

Nutrient cycles



Objective

Understand the importance of nutrient cycles



Keywords

- General facts about nutrients
- Soil- and economic concerns
- Humus is important for sustainable nutrient management



General Facts on Nutrients

Nutrients are key to soil fertility and plant growth

Large number with different needs:

Macronutrients:

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)

Mesonutrients:

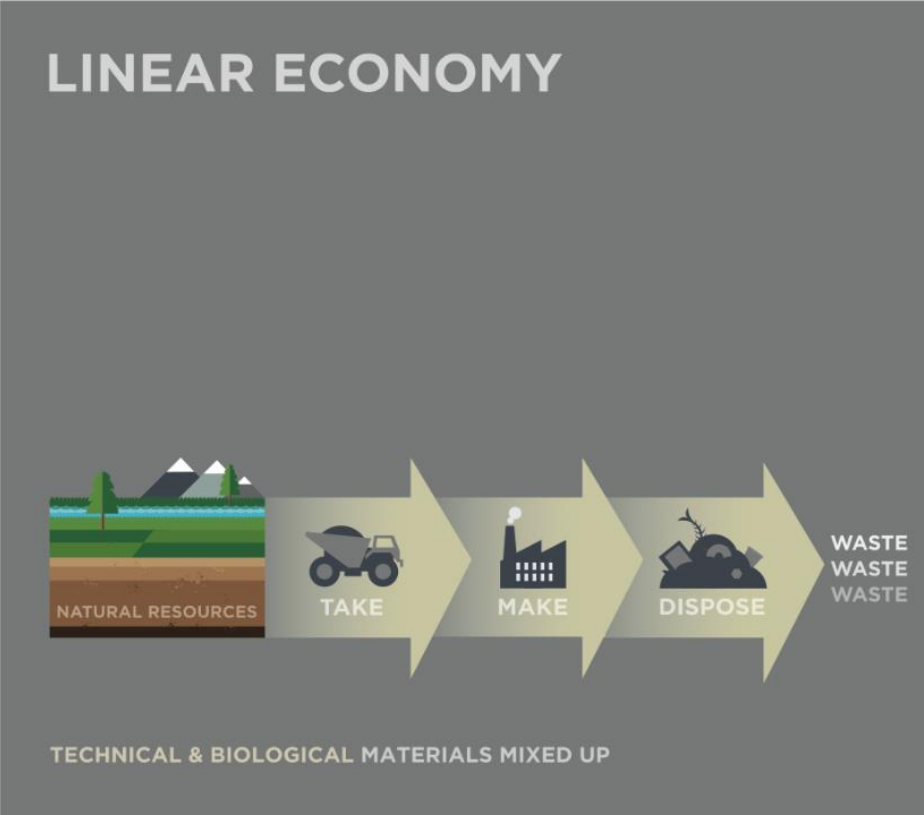
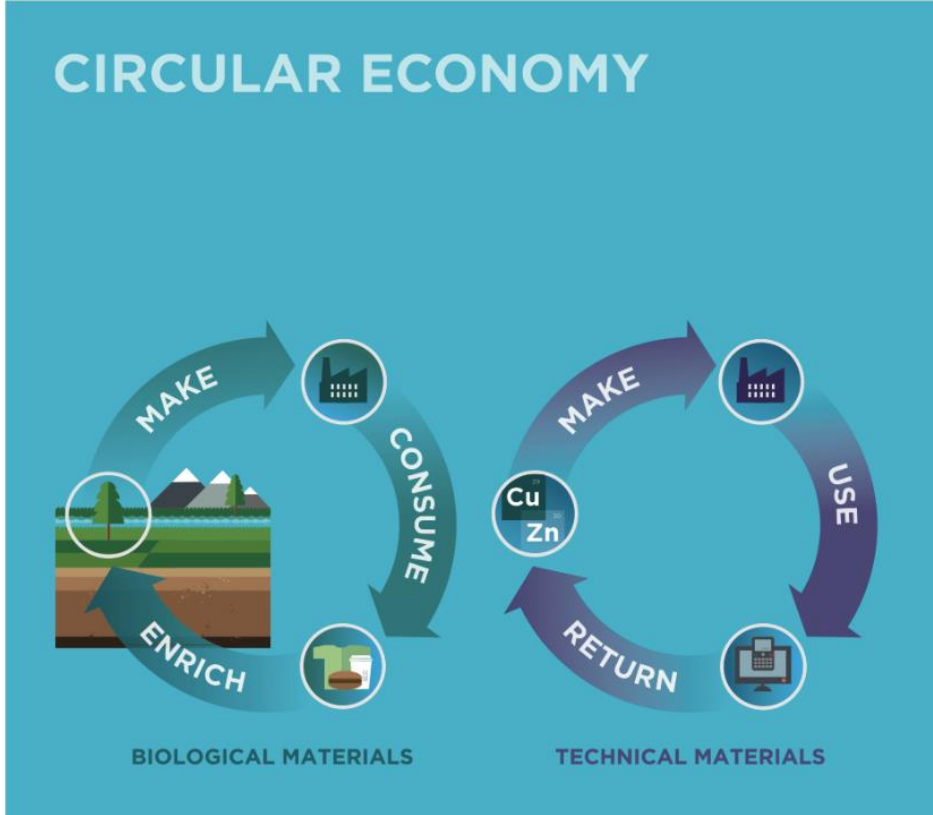
- Calcium (Ca)
- Sulphur (S)
- Magnesium (Mg)

