THE AGRICULTURAL INDUSTRY AND CLIMATE CHANGE

TEACHERS' GUIDE





Foreword

Climate change is now recognised as one of the major problems that the globe faces today. With the pace at which climate on our planet is changing, humans will not have the time to evolve in order to survive the change. Human beings, as a species, is being threatened, and unless we seek out ways to mitigate climate change, or adapt to its consequences, we, and the whole planet, stand to suffer. Underlying the need to mitigate and adapt, is a need to be informed, and be conscious of our contribution to the issue. From there, we can work towards a more sustainable future, for the human species, and other beings that live on Planet Earth.

As such, the reality of global climate change lends increasing urgency to the need for effective education on earth system science, as well as on the human dimensions of climate change. Interwoven with this fact is an urgent need for education to become an essential component of the Seychelles' response to climate change. As a result, local NGO, Sustainability for Seychelles, in collaboration with the British Foreign Office and the European Union, have produced a curriculum guide for post- secondary students and teachers.

This curriculum guide is designed to draw attention to the themes expressed above. It is divided into five sections, in which students learn about climate change itself, how it affects agriculture as well as how agriculture contributes to it. Students will also acquire knowledge and skill as to how the agriculture sector can mitigate and adapt to a changing climate. Some of the ways in which the sector can become more sustainable is also explored. Finally, the guide presents several different examples of activities that could be used to engage students in learning about these different themes.

The document is focused on developing educational materials for students and lecturers of the Seychelles Agricultural and Horticultural Training Centre. The elements of this curriculum have been tailored to meet the specific needs of the training centre and that of the agricultural industry in general. We hope that much can be drawn from it.

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SECTION 1: WHAT IS CLIMATE CHANGE?

The average pattern of weather, called climate, usually stays pretty much the same for centuries if it is left to itself. Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. But the climate we've come to expect is not what it used to be, because our climate is rapidly changing with disruptive impacts and that change is progressing faster than any seen in the last 2,000 years.

Scientists have pieced together a picture of Earth's climate, dating back hundreds of thousands of years. The historical record shows that the climate system varies naturally over a wide range of time scales. So, Climate change itself is not new. Annually, more than 60 percent of global industrial carbon dioxide emissions originate from industrialized countries.

In terms of historical emissions, industrialized countries account for roughly 80% of the carbon dioxide build up in the atmosphere to date.

The Earth is some 4.5 billion years old and during those years there have

been significant changes in climate. The causes of these changes were decidedly natural and not caused by humans since the influence of early people was very small at that stage. In general, climate changes prior to the Industrial Revolution in the 1700s can be explained by natural causes, such as changes in solar energy, volcanic eruptions, and natural changes in greenhouse gas (GHG) concentrations.



Photo: Volcanic eruption Source: universetoday.com



Photo: Sand storm

source: wohba.com

Anthropogenic climate change and global warming

Recent climate changes, however, cannot be explained by natural causes alone. Research indicates that natural causes are very unlikely to explain most observed warming, especially warming since the mid-20th century. Rather, human activities can very likely explain most of that warming. In other words, up until the last century, humans have been accelerating the rate at which the Earth's climate changes and this is known as **anthropo-genic climate change.**

Anthropogenic climate change is caused by the release of extra greenhouse gases by humans at rates with which the Earth's atmosphere cannot keep up. As a result, these greenhouse gases built up in the Earth's atmosphere, and act as insulation around the earth's atmosphere.

In this way, the gases prevent much of the Earth's heat from escaping, leading to a gradual increase in the Earth's temperatures. This is called the **enhanced greenhouse effect**, more commonly referred to as **global warming**.



Photo: Deforestation source: worldwildlife.org



Photo: Processing factory source: abc.net.au



Photo: Vehicle exhaust fumes source: autoextract.co.uk

Why do we use the term 'enhanced' when talking of the greenhouse effect?

This is because greenhouse gases are also released naturally through the eruption of volcanoes or the decomposition of vegetation matters. This natural greenhouse effect has been beneficial, allowing temperatures to remain high enough for the Earth's current life forms to develop.



As a result of the increasing concentration of these gases, more longwave radiation from the Earth is absorbed, thus reducing the energy lost to space and so altering the natural balance between incoming and outgoing radiation. Continued use of carbon-based fuels will further increase the atmospheric concentrations of carbon dioxide and other greenhouse gases.

Rising levels of carbon dioxide and other greenhouse gases in the atmosphere have warmed the Earth and are causing wide-ranging impacts, including rising sea levels; melting snow and ice; more extreme heat events, fires and drought; and more extreme storms, rainfall and floods. These are what constitute a changing climate!!

Scientists project that these trends will continue and in some cases accelerate, posing significant risks to human health, our forests, agriculture, freshwater supplies, coastlines, and other natural resources that are vital to state economy, the environment, and our quality of life.

