Climate Change and Sustainable Crop Production Systems-Issues and Challenges

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Over view

- World Soil Day - History and themes
- Importance of soil and water
- Dwindling Water Reserves
- Urgent challenges facing food production systems
- Sustainable Agriculture
- Conservation Farming and sustainable Agriculture
- Managing water shortages and climate change
- Agro ecosystem health and sustainable production
- Energy needs of the future
- Climate change impact and productivity
- Soil biodiversity conservation and production systems
- Agro ecological farming and sustainability
- Way forward

World Soil Day – History

- Recommended by the International Union Of Soil Science 2002
- World Soil Day (WSD) observed every year on December 5
- Highlight the value of healthy soil
- Promote the sustainable management of soil resources.
- Create Global Partnership on matters related to soils.
- Declaration by the UN General Assembly -2013
- Celebrated from 2014

Themes identified

- Soils - foundation for family farming. 2014
- Healthy Soils for a Healthy Life. 2015
- Soils and pulses - Symbiosis for life 2016
- Caring for the soils starts from the ground. 2017
- Keep soil alive - Protect Soil Biodiversity 2020
- Halt soil salinization, boost soil productivity. 2021
- Soils - Where food begins 2022
- Soil and water - A source of Life 2023

WORLD SOIL DAY - 2023

Theme - **Soil and water - A source of Life**

Aims - Raising awareness

- On soil, the basis of food production systems and survival of life on this planet
- Maintain healthy ecosystems, and human well-being
- Address challenges in soil and water management to improve soil health

Soil – The Soul Of Life

- An essential nonrenewable resource, formed from the weathering of rocks
- Consists of mineral particles, organic materials, air, water, and living organisms
- Components interact slowly and constantly and functions as a dynamic ecosystem
- Degradative processes have revealed alarming facts on deterioration in soil health
- Managing it properly enhances performance of multiple ecosystem services

Dwindling Reserves of Fresh Water

- The earth has 4 billion km3, water
- Only 3% is fresh, mostly locked up in polar ice caps, glaciers, underground reservoirs,
- Only a fraction is available for humans and terrestrial ecosystems
- Fresh water in the 21st century, is growing scarce due to misuse
- Demand exceeds with the remaining pools being drained to meet needs
- Depletion of underground reservoirs outlines need to extend area of irrigated crops
- Climate change and population growth, aggravate water shortages further in future

Urgent challenges facing food production systems

- Feeding the growing population with minimum damage to the soil and environment
- FAO projections show that that the world has to feed a population of 9.1 billion people in 2050 This require raising Food production has to increase by some 70 percent by 2050.

Best Approaches are :