Micronutrients:

- Iron (Fe)
- Manganese (Mn)
- Cobalt (Co)
- Boron (B)
- Zinc (Zn)
- Silicium (Si)
- Sodium (Na)
- Chlorine (Cl)
- Nickel (Ni)
- Molybdenum (Mo)

Toxic elements to plants: Al, heavy metals

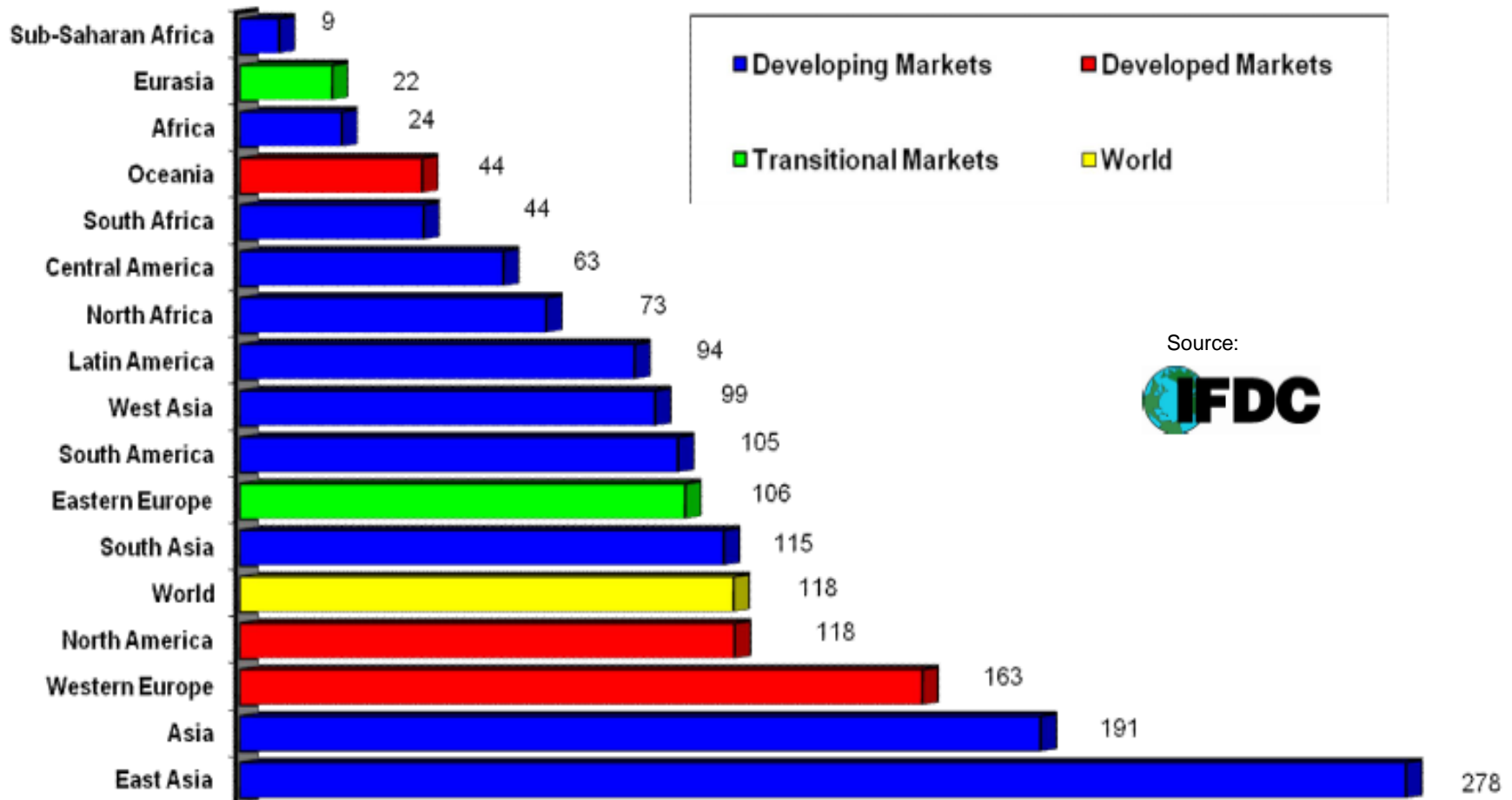
Economic models in agriculture and differences in fertilisation practices



