UNIT 8 INTERRELATIONSHIPS BETWEEN MITIGATION AND ADAPTATION IN AGRICULTURE

Structure

8.1 INTRODUCTION

Agriculture lies at the heart of many fundamental global challenges faced by humanity including food security, economic development, environmental degradation, and climate change Agriculture is one of the sectors that is severely affected by adverse climate conditions, since agricultural production is extremely vulnerable to underlying climate risks such as drought, intense and erratic rainfall, and temperature shifts. The intensity of the impacts differs from community to community, region to region and continent to continent. Some of the key vulnerabilities of agricultural mitigation strategies to climate change, and the implications of adaptation on GHG emissions from agriculture are summarized in Table 8.1.

Table 8.1 Impacts of climate change on agriculture

Biophysical Impacts	Socio-economic Impacts
Physiological effects on cultivated crops, pasture, forests, fish, rangeland and livestock (quantity and quality)	Changes in yields and production
Changes in the quantity and quality of land, soil and water resources;Increased weed and pest challenges, alien invasive species; Sea level rise, changes to ocean salinity.	Reduced Gross Domestic Product (GDP) from agriculture in the long term

Sea temperature rise causing fish to inhabit different ranges	Greater fluctuations in world market prices; Changes in geographical distribution of trade; Increased number of people at risk of hunger and food insecurity.
	Migration and civil unrest

Source: OECD (2009)

Keeping above impacts of climate change in view, all the climate actions are centered on either mitigation or adaptation or both. "Adaptation and mitigation are both processes aimed at reducing the risks and impacts of climate change, although this can happen across different temporal and spatial scales". Adaptation is necessary to limit potential risks of the unavoidable residual climate change now and in coming decades. IPCC defines adaptation as "adjustments made in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2014). Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC, 2001). Mitigation is an "intervention to reduce the emissions sources or enhance the sinks of greenhouse gases". Mitigation actions involve direct reduction of anthropogenic emissions or enhancement of carbon sinks that are necessary for limiting long-term climate damage. "*Adaptation and mitigation present some notable differences, particularly in their objectives. Mitigation addresses the causes of climate change (accumulation of greenhouse gases in the atmosphere), whereas adaptation addresses the impacts of climate change. Both approaches are needed. On the one hand, even with strong mitigation efforts, the climate would continue changing in the next decades and adaptation to these changes is necessary. On the other hand, adaptation will not be able to eliminate all negative impacts and mitigation is crucial to limit changes in the climate system*". Mitigation and adaptation actions can interact with each other resulting in synergies or tradeoffs. An integrated approach that considers these interactions is important to harness the synergies to create win-win situations and to avoid trade-offs for no-regret decisions. Interaction between mitigation and adaptation is a key question for the design of climate policies.

Adaptation and mitigation often operate at different spatial and temporal scales and involve different policy actors and priority sectors. For example, mitigation benefits global climatic conditions in the long term, while adaptation provides both short and long term benefits at the local level. The integration of adaptation and mitigation responses can in some cases generate mutual benefits, as well as introduce co-benefits with development policies. In many cases, reducing the risk of climate change can enhance capacities for management of other risks. Opportunities to take advantage of positive synergies may decrease with time, particularly if the limits to climate change adaptation are exceeded. Keeping above in view, in this unit, we would discuss about the interactions between mitigation and adaptation and integrated and synergetic activities for mitigation and adaptation.

8.2 OBJECTIVES

After studying this unit, you should be able to:

- explain the climate adaptation and mitigation measures in agriculture; and

- explain the interrelationships between the climate adaptation and mitigation measures in agriculture.

8.3 ADAPTING TO CLIMATE CHANGE IN THE AGRICULTURE SECTOR

Climate change adaptation strategies should aim at maintaining, or even increasing, food production in key exporting developed and developing regions, or in regions key to regional food security. Any significant change in food production in these areas, including change resulting from climate change impact, has potential to affect global and regional availability, stability and access to food through direct and indirect repercussions on international and local markets.

Climate change adaptation emerge as the best option to climate-proof the agriculture sector and improve livelihoods, consequently eradicating poverty. Farmers have always adapted to changes in climate. The challenge now is to adapt within very short period of time to potentially extreme impacts and new risks and opportunities. This will be achieved through a combination of managerial, infrastructural and technical measures.

