



Sustainable Agricultural System

University of Lampung
kuliah ke-3



Components and Models of Sustainable Agriculture Management (SAM)

1. Nutrient and soil management,
2. Soil organic matter
3. Soil and water conservation,
4. Water: Harvesting and management
5. Impacts of SAM



1. Soil: Integrated Soil Nutrient Management and Fertilization

Why we need this?:

- **Poor inherent fertility**
- **High erosion**
- **High nutrient leaching and plant uptake**
- **Crops need nutrients (9 macronutrients, 6 micronutrients)**
- **External inputs (chemical fertilizers, insecticides, seeds) is increasingly expensive**



Soil: Integrated Nutrient Management and Fertilization

Major fertilizer constraints to farmer:

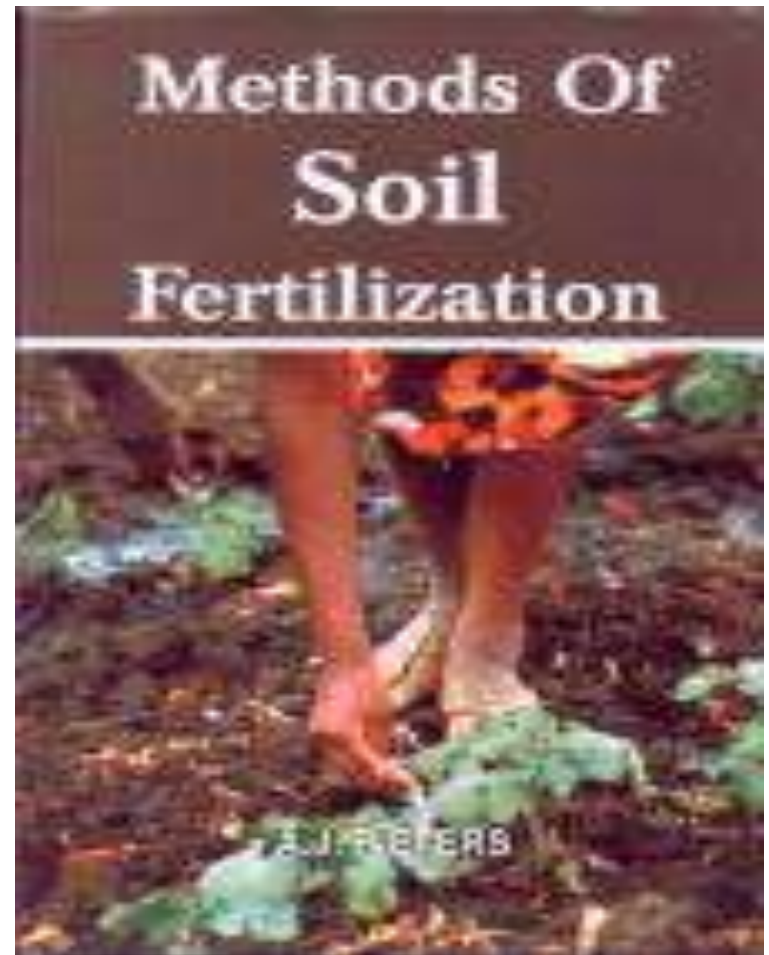
- High price of fertilizer (less subsidize)
- Nutrient contents of fertilizer usually are less than their states
- Fertilizer availability is not on time
- Too complicated procedure to purchase fertilizer
- Lack of credit to purchase fertilizer



Soil: Integrated Nutrient Management and Fertilization

Steps of Implementation:

- Minimize soil erosion, organic and nutrient leaching
- Recycle, reuse organic nutrients
- Enhance biological source of nutrients
- Compensate for nutrient loss (harvest and leaching)
- Select adapted and efficient crop species
- Optimize fertilizer rate