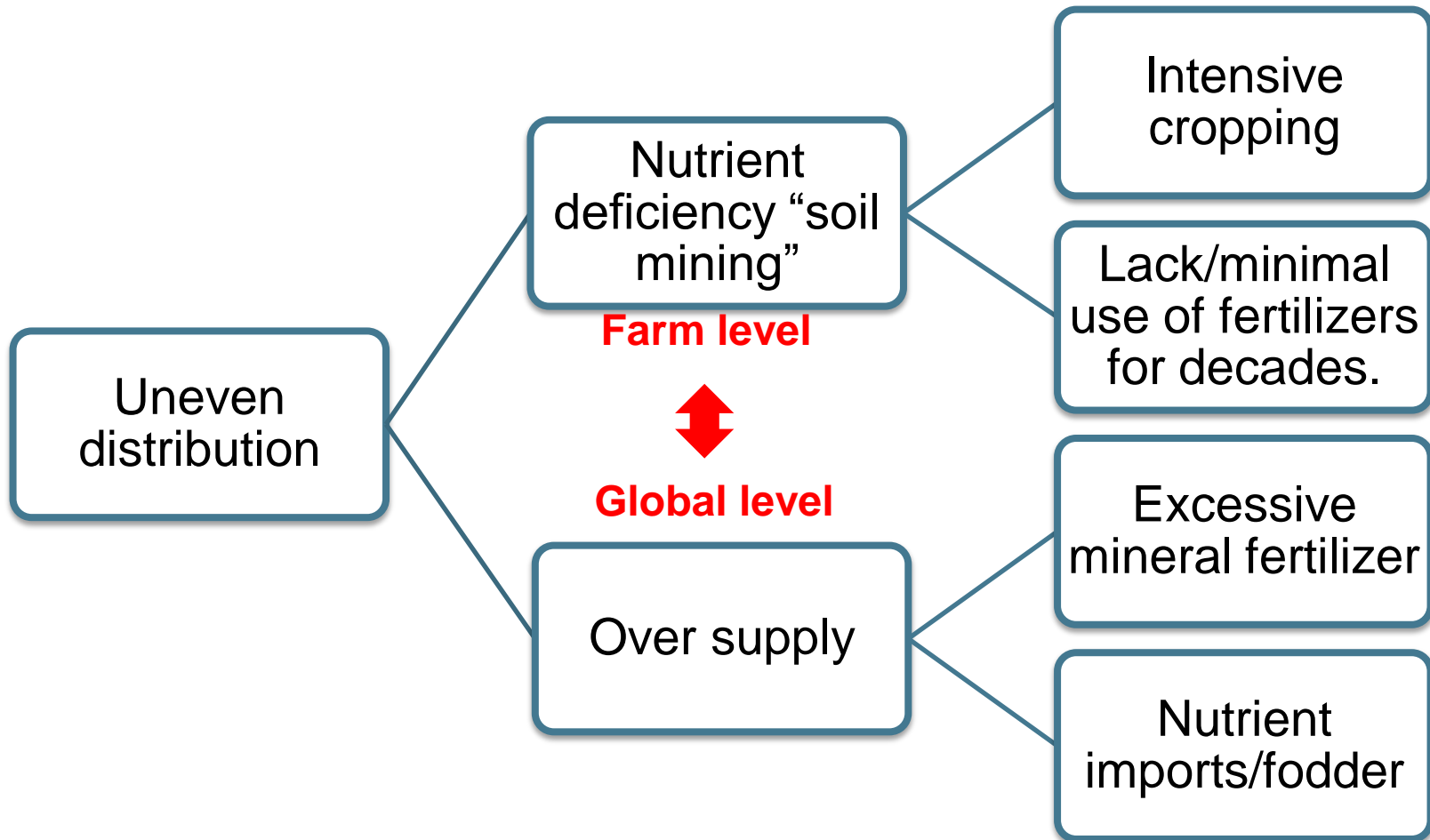
Source : Fondation Ellen MacArthur. <http://www.ellenmacarthurfoundation.org/education>

