**INTERNATIONAL CONFERENCE ON BIODIVERSITY**
**UGM YOGYAKARTA, 19 MARCH 2016**

# Agroecosistem Biodiversity: Managing Diversity in the Agricultural Landscape under Global Change

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# Agroecosistem Biodiversity: Managing Diversity in the Agricultural Landscape under Global Change

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# World has challenges …
# Feeding over 9 billion people in 2050 !

- increase food production by about 70% over the levels of 2005-2007 period

(Boelee et al 2013; FAO, 2009)

- mostly in low-income countries
- ensure more equitable access to food

| 1960's | Today | By 2050 |
| --- | --- | --- |
| • **2/3** of the world's population lived in **rural areas**<br>• 60% of the **economically active** population worked in **agriculture** | • **half of the people** live in rural areas, and<br>• **> 40%** of the active population depend directly on agriculture for their livelihoods (FAO, 2007) | • **2/3** of the world's population will live in **cities**<br>• **Competition for water**<br>• **different expectations** on how rural land and water sources |

# The long-term objective

***A better-performing and sustainable systems that efficiently and equitably provide a range of water-food-energy-urban-ecosystem 'goods' and services.***

# Concept of Agroecosystem

- Agriculture + ecosystem =Agroecosystem
- Human involvement for food, fibre and fodder
- Agroecological research is the idea that, by understanding ecological relationships and processes, agroecosystems can be **manipulated** to **improve** production and produce more sustainably, with fewer negative environmental or social impacts and fewer external inputs

# Impacts of Agriculture in Biodiversity

- Agroecosystems cover 28-37% of the earth' surface, displacing natural habitat and biodiversity.
- Intensive monocultures with chemical inputs and the use of uniform varieties have caused many problems such as:
  - Biodiversity loss, loss of pollinators and natural enemies, increase resistance of pests and diseases,
  - Loss of soil microorganisms and fertility,
  - Contamination of water and soil,
  - Land erosion and degradation, nutrient depletion, loss of productivity of the land,
  - Loss of genetic diversity of crops and livestock.

# Loss of Genetic Diversity

- FAO estimates that 75% of crop varieties have been lost during the last 100 years,
- One third of the 6.500 domestic livestock races are endangered.
- The genetic erosion of crops and livestocks threatens food security.
- Transgenic crops can cause the loss of traditional crops, wild relatives and centers of origin due to genetic contamination.

# What is agricultural biodiversity?

*It includes all components of biological diversity of* ***relevance to food and agriculture:***

*the variety and variability of*

***plants, animals and micro-organisms***

***at genetic, species and ecosystem level***

*which are necessary to sustain*

***key functions*** *in the agro-ecosystem,*

*its structures and processes.*

**Local knowledge and cultural diversity** can be considered an essential part of agrobiodiversity as it is the human activity of agriculture which conserves this biodiversity.

