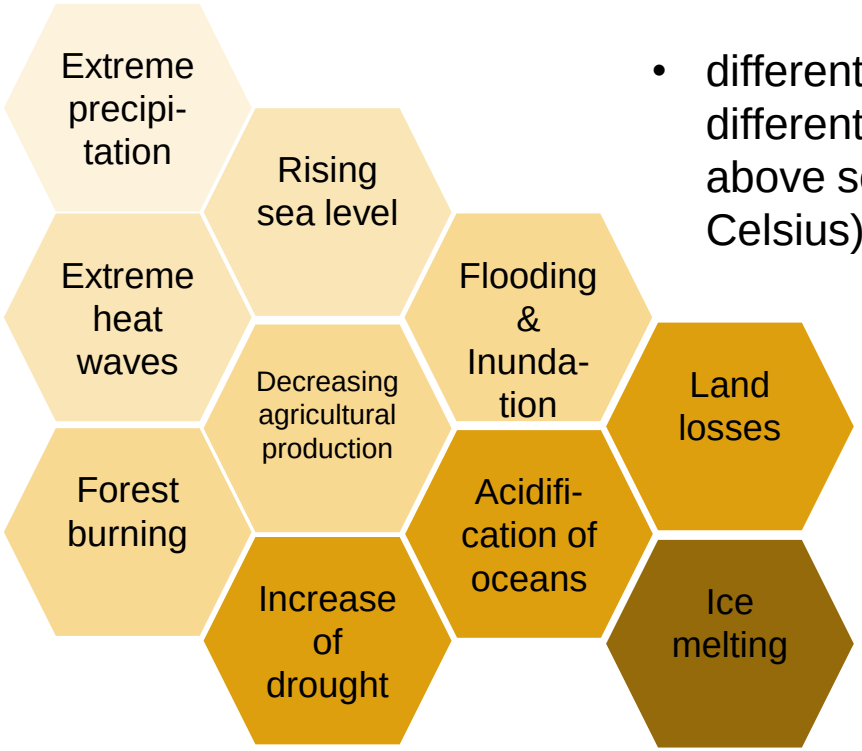
Agriculture:
victim, culprit and potentials for adaptation and mitigation

Results IPCC Report 2014

- *In many regions, changing precipitation or melting snow/ice are altering hydrological systems,* ***affecting water resources*** *in terms of quantity and quality.*
- *…* ***negative impacts of climate change on crop yields*** *have been more common than positive impacts.*
- *Impacts from climate-related extremes … reveal significant* ***vulnerability and exposure of ecosystems and many human systems****…*
- ***Adaptation*** *is being facilitated in some areas through mainstreaming climate adaptation action into subnational development planning, early warning systems, integrated water resources management, and agroforestry.*

Climate Change Effects



- different magnitudes in different regions (warming above sea level 2-10 degrees Celsius)
  - developing countries more affected, also because of lack of resilience

Climate change and agriculture

- Agricultural production suffers from anthropogenic climate change impacts
- Agriculture and land-use change produce important quantities of GHG emissions
- There are potentials to fix (sequester) GHGs in soils and vegetation (sinks).
- Developing countries are specifically vulnerable:
  - ✓ Strong geographical exposition of many areas (exposure);
  - ✓ High dependency on climate reliant natural resources (climate sensitivity);
  - ✓ Population not prepared, limited access to adaptation technologies and sometimes weak institutions (adaptation capacity);

Agriculture suffers from climate change

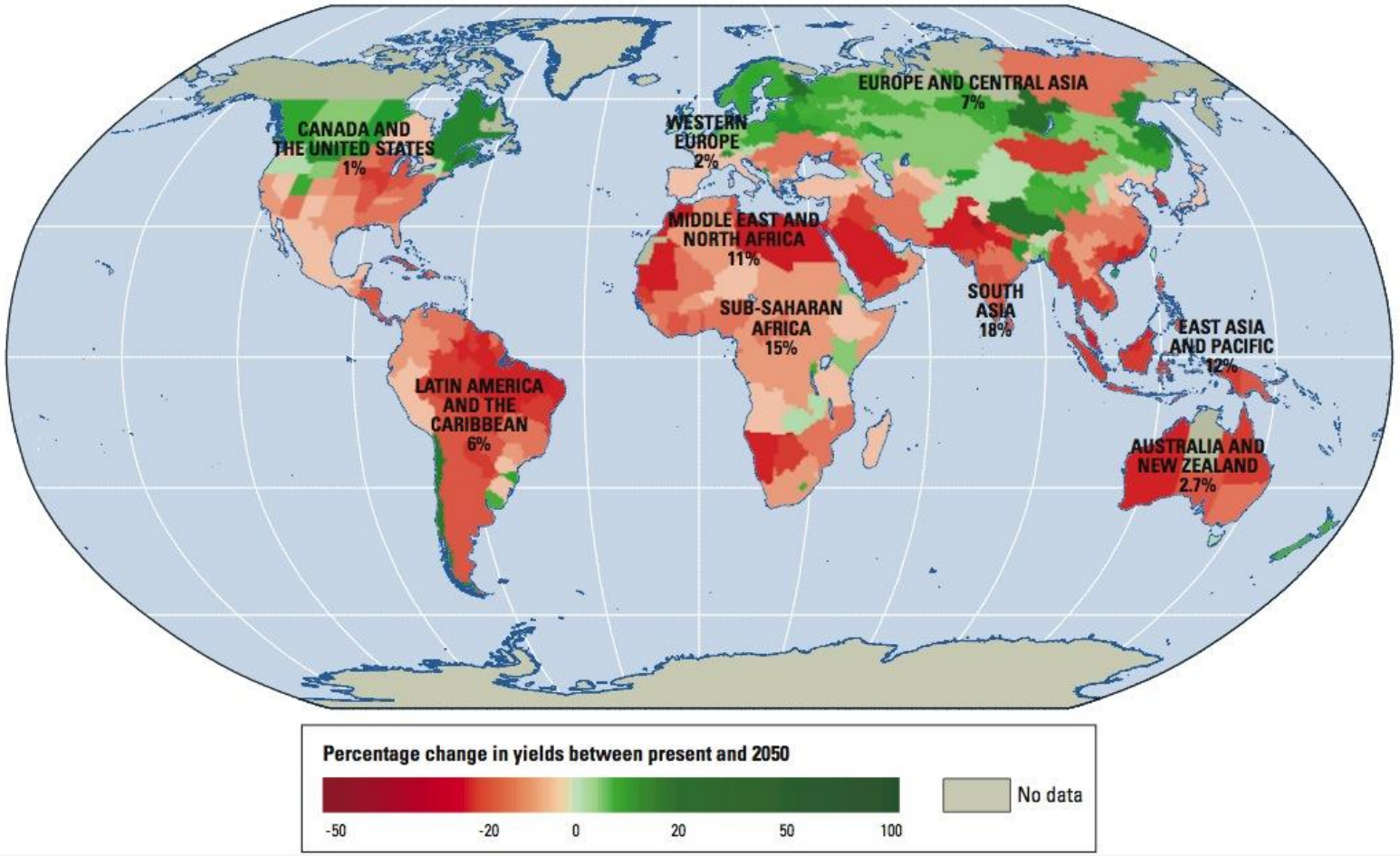
Climate change is associated with:

