



Principles of Soil Science

Lecture -6-



Soil Organic Matter

- Soil organic matter is made up of organic compounds and includes **plant**, **animal** and **microbial** material, both living and dead.
- A typical soil has a biomass composition of
 - **70** % microorganisms
 - **22** % macrofauna
 - **8** % roots.

Soil Fertility

It may be defined as **the ability of the soil to provide all the essential plant nutrients in available form and suitable balance,**

also understood that the soil should be free from any toxic substances.

Soil fertility comprises a number of processes (chemicals, physicals and microbiological) which leads to nutrient availability and balance in soil .

Fertilizers

Supply nutrients to crops.

There are two types of fertilizer:-

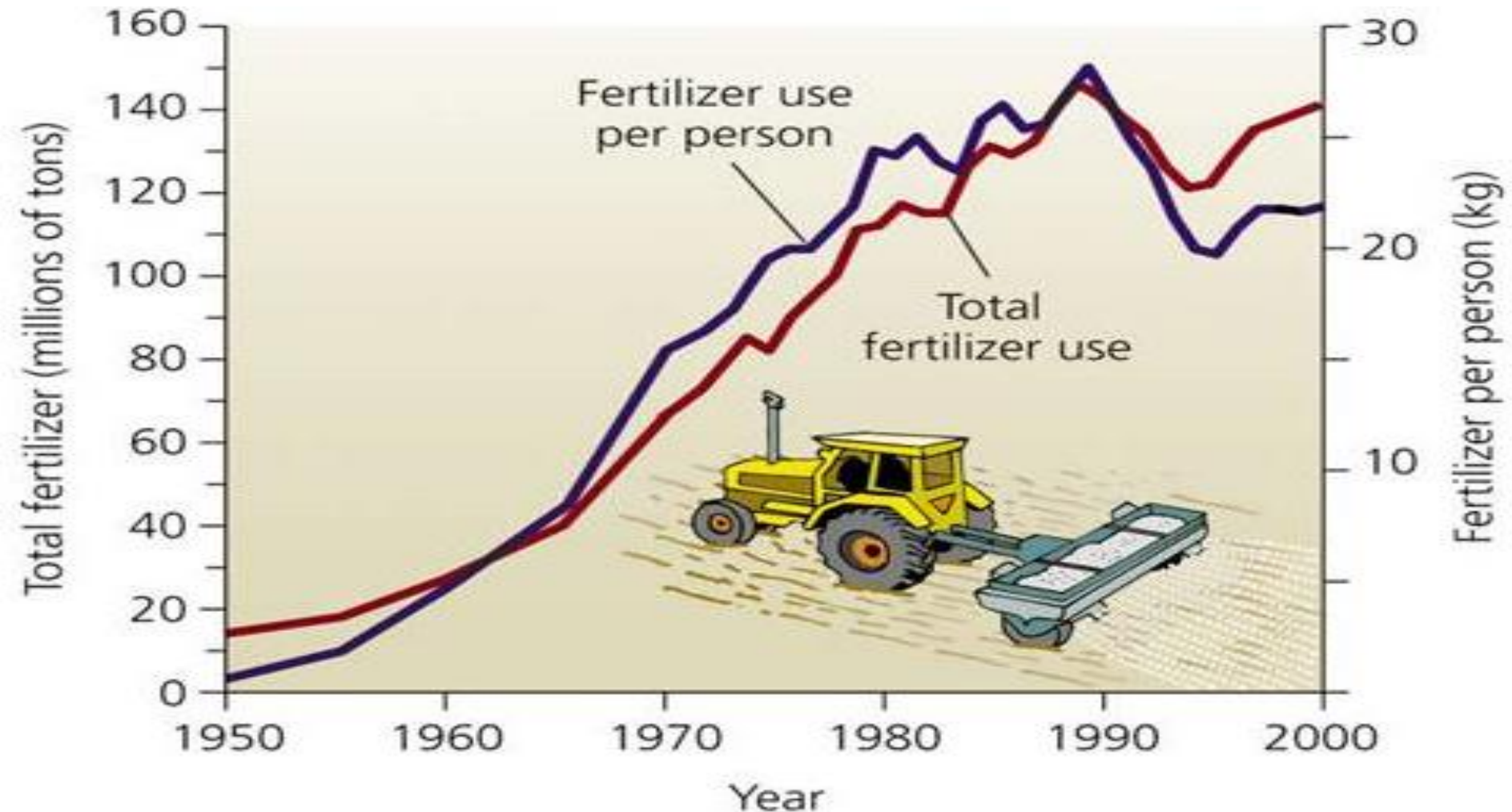
1- Inorganic fertilizers = mined or synthetically manufactured mineral supplements