2. Soil Organic Matter (SOM) Management

- Important of SOM
- Factors affecting SOM
- SOM Management

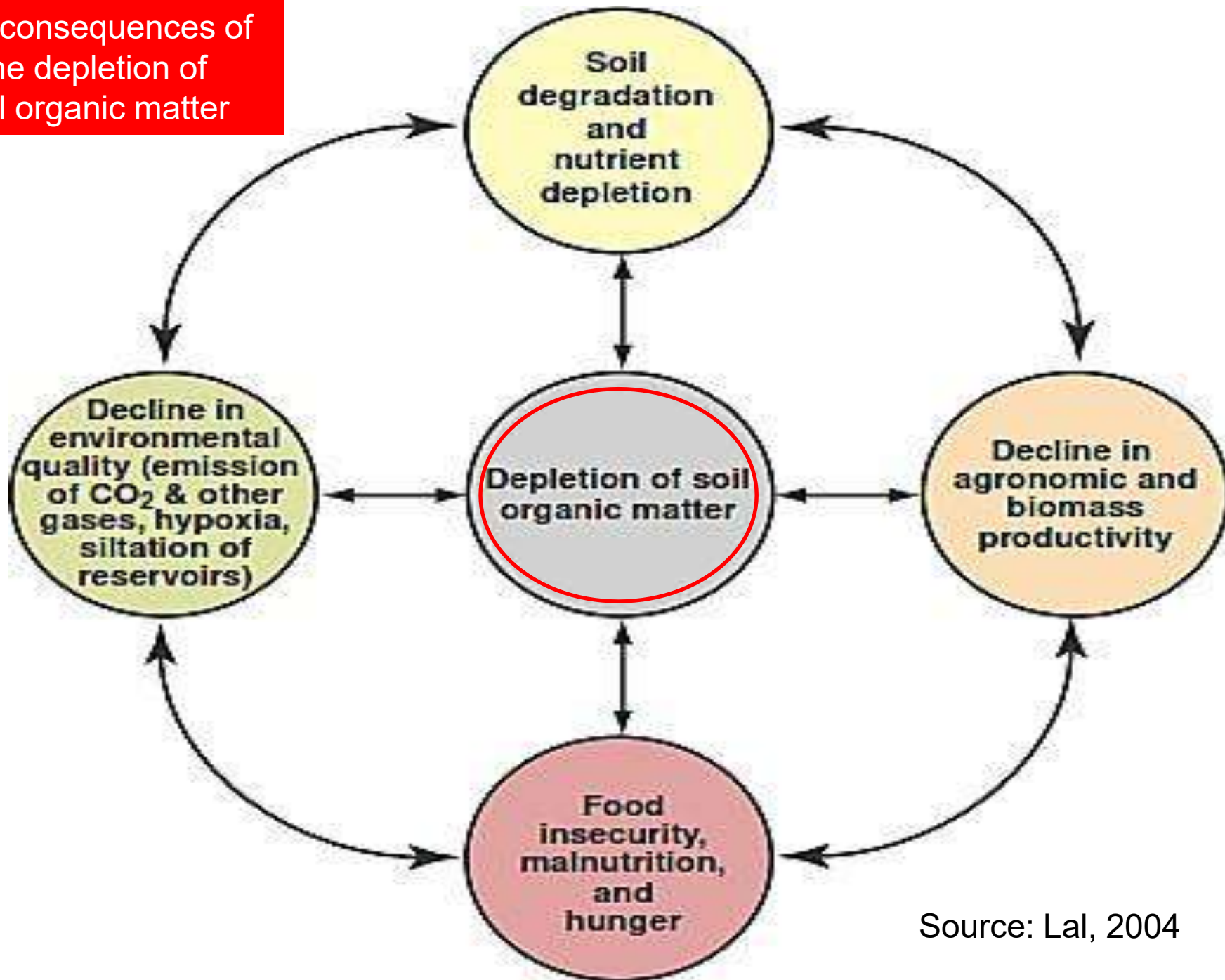


Important of Soil Organic Matter

- **SOM content is a key on decreasing soil degradation**
- **Affect on soil physical, nutrient availability (chemical) and biological properties**



**The consequences of
the depletion of
soil organic matter**



Source: Lal, 2004

Factors affecting Soil Organic Matter buildup

- **Primary factors:**
 - (1) O_2 content in soil
 - (2) C/N ratio of organic matter
 - (3) soil moisture content
 - (4) soil temperature
- SOM turned over—tillage management**



Soil Organic Matter Management

- **Main Soil Organic Matter Managements:**
animal manure, composting,
green manure, mulching,
conservation tillage →
increase SOM.