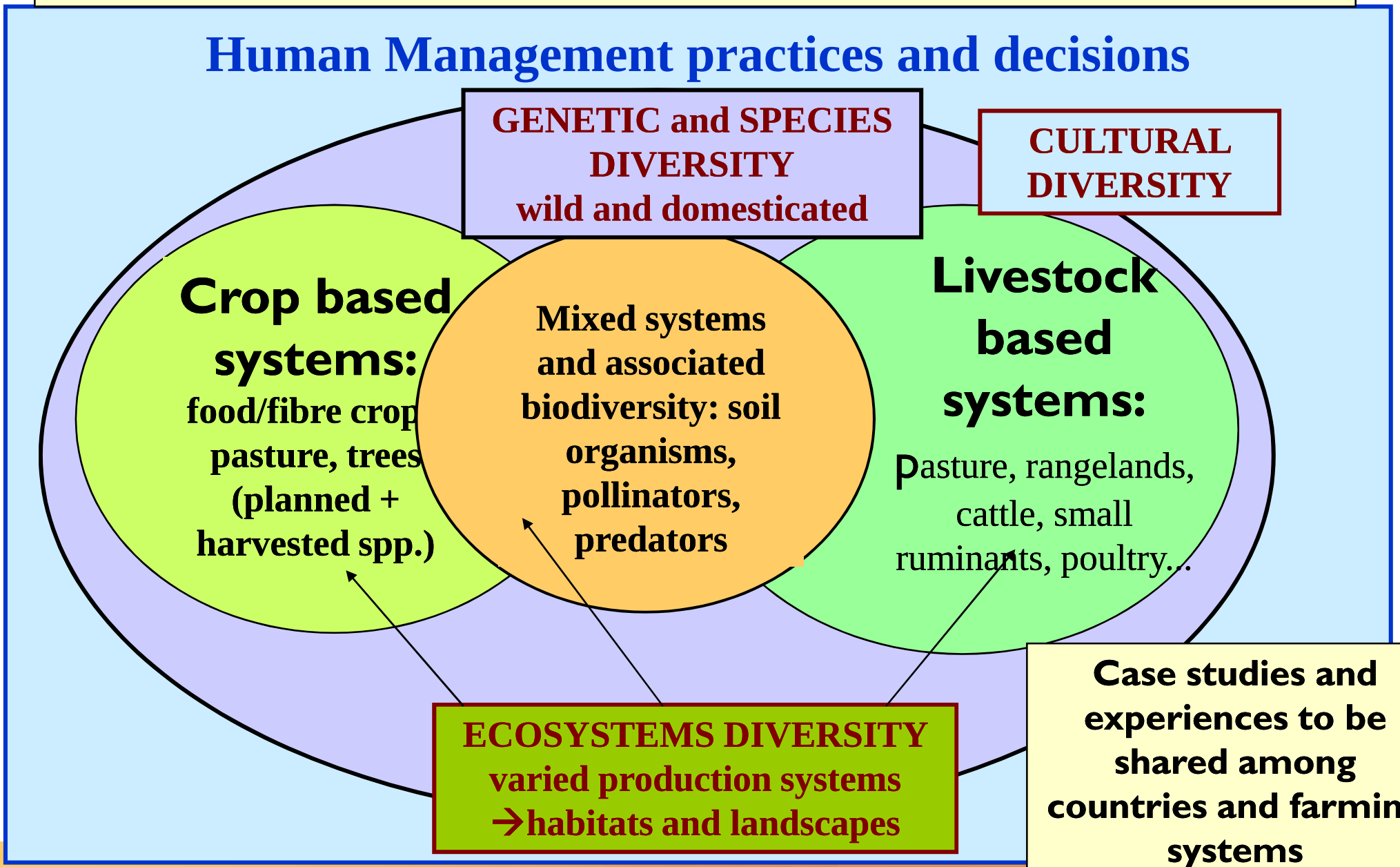
# Importance (value) of biodiversity in agricultural ecosystems

In agricultural systems biodiversity is important

1. **for the production of food, fibre, fuel, fodder...(goods)**
2. **to conserve the ecological foundations to sustain life (life support function)**
3. **to allow adaptation to changing env**
4. **and to sustain rural peoples' livelihoods (sustainable agriculture – food security, income, employment,...)**

**Specificity: it has been developed through human intervention over generations and it requires human management to sustain it.**