Scarcity and over-supply

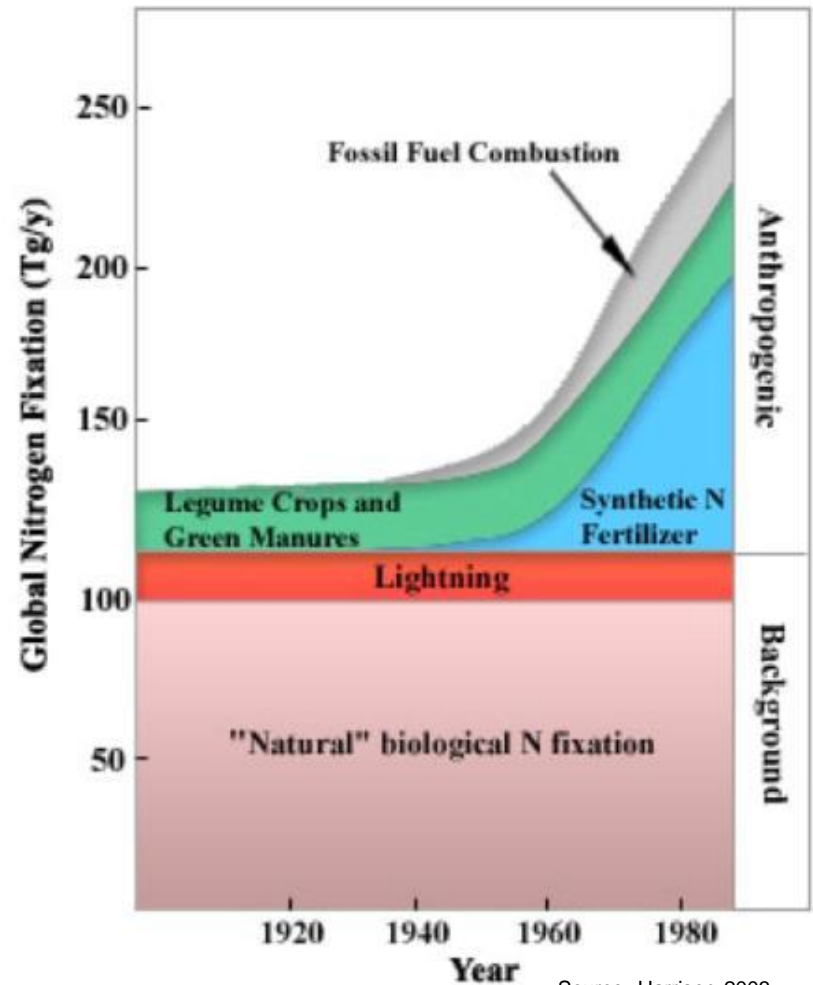
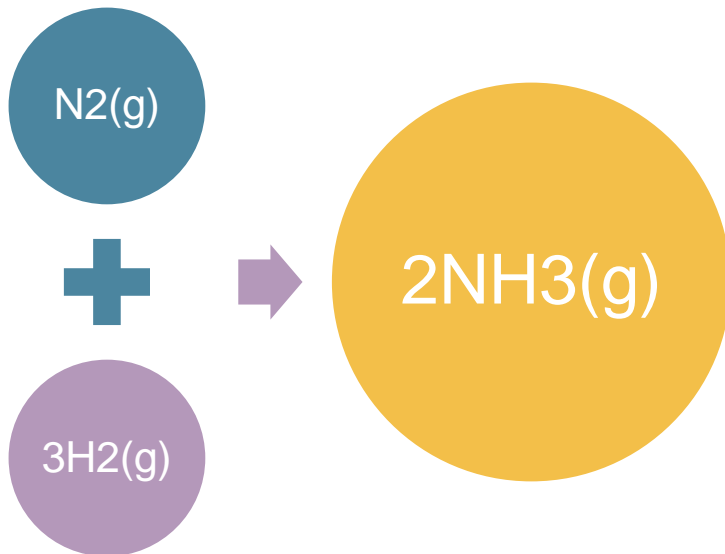
Per Hectare Fertilizer Use by Markets, 2006/07 (kg/ha)



Nutrient Supply and Demand



- In the past 50 years, increases in anthropogenic nitrogen. Due to Haber-Bosch process.



