A HANDBOOK ON

CLIMATE SMART

ENVIRONMENTALLY SUSTAINABLE

BEST FARMING PRACTICES

ACKNOWLEDGEMENT

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Jamaica Agricultural Society
Meteorological Service Division
Negril area Environmental Protection Trust
Rural Agricultural Development Authority
National Environment and Planning Agency

ABOUT THE HANDBOOK

This handbook is an output of a project entitled **"Conserving the Natural Resources through Innovative Agricultural Techniques in the Negril Environmental Protection Area".** The project is implemented by the Negril Area Environmental Protection Trust with funding support from the Global Environment Facility Small Grants Programme. It is a resource for famers to enable them to learn and apply sustainable land management practices as well as other environmental conservation strategies. Thus enabling them to adapt to climate change impacts as well as reduce the negative impacts resulting from their farming activities on the environment. There are nine main sections which are:

SECTION I: OVERVIEW - Details the main units in the Environmental Protection Area (hereinafter referred to as 'EPA') including the Negril Great Morass, Negril Hills, Fish River Hills and Negril Marine Park.

SECTION II: AGRICULTURE IN JAMAICA – Provides information about the importance of the agriculture industry in Jamaica.

SECTION III: CLIMATE CHANGE – Defines climate change and outlines the issues leading to the global problem. It also discusses the impact of climate change on agriculture.

SECTION IV: COMBATING CLIMATE CHANGE: WATER CONSERVATION AND HARVESTING – Water conservation is discussed as a means of combating the water scarcity problem plaguing agriculture.

SECTION V: UNDERSTANDING SUSTAINABLE LAND MANAGEMENT – Promotes Sustainable land management (hereinafter referred to as 'SLM') as a sustainable agriculture practice. SLM techniques are also examined in this section.

SECTION VI: SOIL CONSERVATION – Soil conservation is defined here as well as the benefits of conserving soil resources. Additionally, methods of soil conservation are discussed.

SECTION VII: INTEGRATED PEST MANAGEMENT – In this section pests is defined, pests of agricultural importance in Jamaica are identified and the introduction of integrated pest management as a contemporary strategy of controlling pest population.

SECTION VIII: INNOVATIVE AGRICULTURE - Defines and introduces innovative Agricultural techniques or technology such as greenhouse farming hydroponic systems, aquaponics or integrated approach such as greenhouse integrated with hydroponics creating a sustainable environment whilst promoting sustainable livelihoods.

SECTION IX: CONCLUSION – A summary of the previously outlined sections

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1.0 OVERVIEW:

NEGRIL ENVIRONMENTAL PROTECTION AREA (EPA)

Boundary of Negril EPA | Source: www.wfj.org.jm

In November 1997 the Negril EPA was formally declared as an area of land and water covering sections of Westmoreland and Hanover in western Jamaica. It includes the Negril Hills, Fish River Hills, Negril Great Morass and the Negril Marine Park.

1.1 NEGRIL HILLS

The Negril Hills are located in the south-western end of the Negril EPA boundary. It encompasses areas like Orange Hill, Retirement, Good Hope, Mount Airy and Retreat. The terrestrial ecosystems is a fragment of the dry limestone forests existing in western Jamaica and boasts equally unique wildlife flora and fauna. Large, native forest trees are diffused throughout the area – Silk Cotton and Red Birch to name a few. At the understory of these woody perennials are plants like the endemic Red Mountain Pride, a variety of orchids and bromeliads. Negril Hills have been able to have access to conservation and preservation factors that have been critical in maintaining rare species that are believed to exist only in the area – in the southeast junction lies the rare endemic orchid *Broughtonia negrilensis.* Duck Pond is another significant ecosystem attracting egrets, doves, the West Indian Whistling Tree Duck, herons and coots. All species within Negril Hills are critical for the ecosystem productivity.

DID YOU KNOW?

The West Indian Whistling Tree Duck is endangered.

1.2 FISH RIVER HILLS

The north-south positioned mountains are an approximate 900 feet above sea level and consists of areas like Springfield, Silver Spring and Cave Valley. Similar to Negril Hills, Fish River Hills is made up of limestone rocks that are wetter than the ones found in Negril Hills. The environmental conditions facilitate a variety of vegetation that captures shrubs and small flowering plants. Hovering above these plants are larger trees that have been eyed for their timber and coal value; the Logwood is common in Fish River Hills as well as Lignum Vitae and Guango. Fish River Hills may be described as the "water tank" for Negril EPA since the largest spring providing water around the circumference is found in Logwood. Therefore, conservation is important for maintaining water supply throughout communities in and around Fish River Hills.