Since the start of the industrial revolution vast quantities of carbon dioxide and other so-called greenhouse gases have been released into the atmosphere by the burning of fossil fuels, most notably coal and oil, and to a lesser extent, gas. This has led to an increase in the atmospheric concentration of carbon dioxide from 280ppm (parts per million) to its present level of 355ppm. Carbon Dioxide is one of the main greenhouse gases, along with water vapour and methane.

Effects of climate change

Some effects of the warming planet are already being felt, and further consequences are on their way. These changes will vary from region to region, but general trends include:

- changing precipitation patterns and heavier downpours, even in areas where overall precipitation will decline;
- longer, hotter, and more frequent heat waves;
- rising sea levels due to melting glaciers and land-based ice sheets;
- loss of both sea ice and protective snowpack in coastal areas;
- stressed water sources due to drought and decreased alpine snowfall;
- "positive feedback loops"—consequences of warming that cause further warming, such as melting sea ice decreasing the capacity of the northern oceans to reflect solar radiation back out of the atmosphere.

Whilst we have no control over the natural causes of climate change, we have direct influence over the human causes of climate change.

Greenhouse gases are produced by human activity, including:

- burning fossil fuels
- using energy generated by burning fossil fuels
- some aspects of farming, such as raising cattle and sheep, using fertilisers and growing some crops
- clearing land, including logging
- breakdown of food and plant wastes and sewerage
- some industrial processes

The main greenhouse gases generated by human activity are carbon dioxide, methane and nitrous oxide and some manufactured gases such as chlorofluorocarbons (CFCs), halocarbons and some of their replacements. Water vapour is also a powerful greenhouse gas but the amount in the atmosphere is not directly linked to human activity.

TOO MUCH OF THE GREENHOUSE GASES CAUSE THE EARTH'S TEMPERATURES TO RISE FURTHER TO LEVELS THAT MAY BE POTENTIALLY DANGEROUS FOR EARTH'S LIFE FORMS.



Almost 100% of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO2), methane and ozone. The drastic increase in the emission of CO2 (carbon dioxide) within the last 30 years caused by burning fossil fuels has been identified as the major reason for the change of temperature in the atmosphere.

Reducing Climate change and the Carbon Footprint

More than 80% of the world-wide energy demand is currently supplied by the fossil fuels coal, oil or gas. 72% of the totally emitted greenhouse gases is carbon dioxide (CO2). When you drive a car, the engine burns fuel which creates a certain amount of CO2, depending on its fuel consumption and the driving distance. When you buy food and goods, the production of the food and goods also emitted some quantities of CO2.

Climate change concerns all of us. Scientists believe that the rate at which the Earth's climate is changing can be slowed down, if each of us can make an effort to reduce the amount of carbon dioxide gas we directly and indirectly release into the atmosphere.

Your carbon footprint is the sum of all emissions of CO2 (carbon dioxide), which are induced by your activities in a given time frame. Usually a carbon footprint is calculated for the time period of a year.

Basically, a carbon footprint is a measure of the impact that human activities have on the environment in terms of the amount of greenhouse gases (GHG) produced, measured in units of CO2.

What goes into calculating the carbon footprint? Required data typically includes: on-site energy use of oil and gas, vehicles usage, electricity usage, how much recycling you do etc.

Sustainable living......

Climate change concerns all of us. The rate at which the Earth's climate is changing is alarming, and according to climate scientists, if it does not slow down, every human being's future will be jeopardised.

Sustainable living rests on the fact that each and every individual can engage in reducing the amount of GHG-emitting activities that they are involved in, in order to prolong the life of planet Earth, so that in the end, future generations can have a planet to call home.

SUMMARY

- Our climate is rapidly changing with disruptive impacts, but Climate change itself is not new.
- Climate changes prior to the Industrial Revolution in the 1700s can be explained by natural causes, however, up until the last century, humans have been accelerating the rate at which the Earth's climate is changing.
- The release of extra greenhouse gases by humans act as insulation and trap heat near the Earth's surface, causing temperatures to rise: Global warming.
- Some effects of the warming planet are already being felt. They constitute a changing climate and include changing precipitation patterns and heavier downpours, even in areas where overall precipitation will decline; longer, hotter, and more frequent heat waves; rising sea levels due to melting glaciers and land-based ice sheets, etc.
- Your carbon footprint is the sum of all emissions of CO2 (carbon dioxide), which are induced by your activities in a given time frame.
- Mitigating and adapting to climate change relies on each individual person adopting a more sustainable way of living.



SECTION 2: AGRICULTURE AND ITS CONTRIBUTION TO CLIMATE CHANGE

Agriculture is itself responsible for an estimated one third of climate change. Farming practices, livestock, and clearing of land for agriculture are significant contributors to the build-up of greenhouse gases in the atmosphere.

Sources of greenhouse gas emissions include:

- 1. Deforestation
- 2. The use of non-organic fertilizers
- 3. Rearing of domestic ruminants
- 4. The use of heavy diesel machinery
- 5. Rice cultivation

Over the past centuries, human ingenuity has led to technological advances in agriculture that have allowed substantial increase in crop yields, in part stimulated to meet population growth. Intensive agricultural methods are reported to have detrimental effects on the environment.