Different legumes and forage species for soil fertility and as animal feed in Bansalan, Davao del Sur, The Philippines



Calliandra (red flower)

Grass

Calliandra Callothyrsus

20-21% Crude Proteiin



Desmodium rensonii



Setaria splendida

4-6% CP



Summary:

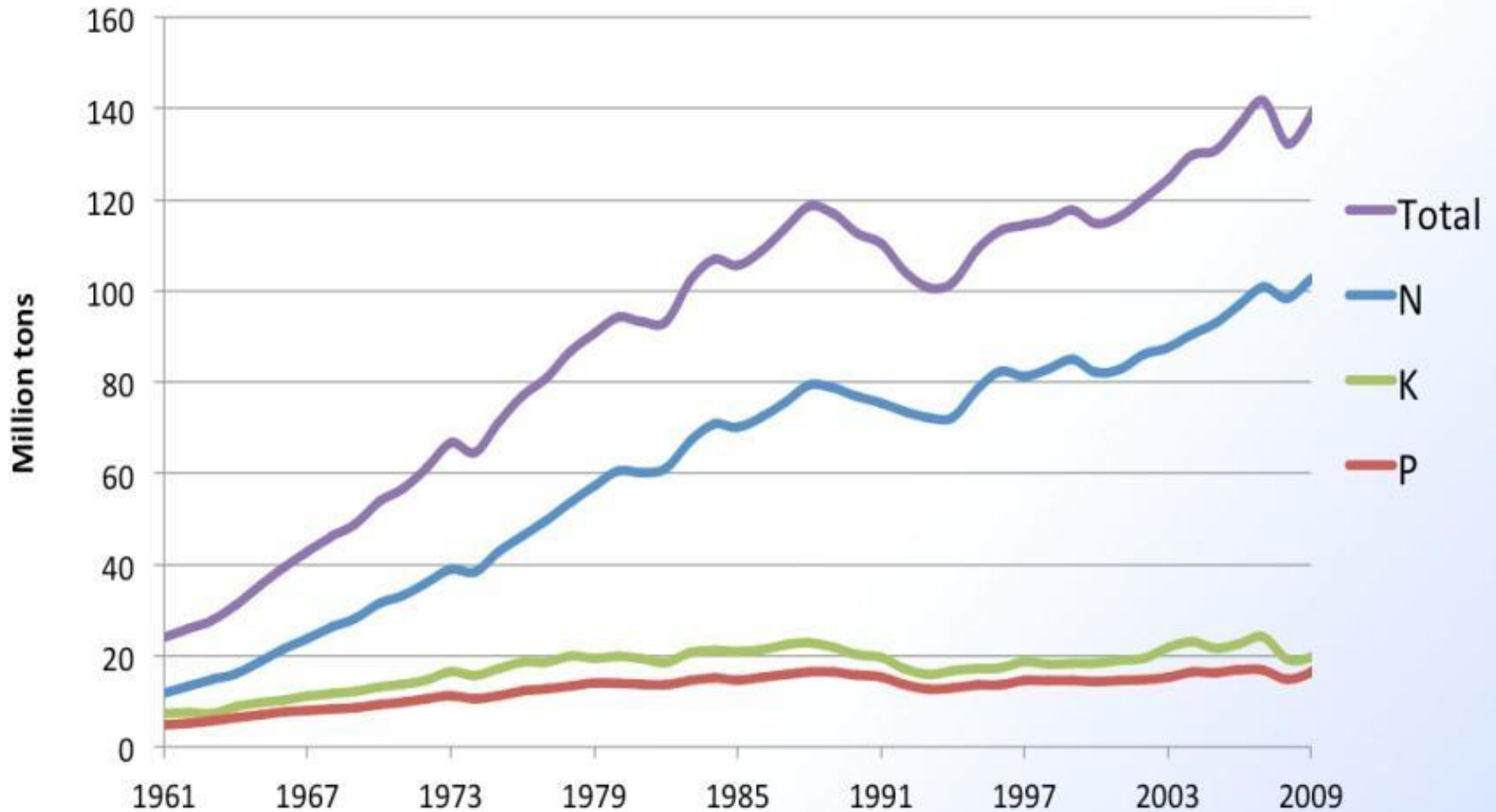
- ✓ Nutrients are needed in the soil and for the plants growth.
- ✓ All the nutrient cycles should be closed (amount of input= output).
- ✓ Human activities especially application of fertilizers disturb the nutrient cycles. Since many minerals are added to the ecosystems
- ✓ Use legumes grasses or plants or trees for biological fertilization



