



Climate Change Mitigation, Adaptation and Sustainability in Agriculture

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Presentation

- Sustainability – the concept and definitions
- Climate change and sustainability – the issues
- Climate change impacts on agriculture
- Climate change mitigation
- Climate change adaptation
- Climate change adaptation frameworks
- WMO Initiatives for Climate Change Adaptation
- Conclusions

Sustainability – the Concept

- The emphasis on sustainability in several world forums makes one wonder whether it is a philosophy, a long term goal or a set of management practices.
- Rapidly rising population growth and diminishing arable land, particularly in the developing countries, has increased the stress on the natural resource base.
- Growing concerns regarding the decline in the non-renewable sources of energy and the degradation of environment are leading us to take a hard look at the way natural resources have been exploited
- It is now incontestable that sustainable agriculture is seen as an important goal throughout the world.

Sustainability – the Definition

- There is no generally accepted definition of sustainable agriculture.
- However, as Swindale (1988) explained, sustainability conveys the idea of a balance between human needs and environmental concerns.
- A common theme among definitions is that sustainable agricultural systems remain productive over time.
- They should provide for the needs of current, as well as future generations, while conserving natural resources.

Climate Change and Sustainability – the Issue

Rapidly raising greenhouse gases, enhanced land and sea temperatures and increased frequency and magnitude of extreme events pose enormous risks to various economic activities and fresh water availability and affect the sustainability of agriculture and food security of billions of people around the world, especially in the developing countries.

Climate Change and Sustainability

— Limits to expansion of land

- Most good quality land is already being cultivated and no significant land expansion is expected in the future.
- Agricultural sector will be under increasing pressures to ensure continued productivity, while safeguarding environmental quality.
- This depends on our ability to maintain the natural resource base that supports and sustains agriculture, especially in the developing world.



Climate Change and Sustainability – Climatic thresholds

- Climate is a renewable resource, but is variable in time and space.
- For proper and efficient use of the other two natural resources (soil and plant/animal genetic material), knowledge of the role of climate is an essential precondition.
- Biological entities, such as crops, are not abstract entities, but a product of their temporal and genetic history in varying environments and there are lethal environmental thresholds which an organism can not transcend.
- The relationships between the productive capacity of the resource base and the adsorptive capacity of the environment - the increasing problems of water and air pollution, soil erosion, and potential changes in the micro- and macro-climate - are not well understood.

Climate Change and Sustainability – climatic risks

- As much as 80% of the variability in agricultural production is due to the variability in weather conditions
- In many developing countries where rainfed agriculture is the norm, a good rainy season means good crop production, enhanced food security and a healthy economy.
- Failure of rains and occurrence of natural disasters such as floods and droughts could lead to crop failures, food insecurity, famine, loss of property and life, mass migration, and negative national economic growth.



Climate Change and Sustainability – climate extremes

- Severe weather events that are responsible for natural disasters impact the socio-economic development of many nations
- Financial losses in 2005 are more than \$200 billions with insurance claims running at more than \$70 billions. In 2004, losses totalled about \$145 billions and claims reached \$45 billions.



Highest-ever rain in India's history

- 94.4 centimeters (37.1 inches) on 26 July 2005 in Mumbai was the highest rainfall in India's history
- Previous heaviest rainfall, was 83.82 centimeters (33 inches) on July 12, 1910 recorded at Cherrapunji
- Floods caused a direct loss of about Rs 450 crores