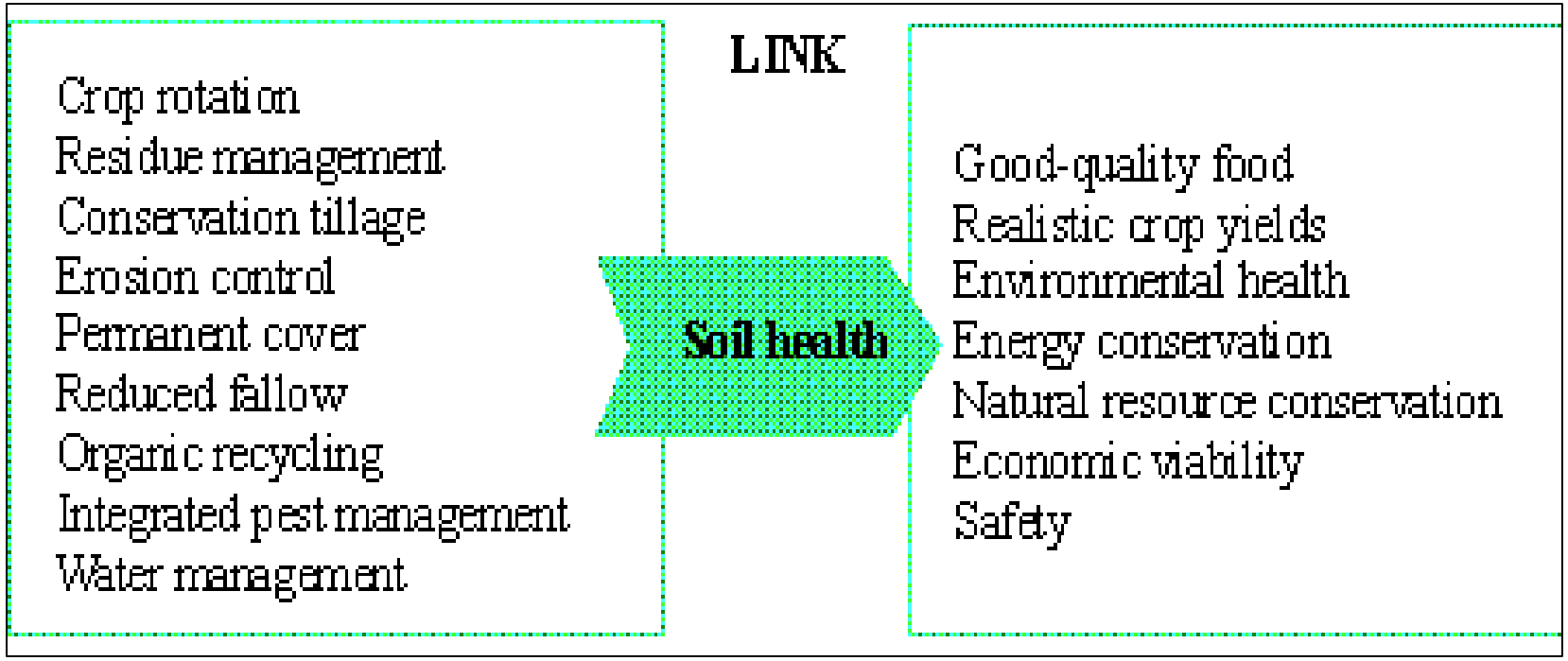
- Intensify existing farming systems with better genotypes,
- More advanced methods of fertilizing, tilling, and planting
- Improved control of weeds, crop pests and diseases
- New approaches to increase yield concurrently preserving other ecosystem functions