**Mulching & conservation tillage
(see slide 23 – 27)**



Soil Organic Matter:

Animal Manure & Composting

What it is?:

- animal manures (AM) are the droppings (decomposed solid manures) which rich in nutrients (such as N, P and base cations)
- Composting is piling up crop and other farm wastes in layers to make them decompose quickly
- it produces organic fertilizer/humus



Soil Organic Matter: Animal Manure & Composting

- **How it work?:**
 - used in all soils with low fertility
 - sandy soil with poor water holding capacity
 - high value crop, horticulture
- **Advantages:**
 - Rich in nutrients (N, P and bases)
 - Relatively cheap, easy to make & apply
 - has multiplier effects: soil fertility and social, and economy
 - improves soil fertility, soil biodiversity, soil aggregation, soil moisture



Pupuk kandang & kompos yang telah matang & siap dipakai

Soil Organic Matter:

Animal Manure & Composting

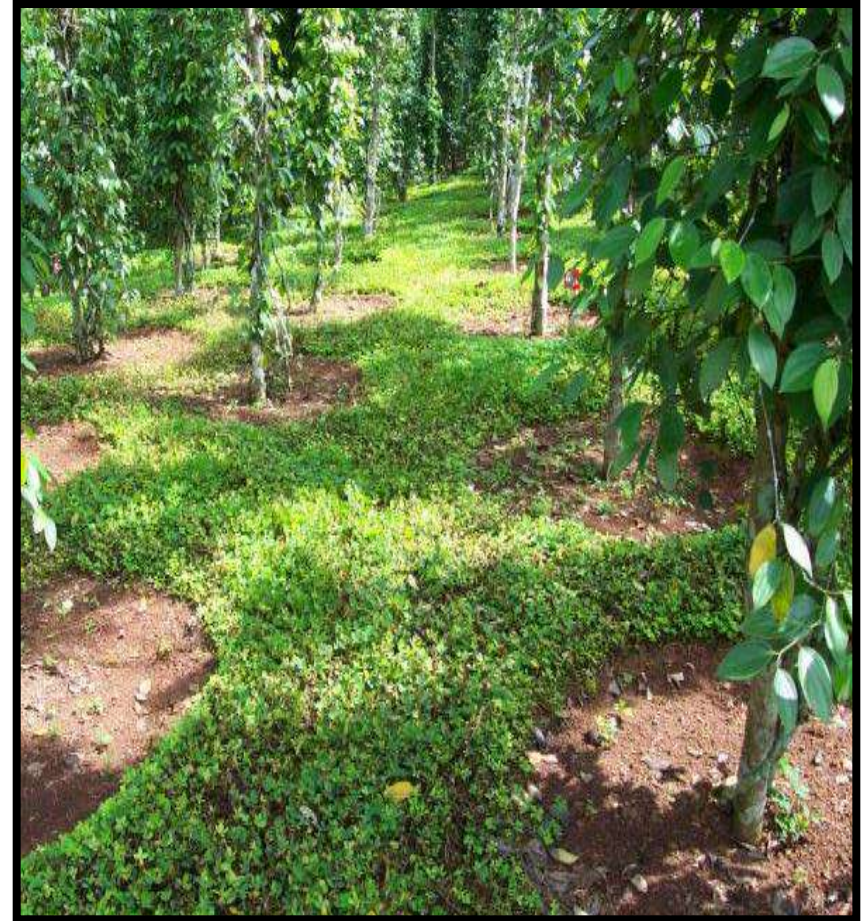
- **Disadvantages:**
 - long term benefit rather than immediate
 - need bulk, larger volume than inorganic fertilizer, difficult to handle, transportation
 - need a lot of labor to make it
 - Nutrient composition varies, depend on material used



Soil Organic Matter: Green Manure

What it is?:

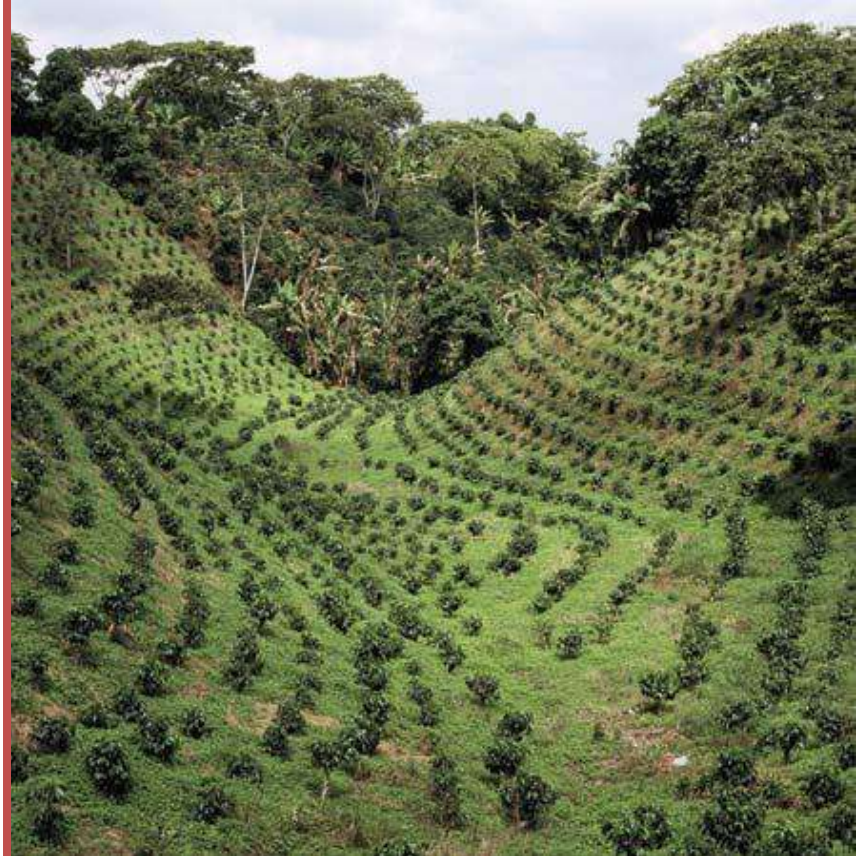
- Green manures (GM) are fast growing plants, legume or non-legume, planted or inter-cropped on piece of land
- During or after the growing season, GMs are slashed and use as mulch or incorporated into the soil
- It increases plant nutrients and improves soil structure