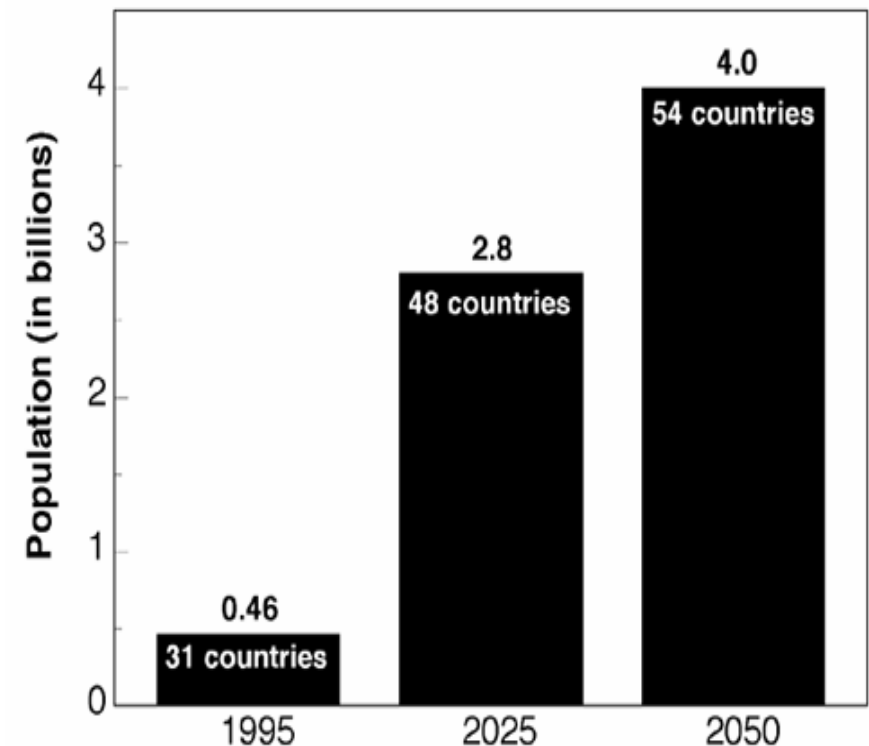


Climate Change and Sustainability – water for agriculture a crucial issue

- By 2025, population in water-scarce countries could rise to 2.8 billion, representing roughly 30 per cent of the projected global population.
- Over the next two decades, the world will need 17 per cent more water for agriculture and the total water use will increase by 40 per cent.
- In many developing countries, 70 per cent of the available fresh water is used for irrigation.

Figure 5. Water Scarcity and Stress

Population in water-scarce and water-stressed countries, 1995-2050



Climate change and Sustainability - Agriculture is also impacting climate

- Area of cultivated land increased from about 265 Mha in 1700 to 1,473 Mha presently.
- Area under pasture increased from 524 to 3,215 Mha.
- 20% reduction in the global area of forests during the last 140 years releasing about 120 GT C to the atmosphere.



Climate change and Sustainability - Agriculture is also impacting climate

- Application of N fertilizers is possibly the largest human-induced source of N_2O emissions in developed countries.
- N_2O has approximately 296 times the radiative forcing of CO_2 .
- Build-up of N_2O and CH_4 in the atmosphere through enteric fermentation in ruminants, and manure management.
- Land degradation leads to higher surface reflectivity and less net radiation, atmosphere cooler, rain less frequent and vegetation growth reduced.



Climate Change and Sustainability - Changes in land cover

- Land use and vegetation type influence processes such as the transfer of heat and moisture from the land surface to the atmosphere.
- These influence both weather and climate through the impact on physical and biochemical properties.
- Agriculture, through the discontinuities in vegetation and differences of soil moisture patterns, can influence the occurrence, location, and intensity of moist air convection.



Climate Change and Sustainability - Changes in land cover

- Between 1850 and 1990 approximately 123 Pg of carbon were released to the atmosphere as a result of changes in land use.
- This is equal to one-half the carbon released by fossil fuel combustion over the same period.
- LUC currently contributes about 18% of the total annual CO₂ emissions; it accounts for about one-third of total emissions in developing countries, and 10% or less in developed countries.



Future Climate Change

- Warming in the 21st century greatest over land and at the highest northern latitudes.
- For the next two decades a warming of about 0.2°C per decade is projected. Increases in the amount of precipitation are very likely in high latitudes, while decreases are likely in most subtropical land regions.
- Drought-affected areas will likely increase in extent.
- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent.

Impacts on Water: IPCC AR4

- Water resources are inextricably linked with agriculture. Annual average river runoff and water availability are projected to increase by 10-40% at high latitudes and in some wet tropical areas, and decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics.



Impacts on Agriculture: IPCC AR4

- Increases in drought and flood frequency are projected to affect local crop production negatively, especially in subsistence sectors at low latitudes.
- Globally, potential for food production is projected to increase with increases in local average temperature over a range of 1-3°C, but above this range, food production is projected to decrease.
- At lower latitudes, especially in the seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase risk of hunger.

Impacts on Agriculture: IPCC AR4

- Crop productivity is projected to increase slightly at mid- to high latitudes for local mean temperature increases of up to 1-3°C depending on the crop, and then decrease beyond that in some regions.
- With the virtually certain likelihood of warmer and more frequent hot days and nights, there are projected to be increased insect outbreaks impacting agriculture, forestry and ecosystems.