Agriculture produces the food humans need to live an active and healthy life and provides livelihoods for about half the world's population. Crop and livestock production have a profound effect on the wider environment. They are the major anthropogenic source of the greenhouse gases. The three most common gases emitted in agriculture are nitrous oxide, CO2, and methane.

AGRICULTURE CAN CONTRIBUTE TO CLIMATE CHANGE IN MANY DIFFERENT WAYS

1. ENTERIC FERMENTATION

This is the special name given to the digestive process which takes place in the bodies of ruminant animals (animals with multi-chambered stomachs), such as cattle and goats. Methane is emitted as a by-product of the normal livestock digestive process, in which microbes resident in the animal's digestive system ferment the feed consumed by the animal. This fermentation process, also known as enteric fermentation, produces methane as a by-product. The methane is then eructated or exhaled by the animal. Methane is a very potent greenhouse gas.

According to the FAO, animal agriculture is responsible for between 40-50% of the total anthropogenic emissions of methane gas. Nitrous oxide, another potent greenhouse gas is also emitted during the breakdown of nitrogen in livestock manure and urine.

2. NITROUS FERTILISERS

Nitrogen is an essential nutrient for plant growth. Nitrogen deficient soils can cause poor growth in plants. To combat this issue, people add nitrogen to the soil through the use of synthetic fertilizers. Nitrogen-based fertilizers, stimulate microbes in the soil to convert nitrogen to nitrous oxide at a faster rate than normal.

Nitrous oxide is a potent green house gas which when released into the atmosphere can stay there for up to 150 years.

Organic fertilisers such as manure can also emit nitrous oxide. Manure that is deposited and left on pastures contributes to global nitrous oxide emissions because of its high nitrogen content. When more nitrogen is added to soil than is needed, soil bacteria convert the extra nitrogen into nitrous oxide and emit it into the atmosphere—a process called nitrification



3. DEFORESTATION

In many tropical countries, vast areas of rainforests are cleared annually to make way for agricultural land. Forests play a vital role in the carbon cycle of our planet. When forests are cut down, carbon absorption from the atmosphere is greatly reduced. In addition, many times, after the trees are cut down, they are burnt. This burning process converts the carbon stored in the plants into carbon dioxide, which is then released into the atmosphere.

4. THE USE OF FARM EQUIPMENT

The vast amounts of fossil fuel-based energy used to cool, heat, and ventilate farm facilities, can result in at least 90 million tonnes of CO2 gas emissions worldwide. Direct emissions result from combusting diesel fuel in the equipment's engine. Diesel fuel is produced from the fractional distillation of petroleum.

The complete and impartial combustion of diesel fuel produces exhaust gases, which are very potent greenhouse gases. Along with carbon dioxide and water vapour, oxides of nitrogen and ozone also make up the composition of exhaust gas.

5. RICE CULTIVATION

Flooded rice fields emit methane (or CH4), which is second in importance to CO2 as a greenhouse gas. Under anaerobic condition of submerged soils of flooded rice fields, methane is produced and much of it escapes from the soil into the atmosphere via gas spaces in the rice roots and stems, and the remainder CH4 bubbles up from the soil and/or diffuses slowly through the soil and overlying flood water.



Photo: Deforestation source: http://nimbuseco.com



Photo: Use of farm equipment source: Ministry of natural resources



Photo: Rice cultivation source: http://upload.wikimedia.org

SO, HOW DOES FARMING INFLUENCE CLIMATE CHANGE?

Mainly by producing three powerful greenhouse gases:

- Methane- from livestock digestion processes and stored animal manure,
- Nitrous oxide- from organic and mineral nitrogen fertilisers.
- Carbon dioxide from cutting down vast areas of forests and burning the wood, to make way for agricultural land

SECTION 3: CLIMATE CHANGE AND ITS EFFECTS ON THE AGRICULTURAL SECTOR

Changes in temperature, amount of carbon dioxide (CO2), and the frequency and intensity of extreme weather could have significant impacts on crop yields.

1. Temperature increase:

Warmer temperatures may make many crops grow more quickly, but warmer temperatures could also reduce yields. Crops tend to grow faster in warmer conditions. However, for some crops (such as grains), faster growth reduces the amount of time that seeds have to grow and mature. This can reduce yields (i.e., the amount of crop produced from a given amount of land).

It is expected that increased air temperatures will cause more stress on livestock. During stifling heat, livestock reproduction declines as well as their appetite. Decreased appetite will lengthen the time needed for the livestock to reach their target weight. Stress can also increase the incidence of sickness, decrease rates of reproduction, and increase fighting among animals in confinement.



source: Adapted from University of Southampton (2000)

2. Extreme weather events

Changes in climate may also impact the water availability and water needs for agriculture. With less reliable rainfall, giving rise to longer droughts, crop failure may be inevitable, as crops wilt and die. On the other hand, extreme rainfall events and the occurrence of floods may also impact on crop yield, as whole farms are flooded, and crops are lost. In addition, increased storminess of rainfall events may lead to soil erosion and landslides.