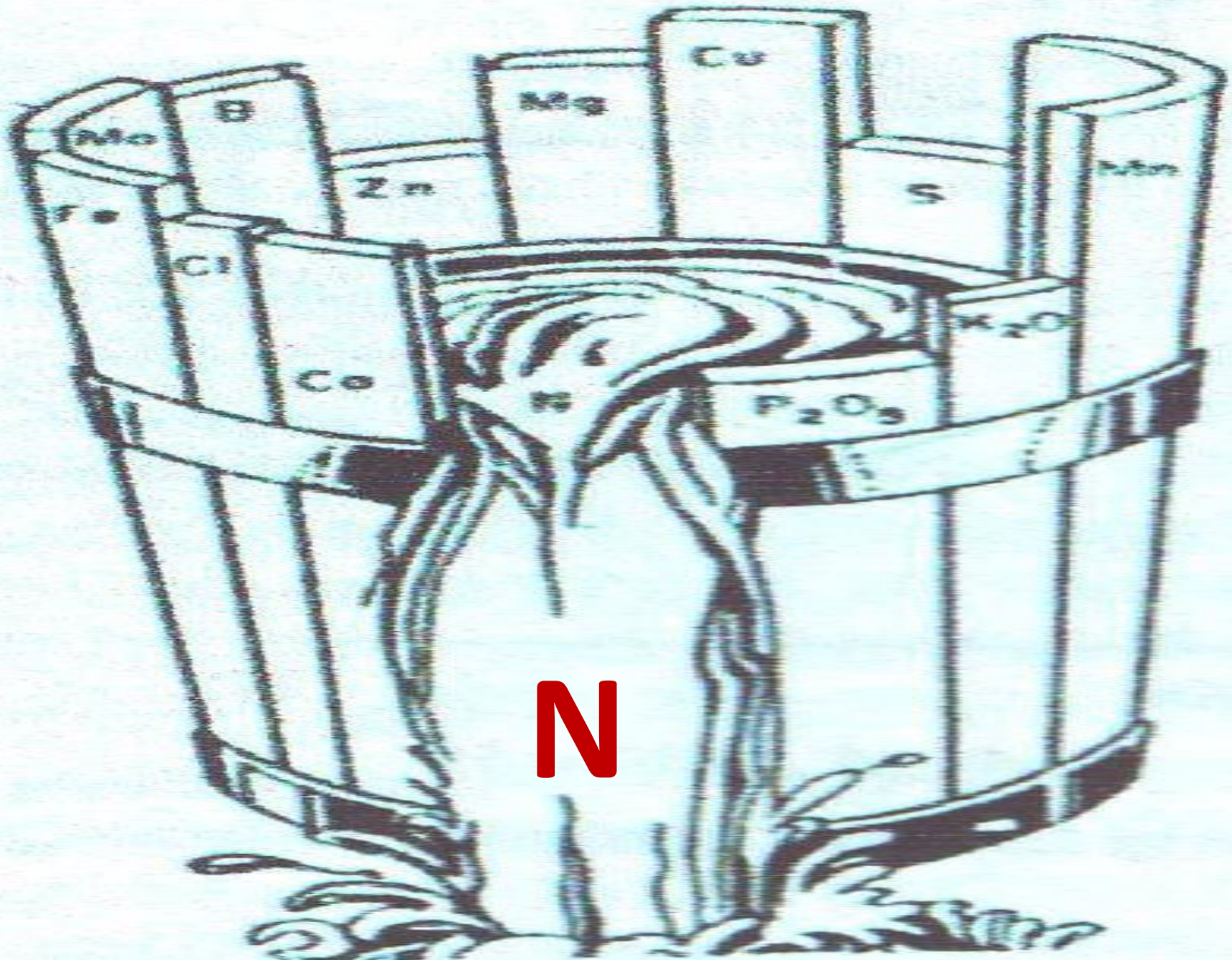
2- Organic fertilizers = animal manure, crop residues, compost, etc.