Regional Impacts

- In many African regions, area suitable for agriculture, the length of growing seasons and yield potential, particularly in semi-arid and arid areas, are expected to decrease. In some countries, yields from rainfed agriculture could be reduced by up to 50% by 2020.
- Projected that crop yields could increase up to 20% in East and Southeast Asia while they could decrease up to 30% in Central and South Asia by the mid-21st century.
- In drier areas of Latin America, climate change could lead to salinisation and desertification of agricultural land. Productivity of important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. Temperate soybean yields are projected to increase.

Climate Change Mitigation – the Concept

IPCC (2007) defines Mitigation as the technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks.

Key mitigation technologies in agriculture

- Improved crop and grazing land management to increase soil carbon storage;
- Restoration of cultivated peaty soils and degraded lands;
- Improved rice cultivation techniques and livestock and manure management to reduce CH₄ emissions;
- Improved nitrogen fertilizer application techniques to reduce N₂O emissions;
- Dedicated energy crops to replace fossil fuel use;
- Improved energy efficiency.

Key mitigation technologies in agriculture (contd)

- A large proportion of the mitigation potential of agriculture (excluding bioenergy) arises from soil carbon sequestration, which has strong synergies with sustainable agriculture and generally reduces vulnerability to climate change
- Considerable mitigation potential is also available from reductions in methane and nitrous oxide emissions in some agricultural systems
- Biomass from agricultural residues and dedicated energy crops can be an important bioenergy feedstock, but current concerns with food prices make this a questionable alternative.

Key mitigation technologies – carbon sinks in forests

- About 65% of the total mitigation potential (up to 100 US\$/tCO₂-eq) is located in the tropics and about 50% of the total could be achieved by reducing emissions from deforestation
- Forest-related mitigation options can be designed and implemented to be compatible with adaptation, and can have substantial co-benefits in terms of employment, income generation, biodiversity and watershed conservation, renewable energy supply and poverty alleviation

Adaptation Strategies to CC

- While AR4 focused on climate change, future impacts, and potential adaptation strategies, the main determinant of agricultural production is still the seasonal variation of temperature, precipitation, sunshine, etc.
- Droughts, floods, frost-freezes, and heatwaves stress both crops and livestock. It is the changing frequency of these events due to climate change that is the concern.



Adaptation Strategies to CC

- There are several adaptation measures that the agricultural sector can undertake to cope with future climate change.

These include:

- Changing planting dates;
- Planting different varieties or crop species;
- Development and promotion of alternative crops;
- Developing new drought and heat-resistant varieties;
- More use of intercropping;
- Using sustainable fertilizer and tillage practices (improving soil drainage, no-till, etc)
- Improved crop residue and weed management;
- More use of water harvesting techniques,
- Better pest and disease control for crops;
- Implementing new or improving existing irrigation systems (Reducing water leakage, soil moisture conservation - mulching);

Adaptation Strategies to CC

- Improved livestock management (Providing housing and shade, change to heat-tolerant breeds, change in stocking rate, altered grazing and rotation of pasture);
- More use of agroforestry practices;
- Improved forest fire management (altered stand layout; landscape planning; dead timber salvaging; clearing undergrowth; insect control through prescribed burning);
- Development of early-warning systems and protection measures for natural disasters (droughts, floods, tropical cyclones, etc);

