CLIMATE SMART AGRICULTURE

TRAINING MANUAL

For Training of Agricultural Officers in the Northern Mountainous Region of Vietnam

Project [illegible]: "Climate-Smart Agriculture: capturing the synergies between mitigation, adaptation and food security"

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PREFACE

Background and Climate Smart Agriculture Project

Climate change and food security cannot be tackled in isolation from each other. Agriculture is a key sector to address these twin challenges as it is a fundamental means of improving incomes and food security, yet at the same time it can contribute positively or negatively to climate change.

Given that agriculture is the key economic sector of most low income developing countries, improving the resilience of farming systems is essential for climate change adaptation. At the same time, improvement in agricultural production systems offers potentials for mitigation of greenhouse gas (GHG) emissions by increasing carbon stocks in terrestrial systems as well as reducing emission through increased efficiency. Climate Smart Agriculture (CSA) is an approach which could help addressing this twin challenge as it involves the direct incorporation of climate change adaptation and mitigation into agricultural development planning and investment strategies (FAO 2010).

In 2012, FAO and the European Commission launched the project "Climate-Smart Agriculture: capturing the synergies between mitigation, adaptation and food security", which takes as its starting point the close linkages between climate change and food security to strengthen the capacities of governments, local institutions and universities in Malawi, Viet Nam and Zambia in addressing the twin challenge of ensuring food security while mitigating climate change and adapting to its effects.

The objective of this project is to provide decision-makers and other stakeholders with the necessary tools, capacity and information to make evidence-informed decisions on climate-smart options for agriculture and to formulate supportive policy instruments and investments.

This training manual, developed under the above mentioned CSA Project, is for use to improve capacity of decision makers, extension officers and agriculture frontline staff working in the Northern Mountainous Region of Vietnam towards adoption of CSA in the region.

This training manual is meant to bridge capacity gaps in addressing climate change and food security in Viet Nam, Northern Mountainous Region in particular, through the agriculture sector. It adds value to existing manuals in the country as it combines agriculture with challenges of climate change and potential solutions by focusing on climate smart agriculture that implies adaptation, mitigation and food security.

Target Group and Learning objectives

The development of this manual targets agricultural technical staff and decision makers at provincial, district and commune levels in the Northern Mountainous Region of Vietnam (NMR), with special focus on the three target provinces of the CSA project: Dien Bien, Son La and Yen Bai.

The purpose the trainings is to build capacity and raise awareness of the trainees so that they will be able to:

i) Assist farmers to increase adaptation to and mitigation of climate change and enhance food security through adoption of CSA practices;
ii) Improve the use of information about climate and agriculture;
iii) Apply appropriate methods and tools to assess, plan, evaluate and make decisions on the mechanisms, measures and strategies in production as well as in climate change mitigation and adaptation.

Content structure of this manual

This Manual is organized around five modules. Each module addresses a distinct theme with learning questions and objectives.

Module 1, CLIMATE CHANGE - AN INTRODUCTION, serves as an introductory session covering the climate change and related concepts. It builds the foundation for the rest modules.

Module 2, AGRICULTURE, CLIMATE CHANGE AND FOOD SECURITY, provides elements to enable participants understand the key linkages between climate change adaptation, mitigation and food security. This module also discuss the impacts of the prevailing agricultural practices (conventional agriculture) on climate and the needs for agricultural transformation. It builds the foundation to module 3.

Module 3, CLIMATE-SMART AGRICULTURE – AN INTRODUCTION addresses the central theme of this manual beginning by introducing the concept of climate-smart agriculture and its three pillars – adaptation, mitigation and productivity.

Module 4, CLIMATE SMART AGRICULTURE PRACTICES IN THE NORTHERN MOUNTAINOUS REGION OF VIETNAM, provides an overview of CSA practices and attempts to promote them in the northern mountainous region of Vietnam.

Module 5, BARRIERS AND OVERCOMING THE BARRIERS TO ADOPTION OF CSA PRACTICES, discusses the barriers to adoption of CSA options, measures for removing these barriers and how to define appropriate CSA options in a specific context.

At the end of the manual there are two annexes. Annex 1 provides the list of main policy documents of both central and provincial governments relating to CSA in the NMR. Annex 2 provide some knowledge on evaluation of CSA practices and selection of practices suitable for specific context.

HOW TO USE THIS MANUAL

Each of the five modules of this manual comprises different sessions which contain background information on the topic, questions for instructing facilitators on how to convey main messages and exercises to undertake.

Each session is organized in 3 different stages:

First, participants are required to discuss and share their experiences on the topic being discussed. There are questions included at the beginning of each session to help facilitators to moderate the discussion and to introduce the session. From the second session, questions guiding discussions for reviewing of the previous sessions are also included to help participants linking the knowledge learnt from the previous sessions with the following session.

Second, based on discussions held on experiences by participants, facilitators are required to consolidate the session with supporting documentation, examples or exercises. Some examples and documentations are included in each session of this manual, but depending on the concrete conditions and target audience, the facilitators should add as many as possible examples from the ground. A mixture of group discussions, brainstorming, world café, and storytelling should be employed as delivery techniques. Facilitators should identify and use the most appropriate delivery technique for their target trainees.

Third, at the end of each session, to help facilitators summarize the main points and stress the main massages, some questions are also included for group work. Depending on the time limit, facilitators can moderate plenary discussions or small group discussions for this purpose.

Last, but not least, this is only a manual. To facilitate the trainings, facilitators should prepare well in advance the handout and presentation materials which should be in languages and styles attractive and easy for their target audience to understand and uptake. For preparation of the handout and presentation materials, facilitators could also refer to the references included at the end of this manual for more information and examples.

ABBREVIATIONS

ADC	Area Development Committee
AWD	alternative wetting and drying (irrigation)
CA	Conservation Agriculture
CC	climate change
CFC	Chlorofluorocarbons
CH_4	Methane
CO_2	Carbondioxide
COP	Conference of Parties
CSA	Climate Smart Agriculture
DARD	Provincial Department of Agriculture and rural Development
DONRE	Provincial Department of Agriculture and rural Development
DRD	disaster risk reduction
DRM	disaster rick management
ECOSOC	United Nations Economic and Social Council
FAO EPIC	FAO Economics and Policy Innovations for Climate Smart Agriculture
FAO	Food and Agriculture Organization of the United Nations
FDP	Fertilizer deep placement
GDP	Gross Domestic Produce
GHGs	Green House Gases
ICM	integrated crop management
IPCC	International Panel on Climate Change
IPM	integrated pest management
LCA	life cycle assessment
LULUCF	Land Use, Land Use Change and Forestry
M&E	monitoring and evaluation
MARD	Ministry of Agriculture and rural Development, Vietnam
MDGs	Millennium Development Goals
MOLISA	Ministry of Labour, Invalids and Social Affairs
MONRE	Ministry of natural Resources and Environment
NAMAs	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programme of Action
NGO	Non-Governmental Organization
NMR	Northern Mountainous Region of Vietnam
NOMAFSI	Northern Mountainous Agriculture and forestry Science Institute, Vietnam
PES	Pay for Ecosystem Services
REDD	Reducing Emissions from Deforestation and Forest Degradation
SLM	sustainable land management
SRI	system of rice intensification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAAS	Vietnam Academy of Agricultural Sciences
VAC	Vườn - Ao-Chuồng (garden-pond-animal pens/cages – or horticulture – aquaculture – animal husbandry)
WB	World Bank

GLOSSARY OF KEY TERMS

Adaptation: Adaptation refers to responses by individuals, groups and governments to actual or expected changes in climatic conditions or their effects.

Adaptive capacity: Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies.

Agro-forestry: The intentional mixing of trees and shrubs into crop and/or animal production systems to create environmental, economic and social benefits.

Climate change: Climate change is a large-scale, long-term shift in the planet's weather patterns or average temperatures.

Climate variability: Climate variability refers to variations in the mean state and other climate statistics (standard deviations, the occurrence of extremes, etc.) on all temporal and spatial scales beyond those of individual weather events.

Climate: Climate is statistical information, a synthesis of weather variation focusing on a specific area for a specified interval.

Climate-Smart Agriculture: Agriculture that sustainably increases productivity and resilience (adaptation), reduces/removes GHGs (mitigation), and enhances productivity and income.

Drought: A temporary reduction in moisture availability significantly below the normal for a specified period.

Food Security: Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Global warming: A gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of greenhouse gasses.

Mitigation: Actions to reduce and avoid GHG emissions and enhance sinks of GHGs.

Weather: Weather is the day-to-day state of the atmosphere and its short-term variations such as temperature, humidity, precipitation, cloudiness, visibility or wind.

MODULE 1: CLIMATE CHANGE – AN INTRODUCTION

MODULE OVERVIEW

This module provides general knowledge on climate change, its causes and impacts. It also discusses the concepts of adaptation and mitigation. The main learning questions are as below.

KEY LEARNING QUESTIONS

- What is climate change? How is it distinguished from natural climate variability?
- What are the expressions of climate change?
- What are the causes of climate change?
- What are the impacts of climate change, and how can we cope with them?

Learning Objectives:

Upon completion of this module, participants should be able to:

1. Explain the meaning of climate, climate change and climate variability;
2. Discuss the linkages between greenhouse gas emissions, global warming and climate change;
3. Classify causes of greenhouse gases into the atmosphere;
4. Appreciate trends in global and local temperatures and rainfall observed over the past few decades as signals of climate change;
5. Explain adaptation and mitigation as measures to respond to climate change.

SESSION 1.1: THE CONCEPTS OF CLIMATE CHANGE

Session Overview

Meteorological data and studies show how climate has been changing over time and particularly over the past few decades:

- mean surface temperature has increased;
- precipitation patterns have changed;
- floods and drought have become more common and widespread.

In Vietnam, many parts of the country have undergone shifting rainfall patterns with highly variable onset, cessation and uneven distribution. More frequent and longer dry and cold spells in some areas and torrential rains in other parts have been observed. However, there is often confusion in the utilization of the two terms - weather and climate.

The aim of this session is to discuss the concepts of weather, climate variability and climate change, and clarify possible misunderstandings associated with these concepts.

Discussion questions for facilitating the introduction of the session

1. Have you ever head of greenhouse gas emission and climate change?
2. Have you experienced any changes in temperature or rainfall patterns during the past years?
3. What do you think are the causes of these changes?

1. The concepts of climate and climate change

As per the definition by IPCC (2007):

- **Weather** describes whatever is happening outdoors in a given place at a given time. Weather is what happens from minute to minute. The weather can change a lot within a very short time. For example, it may rain for an hour and then become sunny and clear. Weather includes also daily changes in precipitation, barometric pressure, temperature, and wind. Changes in weather conditions are not unusual as the atmospheres temperature has always fluctuated in the past over large time scales in response to a variety of natural causes.
- Unusual changes of climate have been observed and recorded since 1900s such as ice smelt and sea level rise, increasingly global warming, more and unpredicted occurrence of natural disasters and extremes of weather conditions. The term **"climate change"** usually refers to such unusual changes of climate; it refers to the average change of weather conditions experienced over a long period, from 30 years and more.
- **Climate change** is largely attributed indirectly or directly to human activity that alters the composition and ratio of carbonic and nitrous oxide in the global atmosphere and hence, warming the earth.

2. Differences between climate variability and climate change

As described in the FAO learners' notes on CC and FS (2012) below are the differences:

- **Climate variability:** Climate variability refers to natural fluctuations of weather elements (temperature, wind, cloud, rain...). Those elements always change naturally and fluctuate around the mean state (Figure 1.1a).

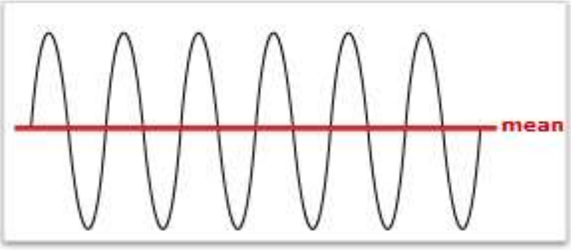


FIGURE 1.1a: Variability around the mean as a "characteristic" of the climate

Climate variability is attributable to natural causes. The Earth's climate varies naturally as a result of interactions between the ocean and the atmosphere, changes in the Earth's orbit, fluctuations in energy received from the sun, and volcanic eruptions etc.

- **Climate change:** Climate change can be detected if standard variations experience significant measurable changes (above or below) the mean value. For example, a change in the mean state is illustrated (Figure 1.1b).

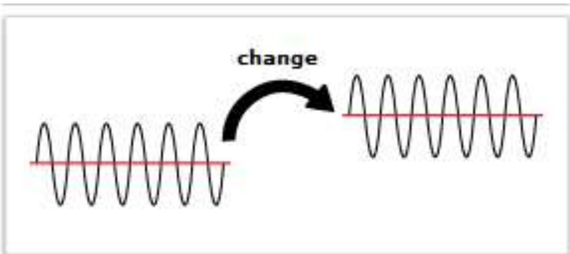


FIGURE 1.1b: Change of the characteristics of climate.

Regarding extreme weather conditions, floods, drought, landslides and typhoons, climate change can be detected if changes are observed in terms of occurrence frequency and/or severity during a long time period.

Thus, climate change and climate variability differ from each other. Long term variations of weather condition, resulting in change in the mean values, are due to **climate change**. Short-term variations around the mean values experienced daily, seasonal and inter-annual are due to natural **climate variability**.

Climate change is attributable to human activities that alter the atmospheric composition (IPCC, 2007). The recent trend in global temperature rise brought by the greenhouse effect is considered mainly as the result of human activities that have increased the atmospheric concentrations of GHG since 1750. Global GHG due to human activities have risen by 70% between 1970 and 2004 (FAO, 2012a).

Key Messages

- Climate variability and climate change are different
- Climate change is due to anthropogenic activities while climate variability is natural events
- Climate change can only be observed in long time period

SESSION 1.2: EXPRESSIONS AND IMPACTS OF CLIMATE CHANGE

Session overview

This session discusses the symptoms of climate change, i.e. the changes in the weather conditions as results of climate change. It also discusses the possible impacts of these changes on human being and livelihood activities.

Discussion questions facilitating the overview of the last session and introduction of this session

1. What are differences between climate change and climate variability?
2. How do you think climate change has expressed in your area?

1. The greenhouse effect (or the changes in temperature, global warming)

Global warming or the GHG effect is the initial and important symptom of climate change:

- We are experiencing an increase of global temperature; changes in both mean temperature and temperature variability to maximum and minimum values. Studies show that from 1995 to 2006 there were eleven of the twelve warmest years in the instrumental record of global surface temperature since 1850. It means that, from 1850 to 1995, there is only one year in which the temperature is higher than the mean, while from 1995 to 2006, there were as many as 11 years in which the temperatures were at high extremes (Figure 1.2a).
- The temperature increase is widespread over the globe. However, the increase rate, high or low rate, depends on locations.
- Global mean temperature has increased at the rate of 0.74°C for the last 100 years, and it is expected to rise between 1.1 to 6.4°C by the end of the 21st century, depending on projected scenarios.

  In Vietnam, the temperature increase has been recorded in many locations. For example, in Figure 1.2b, the temperature records in weather stations in the Northern Mountainous Region (NMR) experienced an increasing trend from 1961 to 2010.

Global warming is also causing the ice sheets in North Polar melting, resulting in sea level rise and changes of other weather parameters.