- increasing temperature, increasingly varying rainfall
- extreme weather events (floods, droughts, storms), melting of glaciers, sea-level rise
- Unsecure cropping conditions, crop failures
- Shift of Agro-ecological zones and displacement of optimal growing regions
- Changes in pest exposition, invading species and genetic losses,
- Overall yield losses but with considerable regional differences i.e. increases in temperate regions, losses in tropical regions

→ Major implications for food and livelihood security

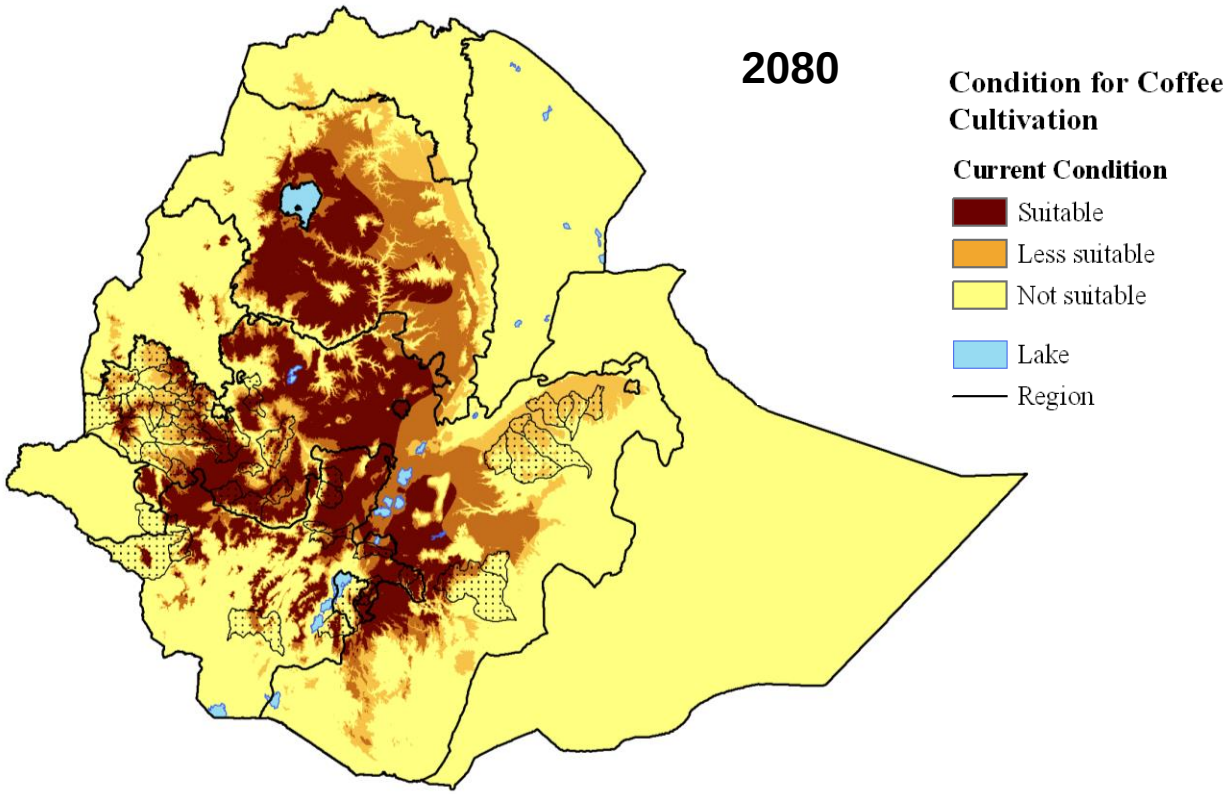
Impact of climate change on agriculture

Map 1 Climate change will depress agricultural yields in most countries in 2050, given current agricultural practices and crop varieties