Climate, with its regional and temporal variability, is a major determinant of agricultural production. All agricultural production is related to the performance of (cultivated) species, which are bound to particular environmental conditions. As climatic conditions change, also production conditions are likely to change with possible positive or negative implications on agricultural production. If climate change impacts on agro-ecosystem functioning are known, measures can be planned to adapt agricultural management in order to prevent the negative impacts of climate change and to exploit new, emerging potentials. In the context of adaptation in agro-ecosystems, Sustainable Development Goal-13 which endeavours to "ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen the capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and progressively improve land and soil quality" is linked to the Sustainable Development Goal-2, which endeavours to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture". While being high on international and national agenda, climate change adaptation is clearly also in the interest of individual farmers or farming cooperatives that rely on the revenue generated from agricultural production. At farm level, changes in land use and management will be required in order to adapt food production systems to changes in climate and other emerging pressures.

Two types of adaptation responses can broadly be distinguished as the short-term and long-term responses.

a) The short-term, incremental responses that are often chosen autonomously in response to observed changes and based on local knowledge and experience. These responses help to improve management efficiency within existing technological, governance, and value systems.

Short adaptation responses may include:

1. **Changes in sowing dates**: By shifting the sowing date, farmers can make use of the extended growing season associated with climate warming. Also, sowing date shifts provide the possibility of avoiding crop exposure to particular

climatic stresses such as heat or drought during sensitive phenological stages. If the growing season is extended, double-cropping or even triple-cropping may become suitable options for increasing the land productivity under changing climatic conditions.

2. **Cultivar or crop choice**: Shifting to cultivars or crops with increased tolerance to the most dominant stress factors can help to mitigate climate risks. In livestock systems, adaptation can involve flexible herd management, stable construction and indoor climate control systems, choosing alternative livestock breeds or species, dietary choices, and innovative pest management. Diversification of farm management is also one possibility for adaptation that is often suggested, especially under conditions of high climatic variability or high uncertainty.

b) The long-term, transformative responses that require strategic planning, which is usually implemented at a larger spatial scale (regional, national or international). These responses may involve alteration of the fundamental attributes of the agro-production systems.

These may include:

✓ spatial shifts in production zones;

✓ structural changes in production systems implying substantial shifts in farming activities;

✓ breeding of new crops and cultivars.

Further breeding goals for adaptation can include tolerances to flooding, drought or increased salinity as well as water- and nutrient-use-efficiencies. Also, the ability of crops to adapt their phenotype to changing environmental conditions (phenotypic plasticity) can be considered a desirable trait when breeding for climate-resilient crops. Transformative adaptation, since it requires greater foresight and coordination, would rely on appropriate intuition and mechanisms to promote the implementation of sustainable adaptation strategies.

Both types of adaptation responses are essential for reducing risks from weather and climate extremes. The ratio of these two types of responses depends on the balance between climate impact and the adaptive capacity of the affected socio-ecological system. If climate impacts are relatively mild, not pushing the existing production system beyond its feasibility boundaries, and if adaptive capacity is high, adaptation can be facilitated by short term responses. If climate impacts are more extreme, and the scope for short term responses is narrow (e.g., due to limited access to resources and technologies), long term responses can quickly become indispensable.

In nut shell, the following are the climate change adaptation measures in agriculture sector.

i) Strengthening management of water resources and promote more efficient irrigation methods and water harvesting techniques

ii) Promoting climate smart agriculture and the adoption of improved livestock breeds that are tolerant to climate related stresses.

iii) Promoting the use of indigenous and scientific knowledge on drought tolerant crop types and varieties and indigenous livestock that are resilient to changes in climate.

iv) Strengthening early warning systems on climate related agricultural risks.

v) Putting more emphasis on incentives to enhance farmer capacity to adopt practices that contribute to sustainable productivity growth while also responding to climate change.

vi) Promoting capacity building through research and development, education and awareness, and training in climate change related issues.

vii) Promoting climate indexed insurance solutions and enabling market frameworks.

viii) Building resilience in managing climate related disasters such as droughts, hailstorms, erratic rainfall and floods

Box 8.1: Adaptation strategies in agriculture

1) Altering inputs, varieties and species for increased resistance to heat shock and drought, flooding and salinization; altering fertilizer rates to maintain grain or fruit quality; altering amounts and timing of irrigation and other water management; altering the timing or location of cropping activities.

2) Managing river basins for more efficient delivery of irrigation services and prevent water logging, erosion and nutrient leaching; making wider use of technologies to "harvest" water and conserve soil moisture; use and transport water more effectively. Diversifying income through the integration of activities such as livestock raising, fish production in rice paddies, etc.