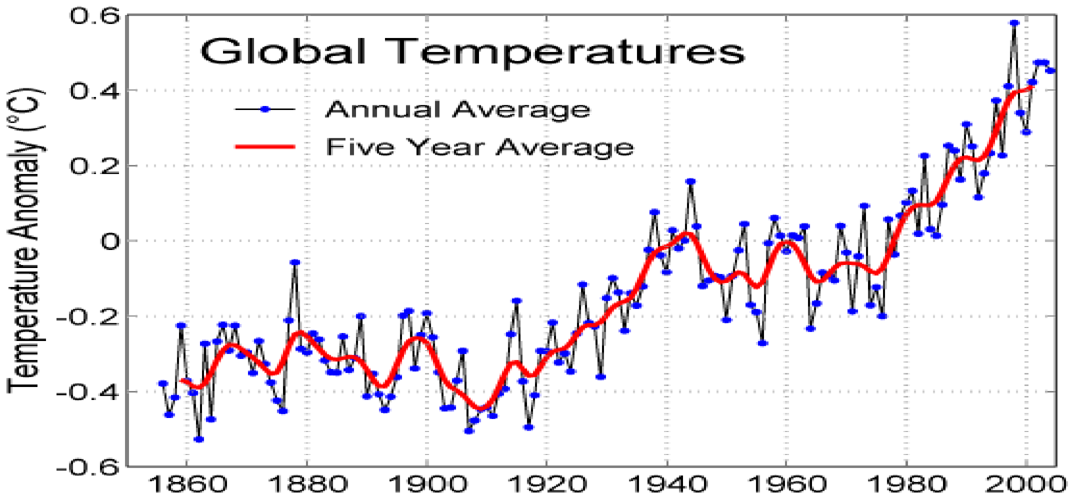


FIGURE 1.2a: Historical trends in global temperatures showing rising patterns since the 19th century (Source: NASA GISS)

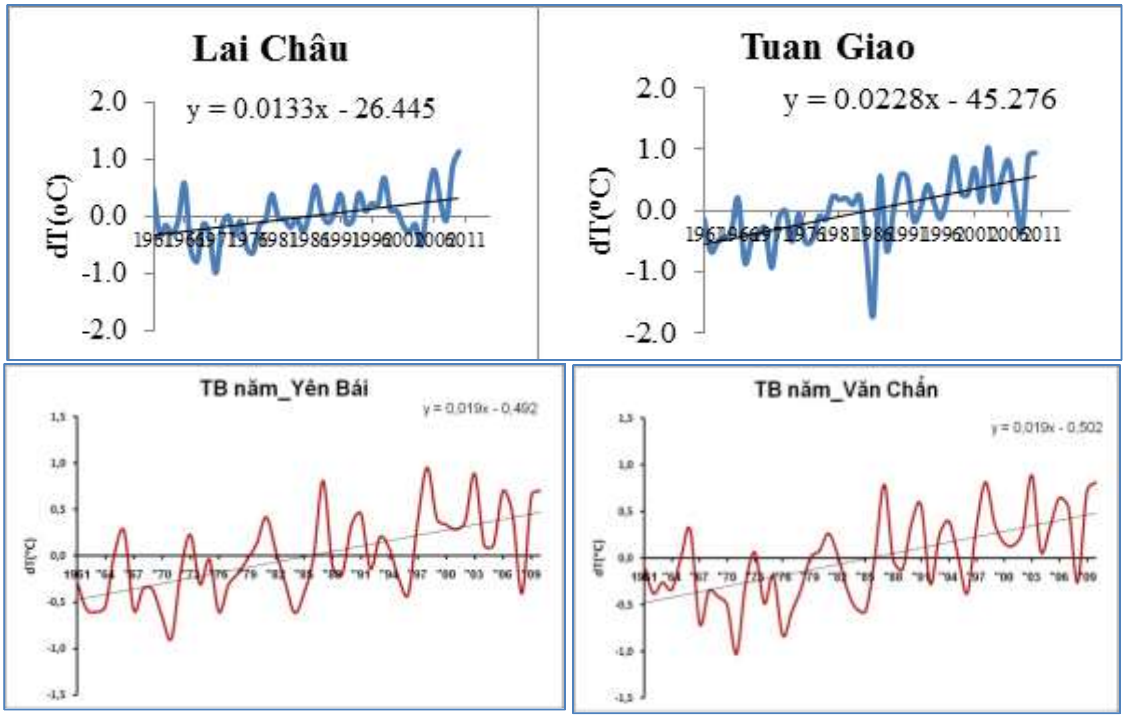


FIGURE1.2b. Trend of change in average annual temperature during 1961 – 2011 in Yen Bai and Dien Bien (Source: Yen Bai and Dien Bien DONRE, 2012)

2. Changes in the rainfall patterns

Rainfall characteristics changes have also been observed:

- **Onset of the rain season**: the onset of rainfall in Vietnam is variable but with changing climate it has become more unpredictable. Rainy season could begin or end earlier or later than the average due to climate change.
- **Duration of the rainy season:** Generally, the period of rainy season has become shorter and rains more concentrated, while the dry period become longer causing increased drought problems to crops in the dry season and increased flood problems in rainy season.
- **Total amount of rainfall:** This refers to the total annual rainfall or total daily rainfall. Due to climate change, the total amount of rainfall could change. It has been recorded to increase in some places while, and reduce in many other places.
- **Distribution of the rains:** The distribution of rainfall has been observed to change in many places due to climate change. The rainfall is distributed more unevenly between months of a year and among locations. Both the rainfall volume and rainfall pattern become more difficult to be predicted.

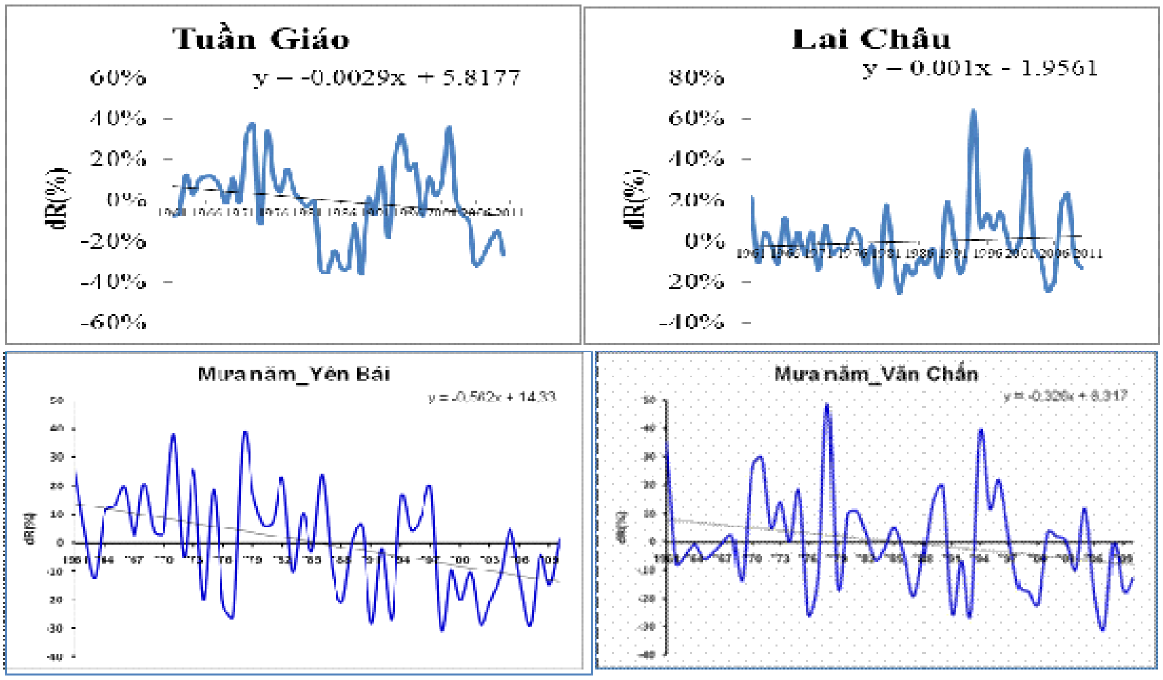


FIGURE 1.2c: Trend of change in annual rain fall during 1961 – 2011 in Dien Bien and in Yen Bai (Source: Yen Bai and Son La DONRE, 2012)

3. Changes in the sea level and extreme weather conditions

Global warming causes the ice sheets in North Pole and in high mountains smelting, resulting in sea level rise which badly influences coastal areas (floods, saline intrusion).

Also, ice in high mountains, such as Himalaya will also be melted. As estimated, to 2030, the current 500,000 km^3 ice in the World' roof-top, Himalaya, will reduce to only 100,000 km^3 (IPCC, 2007).

In Vietnam, according to MONRE (2011), during the past 50 years the sea level rose about 20 cm; and the Mekong Delta is one of the world's most vulnerable deltas to the sea level rise.

According to climate change scenarios, by the end of this century the sea level in Vietnam can rise 75 cm - 1 m compared to the 1980 -1999 period. If the sea level rises by 1 m, about 40% of the Mekong Delta area, 11% of the Red River Delta and 3% of the coastal provinces will be inundated (over 20% of Ho Chi Minh City will be flooded); about 10 - 12% of Vietnam's total population will be directly impacted and the country will lose around 10% of GDP.

Extreme weather conditions, floods, drought, landslides and typhoons also have been observed to have increased in terms of both frequency and severity. All this badly impacted agriculture of Vietnam.

CLIMATE CHANGE IN VIET NAM AND IN NORTHWEST PROVINCES

Vietnam is among the countries most affected by climate change.

- The country's average temperature increased. The increase rate depended on the locations and seasons.
- In winter temperatures increased faster than in summer, in deep inland areas it increased faster than in the coastal areas and islands.
- Changes of maximum temperature over Vietnam range from -3^{o}C to 3^{o}C. Changes of minimum temperature increased faster than maximum one, same as the global trend. Yearly average temperature increased 0.5-0.6^{o}C/50 years in North West, North East, Red River delta, North Central Coast, high land Plateau, and South East while the increase is less than in South Central Coast with about 0.3^{o}C/50 years.
- Country's average, winter temperature has increased 1.2^{o}C in 50 past years. In winter, temperature increase faster in North West, North East, Red River Delta, and North Central Cost (about 1.3-1.5^{o}C/50 years). Less increase is the in South Central coast, Highland Plateau and South East with temperature in January slower increase compare with northern regions (about 0.6-0.9^{o}C/50 years).
- Temperature in July temperatures increased about 0.3-0.5^{o}C in past 50 years
- According to climate change scenarios, in late 21st century, the total yearly and seasonal rainfall will increases while the rainfall in dry season will decrease, the sea level can rise 75cm to 1m compared to the 1980 -1999 period.
- Climate change causes increasingly serious problems to agriculture production in various aspects: pest occurrence and control, cropping season, irrigation, management of lands, etc.

In the Northern mountainous region:

- In Yen Bai: During 1961 – 1970, average temperature in the highlands was about 22.2°C, and in the lowlands was 22.6°C. In the period of 2001-2010, it increased to 22.9°C and 23.4°C, respectively (Figure 1.2b).
- In Lai Chau and Dien Bien: In the period from 1961-1970, the average temperature in the lowlands was 22.3°C, and in the highlands was 18.3°C. In the period of 2001-2010, it was 23.9°C and 19.0°C respectively.
- In Son La: Over 50 years (1961-2010), the temperature increased 0.5 - 1°C, in summer it increased about 0.2 - 0.6°C.

- Regarding the rainfall: changing trends have fluctuated and proven unpredictable. The total annual rainfall could increase or reduce, depending on the locations, while the rainfall distribution become more uneven and less predictable. In Yen Bai, during 1961-1980 the annual rainfall was 2,100 mm, which dropped to 1,700 mm during 2001-2010, while in Lai Chau –Dien Bien it increased (Figure 1.2c).

SOURCE: MONRE (2011) and Provincial DONRE (2012)

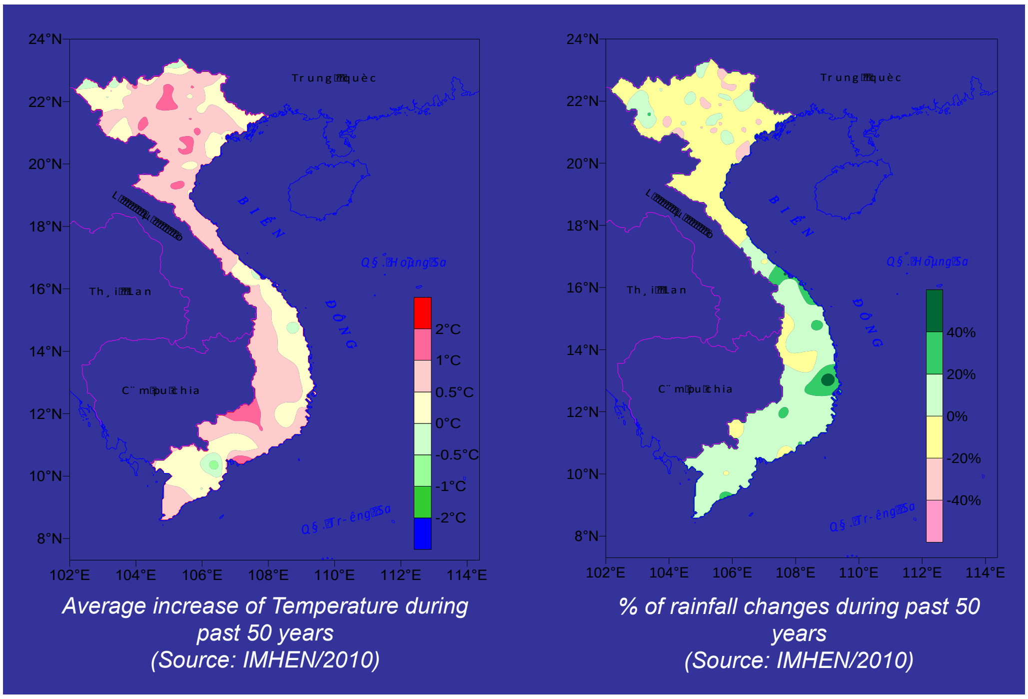


FIGURE 1.2d: Average temperature (^oC) and rainfall (%) changes during the past 50 years in Vietnam (Source: IMHEN, 2010)

Figure 1.2d demonstrates the change in temperature and rainfall during the past 20 years in different regions of Vietnam.

4. Impacts of climate change on human livelihoods and living activities

Climate change, in particular the increased variability in temperature, rainfall amount rainfall patterns and other weather conditions, impact the physical systems as well as the life of all living beings on the earth. It thus cause changes in ecosystems and reduced biodiversity. Valuable genetic resources may be lost while pests may also increase. This creates increasing challenges.

According to the United Nations Economic and Social Council (ECOSOC, 2013), during the past 2 decades, increased extremes conditions caused great loss equalling to US$ 40 bil., affecting 50 mil. people. The Council also predicted that in the coming 50 years, natural hazards will increase fourfold and will affect 2 bil. of people in the world.

Climate change has impacts on all the sectors, including transportation, energy, industries, education, health care and agriculture. Its impacts on agriculture and food security will be discussed in detail in the next module.

Group work: Discussing impacts of climate change

1. List all possible impacts climate change may have on different sectors: transportation, energy, industries, agriculture, forestry, education and healthcare?
2. Are there some possessive impacts?

5. Assessment of climate change impacts

The concept of and the needs for climate change impact assessment

Climate change assessments are needed to determine occurred and expected local climate change and their impacts and potential impacts on agriculture, food security, and livelihoods. The assessments also help determine whether certain measures are or are not climate-smart in a particular context, and thus help develop strategies and plans for coping with climate change. As per definition by FAO (2012a), climate assessments:

- specify the changes in climate in a historic, current or future context;
- establish evidence-based relationships between climate and productivity in the agriculture, forestry and fishery sectors;
- identify the impacts or potential impacts of these changes on agriculture, and the vulnerability of different stakeholders to these changes, and
- serve as an evidence base for strategic planning and selecting of appropriate CSA options.

A climate assessment tries to identify the vulnerability of different stakeholders to a changing climate and the potential impacts of climate change on agriculture. Stakeholders targeted by vulnerability assessments include male and female smallholder farmers, and all involved in the value chains of agriculture products.

A climate assessments also provide an important interface among and between scientists, policy makers, farmers, other stakeholders and the public.

An assessment, thus, is of great value for selecting appropriate measures, and in particular for developing strategic plans for adaptation and mitigation to climate change.

Climate impact assessments are typically conducted at the project's conceptualization stage, but can also be used to inform policy directly.

Means to assess climate change impacts

Normally, to know whether climate change happen or not, and to assess its severity, the past and predicting trends of the following need to be examined:

- rainfall pattern: rainfall amount and distribution;
- seasonality: e.g. time of rainy and dry seasons, spring, winter, summer and autumn, cropping seasons;
- water resources: water availability, water level of rivers and lake systems;
- temperature: e.g. maximum, minimum, annual average, winter average, summer average;
- extreme events: e.g. frequency and intensity cold spells, heat waves, heavy rains, drought periods

To assess impacts or possible impacts of climate change on agriculture the following will be analyzed:

- pests and diseases: occurrence of new pathogens and insects, change in their development patterns;
- crop yields: changes in crop yields due to increase/reduction of temperatures, drought, rainfall, extreme events...
- markets and value chains: changes in market accessibility and price
- income: changes of incomes of each stakeholders as results of the above changes.
- gender, ethnicity and social groups: impacts on men, women, children, elderly, ethnic groups, poor households....

Key Messages

- Climate change is expressed in increased and unpredicted variability in temperatures, rainfall amount, rainfall distribution and sea level rise which in turn impact human livelihood and living activities.
- All sectors can be impacted by climate changes and, thus, all sector have to take measures to cope with and to mitigate climate change.
- Climate change assessments serve for gathering information and are used as basis for developing strategies and plans to respond to climate change in specific contexts.
- Vietnam is among the most vulnerable countries to climate change, and the NMR is also seriously impacted by climate change.

SESSION 1.3: CAUSES OF CLIMATE CHANGE

Session Overview

The previous sessions has been dedicated to understanding the climate change from theory to practical experiences, and their possible impacts. However, these sessions did not explain the causes of climate change. Without knowledge about what causes climate change, the problem cannot be addressed. This session facilitates discussions on the causes of climate changes so to lay out a foundation for further discussions on adaptation and mitigation measures.

Discussion questions facilitating the interview of the last session and introduction of this session

1. Have you experienced climate change in your area? How?
2. What are its possible causes?

1. Greenhouse gasses and climate change

As mentioned before, global climate is largely attributed to human actions. Most likely this is related to increasing emissions of **greenhouse gases** (GHG), most often carbon dioxide (CO_2), methane (CH_4) and nitrogen oxides.

How GHGs cause climate change?

Normally, around the earth there are layers of gasses forming atmosphere. Among them, with high levels are water vapour (H_2O), carbon dioxide (CO_2), nitrogen (N_2), Oxy (O_2), nitrous oxides (N_xOy), methane (CH_4) and chlorofluorocarbons (CFCs). Other gases are present in smaller amounts. The earth emits radiation, and the emitted radiation is absorbed by molecules of some gasses in the atmosphere and re-emitted in all directions. This process of absorption and re-emission keeps the earth warm as it normally is, and these gasses with capacity to absorb and emit are GHG gasses. When greenhouse gases are accumulated and existing at higher than normal content in the atmosphere, more radiations are re-emitted to the earth, causing increase in the temperature. Changes in temperature, in turn cause changes of other parameters of weather (rain, wind, cold, sea level). Thus, any change in the content of GHG in the atmosphere will trigger additional changes.