Soil and Economic Concerns

The Dominance of nitrogen applications

Global application of fertilizers by nutrients (N, P, K)



Synthetic nitrogen - adverse impact on soils

Soil acidification:

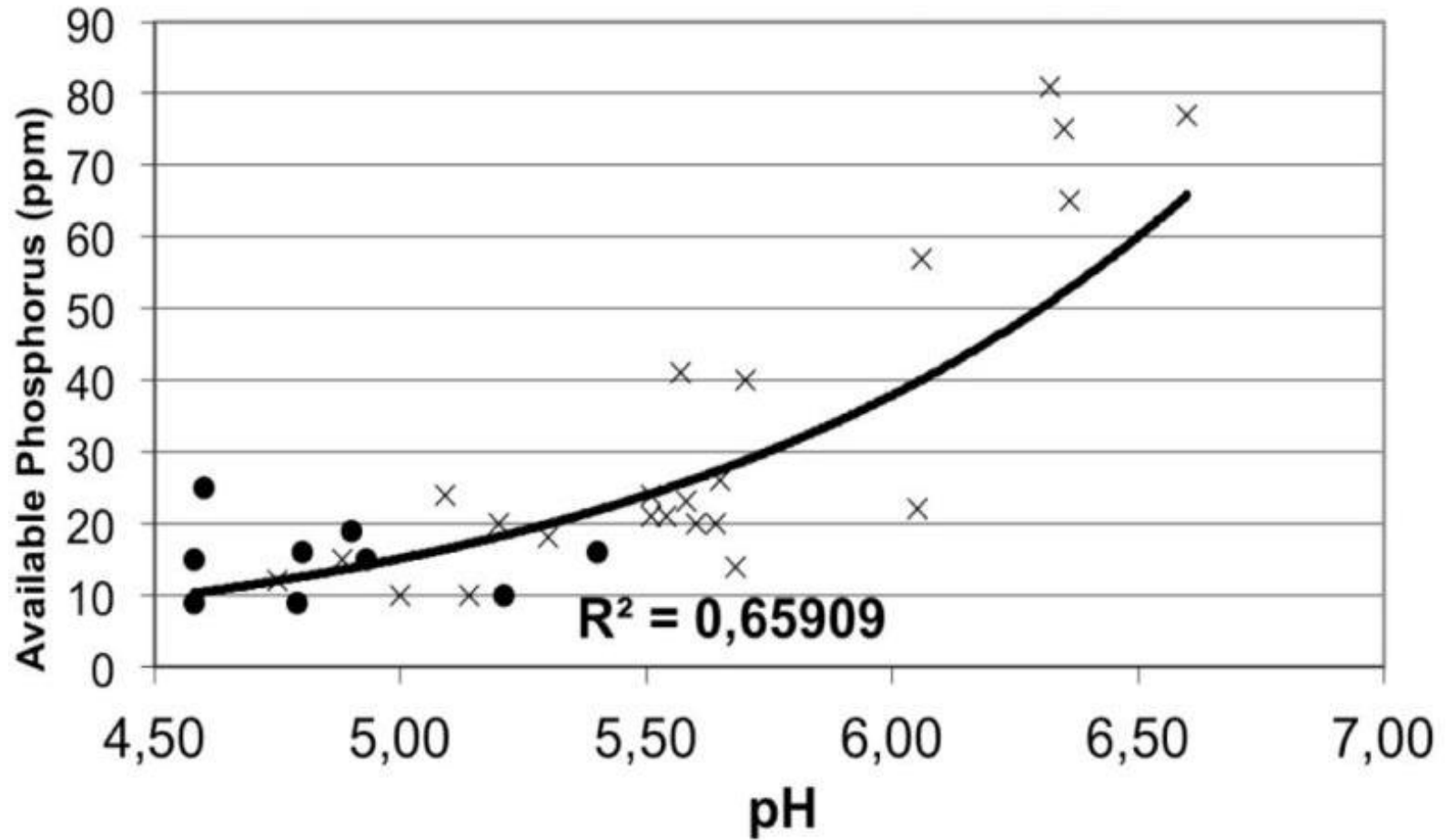
- The commonly used N-fertilisers enhance acidification of soils;
- pH values in tropical soils of 4.2 - 4.5 are not exceptional
- low pH is highly critical notably for phosphorus solubility (fixation in Al- and Fe-phosphates)