Photo: floods source: http://newsinfo.inquirer.net

3. Increase in carbon dioxide:

Carbon dioxide is critical to photosynthesis (and thus plant growth). Scientists agree that even small increases in carbon dioxide result in more plant growth. However, some scientists believe that one drawback to this increased productivity will be crops with lower nutrient and protein levels. If true, this could have a significant, widespread impact on longterm human health.

While crops are expected to respond to increased CO2 with strong vegetative growth, other plants such as weeds are also thought to respond in a similar fashion. Weeds are expected to invade new habitats as global warming increases. Insect pests, some of which carry plant diseases, could become more prolific and widespread as temperatures increase.



Photo: drought event source: http://newsinfo.inquirer.net

Increased carbon dioxide may result in feed and forage that is less nutritious even if there is more of it. It is likely that growers would be forced to use feed additives in order to see the expected growth gains in livestock.

4. Sea level rise

As sea level rises and coastal lands are flooded, it is expected that many low-lying agricultural land will be flooded and lost. Apart from this direct consequence of sea level rise, one indirect impact that will likely have a detrimental effect on agriculture is salt water intrusion.

Salinisation refers to a build-up in salts in the soil. Salt in soils decreases the ability of plants to take up water from the soil. Salinization is especially likely to become a problem on poorly drained soils where the groundwater level has risen to within 3 m or less as a direct impact of sea level rise.

Even if climate change may have certain positive impacts for some northern European regions, most countries will experience negative impacts, which will affect regions already suffering from environmental or other problems. Farming will be most affected in the southern and south-eastern regions of the world such as in Africa, and in the Seychelles.

Summary

Climatic Element	Effect on Agriculture
Carbon Dioxide	Increased photosynthesis, reduced water use
Sea Level Rise	Loss of land, coastal erosion, flooding, salinisation of soils
Temperature	Heat stress risk, increased evaporation
Precipitation	Impacts of drought on soils, im- pacts of heavy rain on soils and the risk of water logging

CASESTUDY: CLIMATE CHANGE AND ITSEFFECTS ON A GRICULTURE IN ETHIPOIA

Future climate predictions agree that changes in temperature and rainfall patterns will have a seriously detrimental effect on agriculture in Ethiopia. Ethiopia is a landlocked country located on the Horn of Africa, and it has a predominantly tropical monsoonal climate. Of all the African countries, Ethiopia is considered the most at risk from climate change.

Ethiopia's agricultural system is largely dependent on rainfall patterns, particularly on its amount and seasonal distribution. The main crops in Ethiopia are teff, maize, and wheat. Global climate models show a decrease in annual precipitation in most highland areas of Ethiopia, although some areas within the country will experience a general increase in rainfall. The models show that temperatures in most of the country would only rise by $1-1.5^{\circ}$ C by 2050.

Research findings suggest substantial reduction in wheat yields and some loss of area, even where rainfall is expected to increase, presumably owing to heat stress due to the higher temperatures.

Small-scale farmers and pastoralists in Ethiopia are likely to bear the brunt of the negative impacts of climate change in the region, which will include increased poverty, water scarcity, and food insecurity.



Photo: Ethiopia

source: http://www.ethioembassy.org.uk

SECTION 4: MITIGATING AND ADAPTING TO CLIMATE CHANGE

Addressing climate change, food security and poverty means we have to be able to adapt to, and also mitigate the impact of, the changes in our agricultural landscapes, particularly in the tropics.

Agriculture is one of the few sectors that can contribute to both mitigation and sequestration of carbon emissions. In addition to reducing its own emissions, carbon sequestration in agricultural soils can play an important role in offsetting emissions from other sectors.

Climate change management actions are often described in terms of adaptation and mitigation. Adaptation to climate change consists of initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects.

Climate change adaptations are those strategies that can be implemented to build resilience and resistance in systems, whether they be environmental, social, economic or business systems.

Mitigation of climate change involves taking actions to reduce greenhouse gas emissions and to enhance sinks aimed at reducing the extent of global warming. Energy and other resource efficiencies, along with long-term changing patterns of tourist behaviour fit within this category. While linked, mitigation is distinct from adaptation to climate change which involves taking action to minimise the effects of climate change.

MITIGATION

Of the options to reduce GHG emissions in agriculture using currently available technologies, significant mitigation can be achieved through improved cropland and grazing land management, restoration of degraded lands, and land use change, e.g. agro-forestry, and the practice of organic agriculture.

ORGANIC AGRICULTURE : OPPORTUNITIES TO MITIGATE CLIMATE CHANGE IN THE AGRICULTURAL SECTOR

Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health. An organic production system is designed to a) enhance biological diversity within the whole system; b) increase soil biological activity; c) maintain long-term soil fertility; d) recycle wastes of plant and animal origin in order to return nutrients to the land.