Main GHGs are CO_2, CH_4, NO_2 and fluoride oxides. As seen in Figure 1.4, CO_2 represent the largest share of GHGs, and its accumulation in the atmosphere is due primarily to fossil fuel use which can be contributed by all sectors, especially industries. Agriculture, Forestry and land use is also a large emitter of GHGs.

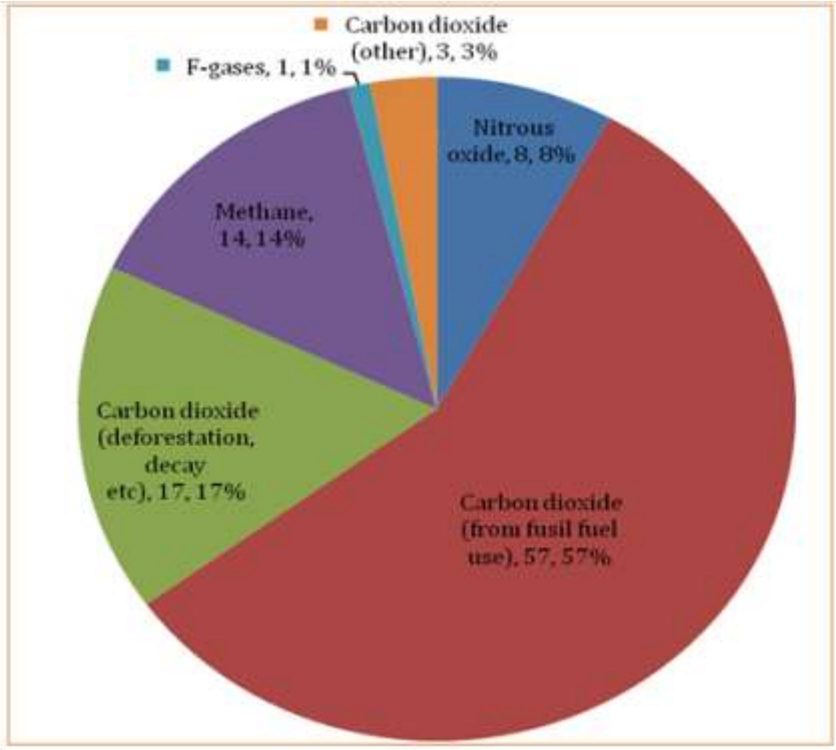


FIGURE 1.4: Global GHG emissions by gas (IPCC, 2007)

Global atmospheric concentrations of these gasses have increased markedly as a result of human activities and thus cause the global warming and climate change. It is evident that the rapid increase in CO2 concentrations has been occurring since the onset of industrialization. The increase has closely followed the increase in CO2 emissions from fossil fuels. This is illustrated in the Figure 1.5; the smooth curve is based on a hundred year running mean.

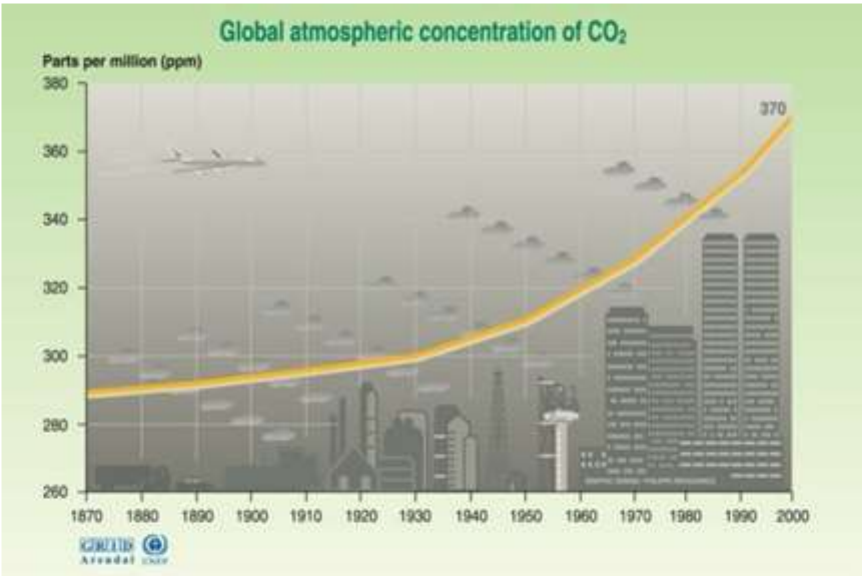


Figure 1.5: Evolution of the global atmospheric concentration of CO_2 during 1870 – 2000. (Source: UNEP/GRID-Arendal)

2. Sources of greenhouse gasses

All human activities using fossil fuel and treating waste improperly can cause GHG emissions. According to IPCC the shares of GHG emissions by different sources can be seen in Figure 1.6.

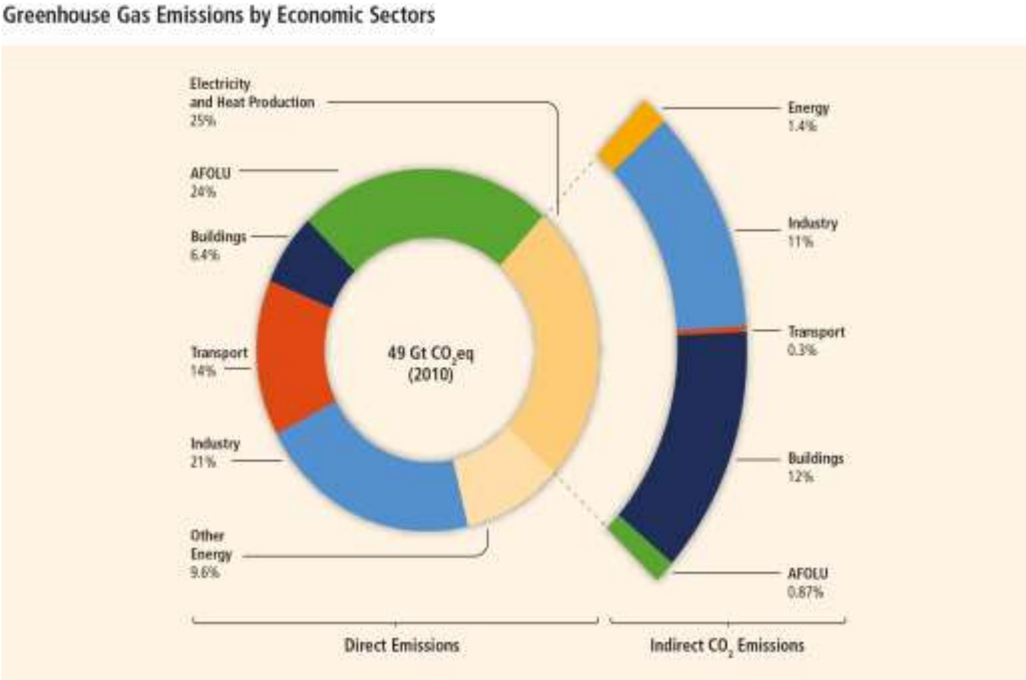


FIGURE 1.6: Global GHG emissions by sector (IPCC 2013/2014[2])

According to IPCC report (2014):

- **Industries** contributes% of GHG emissions. Greenhouse gas emissions from industry primarily involve fossil fuels burned on-site at facilities for energy and burned fossil fuels for production, transport. This sector also creates emissions from chemical, metallurgical, and mineral transformation processes not associated with energy consumption.
- **Agriculture, Land use and forestry:** About 24% of emissions come from agriculture, forestry and other land use (AFOLU). These include also deforestation and desertification. Indeed, one of the consequences of deforestation is that the carbon originally hold in the forests is released into the atmosphere, either immediately when the trees are burned, or more slowly when unburned organic matters decay.

[2]Intergovernmental panel on climate change IPCC (2013/14) climate change report. http://www.ipcc.ch/publications_and_data/ar4/syr/en/spm.html

- **Agriculture** is also a contributor to GHG emissions. Methane (CH_4) is the main gas emitted by this sector, and measures to reduce its emissions are currently not being promoted enough. While emissions from industries, energy production or transportation are still primarily emitted by the developed countries, emissions from agriculture and those of forestry are mainly originated in developing countries. Deforestation and the clearing of land for agriculture provide about 12-14% of global emissions. While the improper management of soils, fertilizer application, livestock management and the burning of biomass is also responsible for 10-12 % of global emissions.
- **Other sectors,** including industries, transportation, energy, construction... also contribute to GHG emission, especially when fossil energy is burnt and waste is improperly managed..
- **Improper waste management** generates carbon dioxide and methane. The way in which these wastes are disposed of and treated has a direct influence on the emissions of these greenhouse gases. Waste incineration generates CO_2 and nitrous oxide, while land filling waste generates methane. Whatever waste management option is chosen it should be accompanied by a set of measures to avoid these emissions as well as other environmental problems.

GREENHOUSE GAS EMISSIONS – THE CASE FOR VIETNAM

- From 1994 to 2010, the total GHG emission in Vietnam increased from 103.8 mil tones to 246.8 mil tones of CO_2 equivalent. The increase was highest in the energy sector, from 25.6 mil. tones to 141.1 mil. tones. Energy sector was also the biggest emitter in 2010.
- In 2010 LULUCF sector sequestrated GHG. The total emission of LULUCF in 2010 was -19,219,000 tones of CO_2 equivalent.
- There were 28 emission sources in 2010, excluding LULUCF and 33 emission sources including LULUCF.
- In 2010, the total GHG emission of Vietnam:
  - 246,8 mil tones of CO_2 equivalent from LULUCF
  - 266 mil tones of CO_2 equivalent from other sectors than LULUCF, of which 53.05% from energy; 33.20% from agriculture, 7.97% from industries, and 5.87% from waste management
  - Total emission of CO_2 from industries was 21,172,000 tone, of which 20,077,000 tones (94.8%) from cement production, 1,095,000 tones (5.2%).
  - Total emission from agriculture was 88,354,770 tones of CO_2 equivalent, of which 50.49% from paddies, 10.72% from digest ration, 9.69% from fertilisation, 26.95% from cultivated lands, 2.15% from burning of agro-waste.
  - Total emission from waste was 15,352,000 tones of CO_2 equivalent, of which 6,827,000 tones were from waste water, 5,000,000 tones from waste burring sites.

  SOURCE:http://www.baomoi.com/Viet-Nam-trien-khai-cac-bien-phap-giam-phat-thai-khi-nha-kinh/45/15864539.epi

Key Messages

- Human activities contribute GHG emission causing climate change.
- Every sector can emit GHGs and can be impacted by climate change.
- Every sector needs to respond to climate change.

SESSION 1.4: CLIMATE CHANGE ADAPTATION AND MITIGATION

Session Overview

Climate change alters the basic parameters of productive ecosystems, especially temperature and rainfall. It also impacts natural resources required for agriculture, in particular land and water availability. As a consequence, it negatively affects food production and food security in many regions. Farmers, herders and fishermen face problems of reduced yields, water shortages, increased weed and pest proliferation, and loss of agricultural biodiversity.

There are two ways to address climate change and associated impacts. One is to adapt to it and lower its negative impacts (adaptation), and the other is to intervene on its causes to reduce its occurrence and level (mitigation). This session will discuss these 2 ways to cope with climate change: adaptation and mitigation.

Discussion questions facilitating the overview of the last session and introduction of this session

1. What are causes and impacts of climate changes?
2. How do you think we can reduce climate change and its impacts?

1. The concept of adaptation

Adaptation refers to responses by individuals, groups and governments to actual or expected changes in climatic conditions or their effects. It is defined as activities that aim "to reduce the **vulnerability** of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing **adaptive capacity** and **systems resilience**" (OECD-DAC, 2011).

Vulnerability is defined as the degree to which a system is susceptible to and unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of exposure, sensitivity and adaptive capacity (IPCC, 2007; FAO, 2012a):

- Exposure refers to the presence of people; property, systems or other elements in zones impacted by climate change and are subjected to potential losses.
- Sensitivity is the degree to which a system can be affected by climate variability or change. It is determined in part and where relevant by development status.
- Adaptive capacity is the ability of a human or nature systems to adjust to climate change to moderate potential damages, to take advantage of opportunities or to cope with the consequences

To farmers, adaptation means increase their ability to produce crops and livestock under climate change conditions. This mean to adopt technical innovations to make their farming systems, crops, animals resilient to adverse climatic conditions to reduce losses of harvest.

Proper adaptation measures can help significantly reduce the negative impacts of climate change and promote positive ones.

Adaptation is also defined as a process by which individuals, communities or countries seek strategies to moderate, cope with and take advantage of the consequences of climatic events (UNDP, 2005).

There are different options for agricultural sector to adapt to CC, such as:

- Use appropriate varieties with tolerance to pests and abiotic stresses
- Diversify crops, animals, agricultural livelihoods
- Improve storage and access to foods sources
- Improve dissemination of information on climate and CC such that every ones, organization, communities can develop and realize plans to cope with adverse changes.
- Adopt sustainable farming practices, such as use reasonably fertilizers and pesticides, soil erosion control, safe water irrigation ...
- Improve irrigation systems, water collection systems and increase the effectiveness of water use

Adaptation to climate change in agriculture will be further discussed in the following sessions.

2. The concept of mitigation

Mitigation is defined as the implementation of all activities that contribute "to the objective of stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system by promoting efforts to reduce or avoid GHG emissions or to enhance GHG sequestration" (OECD-DAC, 2011), including "technological changes that reduce resource inputs and emissions per unit of output" (IPCC, 2007). The IPCC (2007) defines mitigation as: "An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases."

Thus, mitigation addresses the causes of climate change, which involves reducing GHG concentration in the atmosphere while adaptation manage the impacts of climate change on human and natural systems.

The agricultural sector has a substantial potential for mitigation. The IPCC estimates the global technical potential for GHG mitigation in agriculture production at 5.5 to 6 Gt of CO_{2}-equivalents per year by 2030. Agriculture should be promoted to build on synergies between climate change mitigation, adaptation and food security. Options for adaptation and mitigations in agriculture will be discussed in more detail latter, in **Module 4.**

Group work: Discussing impacts of climate change

1. List options, in all sectors, you know and think they have value in climate change adaptation and/or mitigation.
2. Specify their adaptation or mitigation impacts.

MODULE SUMMARY

The Earth's climate has been changing. Globally the mean surface temperature has increased and other associated changes have been observed. Global warming is the key aspect of climate change leading to changes in other weather parameters. This is because; temperature increase triggers alterations in the general circulation of the atmosphere and oceans and in average weather conditions.

Climate change expresses in:

- increased variability and gradually change in mean values of meteorological parameters: temperatures, rainfall, see level…
- changes in frequency and severity of extreme weather events.

Vietnam is among the most vulnerable countries to climate change. Changes in temperature, onset of seasons, rainfall, dry spells, cold spells and sea level have been recorded, and are predicted to continue.

Every sector may create GHG emissions leading to climate change, and vice versa, climate change impacts all the sectors. To take appropriate mitigation and adaptation measures, thus, is a need for all sectors.

Climate change adaptation is to reduce vulnerability, damage by climate change when being exposed or placed in an area affected by climate change. Adaptation is also a means to take advantage of positive impacts of climate change.

Climate change mitigation is to mitigate possibilities and climate hazards. This could be achieved by reducing GHG emitted into the atmosphere and sequestering GHG from the atmosphere so as to prevent their influence to global temperature.

Following sections will discuss in more details the relationships between agriculture and climate change, as well as options for agriculture to respond to it.

MODULE 2: CLIMATE CHANGE, AGRICULTURE AND FOOD SECURITY

MODULE OVERVIEW

The first module already discussed the concepts, causes of climate change and its general impacts on human livelihoods. This module will discuss the linkages between agriculture, climate change and food security. It also describes how these entities affect and influence one another. The module addresses the following questions:

KEY LEARNING QUESTIONS

- What challenges are facing agriculture and why agricultural transformation is now required?
- How does agriculture impacts climate change and vice versa?

Learning Objectives

Upon completion of this module participants will be able to:

1. Discuss the increasing challenges facing Vietnam in ensuring food security;
2. Describe the relationships between agriculture, food security and climate change;
3. Suggest ways through which the agriculture sector can build its resilience to climate change while at the same time reducing its negative impacts on climate.

SESSION 2.1: INCREASING CHALLENGES TO FOOD SECURITY AND THE NEEDS FOR AGRICULTURAL TRANSFORMATION

Session Overview

Food insecurity and climate change are increasingly becoming interdependent – shaped also by a series of other pressures that converge within the agriculture sector - including population size, food demand and degradation of natural resources. There are many reasons why meeting the demand for food is increasingly becoming a formidable challenge (FAO, 2011).

This session discusses challenging facing agriculture in meeting food security and the needs for agricultural transformation.

Discussion questions facilitating the overview of the last session and introduction of this session
1. When do you think "food security" has been achieved at a certain level? 2. What challenges are facing your province in ensuring food security?

1. The concept of food security

The definition by World Food Summit (1996): **Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life**.

Thus, food security has 4 dimensions:

- physical **availability** of food, which addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade;
- the economic and physical **access** to food, including incomes and access to markets;
- the food **utilization**, i.e. the way the body makes the most of various nutrients in the food, which is influenced by people's health status; and
- **stability** of food security ("at all times"), which emphasizes the importance of having to reduce the risk of adverse effects on the other three dimensions.

