and 1 -3kg. chopped neem or other bitter leaves all over the ground. 撒一袋干动物粪肥、炭化的稻壳 (CRH) 或灰、稻壳和 12 公斤。切碎的楝树或其他苦味的叶子满地
- ▶ Using shovel, spade and hoe, or plow and harrow, dig the soil up to 30cm deep. Make sure that the manure, CRH, rice hull, ash and the neem leaves are mixed well as you dig the soil. 用铲子、铁锹和锄头，或犁耙，挖土深达 30 厘米。请确保把粪便（肥料、CRH、稻壳、灰和印度楝树的叶子混合以及你挖土
- ▶ Break up large clogs of soil. 打碎大的土块
- ▶ Raise a bed/plot up to 30cm high, one meter wide and five meters long in an east-to-west orientation. Provide at least 30cm space between the beds. 起畦：高 30 厘米、宽一米、长五米，东西方向。两畦之间至少 30 厘米空间。
- ▶ The plots should be in an east-to-west orientation for equal distribution of sunlight to the plants. 东西方向起畦利于植物均等吸收阳光
- ▶ Cover rows with mulch and water 按行覆盖利于保水



# Soil Health (Vermiculture)



## What is Vermiculture?

**Vermiculture**- the cultivation of earthworms, especially in order to use them to convert organic waste into fertilizer.

## What are benefits of worms in farming?

- ▶ \*Simple and cheap way to help crops.
- ▶ \*Waste reduction.
- ▶ \*Increases the nutrients in the soil by producing excrement that acts like fertilizer that feeds the plant.
- ▶ \*Plant roots require oxygen and worm burrows provide passages for air to get to the roots deep within the ground. This is called aeration.
- ▶ \*Their underground burrows also create channels in the soil, which makes the soil more porous, allowing water to move to greater depths. Worm burrows also allows for drainage after heavy rains reducing erosion.



# Soil Health (Vermiculture)

## What to feed worms?

- ▶ Raw vegetables
- ▶ Small amounts of fruit
- ▶ Tea leaves
- ▶ Coffee grounds
- ▶ Egg shells
- ▶ Newspaper, card board, paper
- ▶ Dead plants, leaves, grass
- ▶ Small doses of onion and garlic.
- ▶ ## These should be chopped up into smaller pieces.##

## What NOT to feed the worms!

- ▶ Citrus fruits (orange, lemons, youzi, etc.)
- ▶ Dairy products
- ▶ Fat
- ▶ Meat
- ▶ Fish



# Soil Health (Vermiculture)

## Vermiculture, Garden Composting Tower

### Benefits

- ▶ 1. Efficient recycling of clean vegetable residues.
- ▶ 2. Feed and multiply earthworms to populate a garden area of up to 1000 sq. ft. (32' X 32').
- ▶ 3. Protect young worms from animal predators.
- ▶ 4. Worm numbers per bed increased 25 fold, over 6 months at ECHO in N. Fort Meyers, FL.
- ▶ 5. Improved conditions, year around, for efficient composting.
- ▶ 6. Enhances the management of permanently located, no till, organic, raised beds.
- ▶ 7. Worm tunnels improve soil aeration, moisture conditions, plant root development and
- ▶ nutrient cycling.
- ▶ 8. Highly favors beneficial microbial, soil health.
- ▶ 9. Improved and better balanced soil fertility.
- ▶ 10. With some three years of use, on poor sandy soil, the Brannen's report improved soil quality and higher vegetable yields and quality.



# Soil Health (Mulching) 地面覆盖

Mulching is simply covering the soil around the plants with protective materials. Mulching helps prevent evaporation of moisture, freezing of roots, and growth of weeds. We can use organic materials such as dried grasses and leaves, hay or straw, sawdust, dried grass clippings, and bark and wood chips. 地面覆盖：简单地放一些防护材料在植物周围的土壤上，可帮助防止水分的蒸发、冻根和生长杂草。可用干的草和树叶，干草或稻草、木屑、干草屑和树皮木屑等材料。