Soil Organic Matter: Green Manure

How it work?:

- Planted before or after planting, used for various type of soils, especially for poor soil
- Used for high valuable crop, control erosion and increases plant nutrients, improves soil structure



Soil Organic Matter: Green Manure

Advantages:

provide fodder (food for cattle),
soil conservation, soil fertility, and
suppress weed

GMs are cheap, easy to manage

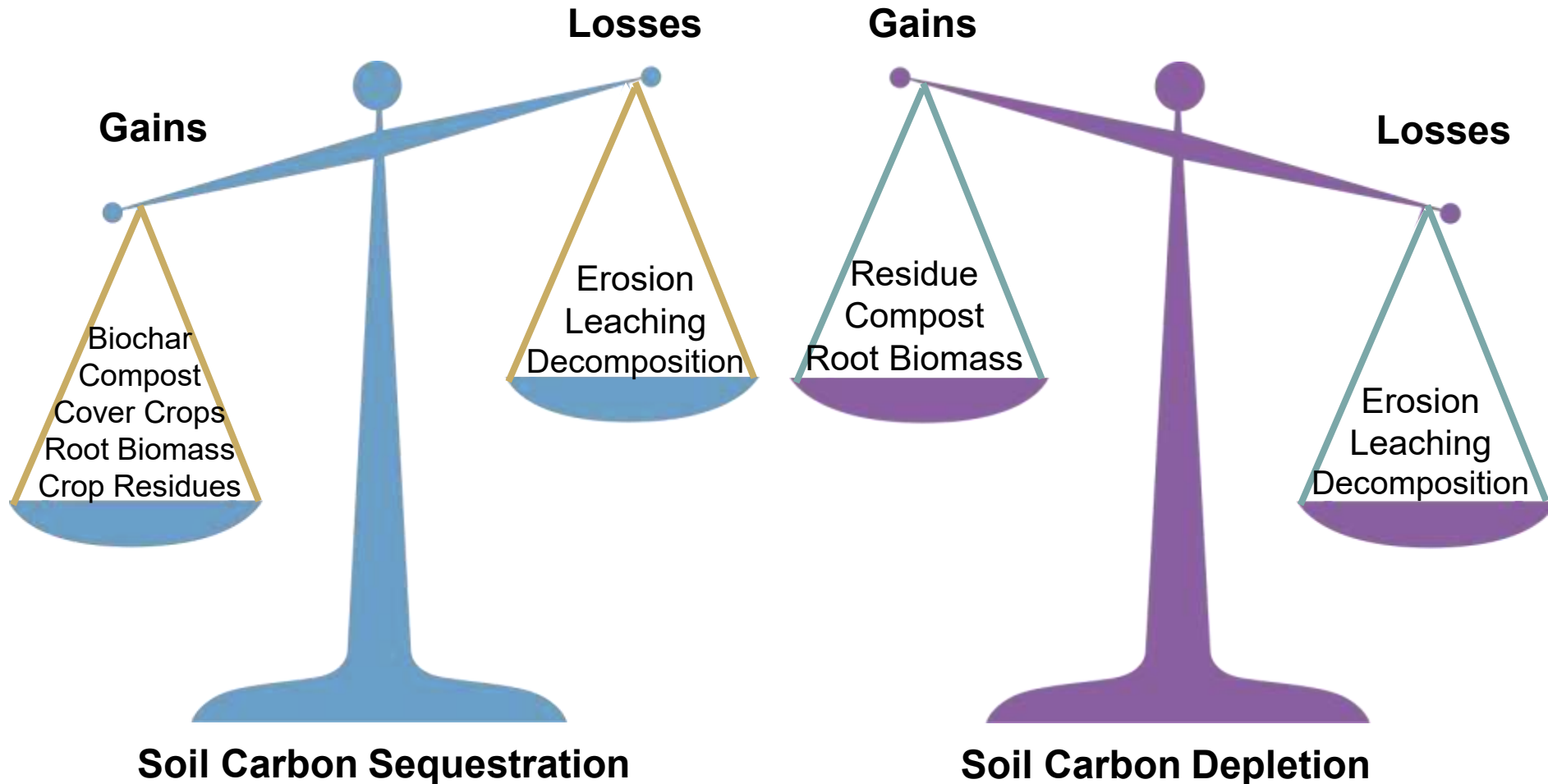
GM seeds are easily available

Disadvantages:

long term benefit,
during dry season compete
for water uptake
some GMs may compete for
light and nutrient