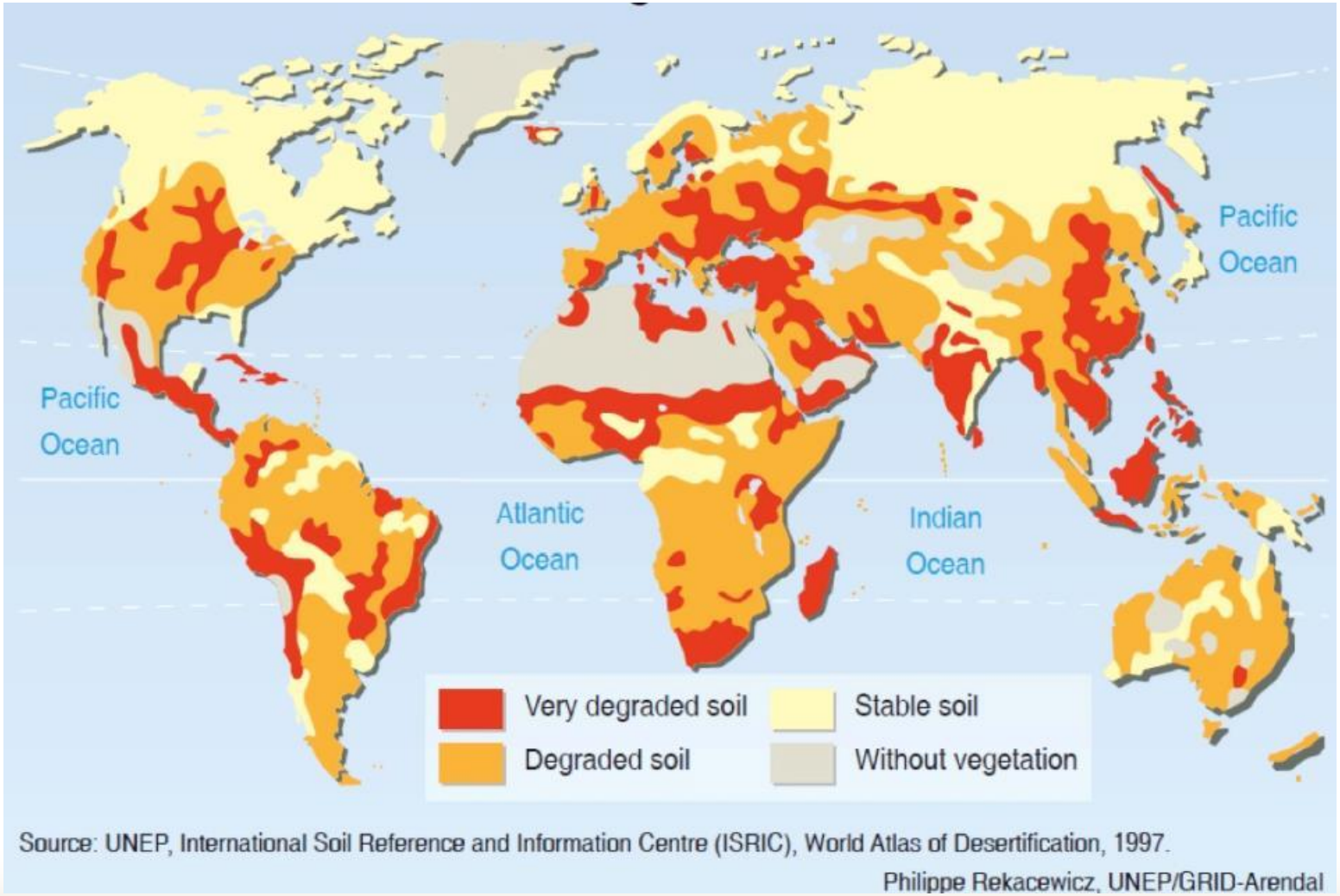
Source: http://www.fao.org/fileadmin/templates/cpesap/C-RESAP_Info_package/Links/Module_1/reduction_yields_wb.pdf