Organic Agricultural is an effective strategy for mitigating climate change and building robust soils that are better adapted to extreme weather conditions associated with climate change. Organic agriculture has several features.

1. CROP DIVERSITY

Crop diversity is a distinctive characteristic of organic farming. Conventional farming focuses on mass production of one crop in one location, a practice called monoculture. Polyculture which is the multiple crops in the same space is often employed in organic farming. Planting a variety of vegetable crops supports a wider range of beneficial insects, soil microorganisms, and other factors that add up to overall farm health. Crop diversity helps environments thrive and protect species from going extinct.



Photo: polyculture source: Min of natural resources



Photo: monoculture source: http://www.somelier.ro

2. SOIL MANAGEMENT

Organic farming relies heavily on the natural breakdown of organic matter, using techniques like green manure and composting, to replace nutrients taken from the soil by previous crops. This biological process, driven by microorganisms such as mycorrhiza, allows the natural production of nutrients in the soil throughout the growing season.

3. WEED MANAGEMENT

Organic weed management promotes weed suppression, rather than weed elimination, by enhancing crop competition and phototoxic effects on weeds.

Mechanical and physical weed control practices used on organic farms can be broadly grouped as

- Tillage- Turning the soil between crops to incorporate crop residues and soil amendments; remove existing weed growth and prepare a seedbed for planting; turning soil after seeding to kill weeds, including cultivation of row crops;
- Mowing and cutting- Removing top growth of weeds;
- Flame weeding and thermal weeding- Using heat to kill weeds; and
- Mulching- Blocking weed emergence with organic materials, plastic films, or landscape fabric.[34]

4. INTRODUCING LIVESTOCK

Raising livestock and poultry, for meat, dairy and eggs, is another traditional, farming activity that complements growing. Organic farms attempt to provide animals with "natural" living conditions and feed.

Cattle used to be a basic farm feature that provided labour, as it was used for hauling, and ploughing. It was also used to maintain the soil's fertility as it provided the farm with manure.



Photo: Livestock ploughing source: http://upload.wikimedia.org/

AGRO FORESTRY: SEQUESTING CARBON DIOXIDE.

Recognised by the Kyoto Protocol as being an effective way to mitigate greenhouse emissions in the agricultural sector, agro forestry describes the practice of growing trees along with other crops.

Agro forestry is an appealing option. Trees sequester a large amount of carbon dioxide through photosynthesis while keeping the bulk of the land under agricultural production. Trees, like growing crops, remove CO2 from the air, storing it as carbon in trunks, branches, leaves and roots. Carbon can also be stored in soils and peat lands. Agro forestry practices such as woodlots, planting shelterbelts, maintaining forested riparian buffers and silvipasture, have the potential to sequester carbon for many decades. Multifunctional trees maintain soil organic matter and fertility, stabilize production, diversify farmers' livelihoods and provide ecosystem services in the landscape (adaptation); plus they generate high levels of plant biomass and soil carbon storage (mitigation).



Photo: agroforestry source: Min of natural resources

In livestock systems, degraded pastures that have been converted to diverse silvo-pastoral systems, with fodder and timber trees interspersed within pastures of shade-tolerant grasses, improve the overall adaptive capacity of the system, greatly enhance carbon storage, increase cattle stocking rates and net per hectare income, enhance biodiversity, reduce the use of herbicides and fossil fuels, release areas for biodiversity protection and sequester additional carbon aboveground.

ADAPTATION

While some regions of the world may benefit from improved conditions, the overall effect of climate change is nonetheless expected to be negative for global agricultural production if no action is taken.

Adaptation to climate change therefore, will have to occur. This may range from altering farm management practices to adoption of new varieties, crops, and animal breeds more appropriate to future climate conditions.

The following adaptive measures are suggested for the Seychelles:

- a. Biotechnology, traditional plant and animal breeding have the potential to develop new 'climate-ready' varieties and new crops or pastures pre-adapted to future climates.
- b. Plant nutrition can be adjusted by measures such as precision fertiliser use, legume rotations, and varietal selection to maintain the quality of grain, fruit, fibre, and forage sources.
- c. Irrigation efficiency can be achieved by identifying less-water intensive production options, by developing better water delivery technologies such as drip-irrigation.
- d. Soil and water conservation sysytems will become more important as climate fluctuates more and extreme weather events become more frequent.
- e. Biosecurity will become more relevant in order to strengthen the control of pests, weeds and diseases under a warming climate.

FOCUS: WHY MITIGATION AND ADAPTATION IS A MUST

Food security: Inaction towards climate change in the agricultural industry is not an option!

Food security is a condition related to the ongoing availability of food. Climate change threatens the world's food security in two main ways; through extreme weather events, such as droughts and floods, and through the increase of agricultural diseases as the climate warms.

1. EXTREME WEATHER EVENTS

Extreme weather events, Ranging from overnight floods to gradually worsening droughts, these will have a range of impacts on the agricultural sector. By 2040, almost the entire Nile region, which once included large areas of irrigated agricultural land, is expected to become hot desert where cultivation is impossible due to water limitation.