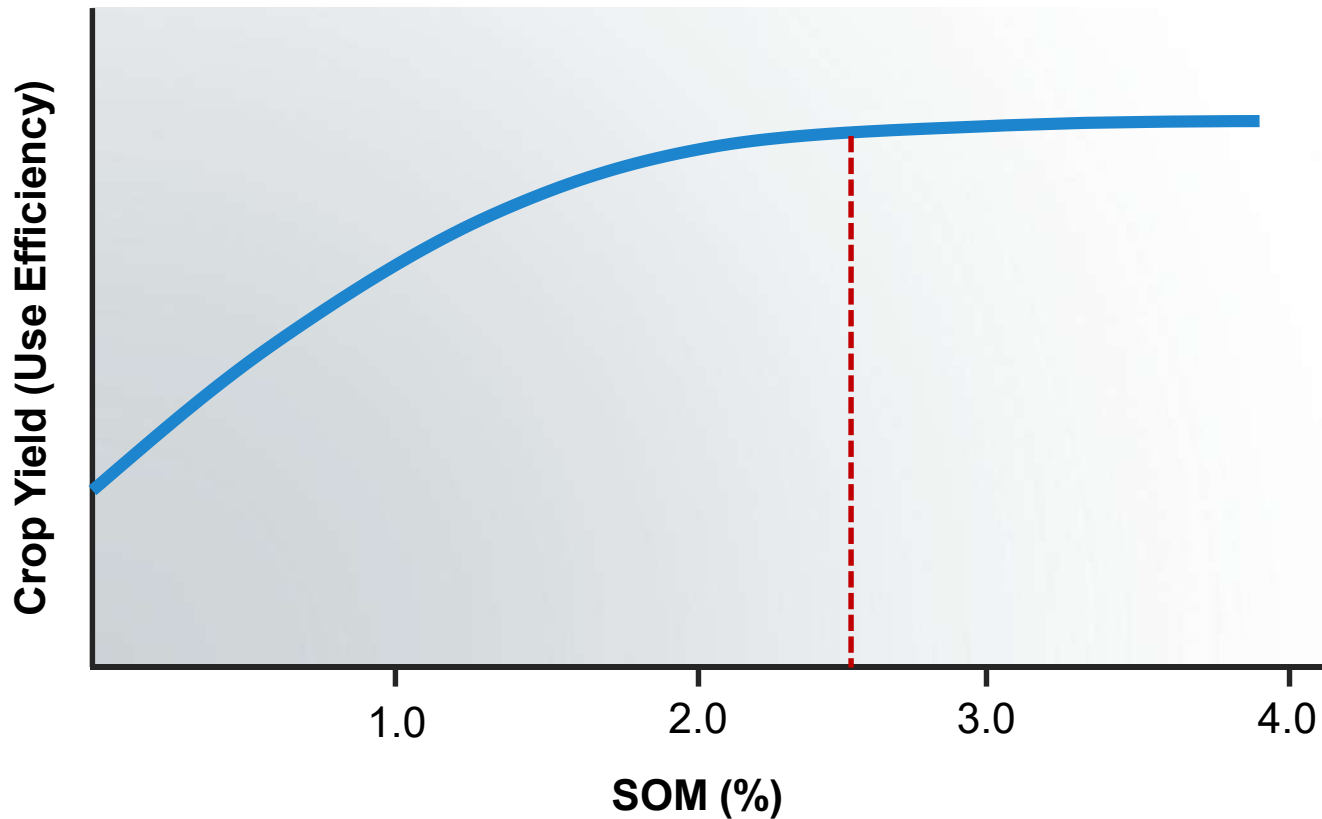
CREATING POSITIVE C BUDGET



THRESHOLD LEVEL OF SOIL ORGANIC MATTER IN 0-30 CM LAYER

SOM : 2.5 - 3.5%

SOC : 1.5 - 2.0%



3. Soil and Water Conservation: *Why we need this?*



Soil degradation vs erosion



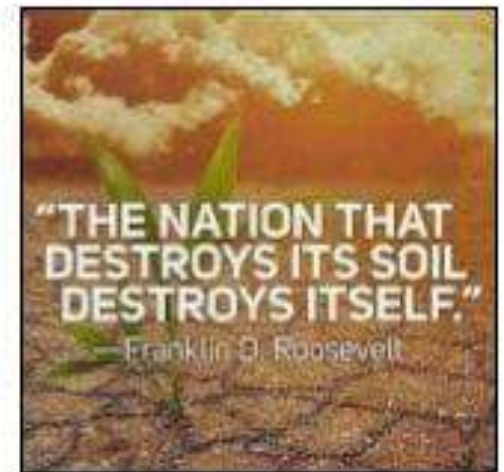
Impact of erosion

On-site

- Loss of fertile top soil
- Loss of nutrients
- Impairing crop productivity

Off-site

- Non-point source of pollution
- Filling of reservoirs and dams
- Degrading on water quality
- Reducing ability to buffer against environmental impacts
- **Flooding**
 - **Loss of upland water storage**



Soil and Water: Conservation Practices

1. Conservation tillage
2. Cover crops (Green manure)
3. Composting
4. Animal manure
5. Mulching
6. Crop rotation
7. Agro forestry
8. Strip cropping
9. Terrace



Soil and water: Conservation tillage

CONTRAST DEFINITION:

- **Conventional (intensive) till:** continuous surface soil manipulation by plowing, no-mulch on soil surface: moldboard, and disking till
- **Conservation till:** less or no surface soil manipulation, > 25% *in situ* mulch on soil surface



Soil and water: Conservation tillage

- **Why Conservation till (CT):**
 - conventional till decreases soil quality (induces soil degradation)
 - CT more sustainable
- **How it works?:**
 - >25% mulch on surface
 - less or no soil surface manipulation
 - for upland: well drain, sandy loam to clay loam
 - region with less labor



Soil and water: Conservation tillage

- **Advantages :**
increases SOM,
increases soil aggregate strength, decrease erosion,
conserve soil and water,
reduce the cost
- **Disadvantages:**
difficult to plant,
cultural restriction



Soil and water: Mulching