3) Making wider use of integrated pest and pathogen management, developing and using varieties and species resistant to pests and diseases; improving quarantine capabilities and monitoring programmes.

4) Increasing use of climate forecasting to reduce production risk.

5) Matching livestock stocking rates with pasture production, altered pasture rotation, modification of grazing times, alteration of forage and animal species/breeds, integration within livestock/crop systems including the use of adapted forage crops, re-assessing fertilizer applications and the use of supplementary feeds and concentrates.

6) Undertaking changes in forest management, including hardwood/ softwood species mix, timber growth and harvesting patterns, rotation periods; shifting to species or areas more productive under new climatic conditions, planning landscapes to minimize fire and insect damage, adjusting fire management systems; initiating prescribed burning that reduces forest vulnerability to increased insect outbreaks as a non-chemical insect control; and adjusting harvesting schedules.

7) Introducing forest conservation, agroforestry and forest-based enterprises for diversification of rural incomes.

(**Source:** Howden, et al., 2007)

Table 8.2: Adaptation options in the water and agriculture sector

Adaptation Option/ Strategy	Underlying Policy Framework	Constraints	Adaptation Option/ Strategy
Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological and financial constraints	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting

Source: IPCC, 2007

8.4 MITIGATION OF CLIMATE CHANGE IN THE AGRICULTURE SECTOR

The main mitigation options involve one or more of three strategies: reduction/ prevention of emissions to the atmosphere by conserving existing carbon pools in soils or vegetation that would otherwise be lost; by reducing emissions of CH_4 and N_2O; sequestration enhancing the uptake of carbon in terrestrial reservoirs, and thereby removing CO_2 from the atmosphere and reducing CO_2 emissions by substitution of biological products for fossil fuels or energy-intensive products. Demand-side options (e.g., by lifestyle changes, reducing losses and wastes of food, changes in human diet), though known to be difficult to implement, may also play a role.

Increasing efficiency in crop and grazing land management which include the reduced tillage and crop residue management, organic soil restoration, increased nutrient use efficiency and water use efficiency, livestock and manure management have immense mitigation potential. The key mitigation initiatives aim at augmenting carbon sequestration through measures like agroforestry, organic farming; emission reduction through improved livestock feed and dietary management; and sustainable grassland management (https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg3-chapter8-1.pdf).

Check Your Progress 1

Note: i) Use the space given below for your answers.

ii) Check your answers with those given at the end of the unit.

1. Define adaptation.

....

....

....

....

2. Define mitigation.

....

....

....

....

3. What are the short-term adaptation strategies?

....

....

....

....

4. What are the long-term adaptation strategies?

....

....

....

....

8.5 INTERACTIONS BETWEEN MITIGATION AND ADAPTATION

In the agricultural sector, the interactions between mitigation and adaptation measures are significant. The adaptation strategies to climate change have both short-term and long-term consequences. However, the mitigation measures generally have long-term benefits. Further, the mitigation measures are robust in nature and are very essential for the sustainability of agro-ecosystem. In many countries, policies pertaining to economics, environment and agriculture sector have indeed far reaching consequence on mitigation strategies in agriculture. In effect, the potential embedded in the mitigation and adaptation strategies, and the interactions thereof, are immense. Scientific implementation of these strategies can contribute greatly in reducing greenhouse gases emissions from the agricultural sector and also in adapting agriculture to changing climatic conditions including climate variability.

Box 8.2 : Examples of synergies between adaptation and mitigation

1. Reducing methane emissions through integrated rice and livestock systems traditionally found in West Africa, India, Indonesia, and Vietnam, is a mitigation strategy that also results in better irrigation water efficiency. It can also provide new sources of income while improving performance of cultivated agro-ecosystems, and enhance human well-being.

2. Reducing N_2O emissions can lead to improved groundwater quality and reduced loss of biodiversity as well as reducing costly production inputs. Integrating animal manure waste management systems, including biogas capture and utilization, for reductions of CH_4 and N_2O could result in

greater demand for farmyard manure and create income for the animal husbandry sector where many poor are engaged. Methane emitted by ruminant livestock represents energy lost to the animal that could otherwise be used to increase animal production. Modification of the quality and quantity of feed by having feeds that are not as badly affected by inclement climate conditions can result in lower methane emissions and increased production. In addition, increased efficiency of production from more climate adapted systems results in less methane per unit product, allowing growth in livestock production without equivalent growth in methane emissions.