Climate fluctuations, such as periods of drought and flood as well as longer-term change, may – either directly or indirectly – profoundly impact all these four components in shaping food security (Figure 2.1).

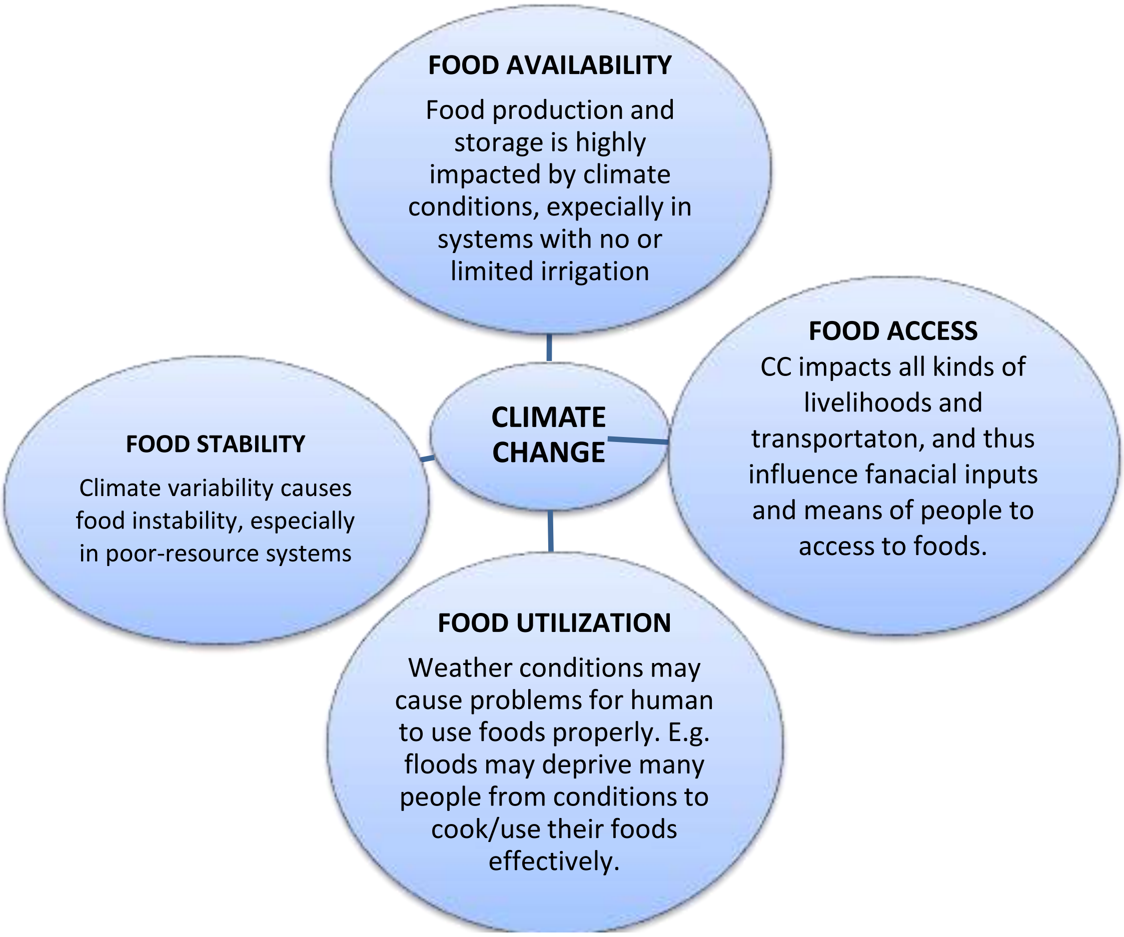


FIGURE 2.1: Linkages between climate change and the four components of food security (SOURCE: Adapted from FAO 2012a)

2. Increasing challenges in meeting food security at the global level

Population growth: At global level, according to FAO, between now and 2050, the world's population is projected to increase by one-third, with 2 billion people who will live in developing countries. The population growth has exerted enormous pressure on land and other natural resources, leading to overexploitation of land and other natural resources and also to increased demands for crop and animal products.

Climate change: Climate change will make the task of producing adequate food more difficult under a business-as-usual scenario, due to adverse impacts on agriculture, requiring spiralling adaptation and related costs. Increased temperatures and changes in precipitation will stress agricultural and natural systems through: increased water shortages, shorter growing periods in some areas, increased magnitude and frequency of flooding and drought, changes in plant and animal diseases and pest distribution patterns and, more generally, reduced suitability of some areas for agriculture. Climate changes could reverse the economic gains obtained in recent years.

Natural resources degradation: Especially water, land and biological resources have been intensively exploited and become exhausted.

And, thus, transformation of the agriculture sector is necessary if it is to feed the global and national growing population and provide the basis for economic growth and poverty reduction. It is estimated that to meet the demand for food of the growing population, agricultural production will have to increase by 60% by 2050 (Alexandratos and Bruinsma 2012).

3. Increasing challenges facing agriculture in Vietnam

In Vietnam, agriculture is and will continue to be a key contributor to socio-economic growth and poverty alleviation. The sector accounts for 22% of the country's GDP, 30% of exports and 60% of total employment. Over 70% of the country's population live in rural areas and relay on agriculture for their livelihoods. In the current situation of demographic growth and increasing demands for foods and other agro-products, agriculture in Vietnam needs to achieve continuous growth. The growth of agriculture not only directly impacts household income and livelihoods, but also stimulates growth in the non-agriculture sectors through both demand and supply linkages.

The population of Vietnam is currently over 90 mil., and is predicted to reach over 100 mil in 2015 and 104 mil. in 2050 (Nguyen Van Tuan, 2013). Thus, steady growth in agriculture is required to meet increasing demands not only for foods but also for diverse products from crops and animals (for energy, medicine, industry purpose)

Vietnam is one of the world's most vulnerable countries to the impacts of climate change (IPCC, 2007). According to the scenarios of Climate Change and Sea Level Rise (MONRE, 2009, 2011 & 2012), by the end of 21st Century, the sea level can rise up to 100 cm, the country's average temperature will increase by 3^{o}C, the climatic change will affect 10.8% of the country's population, and the production of aquaculture and rice of Vietnam will reduce by 20%.

Northern mountainous region of Vietnam (NMR) with increasingly important role to the national socioeconomic development while facing increasing challenges:

- NMR is the upstream of the Northern urban and delta regions.
- As predicted (MONRE, 2011), due to sea level rise, by 2100, crop production will be shift up to the elevation of above 550 m asl., and more to 100 - 200 km to the North. This requires greater production from the high lands, including the NMR.
- NMR is with difficult conditions for agricultural production: complicated topography, scattered and sloping farmland, poorly developed infrastructure, limited access to markets, exhausted and degraded natural resources.
- NMR is highly impacted by climate change: According to provincial MONRE and DONRE of project provinces (MONRE, 2012, DONRE of Yen Bai, DONRE of Dien Bien, DONRE of Son La), during the past 50 years, the average temperature in the NMR increased by 0.1 – 1.7^{o}C and the total annual rainfall decreased by up to 300 mm, the dry seasons became longer and drier, winters became increasingly filled with unpredictable cold spells; natural disasters (e.g. typhoons, landslides, floods, extremely low temperatures, hoarfrost) occurred with increasing frequency and

severity. Climate forecasts predict that, the temperature in the region is going to increase by around 0.5°C in 2020 and by 1.2-1.3°C in 2050 compared to the level in 1980-1999, and the rainfall is going to increase by 1.4-1.6% in 2020 and by 3.6-3.8% in 2050 compared to the level in 1980-1999, depending on different emission scenarios (MONRE, 2009, 2012).

- Households in the regions are endowed with poor resources and highly vulnerable climate shocks: The region has the highest rate and density of poverty; according to the survey data in 2011 by the Ministry of Labour, Invalids and Social Affairs (MOLISA), most of over 2,6 million poor households in Vietnam are concentrated in the NMR.

NMR, also has favourable conditions for food crop production: crop and animal diversification; diverse weather and land conditions; farmers have strong traditional knowledge in agricultural production.

Key Messages

- Climate change impacts all the 4 components of food security: food availability (production and storage of foods), food access, food stability and food use.
- Globally, increasing challenges are facing agriculture in supplying enough food for the growing population in the conditions that natural resources have been exhausted and climate is changing.
- Agriculture of Vietnam in general and of the NMR in particular also face increasing challenges caused by increased population, climate change and exhausted and degraded natural resources.
- Transformation in agriculture is needed to ensure food security and meet increasing demands for products from crop and animal origin.

SESSION 2.2: INTER-IMPACTS BETWEEN AGRICULTURE AND CLIMATE CHANGE

Session Overview

This session further describes the effects of climate change on agriculture. The session also discusses the impacts of agriculture on the climate. Thus, the session will help participants understand the interactions between climate change and agriculture which will serve as the foundation for the next module to discuss on the options for agriculture to respond to climate change.

Discussion questions facilitating the overview of the last session and introduction of this session

1. Why is transition in agriculture needed?
2. What are possible impacts of climate change on agriculture?
3. What kind of impacts of climate change on agriculture have you observed in your location?

1. Impacts of climate change on agriculture

The increase in mean temperature, changes in rainfall patterns, increased variability both in temperature and rain patterns, changes in water availability and the frequency and intensity of ‘extreme events’, as discussed in previous sections, all have profound impacts on agriculture.

Globally, climate change is estimated to have reduced the yield of maize and wheat by 3.8% and 5.5% respectively. Several researchers also warned of dramatic decreases in crop productivity when temperatures exceed critical physiological thresholds (Battisti, D.S. & Naylor, R.L, 2009; Wheeler, T. et al. 2010; Lobell, D.B at al., 2011).According to IPCC (2007), rice yield will reduce by 10% when the temperature increases by 1^{o}C and thus, it is estimated that by 2050 rice yield will be reduced by, at least, 10%, maize yield will be reduced 3 - 6%.

The effects of climate change on agriculture are dependent on a wide range of factors, among them:

- Local biological endowments such as soil content and biodiversity;
- Type of crop grown and animal raised;
- Predominant farming practices;
- Extent of knowledge and awareness of communities about CC impacts and efforts for adaptation and mitigation;
- Extent of support from government and other private agencies;

Vietnam is one of the world’s most vulnerable countries to the impacts of climate change. In the past 50 years, CC has impacted the country’s agriculture:.

- In the provinces in the NMR (Le Thanh Son at el., 2011) dry weather lasts longer than normal, water levels in streams and rivers in the North and Central are lower than yearly average. This causes many difficulties for crop irrigation, consequently, many areas of crops have been damaged severely and many other cropland areas were left uncultivated due to water shortage in dry season.
- In provinces of the Central Region (Hoang Ducking, 2011), the West dry wind and hot surface temperature tend to begin earlier and finish later with more spells, happening in particular locations, difficult to forecast; more extreme hot and sunny days are recorded. These all have badly impacted crop growth and development.
- According the report by the provincial people committee of the NMR provinces, in many years, such as in 2008, 2010 and 2011, winters were characterized by unpredictable low temperatures causing great damages to crops and animals. In 2008, the historic long-lasting and severe cold caused around 100,000 ha of rice in the NMR totally damaged and in each province of the NMR thousands of cattle heads died.
- Reports on agriculture and climate change of provinces show that droughts have significantly impacted agricultural production. Many paddy areas are no longer suitable for rice cultivation with economic efficiency and stable yield; a large paddy area was changed to upland cropping land; many areas producing materials for processing have been narrowed; crop yields reduced (reported by provincial DARDs).
- Pest problems on crops were also recorded to increase, in terms of both pathogen types and occurrence frequency. More pest species/types were identified. Increasing hot and dry conditions resulted in unpredictable pest occurrence and development (reported by provincial DARDs).

In the future, Vietnam's agriculture will continue to be impacted by climate change. According to the scenarios of Climate Change and Sea Level Rise (MONRE, 2009, 2011 & 2012), by 2100:

- The sea level can rise up to 100 cm, the country's average temperature will increase by 3oC, the climatic change will affect 10.8% of the country's population, and the production of aquaculture and rice of Vietnam will reduce by 20%.
- Rainfall will decrease and unevenly distributed. Rainfalls would decrease in almost all climatic regions in dry seasons. Rainfall in the period from March to April would decrease from 6 to 9% in the Northwest, Northeast and Red River Delta, about 13% in the Central Region. In contrast, rainfall in months of high rainy season would increase from 12 to 19% in the Northern and Central Regions.
- In the coastal regions, when the sea level rises 30 cm more (by 2050), lots of farmlands would be salted.

2. Impacts of agriculture on the climate and environment

Group work: Discussing conventional practices

1. Describe the most popularly applied practice/s for cultivation of annual food crops (maize, upland rice, cassava) on sloping lands in your areas. What are possible impacts of this practice on the climate and environment?
2. Describe the most popularly applied practice/s for cultivation of perennial crops (tea, coffee) on sloping lands in your areas. What are possible impacts of this practice on the climate and environment?
3. Describe the most popularly applied practice/s for cultivation of irrigated rice in flat lands in your areas. What are possible impacts of this practice on the climate and environment?

Agriculture contributes to GHG emission:

- Globally, agriculture contributes around a quarter of total anthropogenic GHG emissions and has the potential to contribute significantly to emission reductions especially through sustainable intensification (IPCC, 2014 Working group III).
- Practicing crop production contributes 14% and animal husbandry 13.5% of global GHG emissions (IPCC, 2007).
- The main direct sources of GHG emissions in the agricultural sector are carbon dioxide (CO_2), nitrous oxide (N_2O), mostly by soils and through the application of fertilizers; and methane (CH_4), mainly from cattle's and poultry's manures (Figure 2.2).

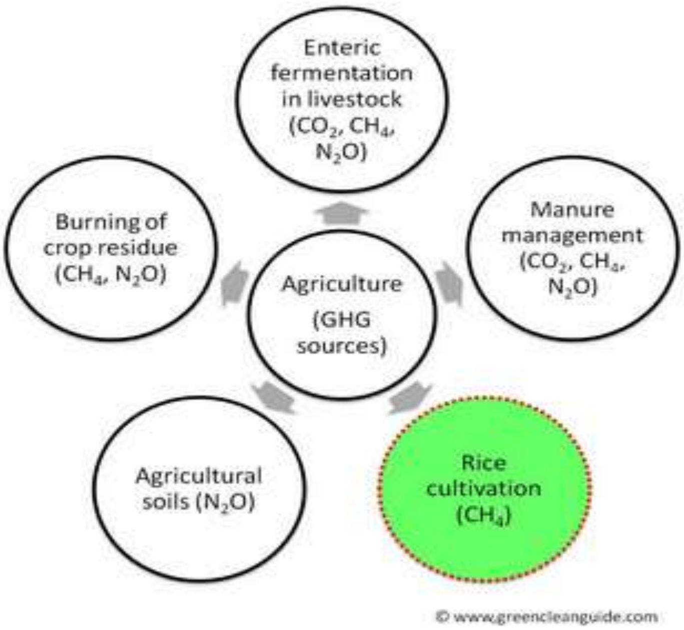


Figure 2.2: "Contributors" to GHG emission in agricultural sectors (SOURCE: greencleanguide.com, 2011).

- Emissions from agriculture depend on techniques applied in crop and livestock production. Emissions could be reduced through application of good practices. An illustration of the carbon cycle from and out of the soils when conventional farming practices are applied is shown in figure 2.3.

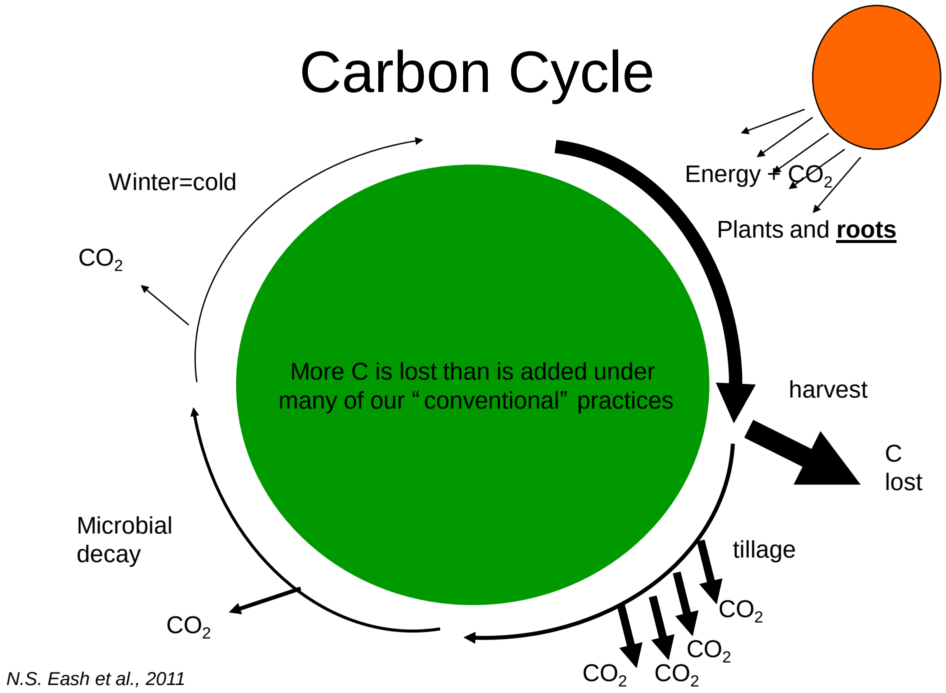


FIGURE 2.3: An illustration of the carbon cycle out of the soils showing the emission of carbon to the atmosphere when conventional farming practices are applied (SOURCE: Eash et al., 2011)

- In Vietnam, 53.1% of the total volume of emissions has been recorded to be attributed to agriculture, of which, 57.5% is from irrigated or paddy rice (Huynh Quang Tin, 2011). This is because with conventional practices anaerobic conditions are generated to allow microorganisms decompose organic matters (rice roots, humus applied for rice...) and produce metal, as illustrated in Figure 2.4.