Example: Coffee cultivation in Ethiopia



Source: Ruegsegger 2008

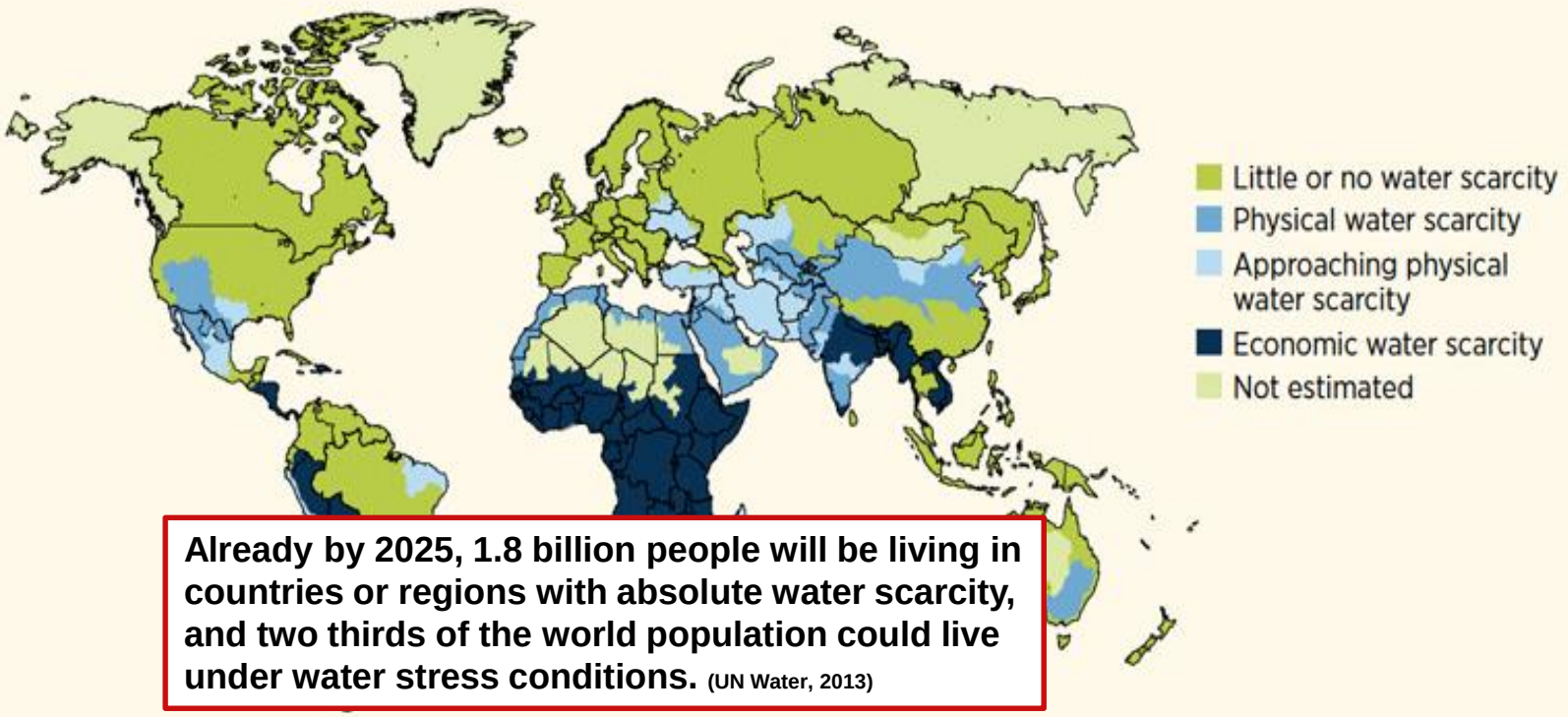
Alarming rates of land degradation



Source: UNEP, International Soil Reference and Information Centre (ISRIC), World Atlas of Desertification, 1997.

Philippe Rekacewicz, UNEP/GRID-Arendal

Global physical and economic water scarcity



Already by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two thirds of the world population could live under water stress conditions. **(UN Water, 2013)**

Source: World Water Development Report 4, World Water Assessment Programme (WWAP), March 2012

Maize sensitivity chart				
climatic stimuli	Production phase			
	germination	**growth/ flowering/ fruit setting**	**ripening**	**harvest**
temperature	low temperature can be harmful	High temperature decreases growth and grain yield		
rainfall	Well distributed rainfall (500 – 750 mm) required			Less water required
drought		affects grain filling		
flooding	damaging effect, but not well quantified			
trop. ozone	few studies, but found some decreases in yield			
salinization	good tolerance	poor tolerance		
tropical storms		hurricanes can damage crop through high wind / heavy rain		
CO_2 conc.	[little effect, as C_4 plant]			

Millet and Sorghum sensitivity chart				
climatic stimuli	Production phase			
	germination	**growth/ flowering/ fruit setting**	**ripening**	**harvest**
temperature		grain yield, pollen viability, and seed-set can be affected if temperatures are > 40^0C		
rainfall	Minimum of 280-350 mm required, reduction with less rainfall			
drought	Pearl and Finger millet less than Sorghum			
flooding	Sorghum sensitive to flooding	Millet can tolerate short periods of flooding		
trop. ozone	[not much information]			
salinization	growth parameters and plant nutrient contents become decreased, and can depend on the cultivar			
CO_2 conc.	little positive effect as C_4 crop			

Who knows ?

What were the CO2 (world) emissions per capita/year in 2013?

What is our aim for 2050, if we want to control climate change?

0.8 t	
2.0 t	
5.0 t	
16.0 t	

Who knows ?

What were the CO2 (world) emissions per capita/year in 2013 ?

What is our aim for 2050, if we want to control climate change?

0.8 t	Subsahara Africa
2.0 t	That is where we aim at
5.0 t	World average
16.0 t	North America

Who knows ?

What percentage is the agricultural contribution to global greenhouse gas emissions?

14 %	
25 %	
50 %	
75 %	

Who knows ?

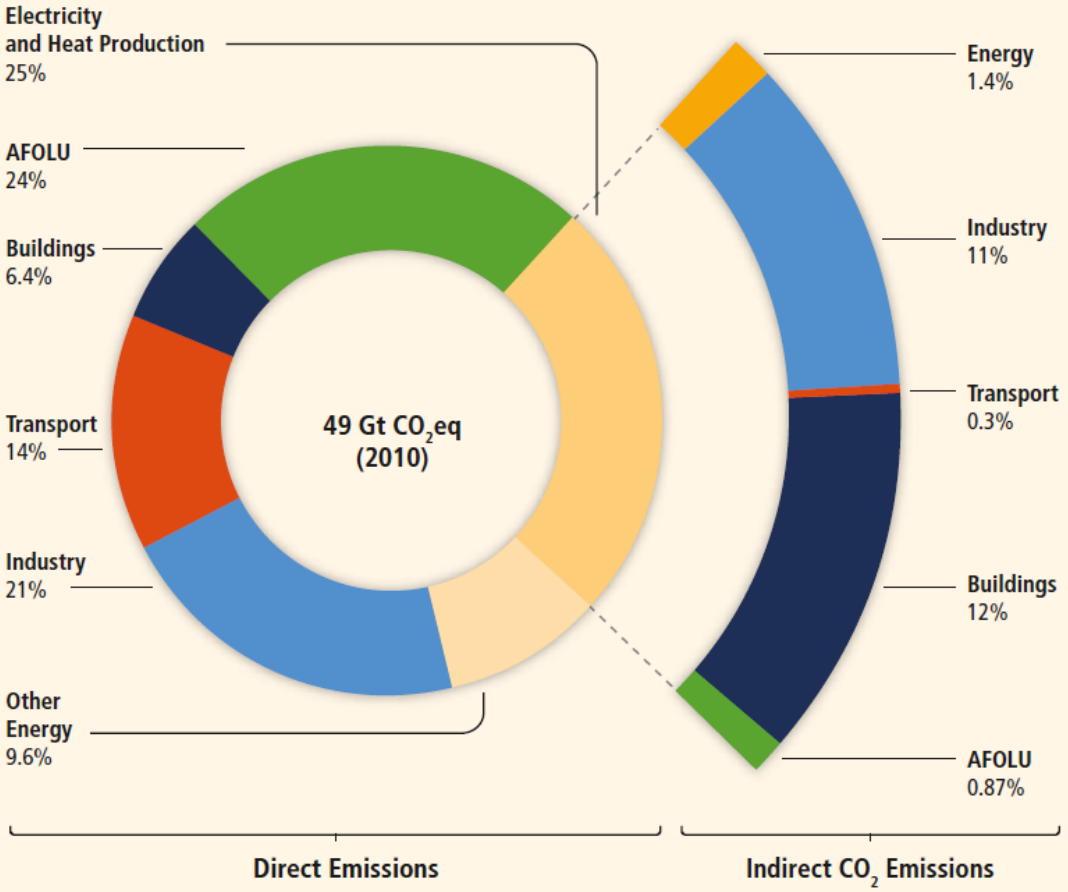
What percentage is the agricultural contribution to global greenhouse gas emissions?