- **What it is?:**

- mulch is vegetative material used to cover soil
- it reduces evaporation, increases soil moisture & organic matter, reduces run off/erosion, increases plant nutrient

- **How it work?:**

- used before and after planting, spread over soil surface or around crop stand
- used for high valuable crop, degradable soil



Soil and water: Mulching

- **Advantages:**
 - mulch keeps the soil moist longer than bare soil
 - it controls soil run off/erosion, increases plant nutrient
 - it suppresses weed
- **Disadvantages:**
 - labor intensive
 - it can introduce new pests and diseases into a field



Soil and water: Agro forestry

What it is?:

- agro forestry involves planting trees or shrubs in the farm
- trees can conserve soil through reducing run off, recycling nutrients from deep in the soil and can increase carbon sink
- also provide ecological, economic and social benefits

How it work?:

- suitable for varies types of soil
- mostly in tropical ecosystem



Soil and water: Agro forestry

Advantages:

- multi functions: provide food and fodder, increase soil conservation, soil fertility, and suppress weed
- provides short term and long term benefits

Disadvantages:

- more complicated farming system



Soil and water conservation: Terrace

- **Why terrace?:**
 - upland: high run off, high erosion (induces soil degradation)
 - land slide
- **How it work?:**
 - reduces run off and erosion
 - for upland: sloping land, deep soil
 - region with high labor



Soil and water conservation : Terrace

- **Advantages:**
Decrease erosion,
long term: increase
yield
- **Disadvantages:**
high cost,
long term effect,
not suitable for
shallow soil



Teras sawah di Bali



Terima kasih