Global fertilizer usages

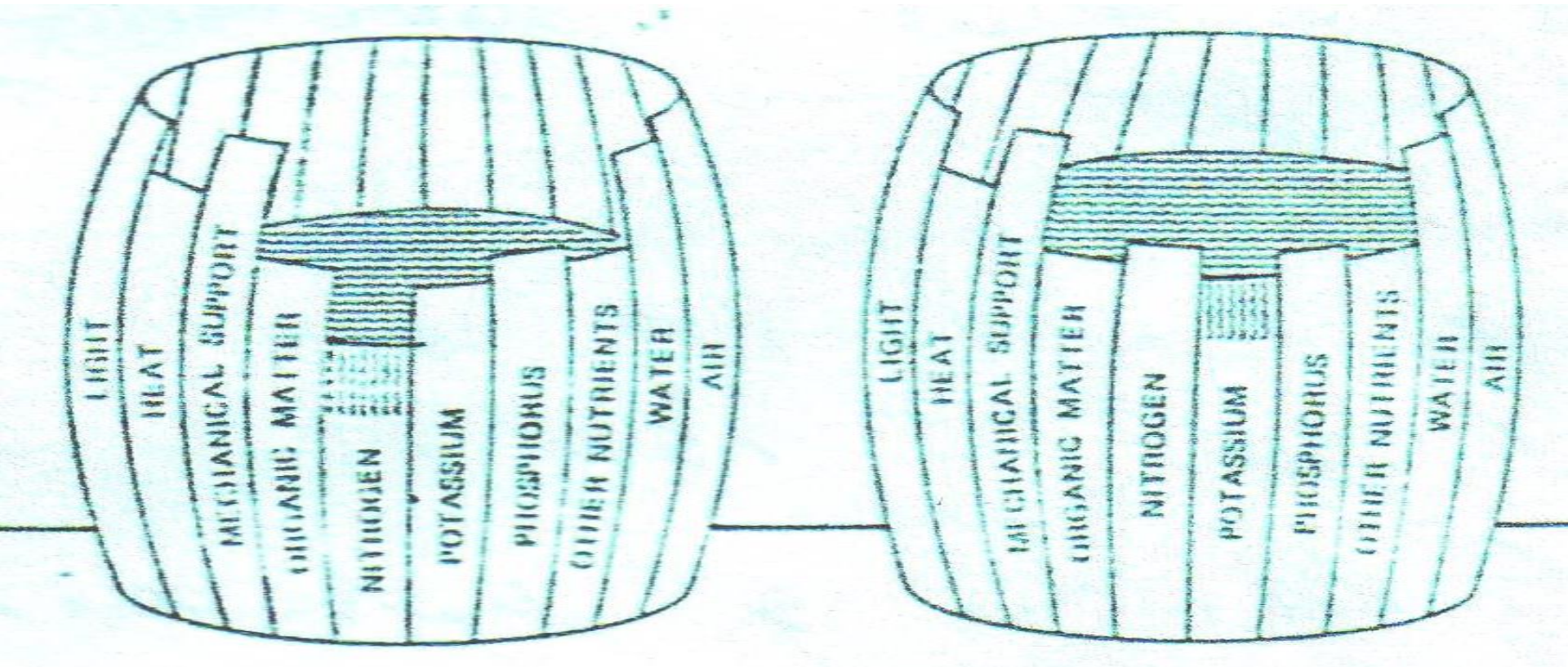
Fertilizer use has risen dramatically in the past 50 years.





N

Supply and availability of plant nutrients



An illustration of the principle of limiting factors.

The level of water in the barrels above represents the level of crop production.

(**Left**) Nitrogen is represented as being the factor that is most limiting.

Even other elements are present in more adequate amounts, crop production can be no higher than that allowed by the nitrogen. When nitrogen is added

(**Right**) the level of crop production is raised until it is controlled by the next most limiting factor in this case potassium.

Trade-Offs

Inorganic Commercial Fertilizers

Advantages

Easy to transport

Easy to store

Easy to apply

Inexpensive to produce

Help feed one of every three people in the world

Without commercial inorganic fertilizers, world food output could drop by 40%



Disadvantages

Do not add humus to soil

Reduce organic matter in soil

Reduce ability of soil to hold water

Lower oxygen content of soil

Require large amounts of energy to produce, transport, and apply

Release the greenhouse gas nitrous oxide (N₂O)

Runoff can over fertilize nearby lakes and kill fish

Land degradation and soil conservation

- **Human activities** are limiting productivity by degrading soils in many areas.
- **Land degradation** = a general deterioration of land, decreasing its productivity and biodiversity Erosion, nutrient depletion, water scarcity , salinization , water logging , chemical pollution.
- The soil's structure and pH change, and it loses organic material.

Erosion degrades ecosystems and agriculture

- **Erosion = removal of material from one place to another by wind or water**
- Deposition = arrival of eroded material at a new location.
- Flowing water deposits nutrient-rich sediment in river valleys and deltas :-
 - Flood plains are excellent for farming
 - Flood control measures decrease long-term farming productivity
- **Erosion occurs faster than soil is formed**
 - It also removes valuable topsoil

Soil erodes by several methods

- **Erosion occurs through wind and four types of water erosion.**
 - Rill erosion moves the most topsoil, followed by sheet and splash erosion
 - Water erosion occurs most easily on steep slopes
- **Land is made more vulnerable to erosion through:**
 - Over cultivating fields through poor planning or excessive tilling.
 - Overgrazing rangelands
 - Clearing forests on steep slopes or with large clear-cuts.