Sustainable Agriculture

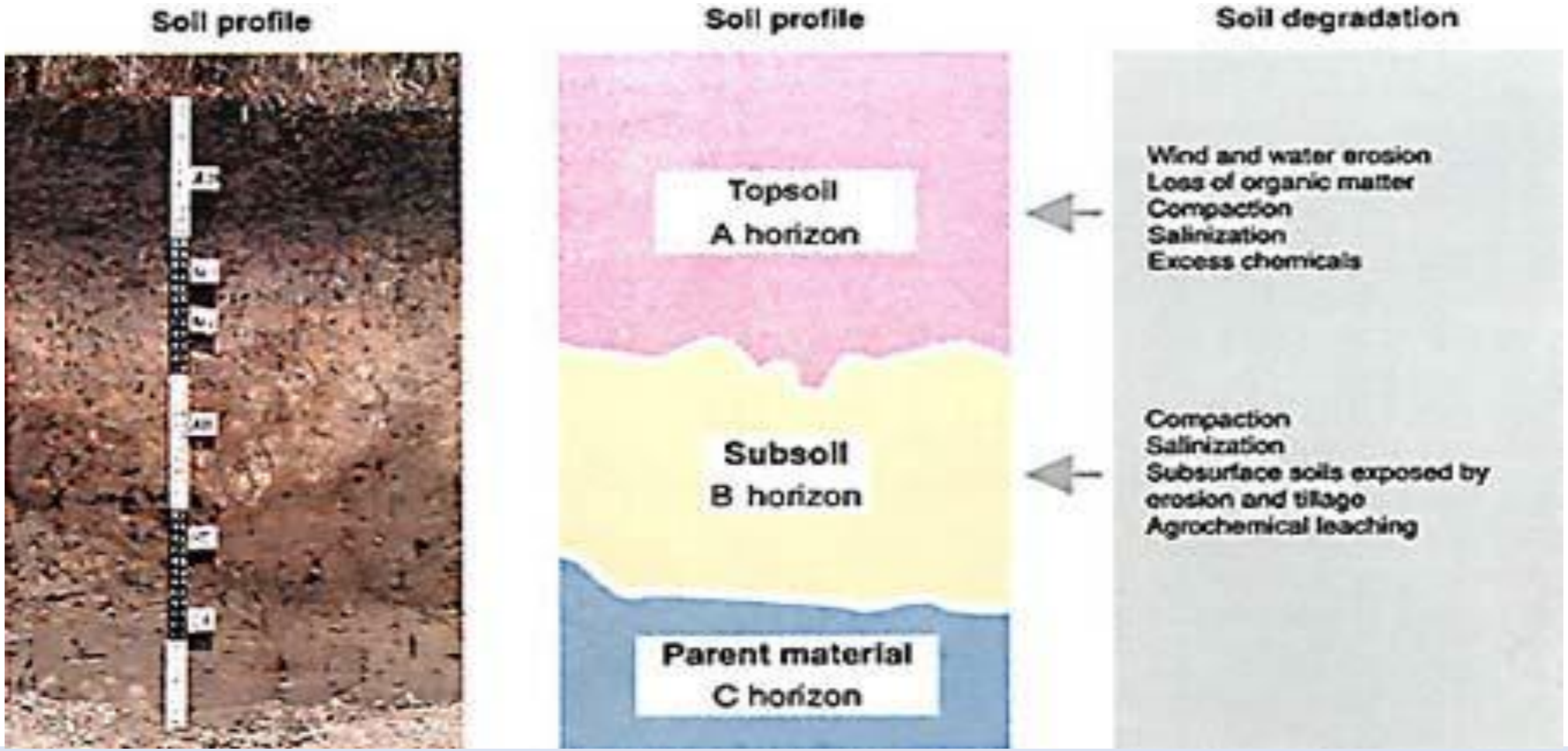
- A way of farming that can be carried out for generations
- Long-term approach combines efficient production and wise stewardship of the earth's resources.
- Over the years sustainable agriculture will cater to the following:
- Meet human needs for food and fiber
- Protect the natural resource base and prevent the degradation of soil and water quality
- Use nonrenewable resources efficiently
- Use natural biological cycles
- Assure the economic survival of farming and the well-being of the community at large
- Without sustainable soil management practices, soil can become degraded, eroded, compacted, toxic, and inhospitable to microbial life with loss of environmental quality

Soil health links conservation farming and sustainable agriculture

Strategy	Goal
Conservation Farming	Sustainable Agriculture



Degradation processes in the soil profile



Managing water shortages to meet human and ecosystem needs on a warmer planet

- Improve water use efficiency by efficient water management methods to minimize drainage and evaporation losses
- Managing plant population and soil disturbance on farms
- Improved Agro Technique like System of Rice Intensification to reduce water use
- Use of cultivars with high water use efficiency
- Reduce pollution of water bodies to get access to more fresh water
- Rely more on vertical fluxes of water “green water” from precipitation and transpiration
- Less on lateral fluxes “blue water” from aquifers, lakes, and reservoirs

Maintenance of Agro Ecosystem health and Sustainability in Crop Production Systems

- Habitat manipulation through agro techniques involving conservation farming
- Crop rotation, residue management, conservation tillage, permanent cover
- Soil and water conservation has to be followed
- Managing soil degradation processes like acidity, alkalinity, salinity
- Soil fertility enhancement through need based nutrient supplements
- Management of soil organic matter
- Conservation of below ground biodiversity
- Innovative ecologically based pest/disease management

Meeting energy needs of the future

- Plant based bio fuels like ethanol are becoming popular to mitigate climate change and provide energy security
- Production mostly from grain corn or sugarcane
- Grain-derived biofuels, relatively inefficient and increase CO2 emissions
- Cellulose-based ethanol yield more energy but technologies are not that efficient
- Growing demand for feedstock's for biofuel
- Careful evaluation of biofuel crops needed to minimize ecological problems to the ecosystem

Contd

- More carbon is removed by biofuel, than food crops and hence more of replenishment needed
- Large scale growing of bio fuel crops as plantations affect water use, and biodiversity
- Long-term effects of energy crops on salinity and other soil properties
- Use of byproducts of bio energy like biochar for soil quality and productivity improvement to be studied
- Large scale use of biomass for energy production has to be viewed from the context of the long term health of the ecosystem and quality of the environment