The impacts will include changing productivity and livelihood patterns, economic losses, and impacts on infrastructure, markets and food security. Food security in future will be linked to our ability to adapt agricultural systems to extreme events.

Approximately 2.4 billion people live in the drainage basin of the Himalayan Rivers. India, China, Pakistan, Afghanistan, Bangladesh, Nepal and Myanmar could experience floods followed by severe droughts in coming decades.

2. AGRICULTURAL DISEASES

With a warming climate, several strands of diseases such as fungus can proliferated and spread to newer parts of the globe, where plants have no genetic ability to withstand infection. This could spell disaster for many of the world's population as crops, fruits and vegetable are rendered inedible by those diseases.





Photo: Agriculture diseases

source: Min of natural resources

SECTION 5: SUSTAINABLE AGRICULTURE

WATER CONSERVATION

As agricultural production increases, resource constraints, particularly water, will become tighter. Agriculture globally accounts for about 70% of the world's freshwater withdrawals (45% in OECD countries). Climate change is expected to alter the seasonal timing of rainfall and snow pack melt which will result in a higher incidence and severity of floods and droughts. Both rain-fed and irrigated agriculture will need to be managed more sustainably to reduce production risks.



Agriculture is a major user of water resources and also contributes to water pollution from excess nutrients, pesticides and other pollutants. But the competition for water is increasing and the costs of water pollution can be high.

DID YOU KNOW?

- Farming accounts for around 70% of water used in the world today.
- 47% of the world's population could be living under severe water stress by 2050,- an increase from 44% in 2005.
- Increased pressure from urbanisation, industrialisation and climate change will provide agriculture with more competition for water resources.
- Climate change could affect water supply and agriculture through changes in the seasonal timing of rainfall and snow pack melt, as well as higher incidence and severity of floods and droughts.

Water is used principally for irrigation and Farms can achieve sustainability through water conservation in several ways:

- 1. Professionally designed irrigation system to suit different soil types are now available. If possible, ensure the supply system is designed to minimise losses and energy inputs. Perform an assessment of the hydrologic characteristics of the soil before adopting any irrigation system. Soil water shall be managed by drainage maintenance in wet climates and by soil moisture conservation practices in dry conditions.
- 2. Ensure timing and amount of irrigation is tailored to crop requirements.
- 3. Irrigate at night and consider using trickle irrigation.
- 4. Use Rainwater harvesting for irrigation.





Photo: irrigation

source: Min of natural resources

FOCUS!!!! RAINWATER HARVESTING

Is the accumulation and deposition of rainwater for reuse. Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply. It provides water when there is a drought. Seychelles has an annual rainfall of 350cm, providing ample opportunity for individual households to harvest rainwater.

Rainwater harvesting systems can be installed with minimal skills. The system could be as basic and simple as an open barrel well placed where the rainwater drains off a roof. It's a good idea to keep your barrel covered when it's full to stop mosquitoes breeding in it.

If you have gutters along your roof and want to go a little more high-tech, you can connect your roof to a downpipe leading straight into a covered tank with a tap installed somewhere down near the bottom. More high-tech options include pumping rainwater up to a tank in the attic or somewhere else high enough to provide good water pressure. If you are still building your house, you could incorporate an underground cistern





Photo: irrigation source: Min of natural resources

PESTICIDES MANAGEMENT

Integrated pest management (IPM), also known as Integrated Pest Control (IPC) is a broad-based approach that integrates a range of practices for economic control of pests. IPM aims to suppress pest populations below the economic injury level (EIL). Over-application of pesticides can be very harmful to the environment, and is not considered sustainable.

The IPM system should be based around 6 governing principles

1. Control, not eradicate

Wiping out an entire pest population is not often possible. By allowing a pest population to survive at a reasonable threshold, genetic selection pressure is reduced. This lowers the chance of pests developing resistance to chemicals, because if many of the pests are killed then any that have resistance to the chemical will form the genetic basis of the future population. By not killing all the pests there should be unresisting pests left that will dilute the prevalence of any resistant genes that appear.

2. Preventive cultural practices:

Selecting varieties best for local growing conditions, and maintaining healthy crops, is the first line of defence.

3. Monitoring:

Regular observation is the cornerstone of IPM. Observation is broken into two steps, first; inspection and second; identification.[9] Visual inspection, insect and spore traps, and other measurement methods and monitoring tools are used to monitor pest levels.

4. Responsible use of synthetic pesticides:

Synthetic pesticides are used as required and often only at specific times in a pest's life cycle. Many of the newer pesticide groups are derived from plants or naturally occurring substances e.g.: nicotine. However, traditional pest barriers such as ash to control snails are ecologically friendly.

ECOLOGICAL AGRICULTURE

Ecological farming generally involves a diversity of crops, animals and methods. Management techniques include cover crops, green manures, composting, mulching, crop rotation, no till cropping and the use of animal waste to maintain fertility. Diversification provides integrated farm systems, complementary production cycles and infrastructure as well as a form of income insurance that helps with production and price fluctuations.