Agriculture causes soil erosion, natural resources degradation and environmental pollution:

- Soil erosion, especially on the sloping lands is due to application of traditional practices (slash and burn cultivation). For example, in annual food crops in the NMR, each year, about tens to some hundreds of tons of soil per hectare are eroded away (Le, Q. D., Ha, D.T., 2008).
- Improper application of fertilizers, pesticides and water regimes has contributed to pollution of air, water and soil resources.
- Improper management of agriculture's waste has negative impacts on the environment. Currently, in all locations of Viet Nam it is common to see rice straw and crop residues being burned right on the field, a rather damaging practice for soil and release of GHG into the atmosphere not to consider the option that such materials could be treated into composts or animal feeds or used for soil covering to prevent erosion and to improve soil fertility.

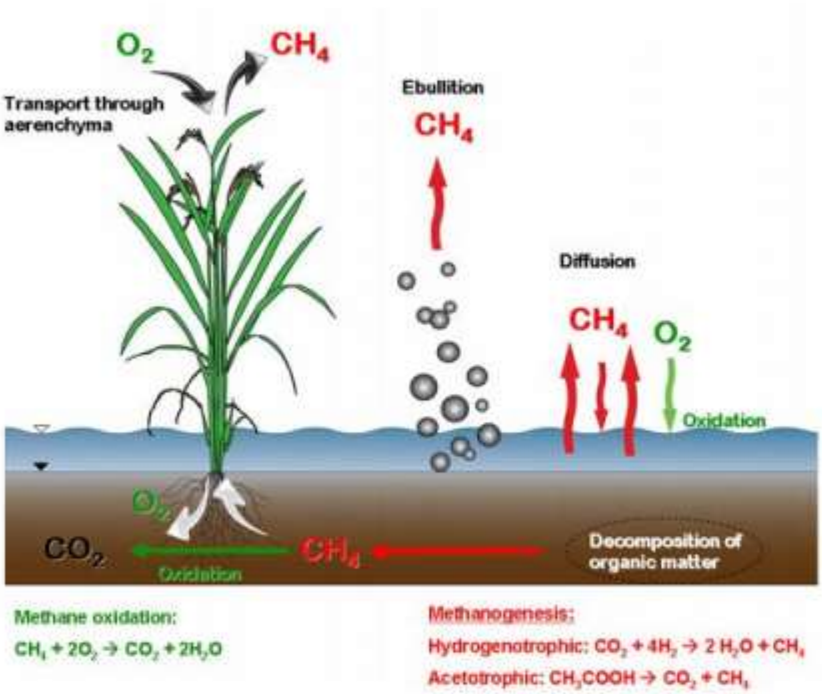


Figure 2.4: An illustration of carbon emission from paddies
(SOURCE: Josef Meyer, ETH Zurich, 2009).

Agricultural lands act as a carbon sink:

This is a positive impact of agriculture on the climate. Farmlands and plants act as carbon sinks. Agriculture can promote this in two different ways:

- Proper application of farming practices: This, in particular and make agricultural lands function as a good carbon sequestration.
- Planting crops and afforestation to create carbon sinks, mitigating considerably CC.

MODULE SUMMARY

The growth in population, degradation of natural resources and pollution of environment pose increasing challenges to agriculture. Climate change adds another challenge by threatening the productivity of the majority of existing food systems and the livelihoods of those already vulnerable to food insecurity.

Climate change impacts all the 4 components of food security: food availability, food access, food stability and food use.

Vice versa, agriculture impact climate, water and land resources and environment. The sector can contribute GHG emissions but can also sequestrate gasses and mitigate climate change.

Enhancing food production under climate change needs, thus, to consider the inter-impacts between climate change and agriculture, and a comprehensive approach is required.

Transformation in agriculture is required for developing agricultural production systems not only with higher productivity but also with reduced GHG emissions and better adaptation to climate variability. This will require increased investments from all stakeholders towards appropriate changes in land use and production practices, enhanced information systems, and better functioning of social safety net programs. Next modules will discuss how such production systems can be built.

MODULE 3: CLIMATE-SMART AGRICULTURE – AN INTRODUCTION

MODULE OVERVIEW

As mentioned in the previous modules, while it is essential to increase the resilience of livelihoods dependent on agriculture (including crops, livestock, forestry and fisheries), in order to sustainably improve food security, agriculture should pay attention also to its contribution to climate change.

This module describes Climate-Smart Agriculture (CSA), an approach to transform and reorient agricultural systems to sustainably support development and food security under a changing climate.

Below are the key learning questions:

KEY LEARNING QUESTIONS

- What are main characteristics of conventional intensive agriculture and of sustainable intensive agriculture practices?
- What is climate smart agriculture?
- How can CSA contribute to adaptation, mitigation and food security?

Learning Objectives

Upon completion of this module participants will be able to:

1. Explain what climate-smart agriculture (CSA) means;
2. Identify adaptation and mitigation practices;

SESSION 3.1: THE CONCEPT OF CLIMATE-SMART AGRICULTURE

Session Overview

This session begins with a discussion of various agricultural practices with their advantages and disadvantages. Emphasis is on characteristics of the conventional or traditional intensive agricultural practices and how they perform under climate change. This session also discusses the concept of CSA and examples of CSA practices.

Discussion questions facilitating the review of the last session and introduction of this session

1. What are the causes of climate change?
2. How agriculture can contribute to climate change?
3. What can do agriculture to respond to climate change?

1. The concept of climate smart agriculture

The CSA concept was first launched by FAO in 2010 in a background paper prepared for the Global Conference on Agriculture, Food Security and Climate Change in The Hague (FAO, 2010) and has been gaining increasing prominence in the international discourse on climate change and food security since then. The Global Alliance for CSA was launched at the Climate Summit in 2014 "to improve people's food and nutrition security by helping governments, farmers, scientists, businesses, and civil society, as well as regional and international organizations, to adjust agricultural practices, food systems and social policies so that they take account of climate change and efficient use of natural resources" (ACSA, 2014).

CSA aims to tackle three main objectives in the context of national food security and development goals: (i) sustainably increasing food security by increasing food production and incomes; (ii) building resilience and adapting to climate change; and (iii) developing opportunities for reducing greenhouse gas emissions compared to expected trends (FAO, 2013).

Thus, CSA has three pillars: (i) increases resistant capacity of agricultural systems to unfavourable conditions reduces theirs vulnerability to climatic extremes (ADAPTATION); (ii) reduces negative impacts of agriculture to climate and environment (MITIGATION); and (iii) maintains or increases economic benefits and productivity (FOOD SECURITY).

- **Adaptation:** CSA helps production systems improve response capacity and provides resistance to the impacts of climate change.
- **Mitigation:** CSA contributes to CC mitigation as it reduces and/or removes greenhouse gases emissions.

- **Food Security:** CSA helps increase the productivity and incomes and thus help to ensure food security in long-term. This is achieved through development and promotion of diverse and sustainable production systems.

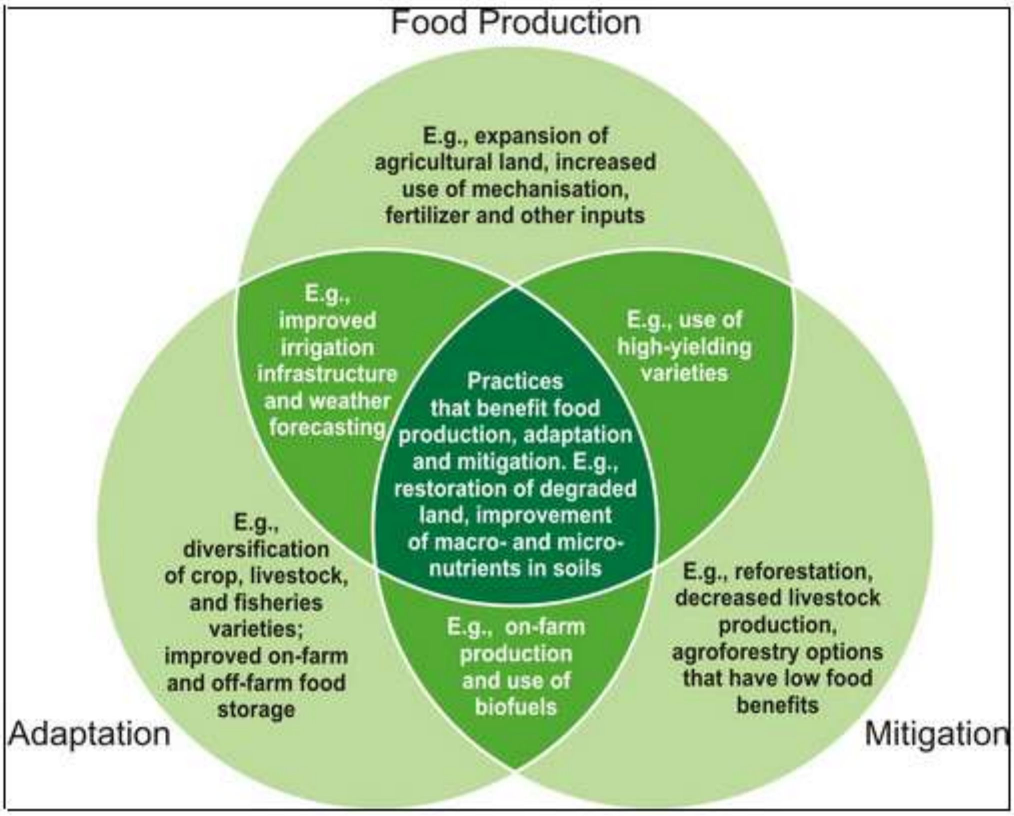


FIGURE 3.1: Three pillars of Climate-Smart Agriculture
(SOURCE: Neha Gupta, devalt.org)

2. The three pillars of CSA

In the process of implementation, the tradeoffs among the three pillars should be kept in mind, especially in developing countries where agricultural growth is national priority for food security and the poor are affected the most by – but have not contributed to – climate change (Lipper et al. 2014).

2.1. Adaptation

Figure 3.2. illustrates the capacity of production systems to adapt to climate variability. The graph shows, e.g. mean annual air temperature fluctuating by times between years. Without adoption of adaption measures, the production system can cope with this variability within only a certain range (coping range). Thus, the system is vulnerable to temperature extremes outside this range (climate shocks). The below graph shows the increased adaptive capacity when adaptation measures have been taken. Then the system can cope with increased ranges of temperature extremes (coping range is larger), and the vulnerability reduces.

Adaptation can reduce vulnerability by altering exposure, reducing sensitivity and increasing adaptive capacity. Some possible measures to do these are listed below:

- **Altering exposure:** to achieve this, one needs to identify CC risks impacting agriculture; develop plans for management and utilization of resources; re-structure crop and livestock production sub-sectors as well as agriculture sector; re-schedule cropping season etc., for altering crop and animal to exposure to unfavourable climatic conditions caused by CC.
- **Reducing vulnerability**: this is achieved through adoption of varieties (e.g. to drought, saline and cold); development of appropriate irrigation and drainage systems; improvement of crop and animal heath through proper management practices; diversification of crops, animals.
- **Increasing response capacity:** through development of proper adaptive strategies and action plans, diversification sources of household income; diversification of production systems; improvement of infrastructure; promotion of appropriate agricultural practices, e.g. effective use of inputs (seeds, fertilizers, pesticides, etc.).

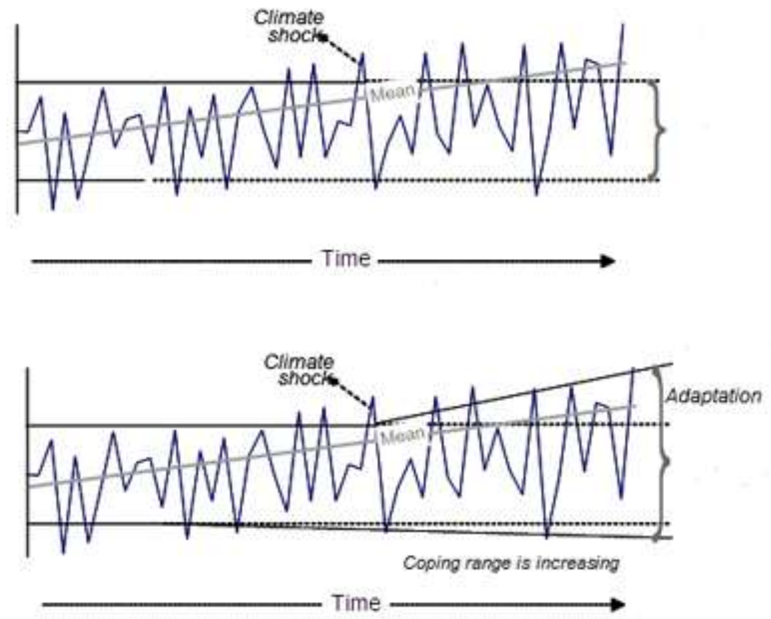


FIGURE 3.2: An illustration of increased adaptive capacity

2.2. Mitigation

Mitigation aims to reduce GHG emissions from agricultural production systems, and or capture GHG from atmosphere into agricultural production systems. Three are 3 major options to mitigate climate change:

1. Reducing emissions;
2. Avoiding or displacing emissions;
3. Removing emissions.

Reducing emissions:

Agriculture releases to the atmosphere significant amounts of CO_2, CH_4, or N_2O. The application of "good" practices that release less such gases will contribute to reduce emissions. "Good" practices involve:

- Soil preparation: limiting carbon emissions into the atmosphere. For example, soil preparation techniques in conservation agriculture.
- Fertilizer application: avoiding overuse of fertilizers, especially nitrogenous fertilizers and incompletely composted manures. These are sources for methane and nitrous oxide emissions.
- Water regime: Keeping the land enough moist, not exceeding water, especially for paddy rice. Submerged paddies are recognized to be the main source of gas emission in agriculture.
- Treatment of waste, particularly animal waste: animal waste and slurry are also one of the main sources for methane emissions from agriculture.
- Forest protection: reduce burning and conversion of forest land into farmland, better forest management also reduces emission.

Avoiding or displacing emissions:

- Use of energy with bio-origin help avoid emissions and reduce emissions per unit of food consumed.
- Application of postharvest technologies for reducing postharvest losses will contribute to decreasing emissions per unit of food consumed.

Removing emissions:

Soils and plants can act as promising carbon sequestration and carbon sinks and thus, it needs to apply practices to help these sinks operating more effectively:

- Enhancement soil's and plant's capacity for carbon sequestration: For example, intercropping, application of conservation agriculture, soil coverage
- Improvement soil & water management: Increased available water in the root zone can enhance biomass production.
- Planting trees: Development of agro-forestry systems and planting forests.
- Replanting mangroves in aquaculture areas.

2.3. Ensuring productivity and food security: Capturing the synergies between adaptation, mitigation and productivity

The priority, particularly for the poor regions, is to increase agricultural productivity and ensuring food security. However, it is possible to capture triple-win and harmonization of three objectives of CSA: adaptation, mitigation and food security.

Group work: Understanding of adaptation, mitigation and synergies

1. List as many as possible examples of practices with value for agriculture to respond to climate change.
2. Define whether they have adaptation, mitigation, and/or synergy impacts, and explain why.

Luckily, there are agricultural practices which can help achieve triple win. However, when applying such practices, at the beginning not all three objectives could be achieved. For example, improvement and revitalization of cultivated land cannot increase crop productivity at the initial period while requiring more labour and investment. Similarly, afforestation or planting of perennials take certain years before commercial harvests while household farmers need annual income for their daily expenses.

Thus, appropriate policies/ mechanisms promoting and supporting application of such practices are required. (This aspect will be further discussed in the coming sections).

Key Messages

- Conventional intensive agriculture, by overusing of inputs and natural resources, cause GHG emission, pollution of water and land, erosion and degradation of farmland while yielding unstable benefits and production.
- CSA practices effectively and smartly use of inputs (fertilizers, pesticides, seeds, labour) and natural resources (land and water in particular), and thus with reduced impacts on land, water and forest while yielding increased production and benefits.
- Climate smart agriculture help obtain synergy between climate mitigation, adaptation and productivity.

SESSION 3.2: DIFFERENCES BETWEEN CLIMATE-SMART AGRICULTURE AND CONVENTIONAL AGRICULTURE

Session overview

This session discusses the differences between conventional agriculture and CSA. To understand these differences will help participant understand why it is necessary to adopt CSA practices and select appropriate CSA practices in specific context.

Discussion questions facilitating the review of the last session and introduction of this session

1. What are the three pillars of CSA?
2. What changes should be made to the current practices of maize, rice, coffee and tea production in the northwest region to meet the three objectives of CSA?