3. Restoring land by controlled grazing can lead to soil carbon sequestration, have positive impacts on livestock productivity, reduce desertification, and also provide social security to the poor during extreme events such as drought (especially in sub-Saharan Africa). Practicing agro-forestry can promote soil carbon sequestration while also improving agro-ecosystem function and resilience to climate extremes by enriching soil fertility and soil water retention.

4. Producing bioenergy can lead to reduced greenhouse gas emissions through substitution of fossil fuels and generate income and employment for rural regions, providing an indirect but powerful adaptation strategy.

Source: IPCC, 2007

Climate-Smart Agriculture

Agriculture is a climate sensitive enterprise. Anthropogenic climate change increases the vulnerability of agriculture and endangers the livelihood of farmers' with small and marginal farm holdings. We have studied in the course MEV-022, about the impacts of climate change on agriculture which include reduced crop yields, pest and disease outbreaks, increasing vulnerability of the farmers' to floods, droughts, etc. "Mounting pressure from growing food demand, declining soil fertility, competing uses for agriculture inputs like land, water, global change including climate change demand greening of agricultural practices, growth and development. Greening of agriculture growth warrants a paradigm shift in agricultural planning, research and development, innovations in food systems, biotic and abiotic risk reduction, hazard management and climate management. In effect, agriculture production system requires resilient development pathways to augment global food grain production, reduce GHG emissions from agricultural activity and adapt agriculture to climate change and variability (Lipper et al. 2014). Due to growing concerns for hunger and malnutrition (Grebmer et al. 2012), potential threats of climate change and extreme weather events on agricultural food systems (Lipper et al. 2014), declining marginal productivity of agriculture inputs, FAO and World Bank conceptualised "Climate Smart Agriculture". Climate Smart Agriculture (CSA) is aptly defined as an "agricultural approach that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) and enhances achievement of national food security and development goals" (FAO 2013). The goals of CSA focusses on food security and poverty reduction; maintaining and augmenting the productivity and resilience of natural and agricultural ecosystem functions (Steenwerth et al. 2014). Climate change threats to agriculture system can be minimised by adopting CSA approach which aims at increasing the resilience, the adaptive capacity of the farmers and resource use efficiency (Lipper et al.

2014). ……. Climate smart agriculture provide a pathway to achieve sustainable development goals which focuses on poverty reduction, food security, environmental health" (Venkatramanan and Shah, 2019).

Agriculture is one such sector which has potential to capitalize both mitigation and adaptation options. For instance, crop management activities aiming at improving soil carbon status, reducing soil erosion, reducing greenhouse gases emissions have both mitigation and adaptation potential. Further, increases in adaptive capacity of the farm and household greatly ensure food and nutritional security. Climate change adaptation in agriculture which includescrop diversification, water conservation measures, intensive agriculture, increases the adaptive capacity of agro-ecosystem and resilience capacity of the farmers'. Agroforestry practices in addition to providing food security and income diversification to households', significantly reduce greenhouse gases emissions. Few adaptation activities like changes in sowing/planting can be adopted by the farmers' themselves. Further, initiatives like crop insurance, and proactive extension services can greatly increase the farmers' resilience capacity.

8.5.1 Mitigation Measures

Mitigation interventions like cropland management, pastureland management, soil management, livestock management, etc. are recommended so as to decrease greenhouse gases emissions. Many mitigation strategies result in adaptation benefits. For instance, mitigation measures result in increased water use efficiency, and nutrient use efficiency leading to higher crop yields and increased resilience capacity. Manure management in livestock sector and methane emission reduction from livestock and paddy cultivation have noteworthy mitigation potential. These measures also provide adaptation benefits like food security, increased productivity, improved livelihood security, etc. Similarly, homestead gardens exhibit higher degree of diversification, reduced fertilizer consumption, and potential to increase the adaptive capacity of the household. In the South America (Brazil), agricultural practices of pasture rotation system and intercropping with legume crops aid in reducing greenhouse gases emissions from livestock and also the animal husbandry provides food security and livelihood support. Another example for mitigation option is windbreaks which not only protect the crops from severe dehydration, but also increase soil fertility through contribution of organic matter. In effect, the mitigation options provide benefits which augment the biophysical capacity of the crop environment and improve the socio-economic conditions of the farming community.