1.3 NEGRIL GREAT MORASS

The Negril Great Morass is Jamaica's second largest freshwater wetland, which stretches from Orange Bay to a little below the South Negril River. The wetland is populated with sawgrass in uniformity to the south and a fragmented combination with ponds to the north. Like a giant sponge, the wetland absorbs water flowing from the eastern bound Fish River Hills.

Many wildlife cling to the Great Morass for survival – the endangered Black Parakeet and American Crocodile being two of them. The endemic Royal Palm vegetate the morass, alongside Bull Thatch and Buttonwood. Many plant and animal species occupying the wetland are either endangered, threatened or endemic. Being a biodiversity hotspot, it has gained the attention of conservation efforts.

Figure 1.3.1 showing The Negril Great Morass

Blue Arrows pointing to the North and South Canals which were constructed to drain the Morass for farming as well as the construction of the Norman Manley Boulevard.

Source: Google earth

DID YOU KNOW?

The endemic Royal Palm is only found in the Great Morass and other wetlands in western Jamaica.

Royal Palm

The West Indian Whistling Duck

The entire Great was greatly affected by the construction of drainage canals around three sides of it in 1959 and 1960. These canals resulted in the drying up of other smaller rivers as well as the morass thus creating dryer conditions. While this may seem ideal for farming it resulted in increased bush fires which affects important plant and animal species populations. The drainage also resulted in the decrease in certain fish populations as well as introducing salt water into the morass affecting fresh water sources.

1.4 NEGRIL MARINE PARK

Figure 1.4.1 show Elkhorn coral in the Negril Marine Park

The Negril Marine Park was the first established protected area in the Negril EPA. It encompasses the marine portion of the Negril EPA and is 161km.sq stretching from Davis Cove in Hanover to St. John's Point in Westmoreland. The Negril Marine Park is rich in corals, sea grass beds, coastal wetlands, and mangroves. It has a very rich biodiversity supporting several livelihoods such as fishing, water sports and eco-tourism. Living in the reefs of the Negril Marine Park are damselfish, parrotfish, sea star, sea egg and several other species. Elkhorn and Staghorn Corals are two very important coral species that are found within the Negril Marine Park. They are endangered species. There is a Coral Nursery established in the Orange Bay Special Fishery Conservation Area in the Negril Marine Park where fragments of these species are grown for coral reef restoration. Coral Reefs are very important as they prevent erosion of the shoreline.

Coral reefs are important ecosystem but they are threatened with climate change. In the Negril Marine Park, coral bleaching is one example of how climate change have affected reefs. Coral bleaching happens when the water is too warm and the corals expel the algae (zooxanthellae) living in their tissues thus causing the coral to turn completely white.

Figure 2.4.2 showing map of the Orange Bay Special fishery conservation area

Figure 1.4.3 showing Bleached coral in Negril Marine Park

2.0 AGRICULTURE IN JAMAICA

2.1 IMPORTANCE OF AGRICULTURE IN JAMAICA

2.1.1 FOOD SECURITY

Food Security in the layman's term is "ensuring that all people at all times have both physical and economic access to the basic food that they need". (Food and Agriculture Organization, 2006) Rural households depend heavily on farming, whether back-yard gardening for domestic use or small-scale farming for income. While half of the country's population live in rural areas, at least 85 per cent of rural people are living on farm lands of about 5 hectares. This is an indication that rural households are reliant on agriculture as a primary economic activity. In addition a significant portion of the farm lands are on hillsides, therefore in order to continue to provide food, soil conservation techniques must be applied as a part of sustainable land management activities. Food security is also affected by climate change therefore farmers have to understand and apply climate smart agricultural practices.

2.1.2 TAX REVENUE AND GROSS DOMESTIC PRODUCT (GDP)

As of 2017, GDP contributions by agriculture in Jamaica increased to 7.3 per cent according to the Ministry of Industry, Commerce, Agriculture and Fisheries. This is evidence that the sector has been boosting the Jamaican economy over the years even though it has experienced fluctuations.

DID YOU KNOW?

In a specific time period, a country calculates the monetary value of all the final goods and services. That monetary value is called GDP.