# Agricultural Biodiversity is complex

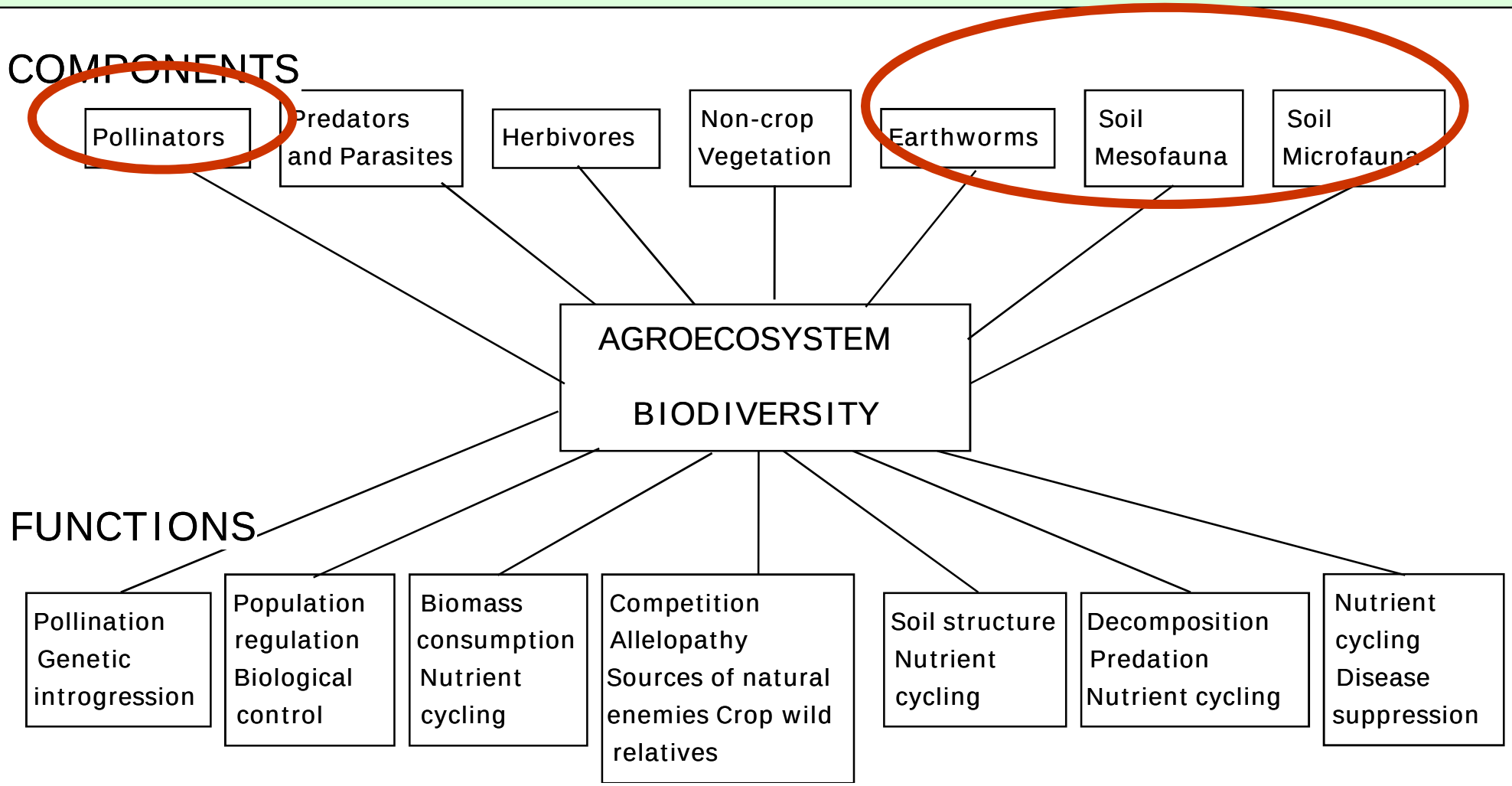


# Need to address all components of agrobiodiversity

- **Habitat diversity** (mosaic of land uses varies with soil and terrain, hedges, borders, trees in the landscape; farm type)
- **Inter-species diversity** (plant, animal and microbial)
- **Inter-species diversity** (very important for agrobiodiversity) genetic resources, unique traits –resistance to drought, cold, disease, etc, rooting, aspect, taste, storage, etc.
- **Harvested species** and **Associated species** (pollinators, beneficial/harmful predators, soil organisms – health/ disease,…)
- as well as **Cultural diversity** (type of farmer and farm; regulations; common property resources/ownership)
- and to understand implication of agrobiodiversity on **ecosystem functions/processes and the services provided**

  (see adapted Table by J. Paruel, Environmental controls and effect of land use on ecosystem functioning in temperate Argentina)

# Managing Agro-ecosystem biodiversity




From Altieri, M.A. Biodiversity and pest management Agro-ecosystems, Haworth Press, New York, 1994)

| ECOSYSTEM SERVICES: FUNCTIONS (biodiversity related examples) |
| --- |
| Food production The portion of gross primary production extractable as raw food. or for processing for food (Game, crops, nuts, fruits by hunting, gathering, subsistence or commercial farming) |
| Raw materials The portion of gross primary production extractable as raw material (Production of wood, energy/fuel, fodder, ..) |
| Genetic resources Sources of unique biological materials and products. (Plant varieties, animal races, medicinal extracts, products for materials science, genes for resistance to plant pathogens/crop pests, ornamental species, pets, |
| Climate and Gas Regulation: of global temperature, precipitation, other biologically mediated climatic processes at global/local levels (GHG); of atmospheric chemical composition (CO2/O2 balance, C sequestration, CO3 for UVB protection) |
| Resilience/Disturbance Regulation: ecosystem response to environmental fluctuation, mainly controlled by vegetation structure (storm protection, flood control, drought recovery, other aspects of habitat response). |
| Water Regulation and Supply: of hydrological flow/regimes; water retention, storage, provisioning in the watershed: (Infiltration, soil water retention determined by vegetation cover/structure; water supply in aquifers, surface water bodies; availability for consumption, irrigated agriculture, industry, transport) |
| Erosion control and Sediment retention: prevent loss of soil by wind, rain impact, runoff; storage of silt in ecosystem, in lakes and wetlands. |

| **ECOSYSTEM SERVICES: FUNCTIONS (biodiversity related examples) 2** |
| --- |
| **Soil formation** Processes of weathering of rock; soil build up **(Accumulation of organic material** |
| **Nutrient cycling:** storage, cycling, processing, input of nutrients **(N fixation, nutrient cycles - N,P et al, breakdown of organic materials to soil OM- humus)** |
| **Waste Detoxification** recovery of mobile nutrients, removal /break down of excess or toxic nutrients/ compounds, pollutions control **(detoxification by soil organisms)**. |
| **Pollination** Movement of floral gametes. **(Supply of pollinators for the reproduction of plant populations- insects, bats, birds)** |
| **Biological control** Trophic (food web) dynamic regulations of populations **(pest-predator interactions e.g. IPM, control of disease transmissions)** |
| **Refugia** habitat for local/ transient populations **(Nurseries, habitat for migratory species, for locally harvested species, over wintering grounds** |
| **Recreation** Providing opportunities **(eco-tourism, outdoor recreational activities –hunting, fishing, birdwatching)** |
| **Cultural** Providing opportunities for non-commercial uses **(Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems)**. |