## Advantages of Mulching 覆盖的优势

- ▶ Suppresses water evaporation 抑制水份蒸发
- ▶ Helps in better penetration of rainwater (A mulch that is two-to-four thick allows 75cm of rain water absorption; an uncovered soil can only allow 45cm of water penetration.) 利于雨水渗透 (一处2-4层覆盖物的土地可使雨水湿透75CM的土地，而未覆盖的只能湿透45CM。)
- ▶ Maintain a more uniform temperature in the root zone. 保持根部温度均衡
- ▶ Improves soil structure by increases the organic matter content of the soil as the mulch decomposes 覆盖物分解后可增加土壤的有机质含量及改善土壤结构。
- ▶ Promotes growth of microorganisms in the soil 促进土壤中微生物的生长
- ▶ Promotes better uptake of nutrients, specially potash 促进更好地吸收营养物质，特别是钾肥
- ▶ Limits growth of weeds Reduces cultivation and weeding 限制杂草生长，减少耕作除草

Cover the newly Transplanted Seedlings



# Soil Health (Minimal Tillage) 少耕

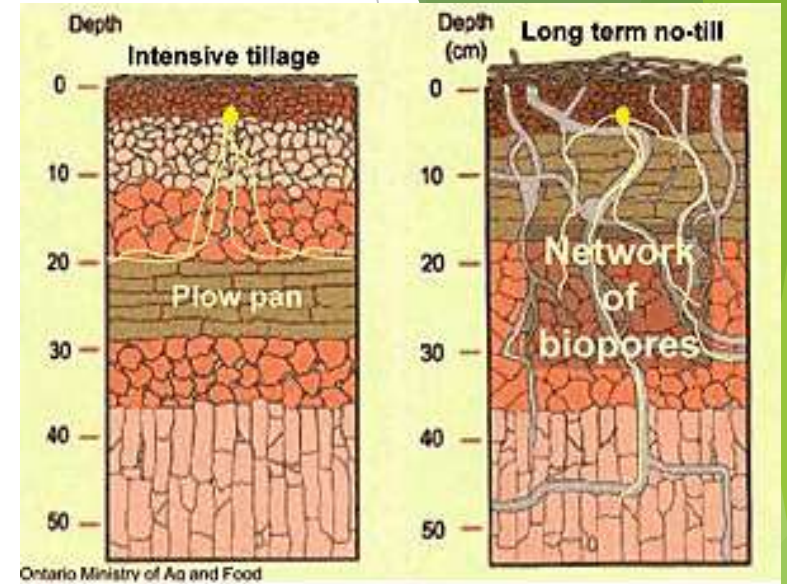
Minimal Tillage is a soil conservation method with the goal of minimum soil manipulation necessary for a successful crop production. It is a tillage method that does not turn the soil over. “少耕”的目标是最低限度进行翻耕并实现水土保持

## Advantages of Minimal Tillage 少耕的优点

- ▶ Reduce labor and saves time. 降低劳动力成本和节省时间。
- ▶ Reduces soil erosion. 减少水土流失。
- ▶ Preserve soil microbiology. 保持土壤的微生物
- ▶ Plants will have better root penetration. 植物根系将更发达
- ▶ Improves water absorption. 提高吸水性

## Guidelines to Minimal Tillage: 少耕的指导方针

- ▶ Do not turn the soil. 不要挖开土壤
- ▶ Use broad forks to aerate the soil 使用宽大农具翻土
- ▶ Do not walk on the beds or allow large animals to walk on the beds. 不要让人和大型动物在种植畦上走



# Soil Health (Cover Cropping) 覆盖作物

Cover cropping is the practice of growing plants that protect the soil between crop rotations. 覆盖作物种植是植物轮作中两茬间应用的一种方法

## *Advantages of Cover Cropping* 覆盖作物的优点

- ▶ Suppresses weeds. 抑制杂草。
- ▶ Protects top soil. 保护表层土壤。
- ▶ Retains soil moisture. 保持土壤水分。
- ▶ Help control pest and disease. 帮助控制病虫害。
- ▶ Protect against soil erosion. 防止水土流失

## Examples of cover crops: 覆盖作物的例子

- ▶ Alfalfa 紫花苜蓿
- ▶ Sweet potato 红薯
- ▶ Peanuts 花生
- ▶ Malabar Spinach 木耳菜



# Soil Health (Indigenous Microbes) 土著微生物

## Types of Beneficial micro-organisms

- ▶ Photosynthetic Bacteria (Purple Bacteria)
- ▶ Lactic Acid Bacteria
- ▶ Yeast
- ▶ Fermenting Fungi

## Benefits:

- ▶ Protect plants from diseases.
- ▶ Increased rates of soil organic matter decomposition
- ▶ Increases in nutrient availability

## Application:

Spray the different mixtures on the rice hulls and CRH before they are mixed into the soil.

Spay mixtures on the soil once a week.



We will explain how to make the mixtures in the crop management lesson.