Fertiliser	Acidity index kg CaCO₃ / kg fertiliser
Urea	0.71
Ammonium sulphate	1.10
Ammonium nitrate	0.62
Mono-ammonium phosph.	0.58
Di-ammonium phosphate	0.37

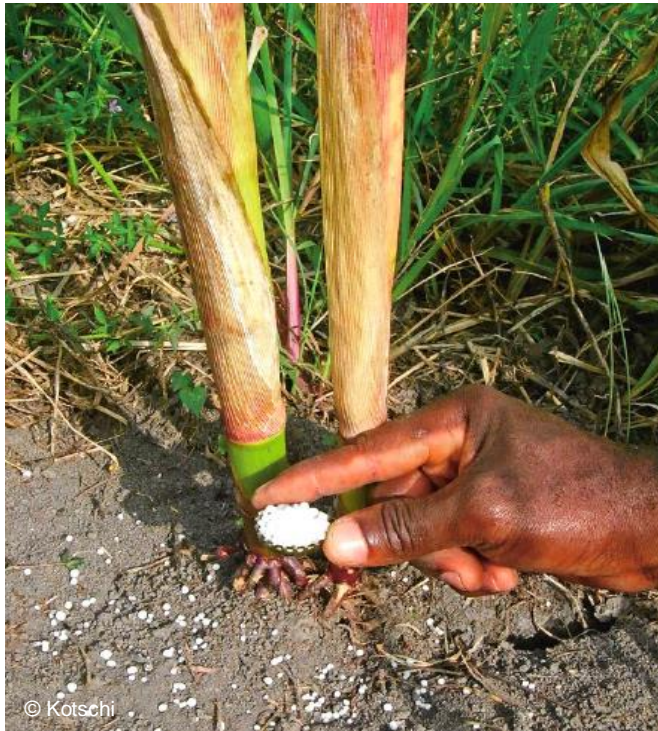
The acidity index indicates the amount of calcium needed (kg CaCO₃) to neutralize 1 kg of mineral fertiliser

Source: Hart (1998)

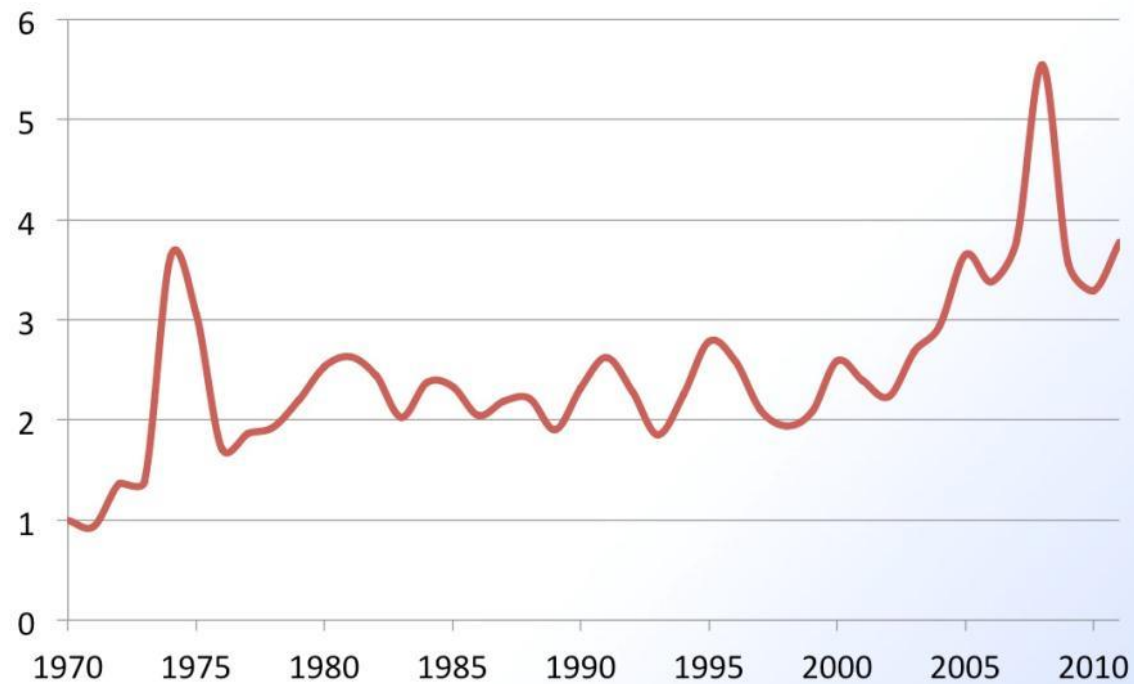
Soil acidity and Phosphorus availability



Plant nutrients have become very costly



Terms of Trade for fertilizer and food
fertilizer price index / food price index



For many smallholders returns from fertilizers are comparatively small

Three- fold disadvantage:

- Due to high transportation and handling costs, mineral fertilizers are comparatively costly.
- Yield increases through fertiliser are often small due to low soil fertility.
- Prices for agricultural products are often low due to limited access to markets and other factors





Summary:

- ✓ Excessive nitrogen application, contributed to many environmental problems (soil acidification, global warming, ..).
- ✓ Mineral fertilizers cost so much in developing countries due to: transportation, sold in small quantities.