Ecological agriculture is truly sustainable – it can regenerate and refertilise the degraded and damaged agricultural soils that cover most of the world, and will allow us to continue producing food on that land indefinitely. Conventional agriculture degrades and depletes the soil, and so cannot continue to feed us, and the "progress" made in agriculture in the last decades has come at an enormous environmental and social cost.



LESSON ACTIVITIES

ACTIVITY 1

List some of the activities that humans undertake that may contribute to climate change.

a)			
b)			
c)			
d)			
e)			
f)			

ACTIVITY 2

Based on your knowledge, design a poster to show the activity you think is the number one contributor to climate change.

ACTIVITY 3

List some of the activities humans may engage in to reduce their carbon footprint.

a)		
b)		
c)		
d)		
e)		
f)		
g)		

Reflect closely on, and scrutinize your everyday activities. Which of these activities do you think are more climate unfriendly? Draw or write them down on the footprint provided. Brainstorm on the possible ways of reducing your footprint.



Working in groups of 4, design and implement a small advert to educate your peers more on one chosen sustainable practice. For example, if you chose 'ride a bicycle to school' as an example, create an advert/promotion for the practice, putting emphasis on the activity's potential as a sustainable practice. The advert/promotion may be for TV/radio or newspaper.

Present to your peers. Ideas:

- ✔ Ride a bicycle to school
- ✔ Ride the bus instead of taking your car
- ✓ Turn off electrical appliances when not in use
- ✔ Recycling and reusing
- ✔ Carry your own water bottle
- ✓ Buy locally produced goods

ACTIVITY 6 (PRINT)

Below is a climate-form that can be used to assess how climate-friendly your school is. Print off the form, and give to the students to complete as an activity.-

 Find 5 ways your school is contributing to climate change. (Remember that 3 of the biggest emitters include transportation, solid waste, and energy)

i.	
ii.	
iii.	
iv.	
V.	
2.	List the ways in which your school is helping to reduce the amount of carbon emitted from its premises.
1.	
2.	
3.	
4.	
5.	
6.	

3. Thinking of the same pollution issues as above, describe what could be done better.

4. Design a poster to educate others on the school premises on a more sustainable way of doing things.

ACTIVITY 7 (PRINT)

Footprint calculator: Assign points to each of the following activities. Be honest!! Add up your score to see how climate friendly you are as an individual.

SCORING:

0 points- Never do this
1 point- Sometimes do this
3 points- Usually do this
5 points - Always do this
I recycle __
I take short showers __
I turn off lights/appliances when not in use__
I have and encourage the use of florescent light bulbs__

I have fruit trees/vegetable patches at home that I use_

I buy locally produced foods/items_

I carry my own water bottle_

I carry reusable lunchboxes_

SCORE:

0-10 you can do a lot more to help our planet

11-22 you've taken a few steps but you have some ways to go

23-35 you've got the idea but need to do just a little more

35-40 you are excellent, and an inspiration to others!!

Some people are still very sceptical about climate change. Research some of their most commonly used arguments and list them below.

i.			
ii.			
iii.			
iv.			
v.			

ACTIVITY 9

Describe some of the damages that may occur to a farm following a flood event.

a)			
b)			
c)			
d)			
e)			
f)			

ACTIVITY 10

Pretend that you own a small farm and that you have been greatly affected by the effects of climate change. Choose one effect of climate change and act out how you have been affected by it. Act out what you are going to do to minimise the impact that any similar event will have on your farm.

ACTIVITY 11

Investigate five or more nearby farm. Agricultural land is almost always affected by extreme weather events such as droughts and flooding events. Design a questionnaire with a few questions to find out

- How many times have the farm been completely crippled due to an extreme weather event in the last five years
- In what way specifically was the farm affected
- Were any crops/livestock lost
- What does this loss represent in monetary terms

Use the responses from the five farms to find out which extreme weather event hits farms the hardest in Seychelles: droughts or heavy rains/flooding. Put together a play, and act out a meeting situation, where one student acts as a consultant for farmers in Seychelles, others act as farmers and two or three act as government officials. The consultant needs to bring to the attention of the government officials which extreme weather events affect farms the most in Seychelles, and in what way. The consultant must then let the farmers suggest to the officials how they want the government to help them out, and the government officials must respond, positively or negatively.

Climate change and food security are tightly linked. Write a letter to the Ministry responsible for agriculture, and suggest ways to make the Seychelles island more food secure.

ACTIVITY 13

Draw a poster to show farmers how they can adapt to climate change

ACTIVITY 14

Design a small leaflet educating farmers about the concept of carbon footprint, and the best ways to reduce it.

ACTIVITY 15

Design (draw and annotate) a climate-proof, sustainable farm.

ACTIVITY 16

FARM ENVIRONMENTAL AUDIT

Choose a farm near your school. Rate the activities listed on a scale of 1 to 5, 1 representing poor performance and 5 excellent performance.