Climate change impact on productivity and resilience of soils

Green house gas emissions per capita annual

- World average 6.3 t Co2e (UNEP Report (2020)
- (including land use, land-use change, and forestry)
- US far above this level at 14t CO2e
- Russia 13t CO2e
- China 9.7 tCO2e in
- Brazil 7.5 t CO2e 7.2 t
- European Union. 7.2t CO2e
- India far below the world average at 2.4 t CO2e

Impact of higher Carbon dioxide emissions

- Affect rte of photosynthesis rate
- Changes in local climate affect the adaptation of plants, animals,
- Increased incidence of crop pests and diseases
- Temperature rise accelerates organic matter mineralization;
- Altered precipitation patterns cause droughts or flooding and soil erosion
- Rising sea levels sea water intrusion and alter coastal ecosystems
- Thawing of ice caps induce methane bursts
- Climate induced changes affect the land
- New systems to be developed to mitigate impact of climate change and boost up the resilience of soils and ecosystems

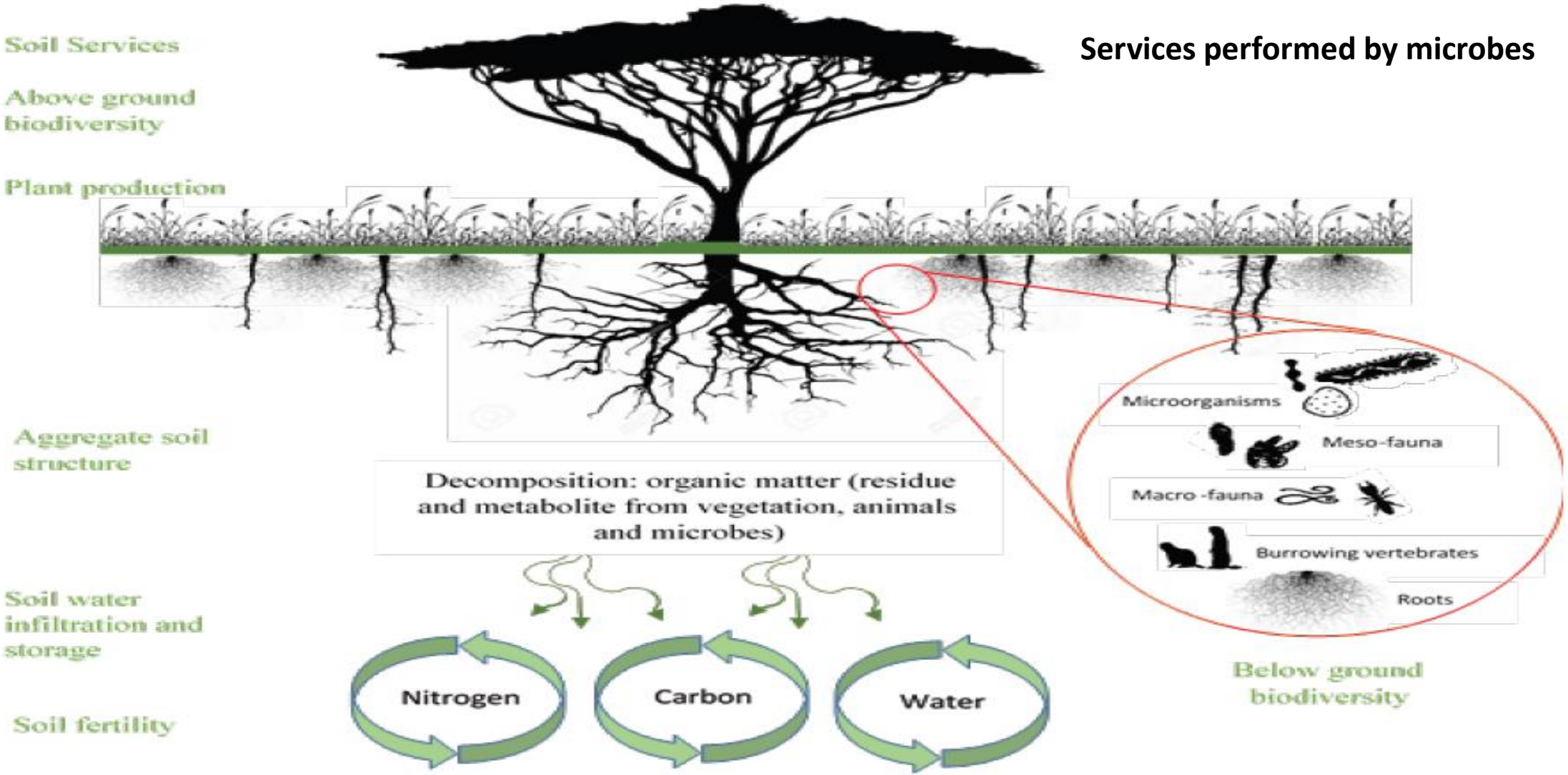
Understanding biodiversity for more productive ecosystems