14 %	Agriculture without land use change
25 %	Agriculture and land use change
50 %	wrong
75 %	wrong

Agriculture contributes to climate change

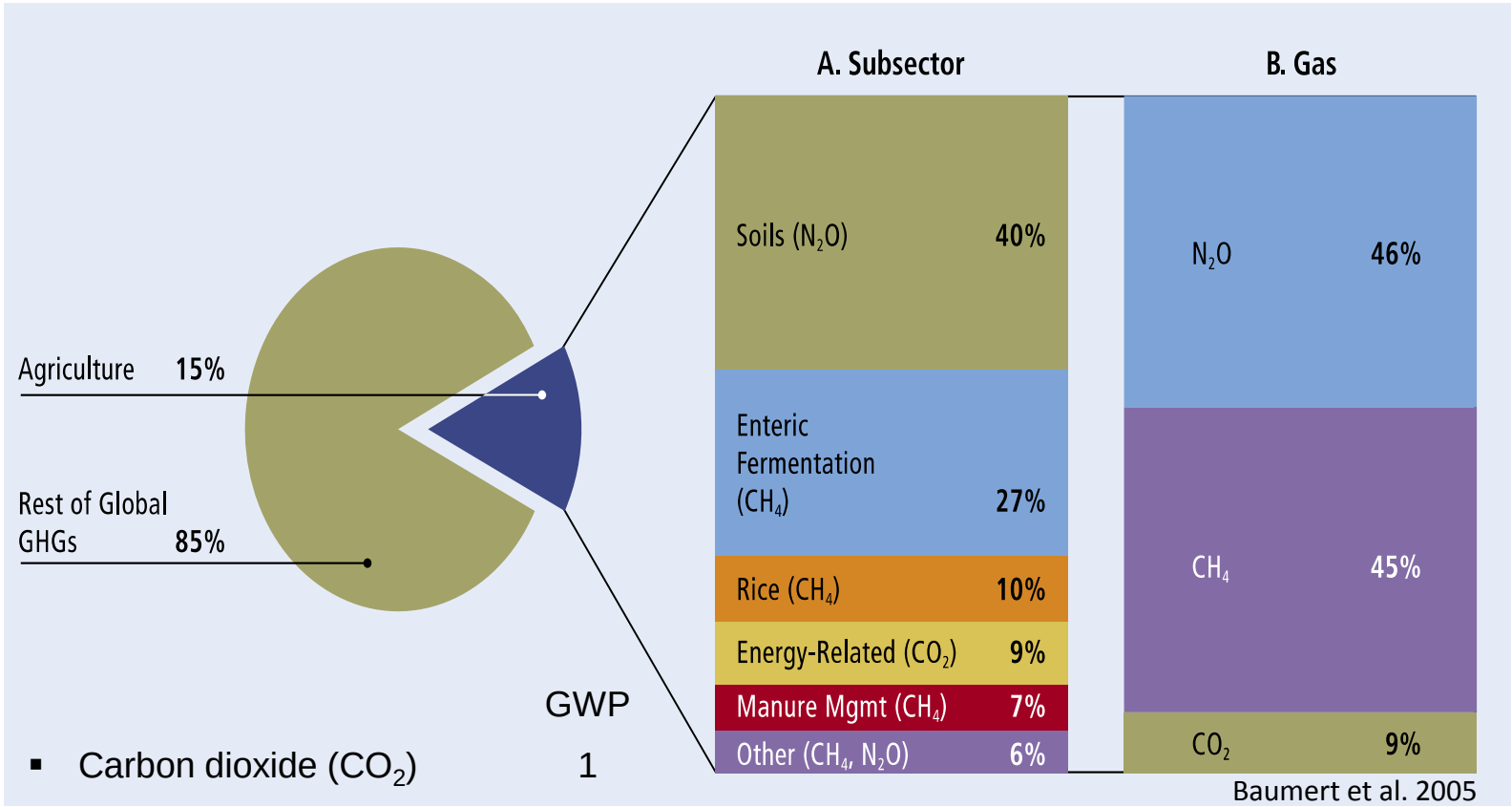
GHG emissions per economic sector

Agriculture , contributes 10%; Forestry and Other Land Use contribute 14%



Source: IPCC, 2014: Climate Change 2014: Mitigation of Climate Change.