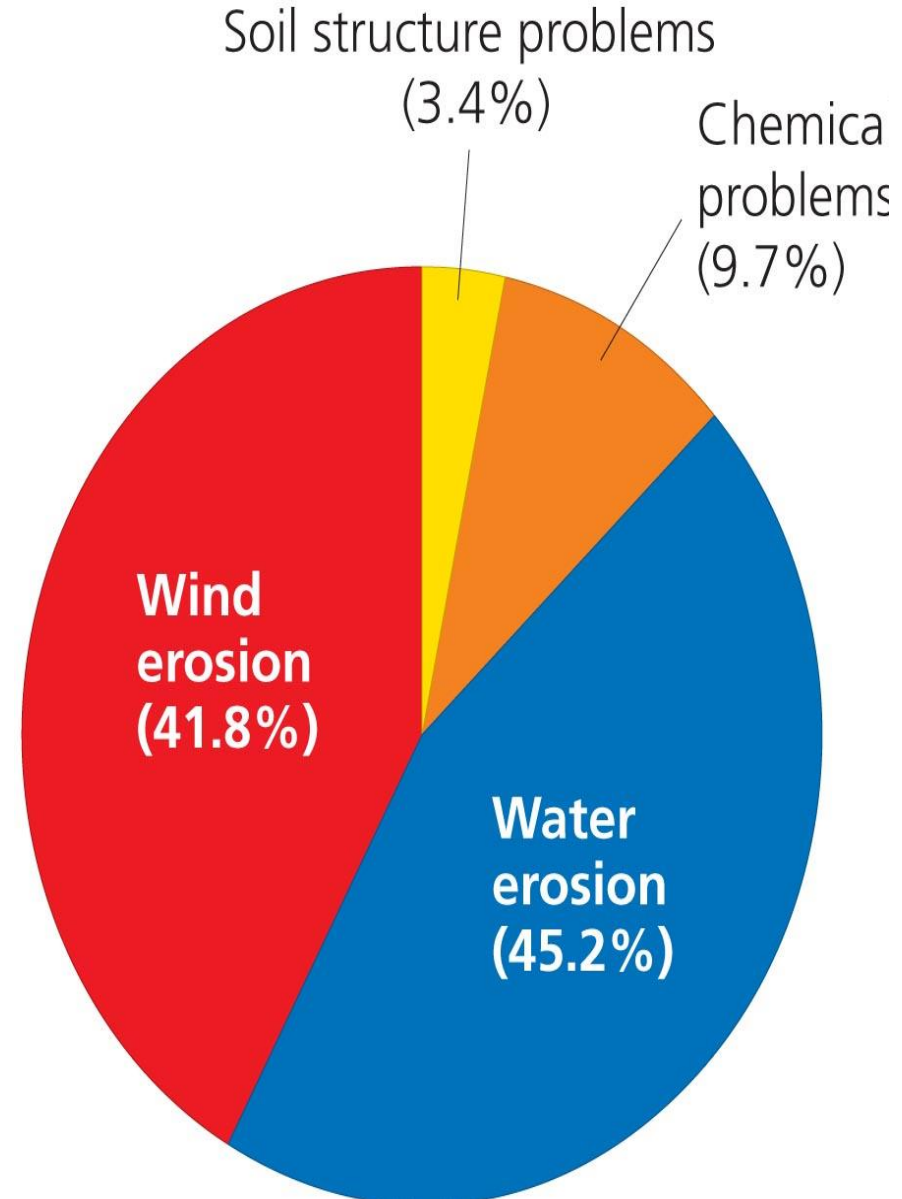
Erosion can be prevented

- **Erosion can be hard to detect and measure**
- Five tons / acre of soil is only as thick as a penny
- Physical barriers to capture soil can prevent erosion
- Plants prevent soil loss by slowing wind and water flow
 - Roots hold soil in place
 - No-till agriculture leaves plant residue on fields
 - *Cover crops* protect soil between crop plantings

Despite conservation measures, the U.S. still loses 5 tons of soil for every ton of grain harvested

Desertification reduces productivity

- **Desertification** = a loss of more than 10% productivity
 - Erosion, soil compaction
 - Deforestation and over grazing
 - Drought, salinization, water depletion
 - Climate change
- Most prone areas = arid and semiarid lands (*drylands*)



Desertification has high costs

- Desertification affects one-third of the planet's land area
 - In over 100 countries
 - Endangering food supplies of 1 billion people
- It costs tens of billions of dollars each year
 - China loses over \$6.5 billion/year from overgrazing
 - 80% of land in Kenya is vulnerable to desertification from overgrazing and deforestation
- Desertification is intensified
 - Degradation forces farmers onto poorer land
 - Farmers reduce fallow periods, so land loses nutrients