Activity	
Practices polyculture	
Practices agroforestry	
Uses natural pest-control techniques	
Have a rainwater harvesting system	
Has water conserving irrigation systems	
Incorporates climate-proof varieties of cropping	
Uses natural ways to ventilate livestocks	

Look at the total score of the sustainability audit. A good rating lies between 90 and 100 and indicates serious effort to be sustainable. A rating of 50-90 indicates conscious effort to be sustainable, but clearly there is room for improvement. A rating of less than 50 is not a very good one.

If you were to have a resort that scored less than 50, what would you suggest to them so that they can improve their rating? Write a letter, which should include the following:

- Reasons why resorts should be sustainable.
- A description of 2 or 3 things they could do to improve their rating.

Extreme rainfall events are a direct effect of climate change. Briefly describe how this phenomenon may have an adverse impact on the agricultural lands of the Seychelles. Think about actual flooding events, landslides, severe topsoil loss etc and their direct consequences (loss of crops, soil nutrients, livestock, land area, other infrastructure etc) and some of the more indirect consequences.

ACTIVITY 18

Choose one direct effect of climate change that may impact on the agricultural sector. Using the internet, and other sources, produce a small case study of the likely (or actual) impact that your chosen effect will have/is having on the agricultural industry of a tropical country of your choice

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Suggested destinations: Maldives, Kenya, Ethiopia, La Reunion, Mauritius, Madagascar, Jamaica, Haiti, the Bahamas, the Seychelles etc

ACTIVITY 19

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Interview an older person about traditional agricultural practices used in Seychelles in the past. Armed with your traditional examples, visit a 'modern' farm that you know. What are some of the similarities, and some of the differences?

Define the terms mitigation and adaptation

ACTIVITY 21
List examples of mitigative actions taken by farms in Seychelles to help combat climate change.

ACTIVITY 22

Work in groups and design a small poem/song/play/collage to show how the agricultural sector can help mitigate climate change.

case study

Organic agriculture is described as a way of mitigating climate change in the agricultural sector. Do you know a family member, a friend or a neighbour who practices organic agriculture on a small scale at home? Ask for their permission, and use their garden to put together a small case study (10 pages) on the methods they are using. Include an introduction, and then briefly describe the method they are using. Include some photos.

ACTIVITY 24

List some of the ways that farms can become more sustainable in:

a .	Their water usage.
•••••	
•••••	
•••••	
•••••	
•	
b.	Their power usage

Debate: Discuss the pros and cons of using organic pesticides versus using synthetic ones.

School project 1: Compost Heap Worksheet

Composting is a simple way to add nutrient-rich humus which fuels plant growth and restores vitality to depleted soil. It's also free, easy to make and good for the environment.

Materials to compost

- Table scraps
- Fruit and vegetable scraps
- Newspapers
- Flower cuttings
- Grass clippings
- Egg shells
- Used tea bags
- Livestock manure
- Chicken manure
- Cardboard
- Woodchips

Composting tip

- Do not compost meat, bones or fish scraps (they will attract pests), perennial weeds (they can be spread with the compost) or diseased plants.
- Do not include pet manures in compost that will be used on food crops.
- Banana peels, peach peels and orange rinds may contain pesticide residue, and should be kept out of the compost.
- Sawdust may be added to the compost, but should be mixed or scattered thinly to avoid clumping. Be sure sawdust is clean, with no machine oil or chain oil residues from cutting equipment.

How to compost

- 1. Start your compost pile on bare earth
- 2. Lay down twigs or straw first, a few centimetres deep
- 3. Add compost materials in layers, alternating the moist materials with the dry.
- 4. Add manure (green or livestock).
- 5. Keep compost moist (water occasionally or let the rain do it)
- 6. Cover your compost
- 7. Turn your compost pile every two weeks

Internet research: As your compost is composting, use the internet to answer these questions

- 1. List some of the environmental benefits of composting
- 2. Composting requires that we follow the '2 parts green, 1 part brown' principle. What is this principle and why is it important?
- 3. Why should the compost pile be kept moist?
- 4. Why do we need to turn the compost pile evry now and then?
- 5. Trouble shoot of the ideas to keep rodents away from the composting pile.

One way of combating Climate change is to practise organic agriculture, and composting is a major part of this!! But there are many different types of compost. Test out 3 different compost piles by adding them to a vegetable patch outside the school.

Collect the necessary data to record which vegetable row in the patch grows best. Think of reasons why you think the relevant row did better. Think of nutrients, soil moisture.

Punching Climate change

Which compost is more ideal for the dry season? Think of the soil moisture beneath the compost.

School project 2: Rainwater harvesting

Set up a rainwater harvesting system for the school, to be used in an irrigation system for the agriculture plots around the school.









Sustainability for Seychelles (S4S) is a non-governmental environmnetal organisation (ENGO) based in the Seychelles, with the mission to promote sustainable. 'green' living in Seychelles, in collaboration with citizens, the Government, other NGOs and the private sector.

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