- Soils are the foundations for the ecosystems that house terrestrial biota,
- Preserving biodiversity often a first step in preserving soil
- Soils themselves hold an astounding abundance and variety of organisms, many of which remain unidentified and unstudied
- Without knowing exactly what they do, we cannot even be sure what we have lost when they vanish.
- Soils are therefore one of the great frontiers for biodiversity research
- Recently, soil degradation has accelerated the rates of extinction, of many species highlighting the need for conserving biodiversity

Services Performed by Biota

- Terrestrial biota drive many of the countless essential processes performed by ecosystems
- Includes furnishing food to filtering water to delivering pharmaceuticals
- Preserving biodiversity confers resilience and stability to ecosystems
- Organisms perform overlapping functions, this redundancy provides stability during disturbances, upheavals and contingencies

Services performed by microbes



FAO Frame work on Biodiversity Conservation

- Developing standard protocols and procedures for assessing soil biodiversity
- Developing information and monitoring systems on soil biodiversity as an indicator of soil health
- Improving knowledge (local / traditional) on soil micro biome
- Monitoring influence of different farming systems, forestry practices on microbe communities
- Strengthen the knowledge on the different soil groups and biodiversity components viz: microbes, micro, meso, macro and mega fauna
- Global capacity building on the use and management of soil biodiversity
- Establish Global Soil Biodiversity Observatory.

Recycling of Wastes- Soil as a biogeochemical reactor

- Wastes are ubiquitous whatever we do leave wastes
- Includes waste from households, cities, and farms etc
- As population grows our consumption intensifies, the volume of our refuse increases
- Wise use of wastes becomes a bigger challenge.
- The 3 R's of waste management –recycle, reduce, reuse has to be the watch word
- What is needed, is a regenerative cycle where the "waste" becomes input
- A cycle, mimicking nature, and continues without end
- Soils are agents of recycling, but also benefit from the recycling through decomposition in soil releasing plant nutrients, improving soil physical properties, structure, aeration, water movement
- Serves as source of energy- for the biota
- Inputs of wastes need to be balanced by the soils' capacity to recycle them

Agro ecological innovations in Sustainable Agro ecosystem productivity

- Farming in an area has to be carried out on Agro ecological basis
- Use appropriate eco friendly time tested local technologies and innovations in cultivation operations
- Best management practices for the AEU will have to be evolved
- Sustainability has to be the watch word with successful management of resources
- Maintain/ enhance quality of environment and conserve natural resources
- Vitality of entire agro ecosystem - humans, crops, animals, soil organisms have to be ensured
- Maximum use of local resources to minimizes loss of nutrients, biomass, energy, and pollution
- All operations have to be economically viable and farmers produce enough to meet their changing needs and well being of community

Way Forward

- Ecosystems provide countless services and many are tangible and self-evident: food, fuel, fiber, shelter for wildlife and people, livelihood and places to play,
- Others happen quietly, in the background may be invisible but such services are essential
- Future, studies should probe these unknown services by linking with other disciplines
- So far the thrust was on the surface and downward into the soil, now we look upward and outward from the soil, encompassing the biosphere from its foundation.

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Soil is the foundation of a sustainable future.
A healthy smiling soil is the key
to happiness of the planet.
Thank You