# Understanding Human Pressures on and threats to agricultural biodiversity

**Increasing pressure on species and their environments**:

- Population growth and poverty (increasing demand)
- Overexploitation, mismanagement
- Expansion into wetlands and fragile areas
- Intensification and Specialisation of agriculture – market forces
- Pollution
- Urbanisation, changing consumption patterns, globalisation

**Threats and risks**

- loss of plant and animal species
- loss of plant varieties and animal races/breeds (loss of unique traits)
- also loss of essential natural processes
  - pollination by insects, birds, bats etc.
  - regeneration of soils by micro-organisms
- also reduced resilience.

**Need to increase resilience of agriculture and human capacity to adapt** (to harsh periods, drought, climate change, pests, diseases) **by maintaining a wide array of life forms with unique traits**

(e.g. trees that survive drought or cattle that reproduce in harsh conditions).

# Wide range of case studies illustrate Sustainable Use of agrobiodiversity

- **Integrated agro-ecological approaches** : soil biological management
- **Community-based adaptive management** – animal and plant genetic resources, diverse farming systems
- **Local knowledge systems**
  - multiple uses of species (diet, nutrition, medicines; gender differentiated knowledge of agrobiodiversity
  - community perspectives/strategies in managing crop and livestock and associated biodiversity; coping strategies for HIV/AIDS, climate change)
- **Ecosystem approach:** address all components, systems functioning and services and human management
- **Strengthening viability of farm-livelihood systems with under-utilized and under-valued biodiversity** (opportunities; options)
  - grasslands (grazing species preference, productivity; deep roots-below ground biomass)
  - mountains (adaptation to altitude, cold; disease resilience, etc.)
  - **marketing** (diverse products, niche markets, organic agriculture, etc.
  - **recognition of positive externalities** (valuing ecological services provided by biodiversity associated with agricultural systems)

# SUSTAINABLE AGROECOSYSTEMS

- **Maintain their natural resource base.**
- **Rely on minimum artificial inputs from outside the farm system.**
- **Manage pests and diseases through internal regulating mechanisms**
- **Recover  from the disturbances caused by cultivation and harvest**

# Need to use common Agricultural Definitions

***Sustainable agriculture*** **is ecologically sound, environmentally sustainable, economically viable, socially just and culturally appropriate … is based on a holistic scientific approach and productive over the long term.**

***Farm System*** : the farm household, its resources, and the resource flows and interactions at this individual farm level

***Farming System***: a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints

**Sustainable agricultural systems provide a range of goods (food, fuel, fibre, materials, etc.) and services (also considered as positive externalities)**

**Need to select indicators for monitoring sustainability:**

- **soil** (sustained health + productivity, prevent soil erosion, minimise off-site impacts, ... );
- **water** (water retention, maintain water regime, flood protection, etc);
- **vegetation** (protective land cover, structure, biomass, C sequestration)
- **biodiversity** (resilience, adaptability, opportunities) conservation of wildlife and wild species; agricultural biodiversity: genetic resources inter- and intra- species, farmed and associated species, ecosystem functions,
- **air quality** (minimise greenhouse gas emissions)
- **rural amenities** (e.g. landscape, tourism).

# Case studies of Sustainable agriculture - enhancing agricultural biodiversity

- **Increased use of mixtures** (intercropping, multistorey, agro-forestry, crop-livestock systems)
- **Access to a wide range of good quality genetic material** (plant and animal)
  - **Promote production of local germplasm and commercialization**
  - **Promote decentralized and participatory breeding**
- **Improve use of genetic diversity as part of IPM strategies**
- **Monitor and identify underutilized species, support needs**
- **Develop sustainable management practices and post-harvest and marketing methods;**
- **Stimulate demand for diverse local products** (niche markets, labelling, registration)
- **Review and promote policies for development and use** e.g. biodiversity conseravtion and coping with climate change

# Soil Biodiversity

From Micro-organisms
e.g. bacteria + fungi

Micro & meso-fauna
protozoa, nematodes
to
& springtails

**...Roots in the soil and their interactions with species above & below ground**

**Macro-fauna e.g. ants, termites, earthworms**

# Managing Pollinators

**Management practice:**

→In Himachal Pradesh in Northwest Indian Himalayas farmers are using colonies of honeybees – *Apis cerana* and *Apis mellifera* for pollination of apple crop.

→ An organized system of hiring and renting bee colonies for pollination exists

# Thank you