The main difference between CSA and conventional agriculture is related to the use of inputs and resources (seeds, fertilizers, pesticides, land and water resources), in term on both volume and method of use, i.e. the core of CSA is effective and smart use of resources, both natural and non-natural (Table 3.1).

TABLE 3.1: A comparison between CSA and conventional agriculture intensification.

	Conventional intensive agriculture	**Climate-smart agriculture**
Agricultural input	- overuse, high ratio of nitrogenous fertilizers, surplus of pesticides and herbicides, high planting density seed sowing, too much water; - improper use time and method: broadcasting, not in right time (e.g. fertilizers or pesticides applied before heavy rains) ➔ wasting of inputs; polluting land, water and air; GHG emission	- balanced fertilization regimes, application of pesticides only when really needed with right dose and methods (IPM), planting with right density, ... - right time and right method of application of fertilizers, pesticides and ➔ reducing cost, environmental pollution and GHG emissions
Land	- only exploitation, no application of soil protection practices - deforestation and conversion from grasslands to croplands. ➔ causing degradation of soil and	- sustainable land use: soil erosion control, soil fertility restoration - land use change: right cropping system/s to suit the

	forest resources, soil erosion, and GHG emission	land and water conditions ➔ protecting and restore land and forest resources, increasing economic benefits, reducing GHG emission and environmental pollution
Water	- improper management of water , no water saving approaches ➔ wasting of water, increasing GHG emission, reducing crop growth and yield.	- proper water saving irrigation (dry and wet alternative for rice, dripping irrigation, etc.) ➔ saving water, improving growth and yield, reducing GHG emission, reducing wash-off of nutrients.
Biological resources	- improper expansion of mono-culture of few high yielding crop varieties and animal breeds - destruction of natural enemies and flora due to improper application of chemical and expansion of cropland areas ➔ loss of traditional varieties, reducing adaptability of the systems, increasing risks for harvest losses in a large scale.	- diversification of crops and animals, restoration of local varieties and breeds... ➔ increasing adaptive capability to natural disasters and climate extremes and diseases, reducing risks of harvest loss in a large scale.
Markets	- mono-cropping intensive farming yield un-diverse products, and hence, markets are developed for only few un-diverse products ➔ risks caused by volatility of market demands and market prices. To many examples for this (litchi in Ha Duong, banana in the Red River Delta, cash chew nut in the Highland, coffee...)	- Diversification of crop, animals in productions systems yielding diverse crops and links to diverse markets ➔ reduced risks caused by market instability
Productivity and benefits	- low effectiveness in use of inputs and resources - unstable yields due to low adaptation to climate variability ➔ Low and unstable benefits and production	- increased effectiveness in use of inputs and resources - increased adaptation to climate variability, stable yields ➔ Improved and stable benefits and production

To develop CSA in a certain regions the following is required:

- Selection of right CSA options suitable to the local conditions (land, water, people knowledge and culture, markets...).
- Development of mechanisms and policies promoting the adoption of these options
- Budgets to carry out adaptive research to refine the selected, and to carry out outreach activities promoting the adoption of the refined options.

This requires effective cooperation and coordination of all relevant stakeholders.

EXAMPLES OF ADAPTATION, MITIGATION MEASURES IN THE NORTHERN MOUNTAINOUS REGION

Adaptation:

- Land use change: growing upland crops in the previous paddy land areas which currently face problems of drought due to shortage in irrigation water
- Use short duration varieties, proper schedule the sowing/planting times in order to avoid exposure to unfavourable weather conditions (early or late cold spells, longer drought, etc.)
- Use drought, cold tolerant and pest resistant varieties
- Re-store local crop varieties and animal breeds with good adaptation to local conditions
- Build community self-sufficiency in seeds: Build capacity for community in production and supply of quality crop seeds and animal breeds such that they can restore production after disasters
- Adopt sloping land soil erosion control cultivation practices, such as mulching, minimum tillage, mini-terracing, planting hedgerows etc.
- Adopt Integrated Crop Management (ICM), Integrated Pest Management (IPM) such that to developed systems with healthy plants and crops resilient to adverse conditions
- Develop integrated production systems high diversity, with integration of crops with animals and perennial trees with effective
- Crop rotation to reduce the risk of pests.

Mitigation:

- Applying mulch and minimum tillage (conservation agriculture)
- Applying ICM, SRI (System of rice intensification)
- Applying DFP (deep fertilizer placement)
- Reducing free grazing, treatment of animal waste
- Recycling biomass and waste
- Integrated pest management (IPM)
- Develop integrated production systems, rich and diverse in genetic resources

Key Messages

- Conventional intensive agriculture, by overusing of inputs and natural resources, cause GHG emission, pollution of water and land, erosion and degradation of farmland while yielding unstable benefits and production.
- CSA practices effectively and smartly use of inputs (fertilizers, pesticides, seeds, labour) and natural resources (land and water in particular), and thus with reduced impacts on land, water and forest while yielding increased production and benefits.
- Climate smart agriculture help obtain synergy between climate mitigation, adaptation and productivity.

MODULE SUMMARY

Climate and agriculture are inter-impacting each other. To cope with climate change synergy between mitigation, adaptation and productivity is required. CSA, with its three pillars – adaptation to climate change, mitigation of climate change and increasing productivity of the production systems is an effective approach for this.

CSA can be realized through smart use of inputs and natural resources: increasing the effectiveness of using water, land and other natural resources, reducing input cost of fertilizers, seeds and labour while increasing the benefits.

There are different options of CSA, but for certain region, in certain context, these options need to be selected and refined smartly such that to make them adoptable to local farmers in specific context. The next module will discuss potential priority CSA practices for the NMR of Vietnam.

MODULE 4: CSA PRACTICES THE NORTHERN MOUNTAINOUS REGION OF VIETNAM

MODULE OVERVIEW

CSA is not a new production system – it is a means of identifying which production systems and enabling institutions are best suited to respond to climate change for specific locations, to maintain and enhance the capacity of agriculture to support food security in a sustainable way.

One of the key issues is to identify and promote the best suitable CSA options in the specific context. In this module CSA practices of potential values for the northern mountainous region of Vietnam are described together with their potential impacts/benefits as well difficulties facing small households in their adoption. This module, thus, provides the participants with foundation for selection of suitable CSA practice for concrete local conditions. In addition, it also describe the general policy landscape relating to CSA in the NMR.

KEY LEARNING QUESTIONS

- Which agricultural practices are of potential values for the NMR?
- What are difficulties facing small households in the NMR to adopt CSA practices?

Learning Objectives

Upon completion of this module participants will be able to:

1. Describe agricultural practices that can be considered to be climate smart in the NMR;
2. Discuss the main challenges in the adoption of each of them in the region;

SESSION 4.1: PRIORITY CSA PRACTICES IN THE NMR

Session Overview

As discussed earlier in the previous modules, CSA is a bundle of activities packaged to help farmers adapt to, and mitigate, climate change and achieve long-term food security. This session is dedicated to discussing priority CSA practices in the northern mountainous region.

Discussion questions facilitating the review of the last session and introduction of this session

1. What are the main impacts of current intensive agricultural practices in the NMR to local natural resources and climate?
2. List CSA practices in the NMR and specify their mitigation/adaptation impacts.
3. Which barriers facing local farmers in adopting each of these practices?

1. Sustainable intensification for paddies

of the practice vs. the control: Different "versions" of sustainable intensification practice for paddies have been designed/refined, demonstrated and recommended for large scale adoption in the three target provinces, namely ICM (integrated crop management), SRI (system of rice intensification) and IPM (integrated pest management). All of them aim at increased production with reduced inputs and reduced negative impacts on the environment.

ICM technical package

- Use appropriate varieties and quality seeds;
- Transplant younger seedlings (3-5 leaves) at reduced plant density: hill x hill = (18-20) cm x 11 cm; 2-3 seedlings per hill (60 – 80 kg of seeds per hectare);
- Apply fertilizers according to the plant needs at each development stage (balanced fertilization of nitrogen, potassium and phosphate);
- Keep water level at 1 – 5 cm, depending on the plant development stage, drain (for 3-5 days) after tillage stage and before the harvest;
- Apply IPM for pest control;
- Harvest at right time (considering the repining of rice and also the weather conditions).

Detailed description of this technical package can be found in the training manual of t "Quản lý tổng hợp cây lúa và sản suất thóc giống"[3].

SRI package

- Transplanting: Rice seedlings are transplanted:
    - when are very young, at the 2 leaf-stage, usually between 8 - 12 days old
    - carefully and quickly for protecting the seedlings' roots and minimizing the transplanting shock
    - singly, one plant per hill instead of 3-4 as conventionally
    - widely spaced in a square grid pattern, 25 x 25 cm or wider
- Soil preparation and base fertilization: The soil is enriched with organic matter to improve soil structure, nutrient and water holding capacity, and favour soil microbial development. Organic matter (5,500 – 8,000 kg/ha) and phosphate (400 kg/ha) represent the base fertilization.
- Irrigation: Minimum of water is applied during the vegetative growth period. A 1-2 cm layer of water is introduced into the paddy, followed by letting the plot dry until cracks become visible, at which time another thin layer of water is introduced. During flowering a thin layer of water is maintained, followed by alternate wetting and drying in the grain filling period, before draining the paddy 2-3 weeks before harvest. This method is called 'intermittent irrigation' or 'Alternative Wetting and Drying' (AWD).
- Additional fertilization (dressing): Depending on the rice yield and the soil conditions, different levels of chemical fertilizers, most often urea and potassium, are applied in order to achieve a balanced fertilization regimes for the crop.
- Weeding: While avoiding flooded conditions in the rice fields, weeds grow more vigorously. Weeding need to be done at appropriate times, either by hand or using herbicides.

IPM package:

- Use resistant varieties and quality seed;
- Transplant young and healthy seedlings at reduced density (as above for the ICM);
- Apply balanced fertilization regime;

[3] *"Quản lý tổng hợp cây lúa và sản suất thóc giống" Tài liệu tập huấn trong khuôn khổ dự án UNJP/VIE/039/SPA do Viện Khoa học kỹ thuật nông lâm nghiệp miền núi phía Bắc biên soạn. (training manual on ICM for quality rice seed production, developed by NOMAFSI under the proect UNJP/VIE/039/SAP).*

- Consider all the factors (pest density, weather conditions, and natural enemies, plant development stage…) to make decision on the options of pest control. Follow the 4 rights of pesticide application.

Main benefits/impacts:

- Reduce production inputs while increase rice yield (Nguyen Van Bo, 2001). Amount of seeds required can be reduced by 50% (in case of SRI the figure is 80%). The net profit can be increased by 3-5% with SRI application, as reported by the Plant Protection Department, MARD (available at http1); and by VND 8,400 - 16,450 per hectare when ICM is applied, depending on the variety of rice, as reported by NOMAFSI – FAO project (available at NOMAFSI and FAO Hanoi).
- Increase in effectiveness of water use (Hoàng Đức Cường, 2011).
- Reduce GHG emissions and other negative impacts on the environment due to reduced level of nitrogen fertilizers and pesticides. It was reported that the application of SRI can reduce 50% of the GHG emissions from paddies (Hoàng Đức Cường, 2011; Huỳnh Quang Tín at al., 2011).

FIGURE 4.1: Farmers in Yen Bai practicing ICM in a pilot plot

Main difficulties for farmers to adopt:

- In term of SRI: requiring certain infrastructure conditions of rice fields (irrigation systems, surface evenness, etc.) which currently cannot be met for almost all the paddy area in the 3 provinces.
- Great changes in various aspects compared to the conventional practice, and thus it is difficult for farmers to adopt, especially in SRI requirements, it is also difficult for farmers to believe that it can produce good harvests when the planting density is much reduced with only a single young plantlet per hill. Farmers' habit is to grow rice at higher density and use more nitrogen fertilizers.
- In some remote locations, it can be difficult for farmers to access to necessary fertilizers or pesticides sources.

2. Fertilizer deep placement (FDP) for paddies

Fertilizer Deep Placement (FDP) is an innovative fertilizer application technology. Potassium and nitrogen fertilizers are mixed and compressed into larger fertilizer granules which are physically placed (5-8 cm deep) below the soil surface, in proximity to the root zone of rice plants. In comparison to the conventional hand broadcasting method of fertilizers application in rice cultivation this technique reduces the fertilizers' losses and thus leading to increase in fertilizer use effectiveness and reduction in negative impacts on the natural ecosystems.

- Transplanting: Rice seedlings are transplanted:
    - when are very young: at the 3 - 4 leaf-stages.
    - at reduced density: 1-2 plantlets per hill, instead of 3-4 as conventionally
    - in a square grid pattern: 18 x 18 cm for pure line rice; 20 x 20 cm or 22 x 22 cm for hybrid rice
- Soil preparation: The soil is enriched with organic matter to improve soil structure, nutrient and water holding capacity, and favour soil microbial development. Organic matter (5,500 – 8,000 kg/ha) and phosphate (300 - 400 kg/ha) represent the base fertilization.
- Irrigation: A 1-2 cm layer of water during the period from soil preparation to transplanting and until far after application of fertilizers (FDP)
- Deep fertilizer application: 2-3 days after transplanting, dose of 200 - 250 kg/ha, depending on soil quality, rice varieties and plant density. fertilizer granules are physically placed (5-8 cm deep) below the soil surface between the rice hills. The amount of fertilizers applied can be adjusted to best suit the concrete soil conditions and the requirement of the rice varieties.

Main benefits/impacts:

In comparison to the conventional hand broadcasting method of fertilizers application, this technique application results in a reduction in the amount of nitrogen fertilizer required for rice cultivation (by 30% - 35%) and an increase in rice yield (with 10 – 20%) (CODESPA, 2011). An increase in the effectiveness of nitrogen fertilizer use, in turn, will reduce the pollution by this fertilizer in water resources. FDP application also results in a reduction in water use for paddy (Nguyen Tat Canh, Nguyen Van Dung, 2006).

FIGURE 4.2: Farmers in Yen Bai province applying FDP

Main difficulties for farmers to adopt:

In addition to the above positive impacts, the technique is rather simple and requires less labour cost (fertilization is applied only once throughout a cropping season while conventional practices requires 2-3 times of fertilizers application after transplanting). However there are still difficulties facing farmers in adoption:

- It is not easy to change local people's habits and attitude towards adoption of a new farming practice.
- The technique need to be followed strictly: seedlings to be transplanted at equal spaces and fertilizer pellets need to be placed at right depth (5 – 10 cm).
- It is difficult for farmers to buy fertilizer pellets as they are not yet available widely in the markets.
- FDP technique is not recommended for fields where soils are with low capacity to maintain water (e.g. sandy soils).

3. Mulching and minimum tillage

This practice is often called also conservation agriculture (CA) practice although CA include also other elements, such as crop rotation. The aim of this practice is protect soil from erosion and gradually improve soil quality and fertility through to reducing soil disturbance and maintaining permanent cover on land surface.

Plant residues (crops and weeds) are maintained and used to cover the land surface. Soil disturbance is reduced through reducing tillage, i.e. not all the fields are tilled, instead, trenches or holes are made for seeding and base fertilization.

Main benefits/impacts:

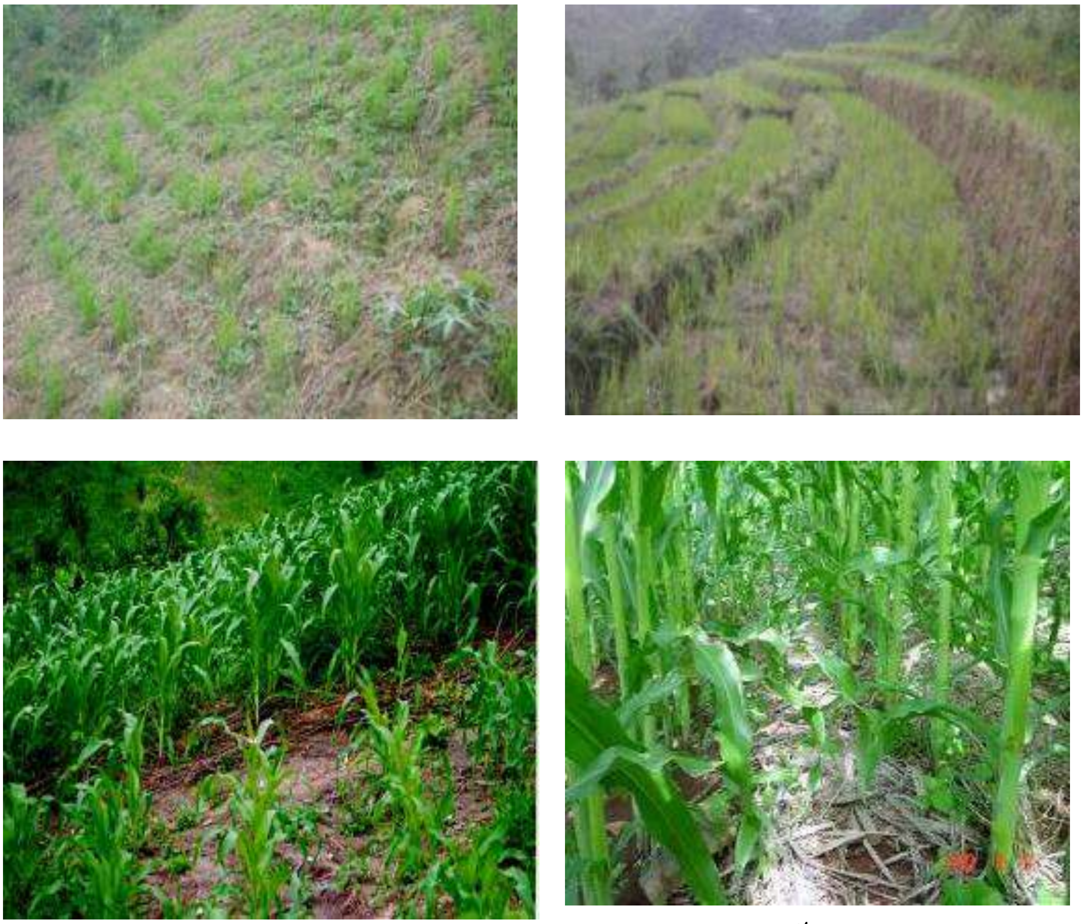
There are many reports stating impacts of this technical innovation (Agustin R. Mercado Jr. at al., 2012; Benites J. R., 2007; Hussion O. at al., 2003 & 2001; Neal Menzies at al., 2012; Stephane Boulakia at al., 2012. Hà Đình Tuấn at al., 2001; Lê Quốc Doanh at al. 2005; ACIAR-NOMAFSI project reports (2009- 2013):

- Reduce soil erosion
- Better maintain soil moisture
- Improve fertility and water absorption by plants
- Improve efficiency of fertilizer application
- Create favourable conditions for microorganisms to grow
- Gradually improve soil quality and fertility
- Prevent weeds growth

Main difficulties for farmers to adopt the practice:

- Requiring more labour at the beginning (few first years of the adoption) to adopt this practice compared to the conventional practices (NOMAFSI-ACIAR project's reports). In the 3 provinces, where labour is short at critical times and there are no readily available direct seeders or other tools for direct sowing, this in one of the main constraint to adoption of the practice.