GHG emissions in agriculture



Baumert et al. 2005

	GWP
▪ Carbon dioxide (CO_2)	1
▪ Methane (CH_4)	21
▪ Nitrous Oxide (N_2O)	310

Ecosystems and their CO2 storage capacity

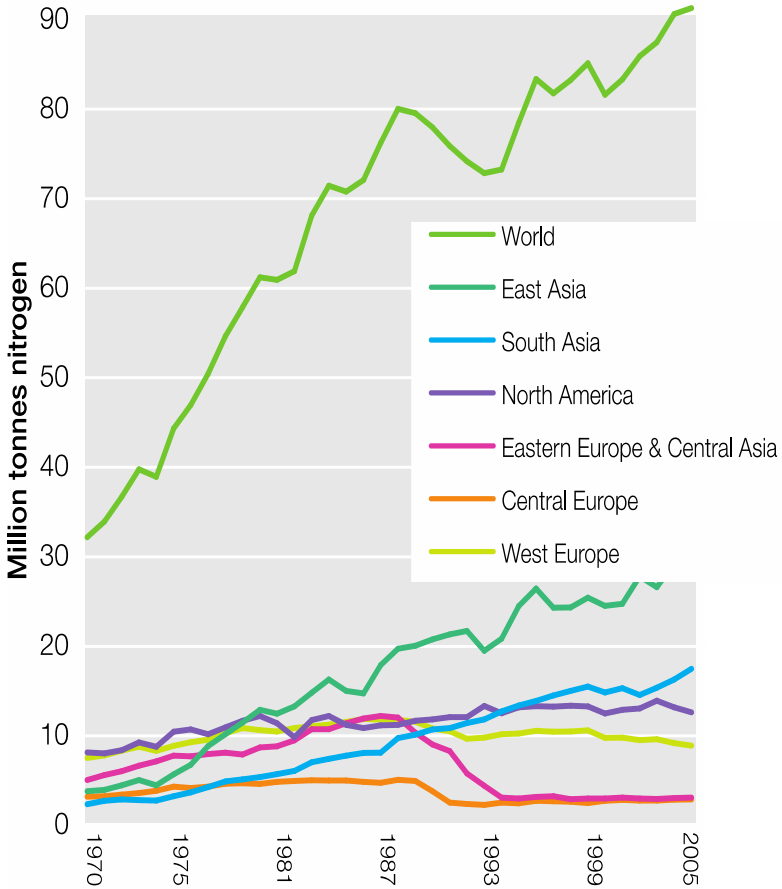
Biome	Area (M km²)	Carbon stock (Gt CO_2 eq.)	Carbon concentration (Gt CO_2-eq M km²)
Tropical forest	17,6	**1.566**	**89**
Temperate forest	10,4	582	56
Boreal forest	13,7	**2.046**	**149**
Tropical savannah	22,5	**1.208**	54
Temperate grassland	12,5	**1.113**	**89**
Desert / semi-desert	45,5	728	16
Tundra	9,5	465	49
Wetland	3,5	878	**251**
Cropland	16,0	479	30

IPCC 2001

- Not only tropical forests but also cold temperate forests and temperate grassland store large quantities of carbon.
- Wetlands have the highest carbon concentration in their soils.
- Carbon storage capacities of agricultural soils are comparatively low.

Emissions from soils

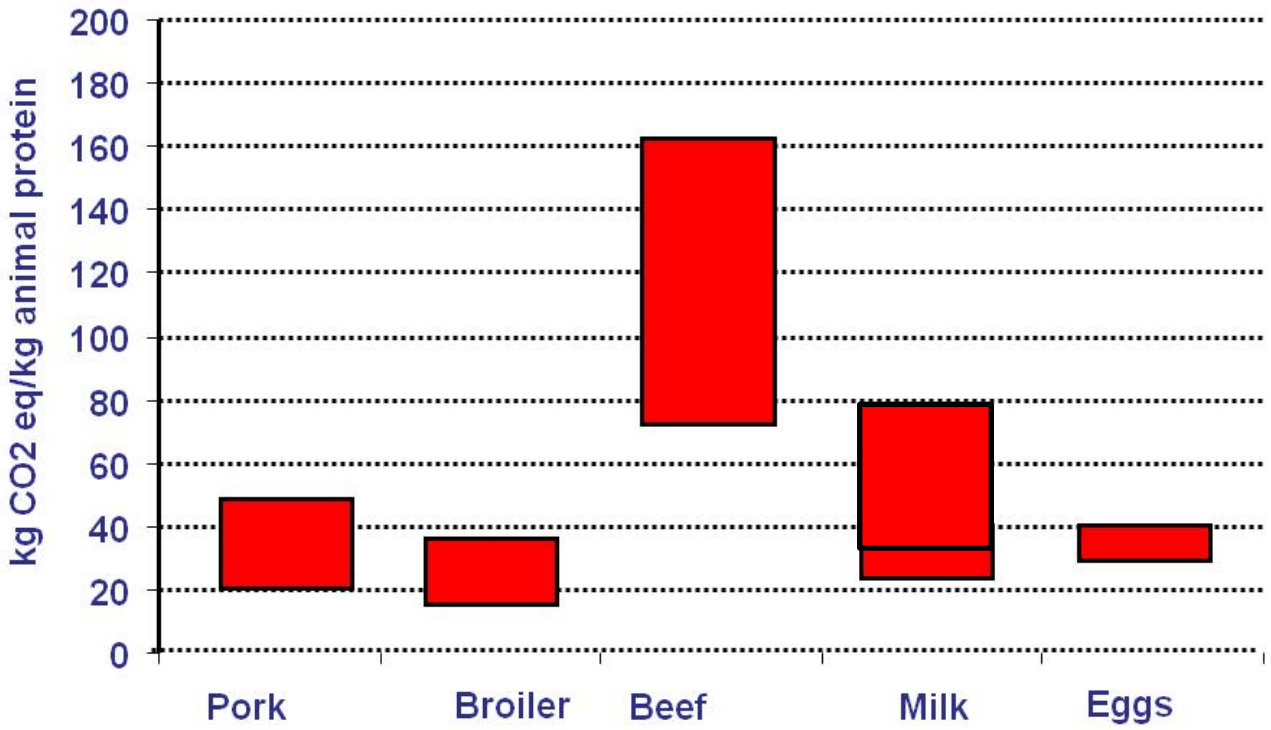
- **N_20: Consumption of synthetic nitrogen fertilizer (1970 – 2005)**
  - ✓ Global consumption of synthetic N-fertilizer has tripled (strong increase in Asia, stable or reduction in industrialized countries, stagnant in many African countries.)
  - ✓ N_2O emissions through high application rates / wrong application;
  - ✓ Basic N application has positive effects on GHG-balance (productivity).
- **CO_2: Decomposition of soil organic matter (humus)**
  - ✓ Degradation of soils (intensive tillage, insufficient input of organic matter, erosion).
  - ✓ Land-use changes.