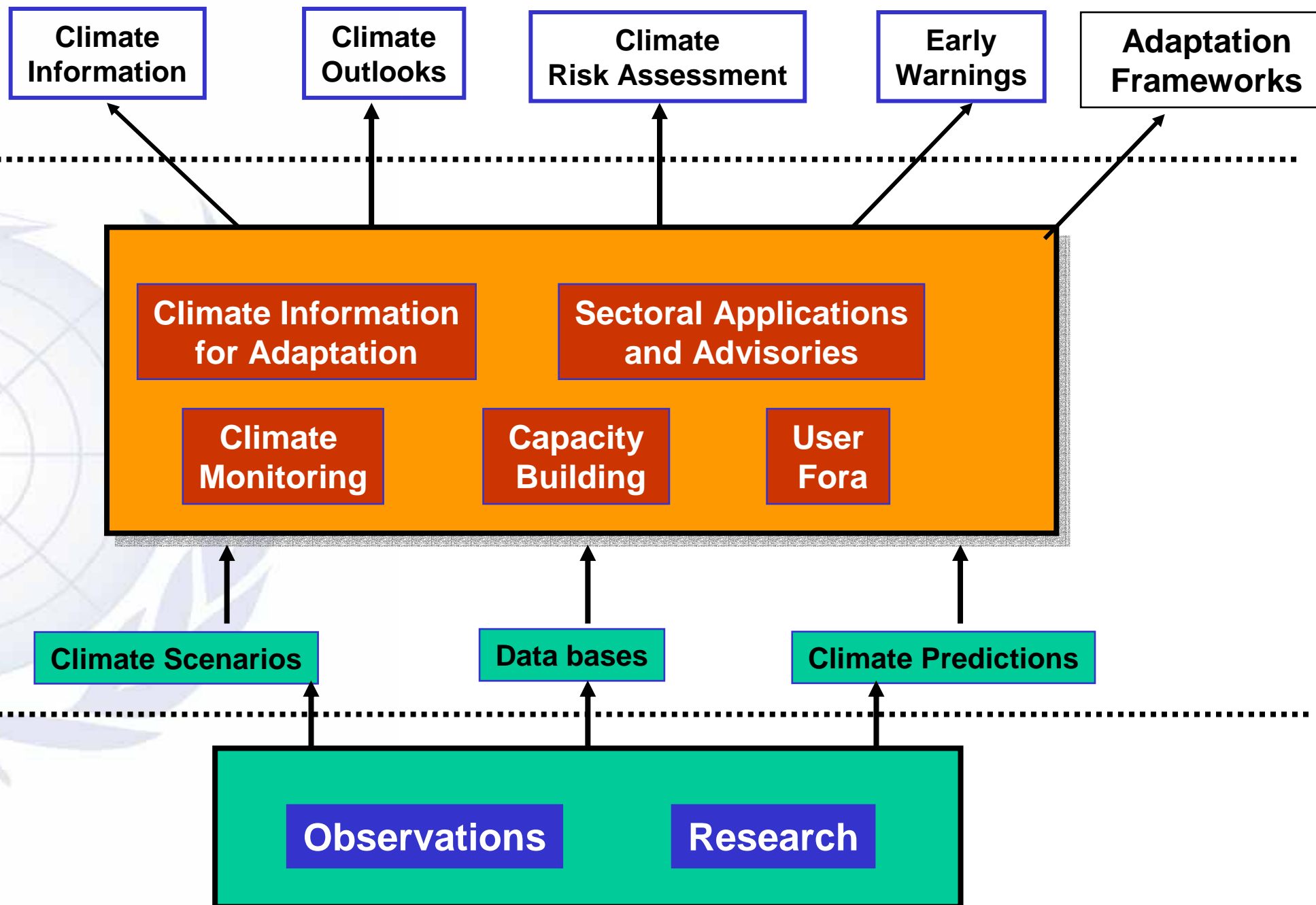


Need for Integration of Mitigation and Adaptation Frameworks into Sustainable Development Planning

- Addressing climate change can be considered an integral element of sustainable development policies.
- Climate change and other sustainable development policies are often, but not always, synergistic.
- There is growing evidence that policy decisions eg., about macroeconomic policy, agricultural policy etc., which are often treated as being apart from climate policy, can significantly reduce emissions.

Need for Integration of Mitigation and Adaptation Frameworks into Sustainable Development Planning (contd.)

- Reducing both loss of natural habitat and deforestation can have significant biodiversity, soil and water conservation benefits, and can be implemented in a socially and economically sustainable manner.
- Making development more sustainable can enhance both mitigative and adaptive capacity, and reduce emissions and vulnerability to climate change.
- Synergies between mitigation and adaptation can exist, for example land management. In other situations, there may be trade-offs.



Conclusions

- Climate change is widely considered to be one of the greatest challenges to modern human civilization that has profound socio-economic and environmental impacts.
- It is essential to develop a portfolio of strategies that includes adaptation, mitigation, technological development and research (climate science, impacts, adaptation and mitigation) to combat climate change

Conclusions (contd.)

- It is imperative on countries to take a proactive role in planning national and regional programmes on adaptation to climate variability and climate change.
- Integration of mitigation and adaptation frameworks into sustainable development planning is an urgent need, especially in the developing countries.