- Requiring additional attention/inputs for pest control because vegetation residues can be good "houses" for mice, insects and pathogens (NOMAFSI-ACIAR project's reports)
- Local farmers have long time practiced the conventional practices; they used to burn plant residues, and are not yet ready to change
- Due to free grazing practice which is normally practiced in the region after the crop harvest, it is difficult to maintain plant residues for mulch. On other hand, it is difficult to produce mulch material on-farm, while bringing additional materials from outside for mulch is expensive and labour-consuming.



Pic.4.3: Rice in sloping land and terraces with mulch (1st row); and maize in sloping land with mulch (2nd row)

4. Intercropping with legumes

Intercropping is traditionally applied by farmers with purpose to get harvest of both intercrops (often legumes, pumpkins) and main crops (maize, rice, cassava). Less often farmers also intercrop annual food crops (rice, maize, legumes, cassava...) with perennial plantations (mostly fruits and tea). Nowadays, due to increased intensification and mechanization, the application of traditional intercropping practice become rare.

Aiming to: (i) produce biomass for soil mulching, (ii) enrich soil with nitrogen feretilizers thanks to nitrogen fixation capacity of legumes, (iii) create an additional income for HHs, during past year this practice has been re-developed and introduced in the NMR (Phạm Thị Sến at al., 2015). Different legumes (black bean, mung bean, rice bean, soybean, and groundnut) or other annual crops are intercropped into maize, upland rice, cassava, fruits, coffee or tea. The density of the main crop can be slightly reduced or remained the same as the control (without intercrops). The density of the intercrops should be thick enough to form a "live cover".

PICTURE 4.4: 1st row: peanut intercropped in cassava (left) and soybean in coffee (right)
2nd row: upland rice in tea (left) and soybean double maize inter-row (right)

Main impacts/benefits:

According to Le Quoc Doanh et. al. (2005), Phung Quoc Tuan Anh (2011) and Oleg Nicetic at al. (2011), below are the main benefits of intercropping:

- Increase income for households (additional income from the intercrop/s);
- Reduce soil erosion (due to increased cover of the land surface by intercrops);
- Improve gradually the soil quality (cover crops' biomass and nitrogen fixation by legume intercrops).

Main difficulties facing farmers to adopt the practice:

- More difficult and more labour is required (additional labour for planting and management of intercrops);
- Plant protection (pest control) is more difficult and complicated, especially for the intercrops. Improper pest management often results in total failure of the intercrops (no harvest at all) and may also cause problems for the main crops;
- Lack of appropriate crop varieties suitable for intercropping (drought tolerant varieties are often required);
- In case fruits: small scale and scattered plantations result in difficulty for intercropping;
- Limited and unstable markets for products of intercrops.

5. Mini-terracing

In sloping lands (often with slopes from around 15^{o} and above), terraces (mini-terraces) are made wide enough to grow a single row of crop on each terrace. The distance between the terraces, depending on the crop, is equal to the distance between crop rows when cultivated normally (without terrace).

Mini-terracing can be applied in combination with mulching and/or intercropping.

FIGURE 4.5: Making minterraces for coffee (above) and for maize

Main benefits/impacts:

- Reduce soil erosion
- Gradually improve soil structure and fertility
- Increase in effectiveness of fertilizer use and improve economic benefits for farmers
- When applied together with mulch and/or intercrop/s these impacts will be higher (Le Quoc Doanh at al., 2005; Oleg Nicetic et al., 2011).

Main difficulties for farmers to adopt:

- High labour cost to make mini-terraces (Oleg Nicetic at al., 2011)

- In the following years, mini-terraces still require to be repaired and stabilized.

6. Forage hedgerows

In sloping lands, grass (Guatemala, Guinea, Enticer, Paspalum, Miscanthus, VA06, Mulato, Ruzi etc.) are cultivated in hedgerows, at distance of 10 m from one another for both soil erosion control and also for feeds. On steep slopes, the distance of hedgerows should be reduced to 6-8 m for more effective soil erosion control.

Main impacts/benefits:

- Prevent erosion and land degradation. When grasses are grown in hedgerows, especially, the impact on erosion control is very high (Le Quoc Doanh et al., 2005; Hussion O. at al., 2003)
- Contribute to intensification of cattle raising and reduce free grazing, and this in turn contributes to crop, forest and environmental protection
- Help to produce biomass for mulch
- Increase household economy: though improving cattle raising

Main difficulties facing households in adoption of this technique:

- More labour is required (to plant, manage and harvest grasses)
- Farmers are familiar with grazing practice, and not yet ready to change.
- Limited cultivatable land resource; farmers give priorities for food crops production rather than for grasses
- Additional financial inputs are required for households to grow grasses

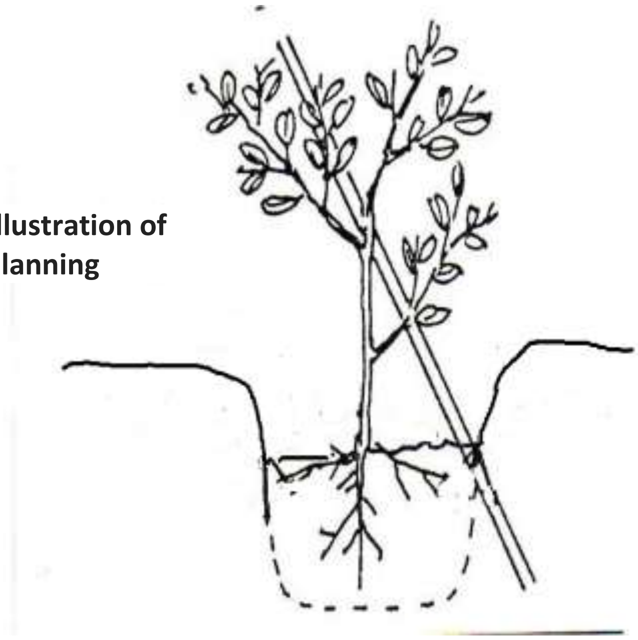
FIGURE 4.6: Grass strips in maize on slopes

7. Pit Planting

In the North of Vietnam, pit planting is introduced for fruits and recommended for application in dry and water shortage areas. Objectives of this practice are:

- To maintain moisture conditions for trees to develop;
- To reduce fertilizer erosion , consequently, environment pollution;
- To improve the economic benefit.

Pic. 4.8: An illustration of pit planning



8. Raising fish in paddies

The recommended practice is as below:

- Right after rice harvest, cleaning the fields and canals.
- Transplanting rice as usual
- Fishes first are raised in surrounding canals. Depending of the fish and the season, the time of releasing fishes into canals can be differently: the same time with rice panting, 1 month latter or 2 month latter.
- When rice plants are big enough (no longer can be affected by fishes), raise the water level in the paddy field for fishes to swim from canals into the fields
- No pesticides application for rice

Another ‘version’ is that after planting of rice, when plants are big enough, release fishes in the field. But the fields then need to be designed such that water level can be easily regulate and fishes can be ‘gather’ to a small area/s when needed.

Benefits/impacts:

- Increase income and diversify income sources for households;
- Improve fertility of soil;
- Reduction of environment pollution and emissions thank to no use of pesticides-

FIGURE 4.9: Rice production and fish raising field in Yen Bai province

9. Maize transplanting

The objective of this technique is to develop additional winter maize crop in double rice cropping lands. Maize seeds are sown in hard muddy soils (5-10 cm thick base) on a concrete or hard floor (or rarely in small plastic bags) about 10 days in advance to the planting time (when the lands is available) so that right after the harvest of the 2nd rice crop seedlings can be transplanted. This helps the crop to be established earlier and better, and thus can escape some cold and dry time, and correspondingly winter maize crop can give good profits.

The practice include: Prepare 1.5 – 2 kg maize seeds for every 1,000 m2 rice field. Soak the seeds into water for 10 – 12 hours, then keep them in humid condition for germination. Divide the hard muddy base (prepared in advance)into 5 cm x 5cm pieces; dig a 1 cm-depth hole in middle of each piece and place a germinated seed in. Fill the hold with soft soil. Water enough for the seeds to continue germinating and seedlings to grow well. After 7-10 days, seedlings with 3 leaves are ready for transplanting.

Benefits/impacts:

- Increase income and profits for households
- Avoid the risks associated with bad weather conditions for winter crops

Difficulties for farmers to apply:

- Increase in labour cost for seed sowing
- Lack of short-duration maize varieties with good drought tolerance
- Drought and cold problems some years may cause poor harvest of maize and thus make farmers reluctant to apply the technical innovation.

FIGURE 4.10: Winter maize and peanut after 2 rice crops

10. Agro-forestry practice and integrated agricultural systems

"Agro-forestry" stands for complex production systems, not practice. In this manual, however, "agro-forestry'' stands for practice of intercropping agricultural crops into forestry perennials with the aim to increase income for HHs and protect soil from erosion during the first years after planting of forestry trees. Often, it is recommended that trees are planted as normally and during 1-5 years after planting (depending on trees) crops, mostly beans, maize, peanut, cassava, finger, canna... are planted in each inter-row of trees. Intercrops are managed as appropriate.

Agro-forestry and integrated production systems that combine a diversification of crops and animals have potentials to:

- Cope with climate change and climate variability: being less vulnerable and quickly restore after being impacted and thus generate stable income;
- Sequester carbon better, produce more biomass;
- More effectively use land and water resources, and better recycle waste and energy.

In Vietnam, home gardens and garden-pond-cage systems (VAC) or garden-pond-cage-forest systems (VACR) are obviously diversified agroforestry systems which have long been developed and conserved in all regions (Phạm Thị Sến at al., 2008).

The most common integrated systems is VAC (the abbreviation of the Vietnamese phrase Vườn-Ao-Chuồng standing for garden-pond-animal pens/cages – or horticulture – aquaculture – animal husbandry). VAC stands for the integrated production systems comprising three production components: gardening (agricultural and forestry plants), aquaculture and animal husbandry.

The most common production patterns in a VAC system:

- In the garden: different plants (mostly fruits and timbers but other plants like bamboos, rattans and creepers and some vegetables) are cultivated
- In the pond: fishes, shrimps, tortoises, amphibians are raised. Some crop, such as taro as duckweed, are also cultivated
- In cage (animal husbandry): Buffalos, cows, pigs, chickens, ducks, rabbits etc. are frequently reared. Honey bears can also be raised.

Traditionally, different types of VAC systems were practiced by most households with the scale greatly variable; the areas and types of crops and the number and types of animal heads differed much between the households. Nowadays, especially in the highland villages, the component A (pond) is often missing.

FIGURE 4.10: Intercropping maize in rubber(left) and maize in timber (right)

Main benefits, impacts:

- Increase biodiversity and income sources helping HHs adapt to CC and gain sustainable incomes and quickly restore production after climate variability or disasters.
- Increase sequestration of carbon waste recycling, and thus help reduce GHG emission and CC

Difficulties for farmers to adopt:

- Lack of capital investment,
- Fragmented land areas owned by households
- Lack of appropriate plant types and crop varieties, limited knowledge of farmers in designing appropriate systems.

MODULE SUMMARY

There are a number of CSA practices designed and introduced in the NMR which can help solving the problems facing agriculture in the region in the conditions of CC through capturing synergies between production, CC adaptation and mitigation. To adopt each of these practices however farmers face difficulties, especially in the first 1-5 years.

To understand the procedure, the impacts and the barriers to adoption of each of these practices allows us to be able to select appropriate practices for solving problems in concrete conditions and to meet concrete needs. In the next module we will discuss in more details the barriers and about how to remove them for promoting adoption of CSA practices.

MODULE 5: REMOVING BARRIERS AND ENABLING THE ENVIRONMENT FOR ADOPTION OF CSA

OVERVIEW

From the discussions in previous sections it is seen that CSA practices are not new practices, they are sustainable practices developed and introduced in the NMR by projects implemented during past years, or are traditional knowledge/experience of local communities to cope with adverse conditions of land, climate, water and markets during many years. The adoption of practices however remain limited in the NMR (Phạm Thị Sến at al., 2015a, 2015b) due to barriers and difficulties facing local HHs in applying technical packages.

This module explores these barriers and measures for their overcoming such that CSA can be implemented to realize the goals of food security and climate change mitigation and adaptation.

LEARNING QUESTIONS

- What are the main barriers to adoption of CSA practices?
- How to overcome these barriers?

Learning objectives:

After completing this module participants will be able to:

1. Discuss about the barriers and difficulties facing local HHs in adoption of CSA practices;
2. Discuss and select appropriate measures to overcome these barriers and support local HHs to adopt CSA practices

SESSION 5.1: BARRIERS TO ADOPTION OF CSA

Session overview:

There are a number of challenges and barriers that make adoption of climate-smart agricultural practices rather difficult and lengthy.

Main barriers are related to the following:

- additional costs and risks in the initial phase of adoption
- tenure security: no long term for land tenure might limit farmers to spend long term investments in their current cultivated land
- prohibitive cultural factors, such as community norms and rules
- scarce information and limited access to extension service
- limited availability of inputs in local markets, limited financial inputs of farmers
- absence of credit/insurance markets.

This session will help participants discuss and understand better these barriers.

Discussion questions facilitating the review of the last session and introduction of this session

1. According to you, the adoption of CSA practices in your location is at large, or small or very small/limited scale?
2. What are the reasons for this limited or large scale adoption?

1. **Additional costs and risks in the initial phase of adoption**

Generally speaking costs and risk are in fact a major challenge in the adoption of climate-smart agricultural practices. Some CSA practices, e.g. mini-terracing or planting hedgerows require substantial initial investment. Also risks appear to be an additional barrier to adoption. E.g. mulching may create increased problems of pests.

This is the main barriers to adoption of many CSA practice in the NMR. Mini-terracing, mulching, growing hedgerows... required additional inputs of labour and also other inputs. On the other hand, adoption of these practice do not bring economic benefits in first years, while the risk can increase. At small scale of research or piloting, ricks can be well managed by researchers, but HHs may not be able to manage the risks. Most technical packages are complicated involving many elements and thus are difficult for HHs to apply them properly. The improper adoption of technical packages in turn may cause bad impacts on income and environment (Phạm Thị Sến at al., 2015b).

Adoption costs can be divided into categories:

- "one-off" investment costs (equipment, machinery, on-farm structures): For example, cost for application of mini-terracing practices) is a kind of "one-off" investment costs. This is because building mini-terrace structures can be a very labour-consuming. CSA practices, such as mini-terracing and SRI, are too complicated, requiring additional inputs for application.

- maintenance costs: recurrent expenses to purchase inputs or labour cost to maintain the structure (such as to maintain terraces) and practices
- opportunity costs/vulnerability and risk: the income of producers may reduce due to adoption of the practice/s, especially at the beginning of adoption (increased input cost but no increase in yield). Also, there are other risks facing production: economic and price-related risks (unstable markets, especially for new animal and crops developed in the region as results of the adoption of CSA practices), climatic, environmental, pests and diseases, at different scales and, often, political instability.

While the benefits of CSA practices are not always appreciable in the short term, costs are borne immediately and farmers often cannot afford the consequent up-front cash outlays. The following graph (Figure 5.1) shows the impacts on smallholder incomes of adopting an improved practice which has long-term impact on soil quality and crop production. For example, mulching and minimum tillage can result in a decrease in incomes over the short run (increased labour cost rightly at the beginning of adoption, while the soil quality can be improved only after 3-5 years) but eventually leads to an overall increase in incomes and a sustainable production system.