8.5.2 Adaptation Measures

Increasing temperature reduce crop yields of sensitive crops like maize, rice and wheat, demanding the farmers' to adjust the crop management and livestock rearing so as to secure the stability of agro-ecosystem. Several adaptation measures pertaining to land management provide benefits like carbon sequestration. For instance, agricultural practices like legume intercropping, temporal and spatial diversification provide income support to the stakeholders' and improvement of soil properties particularly water holding capacity and soil fertility. Practices like conservation tillage, soil and water conservation transform the agricultural system to be more climate-resilient. In the livestock sector, the adaptation measures like changing the composition of livestock, rearing small ruminants can provide the farmers' with income support, milk and other dairy products even during the water scarce periods.

8.6 CLIMATE-RESILIENT PATHWAYS

The pursuit of climate-resilient pathways involve identifying vulnerabilities to climate change impacts; assessing opportunities for reducing risks; and taking actions that are consistent with the goals of sustainable development. While the adaptation and mitigation have the potential to both contribute to and impede sustainable development, the sustainable development strategies and choices have the potential to both contribute to and impede climate change responses. Adaptation and mitigation are needed, working together to reduce risks of disruptions from climate change. These actions, however, may introduce trade-offs between adaptation and mitigation, and between economic goals and environmental goals. In some cases, for example, adaptation may increase greenhouse gas emissions (e.g., increased fossil-based air conditioning in response to higher temperatures) and in some cases mitigation may impede adaptation (e.g., reduced energy availability in countries with growing populations). In many cases, strategies for climate change responses and strategies for sustainable development are highly interactive. These actions may involve a combination of incremental and transformative responses that take into account current and anticipated changes in both climate averages and extremes; the dynamic development context influences social vulnerability, risk perception, conflict resolution, and resilience; and recognition of human agency and capacity to influence the future. In fact, humans have the capacity to manage risk and to decrease vulnerability through both mitigation and adaptation, as well as through choices of development goals and strategies (Denton et al., 2014).Climate-resilient pathways include two overarching attributes: (1) actions to reduce climate change and its impacts, including both mitigation and adaptation, and (2) actions to ensure that effective risk management institutions, strategies, and choices can be identified, implemented, and sustained as an integrated part of development processes.

Check Your Progress 2

Note: i) Use the space given below for your answers.

ii) Check your answers with those given at the end of the unit.

1. Give two examples showing synergies between adaptation and mitigation measures in agriculture.

....

....

....

....

2. What is climate smart agriculture?

....

....

....

....

....

3. What are climate resilient pathways?

....

....

....

8.7 LET US SUM UP

In agriculture, interactions between adaptation and mitigation are particularly important. The adaptation actions can have positive, negative or neutral effects on mitigation and vice-versa. For example, adaptation strategies, such as water savings and soil conservation can maintain and sequester carbon. Yet, increasing nitrogen fertilization, energy intensive irrigation, or expansion in peatland can increase carbon emissions. Similarly, carbon payments can contribute to local adaptation through diversification of livelihoods and improved economic resilience to climate shocks. Yet, other mitigation measures, such as the development of fast growing tree monoculture aimed at maximising carbon sequestration may reduce options for ecological adaptation. In order to address negative interactions and facilitate the realization of mutually beneficial outcome, it is necessary to take these interactions into account. We have discussed in this unit about the interrelationships between mitigation and adaptation measures in agriculture.

8.8 KEY WORDS

Adaptation : Adjustments in natural or human systems in response to climatic change.

Autonomous Adjustments : Adjustments initiated and implemented by individuals, households or private companies.

Planned Adjustments : Adjustments initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.

Mitigation : An intervention aimed at reducing the severity of climate change by controlling emissions of greenhouse gases and/or enhancing carbon sinks.

Resilience : Amount of change a system can undergo without changing state.

8.9 SUGGESTED FURTHER READING/ REFERENCES

Bakkegaard, R. K., Møller, L. R., & Bakhtiari, F. (2016). Joint Adaptation and Mitigation in Agriculture and Forestry. UNEP DTU Partnership.

FAO. (2013). Climate-smart agriculture: Source book, pp. 557.

Grebmer, K., Ringler, C., & Rosegrant, M. et al. (2012) Global hunger index. The challenge of hunger: Ensuring sustainable food security under land, water, and energy stresses. Washington.https://doi.org/10.2499/9780896299429

Howden, M., Soussana, J.F. &Tubiello, F.N. 2007. Adaptation strategies for climate change. Proc. Nat. Ac. Sciences 104:19691-19698

IPCC, 2001: Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 398 pp.

IPCC, 2007: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., XXX pp.