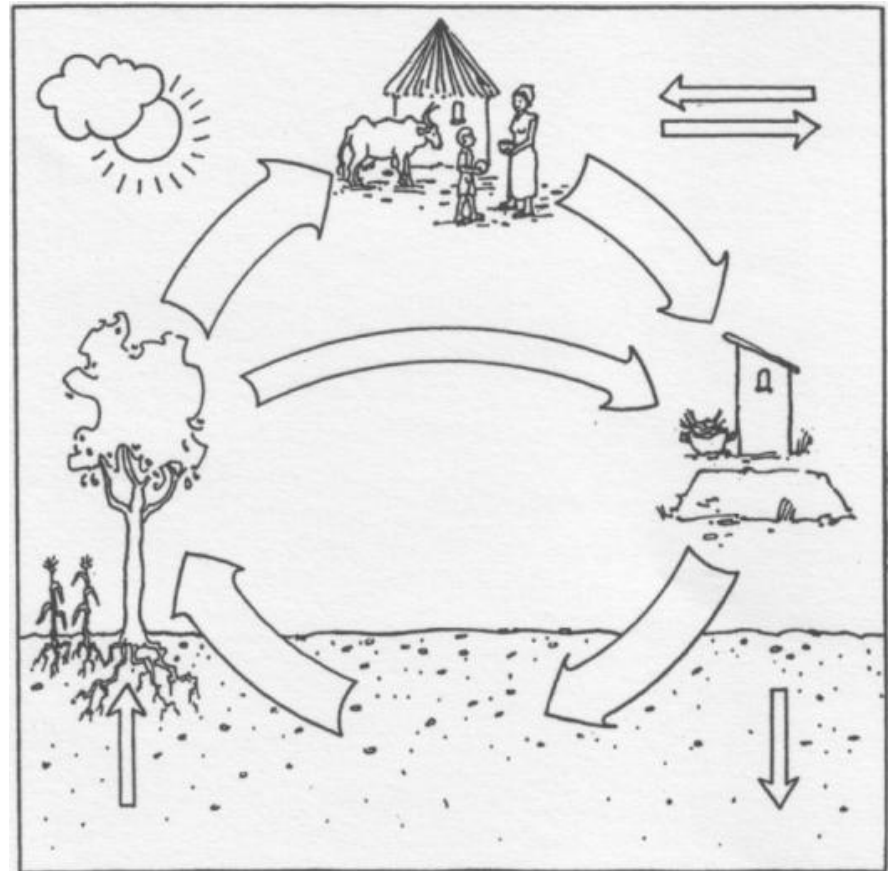
Soil Humus is key for sustainable nutrient management



Increase nutrient use efficiency

➤ Main principles:

- Close nutrient (and energy) cycles further
- Speed up turn-over of nutrients



Soil Humus is paramount for sustainable nutrient management

- Nutrient storage capability -> measured as Cation Exchange Capacity (**CEC**).
- Cation exchange capacity of soils and their components (meq/100g).
- Soils with high humus content can storage the nutrient well.
- High CEC is key for closing nutrient cycles.
- In degraded soils -those with low soil fertility and minimal organic matter— nutrient losses can be enormous.





Soils with high humus content can utilize mineral fertilizers well

Decomposition of soil organic matter:

- Mineralisation is increasing with higher and on-sided nitrogen doses.
- Low Soil Organic Matter (SOM) in many tropical soils is particularly critical, due to their important nutrient storage function.



Summary

- ✓ Nutrient use efficiency is related to presence of humus
- ✓ Soil humus is important for sustainable nutrient management.
- ✓ Nutrient storage capability is measured as Cation Exchange Capacity (CEC).
- ✓ High CEC is key for closing nutrient cycles. In degraded soils – i.e. those with low soil fertility and minimal organic matter – nutrient losses can be enormous
- ✓ Soil organic matter is important in nutrient storage function in the soil