Quelle: Bellarby et al. 2008, IFA Statistik

Livestock produces GHGs from different sources:

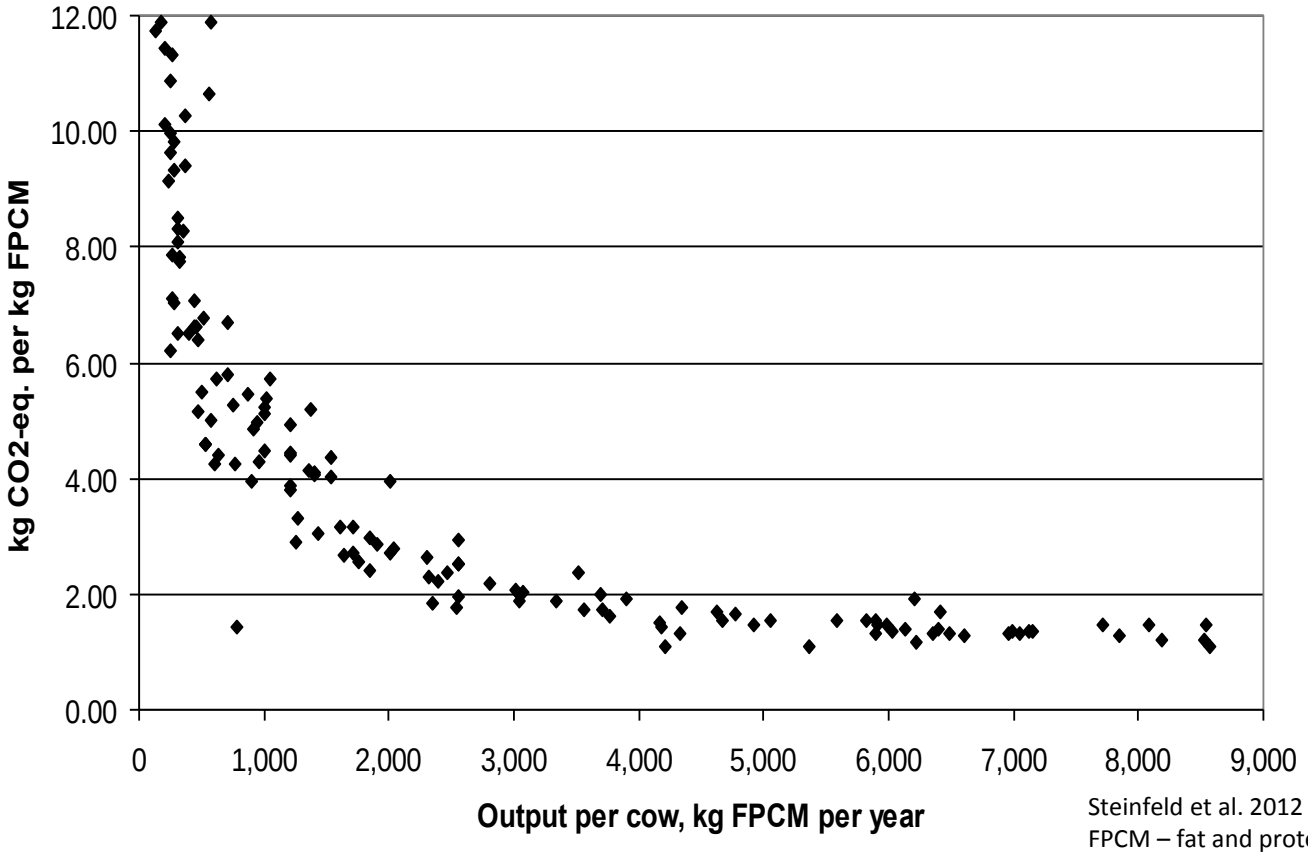
- Direct CH_4 emissions through ruminants (cattle 75 Mt CH_4, sheep/goats 9 Mt);
- Increasing meat consumption causes extension of fodder and grazing areas often by transforming forests and wetlands;
- 73% of the world‘s grazing areas are degraded;



Global emission intensities by commodity

Methane emissions per kg milk as related to milk production per cow

- Extensive cattle rearing with low productivity (especially milk) produces high GHG emissions per unit milk;
- On the other side extensive livestock systems are the only use option for semi-dry areas and livelihood of many (agro-)pastoralists.