IPCC, 2014: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Denton, F., T.J.Wilbanks, A.C. Abeysinghe, I. Burton, Q. Gao, M.C. Lemos, T. Masui, K.L. O'Brien, and K.Warner, 2014: Climate-resilient pathways: adaptation, mitigation, and sustainable development. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1101-1131.

Lipper, L., Thornton, P., Campbell, B., et al. (2014). Climate-smart agriculture for food security. Nature Climate Change, 4, 1068–1072. https://doi.org/10.1038/nclimate2437.

OECD – Organisation for Economic Co-operation and Development 2009: Integrating Climate Change Adaptioninto Development Co-operation.

Steenwerth, K., Hodson, A., Bloom, A., et al. (2014). Climate-smart agriculture global research agenda: Scientific basis for action. Agriculture & Food Security, 3, 11. https://doi.org/10.1186/2048-7010-3-11.

Venkatramanan V, Shah S (2019) Climate smart agriculture technologies for environmental management: the intersection of sustainability, resilience, wellbeing and development. In: Sustainable green technologies for environmental management. Springer, Singapore, pp 29–51. https://doi.org/10.1007/978-981-13-2772-8_2

https://orbit.dtu.dk/ws/files/157400483/Joint_adaptation_and_mitigation_updated_09_08_16_1_.pdf

https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg3-chapter8-1.pdf

8.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. Adaptation as defined by IPCC is the "adjustments made in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities".

2. Mitigation is defined as an "intervention to reduce the emissions sources or enhance the sinks of greenhouse gases".

3. The short-term adaptation measures are incremental in nature. They are often chosen autonomously in response to observed changes and based on local knowledge and experience. These responses help to improve management efficiency within existing technological, governance, and value systems. It may include changes in sowing dates, choice of crops and cultivars, etc.

4. The long-term adaptation measures are usually implemented at a larger spatial scale (regional, national or international). These responses may involve alteration of the fundamental attributes of the agro-production systems. These may include, for instance, the spatial shifts in production zones; structural changes in production systems implying substantial shifts in farming activities; and breeding of new crops and cultivars.

Check Your Progress 2

1. Synergies exist between adaptation and mitigation measures in agriculture.The following are few examples.

   - Reducing methane emissions through integrated rice and livestock systems traditionally found in West Africa, India, Indonesia, and Vietnam, is a mitigation strategy that also results in better irrigation water efficiency. It can also provide new sources of income while improving performance of cultivated agro-ecosystems, and enhance human well-being.

   - Reducing N_2O emissions can lead to improved groundwater quality and reduced loss of biodiversity as well as reducing costly production inputs. Integrating animal manure waste management systems, including biogas capture and utilization, for reductions of CH_4 and N_2O could result in greater demand for farmyard manure and create income for the animal husbandry sector where many poor are engaged. Methane emitted by ruminant livestock represents energy lost to the animal that could otherwise be used to increase animal production. Modification of the quality and quantity of feed by having feeds that are not as badly affected by inclement climate conditions can result in lower methane emissions and increased production. In addition, increased efficiency of production from more climate adapted systems results in less methane per unit product, allowing growth in livestock production without equivalent growth in methane emissions.

2. Greening of agriculture growth warrants a paradigm shift in agricultural planning, research and development, innovations in food systems, biotic and abiotic risk reduction, hazard management and climate management. In effect, agriculture production system requires resilient development pathways to

augment global food grain production, reduce GHG emissions from agricultural activity and adapt agriculture to climate change and variability. FAO and World Bank conceptualised "Climate Smart Agriculture". Climate Smart Agriculture (CSA) is defined as an "agricultural approach that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) and enhances achievement of national food security and development goals". The goals of CSA focusses on food security and poverty reduction; maintaining and augmenting the productivity and resilience of natural and agricultural ecosystem functions.

3. The climate-resilient pathways involves identifying vulnerabilities to climate change impacts; assessing opportunities for reducing risks; and taking actions that are consistent with the goals of sustainable development. Climate-resilient pathways include two overarching attributes: (1) actions to reduce climate change and its impacts, including both mitigation and adaptation, and (2) actions to ensure that effective risk management institutions, strategies, and choices can be identified, implemented, and sustained as an integrated part of development processes. While the adaptation and mitigation have the potential to both contribute to and impede sustainable development, the sustainable development strategies and choices have the potential to both contribute to and impede climate change responses. In essence, humans have the capacity to manage risk and to decrease vulnerability through both mitigation and adaptation, as well as through choices of development goals and strategies.