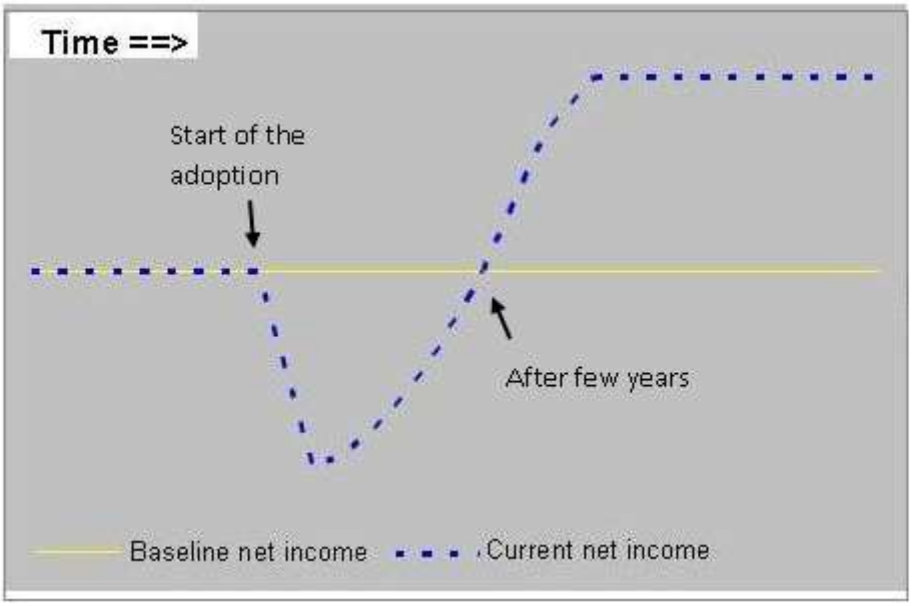


FIGURE 5.1: Adoption of a CSA option may have negative impact on the net income during first years

2. **Tenure insecurity and other barriers**

Tenure Security: Lack of tenure security and limited property rights, may hinder adoption of CSA practices, especially practices for sustainable land intensification and management (SLM). In order to provide incentives/capacity for long term investments on land, there is need to create adequate incentives over heterogeneous interests under collective rights.

Lack of a management mechanism and an effective collective action, particularly over management of communal resources (forests, water resources etc.) and lack of a provision of local public investments (soil and water management measures) is another barrier to CSA adoption. In Vietnam, for example, there are a number of institutions working in agriculture, natural resources management and food security. The lack of efficient linkages between institutions and effectively functioning institutional arrangement is also an important barrier to CSA adoption. Main shortcomings from institutional aspect include:

- Inappropriate mainstreaming of CC into national and local political agendas
- Lack of operational capacity
- Overlapping and unclear demarcation of responsibilities
- Ineffective decentralization
- Lack of capable coordination, good leaderships

Customary/collective systems can be inequitable (gender biased), and this may also hinder the adoption.

Prohibitive cultural factors, such as community norms and rules also hinder the adoption of technical innovations, among them CSA. Community norms may constrain community members from adopting innovations, while long term habits require long time to be changed. In many cases, famers have been used to conventional practices and are not yet ready to change.

Scarce information and limited access to extension services, and inputs and outputs markets: In many locations, extension services are inadequate and access to information and sources of inputs (fertilizers, seeds, tools...) are difficult, and this highly impedes the adoption. For example, for adoption of conservation agriculture innovations, direct seedlings are required. But for regions with complicated topography there is a not yet suitable direct seedling.

Regarding institutional and organisational aspect: There are different organisations working in natural resources management, agriculture and food security in Vietnam in general and NMR in particular. However, currently these organisations are not well linked and cooperating one with another, and CC has not been integrated into programme and plans of different sectors. Lack of coordination between sectors and organisations is one of the barriers (Đỗ Trọng Hiếu at al., 2015).

In conclusion, there are many barriers to adoption of CSA practices. These incentives and other measures to overcome the barriers are discussed in the following session.

Key massages

There are barriers to be removed to promote the adoption of CSA practices.

The barriers are mainly related to:

- Increase in input and labour cost, especially during the first 1-5 years of adoption;
- Limited access to information, markets and extension cervices;

- Lack of mechanism and collective actions for management of community assets, such as land, water and forest resources; and
- Lack of cooperation and coordination between sectors and institutions.

SESSION 5.2: OVERCOMING THE BARRIERS AND ENABLING ENVIRONMENT FOR CSA ADOPTION

Overview

The previous sections already discussed the needs for adoption of CSA practices, priority CSA practices in the NMR, and barriers to their adoption. This session discusses about how to overcome the barriers and provide an enabling environment for CSA.

After completing this session participants will be able to define stakeholders and their roles in promoting CSA, and to identify options for linking these stakeholders in providing an enabling environment and supporting HHs to adopt CSA.

Discussion questions facilitating the review of the last session and introduction of this session

1. What are barriers to adoption of CSA practices by HHs in the NMR?
2. How to overcome these barriers?

To secure an enabling environment for adoption of CSA, appropriate initiatives, institutional and landscape approaches are required .These approaches may require trade-offs, which would need to be explicitly quantified and addressed through cooperation among all stakeholders, both within and between sectors.

1. Improve institutional linkage and arrangement

Group work: Quick institutional context assessment

1. List all actors (organisations and individuals) existing in your area (district or commune) involved in agriculture, climate change, natural resources management and food security.
2. Put them in the VENN diagram with the CSA in the centre and distance from the centre to the actors promotional to the extent of their importance to CSA promotion in the area.
3. Draw the all possible information flows for dissemination of information to farmers in your area.

In Vietnam as whole, and in each province of Vietnam also, there a number of institutions working in areas related to climate change, natural resources man agent, agriculture and food security. They all have role in agriculture and rural development, and thus also in CSA research and development. The “levels of importance” of institutions to CSA in a commune in the NMR is shown in Figure 3.4., as the result of a group work by the trainees participating a CSA training course in Yen Bai, Dien Bien and Son La, in 2014.

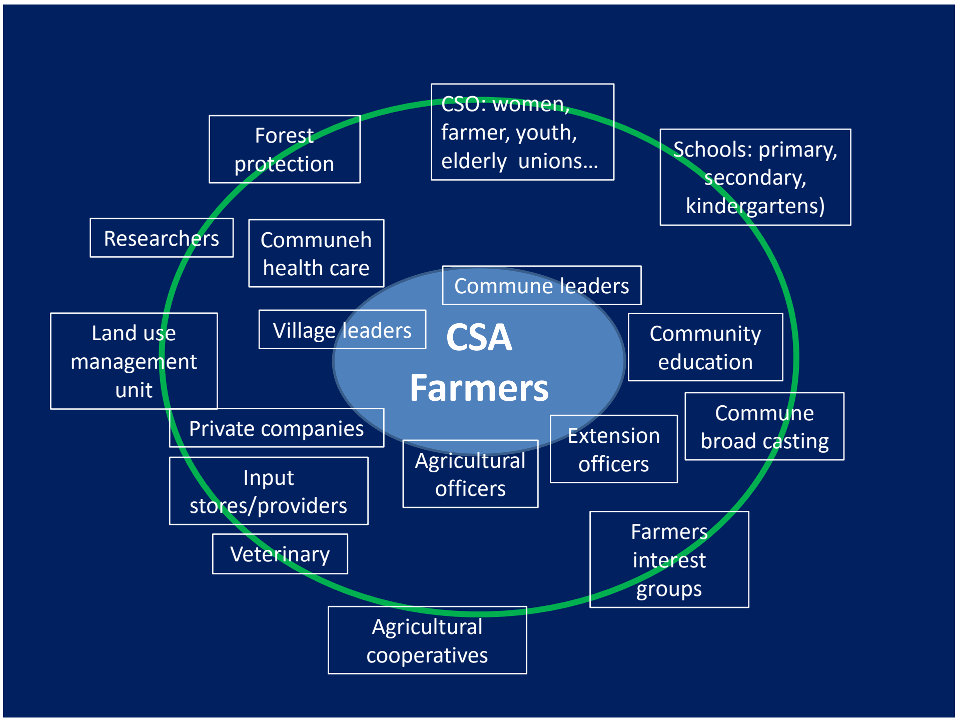


FIGURE 5.2: A VENN diagram showing the comparative levels of “importance” of institutions to CSA in a commune in the NMR (SOURCE: Group work result at the training session on CSA in the NMR)

However, at the present there is a lack in coordination between stakeholders. The above actors are not well linked, and their activities not coordinated. Thus, for these organisations to it is necessary to improve the linkages and arrangement among these actors such that every one can fruitfully realize their roles, and such that efforts of all actors can be synergised in order to ensure the following:

(1) Technical knowledge produced and shared:

- Identify the risks and vulnerabilities caused by climate change to local agricultural and food systems, and the vulnerable households (people) groups
- Identify potential locally appropriate CSA innovations and refine them (with local community participation) for easier application of these innovations in the local specific context.
- Relay rapidly throughout the community new information on weather, climate, climate change and potential practices for application.

(2) Financial services (including credit) and market links developed to facilitate the CSA adoption:

- Develop and apply financial support mechanisms to kick-start new practices, technologies and behaviours among communities
- Provide credit, insurance, social safety nets, and payments or rewards for environmental services.
- Stimulate local markets, build links with national and international markets for plant and animal products, and, in the same time, improve market literacy among smallholder farmers.

(3) Actions linked and coordinated:

- Improve coordination between concerned agencies across sectors at the national and local level, and partnerships with non-state stakeholders play a key role. This coordination need for all steps, from planning to implementing and monitoring of CSA-related activities.
- Encourage new cultural norms for practice in agriculture, food distribution and household food management
- Shift the focus of agricultural extension from delivering technology to working in partnership with local farmers to refine CSA practices and to overcome barriers to their adoption
- Underpin the sustainability of CSA through locally workable mechanisms for benefit sharing, dispute settlements and other governance issues, with specific focus on the vulnerable groups, such as women, children or immigrants, in the benefits of climate smart agriculture;
- Ensure that disaster relief in response to climate shocks reaches the right people quickly and effectively.
- Co-deliver wider services in support of CSA (e.g. health and sanitation services, education and knowledge exchange).

2. Adopt supportive policies

The aim of CSA is to contribute to broader economic growth, poverty reduction and sustainable development goals. It also have close link to natural resources as well as finance management and use. Policies supporting CSA, thus, are to cover all these aspects and to motivate all stakeholders and sectors such that being able to promote an integrated approach to providing incentives for CSA. Especially, as investment for CSA is for long-term interest, policies relating to land use rights may have role in enabling environment for investments for CSA. To develop such policies, coordination/links between policies makers from different sectors (agriculture, environment.....) is required, while support for implementation of policies at local levels (provincial, district, commune levels) is also necessary.

(1) Policy relating to finance for CSA

The role of climate finance is also crucial in providing an enabling environment for CSA adoption. As mentioned before, implementation of CSA practices requires additional costs and may create additional risks, although in the long-term benefits can be realized.

Nevertheless, specific funds allocated for CSA is always not enough, and thus, it is needed to mainstream CSA activities in existing programmes in order to take advantage of available funding opportunities. Agricultural investment projects/ programmes, opportunities for CSA should be formulated. Also, investment from private sector can be an important part in creating an enabling environment for CSA. Thus, it needs to have workable mechanisms and policies to encourage investment from this sector.

Globally, there is Finance to support adaptation or mitigation activities. International financing opportunities for agricultural adaptation include the Adaptation for Smallholder Agriculture Programme (ASAP) of the International Fund for Agricultural Development (IFAD), the Strategic Climate Fund (SCF), the Global Facility for Disaster Reduction and Recovery (GFDRR), the Global Environment Facility (GEF) and grants and loans channelled through the Asia and Africa development banks.

(2) Mainstreaming CSA in policies and strategies:

To overcome the barriers to CSA adoption needs to mainstream CSA into core government policies and programmes, including monetary policy. Priority needs to be given to CSA practices that bring productivity gains, enhance resilience and reduce emissions. It is also needed to integrate climate change and CSA in national, sectoral, local development programs/project climate.

At global level also, incorporating climate change considerations into agricultural investment projects is necessary: Standalone programmes designed to specifically address climate change are rare. CSA requires a wider landscape approach for the better management of agricultural production and ecosystem services (FAO 2012a).

In Vietnam there is the Directive of the Agricultural Sector for integration of CC adaptation/mitigation in developing strategies, framework plans, programs, plans, projects and activities (809/CT-BNN-KHCN, 2011);

3. Improve information and market accessibility

Development of CSA depends on the ability to convey technical and market information, coordinate production and marketing. Especially, to develop market links for new products from animals and crops produced as results of adoption of CSA (diversification, land use change, intercropping) play the vital role in promoting the adoption of such CSA option. In many cases, this is the “must” for farmers to economically benefit from the adoption.

In the NMR, the information flows from research to the farm, in general, is illustrated in Figure 5.3. Based on this, necessary measures can be taken and appropriate outreach strategies can be developed and realized for effective dissemination and use of information.

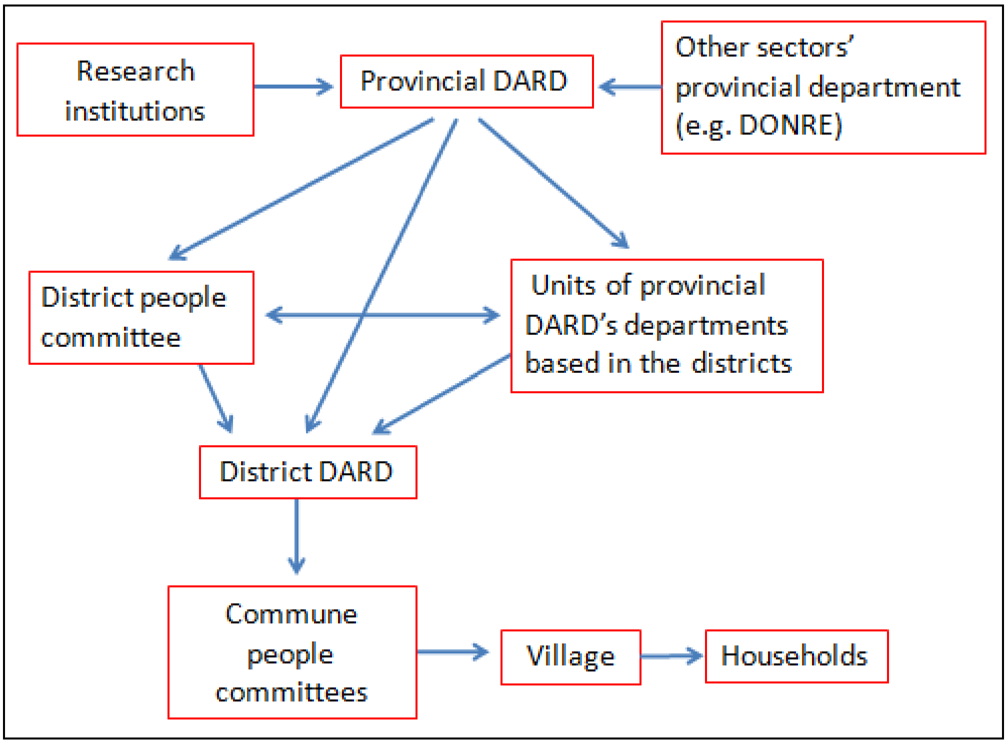


FIGURE 5.3: Information flows for dissemination of information to farmers in the NMR ((SOURCE: Group work result at the training session on CSA in the NMR).

4. Financing for CSA and developing insurance and safety nets

As mentioned already in previous parts, adoption of CSA practices may cause increasing risks to HH income, especially during the first years of adoption. This, to manage risks is necessary for overcoming the barriers.

In order to overcome the barriers, risk management tools such as safety nets, crop insurance are needed. Therefore linking farmers to new sources of information on climate change is important, but equally important is 'translating' the risks and potential margins of error in ways that farmers can understand and use in making decisions to adopt CSA technologies that will increase their adaptive capacity.

On the other hand, in addition to mainstreaming CSA into core government policies and programmes, it is also required a finance source for CSA. This financial source is especially needed for improvement of some infrastructure items, capacity building for responding to urgent climate variability and shocks.

Globally, there are financing opportunities for agricultural adaptation include the Adaptation for Smallholder Agriculture Programme (ASAP) of the International Fund for Agricultural Development (IFAD), the Strategic Climate Fund (SCF), the Global Facility for Disaster

Reduction and Recovery (GFDRR), the Global Environment Facility (GEF) and grants and loans channelled through the Asia development bank. The CCAFS program of CGIAR also provide support to communities in some countries to adapt and mitigate CC.

MODULE SUMMARY

There are barriers to adoption of CSA, which mainly are related to the following:

- Increase in input and labour cost, especially during the first 1-5 years of adoption;
- Limited access to information, markets and extension cervices;
- Lack of mechanism and collective actions for management of community assets, such as land, water and forest resources; and
- Lack of cooperation and coordination between sectors and institutions.

To overcome the barriers it is required active involvement and cooperation of all stakeholders to facilitate landscape approaches and provide support to HHs. In concrete, the cooperative actions are to:

- Select appropriate CSA options for concrete context
- Refine CSA technical packaged to suit best local HH conditions and capacity
- Support HHs in access to market information and to develop market linkages for their agro-products
- Provide necessary incentives and financial sources for HHs and other stakeholder
- Develop and implement risk management strategies and measures.

In all levels, it is difficult to have enough financial source for CSA, and thus it is necessary to mainstream CSA in to governmental, sectoral and local programs, projects and plans.

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