Steinfeld et al. 2012
FPCM – fat and protein corrected milk

Potentials

Mitigation options in agriculture and land use

- **Sequestration** of atmospheric CO_2 in soils and vegetation (tree planting, humus build up)
- Reduction of **direct emissions** through improved management:
  - ✓ Reduced emissions from fertilizer application, soil degradation, livestock keeping and rice cultivation, biomass burning
  - ✓ Planned land use change
  - ✓ Reduce post harvest losses and food wastage,
- **Indirect measures** to reduce emissions
  - ✓ Reduce population growth
  - ✓ Use climate-sensitive diets i.e. reduced meat consumption

Using Synergies between Adaptation and Mitigation in Agriculture to Combat Climate Change

Adaptation in Agriculture - a multidimensional and multi-level process to increase resilience and improve livelihood of farmers

Farm-level

- Improved crop management (crop varieties, diversification)
- Improved nutrient, soil and water management (organic and mineral fertilizer, improved water use efficiency, reduced tillage, mulching, soil and water conservation in fields etc.)
- Livestock management (e.g. breeds and herd composition, improved feeding and animal health)
- Reducing post-harvest losses

Adaptation in Agriculture – a multidimensional and multi-level process

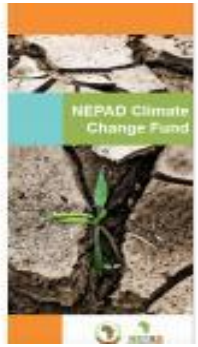
Community level

- Soil and water conservation on communal land
- Agro-biodiversity and biodiversity management
- Land-use regulation
- Supporting farmers‘ organisation
- Gender equity and women‘s rights
- Livelihood diversification (off-farm income)
- Improved processing and marketing

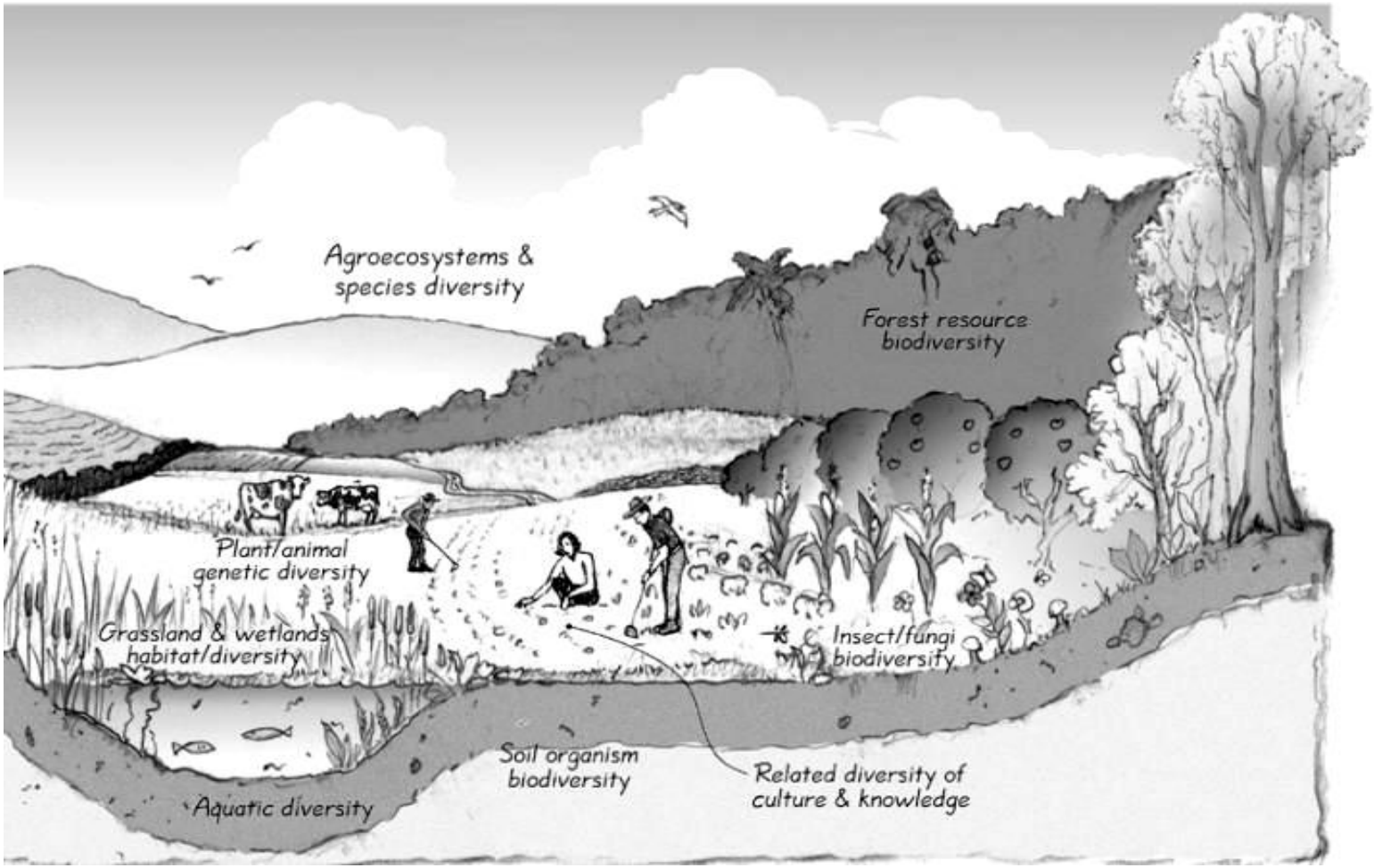
Adaptation in Agriculture – multidimensional and multi-level process

Public level

- Improved weather forecast
- Landscape planning
- Biodiversity management
- Crop insurance systems
- Policy, legal and regulation amendment (e.g. NAPs,)
- Financial instruments (e.g. NAIPs, credit schemes, NEPAD Climate Change Fund)



What adaptation and mitigation measures can you see?



Source: Ecoagriculture policy focus series

Thank you very much !

'No-one has ever advanced a scientific reason for plowing'

Edward Faulkner. 1943. In: Plowman's Folly