2.1.3 JOB CREATION

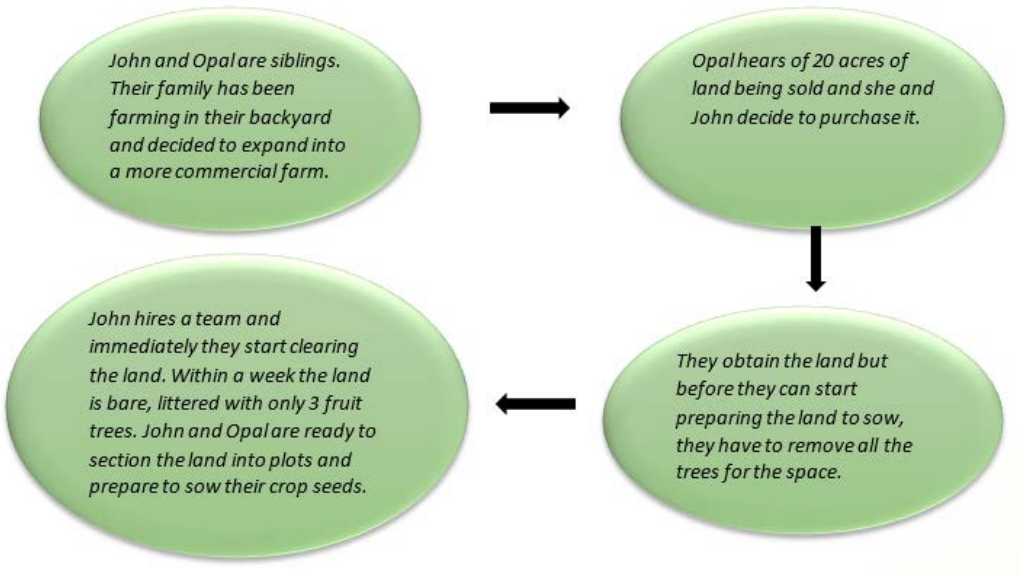
Although one-fifth of the employed labor force is accounted for by agriculture as of 2014, many other jobs are reliant on it. What are jobs/careers in agriculture that you can think of? Here are a few:

- Livestock farmer
- Crops farmer
- Veterinarian
- Plant Scientists
- Extension Officer

2.2 IMPACT OF AGRICULTURE ON THE ENVIRONMENT

While agriculture is very important, it also has a direct impact on the environment. Depending on the farming practices that are done, the impacts can be very negative. In fact Agriculture contributes to global warming, deforestation, biodiversity loss, soil degradation, waste and poor water quality.

Imagine this scenario:



2.2.1 DEFORESTATION

So let's talk a little about deforestation. Deforestation is the removal of a forest or stand of trees from land to make room for something else that is not a forest. So in the scenario above, the land is made available but without removing all the vegetation, John and Opal could not start their new business venture. This is the main situation in agriculture; large acres of forests are being removed yearly to create space for crop cultivation. Yes, it is good for business and it is good for the economy but the environment pays the price. These are some of the ways that the ways that the environment pays the price: soil erosion, destruction of homes for wildlife, reduced rainfall, increased carbon dioxide emissions.

Trees are diverse; not only do they create a habitat for birds and other species but they also help with climate regulation. How, you may ask?

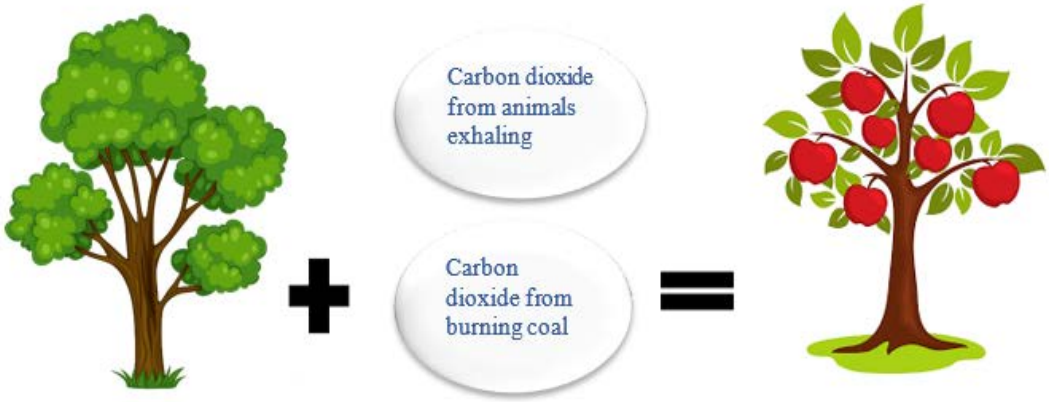


Figure 3.2.1.1 showing how Trees regulate Climate.

Trees are what is known as a "carbon sink". They use carbon dioxide to produce fruits or use up nutrients in a process known as photosynthesis.

DID YOU KNOW?

Forests are the world's third largest carbon sink. The first largest is sea grass and the second largest is mangrove plants.

While preparing the land for cultivation, clear-cutting and burning of forested areas causes extensive degradation to soil quality and soil structure. The physical structure of the soil is left vulnerable to agents of erosion (water & wind). Without cover or fodder crops to intercept precipitation, water will not seep into soil and causes increase run-off thus causing erosion. Furthermore the burning of forested lands will degrade soil nutrient content while killing very important soil organism. These organisms aid in the aeration of the soil and even add nutrients by means of decomposition. Due to the potential negative impact agriculture has on the environment, farmers are urged to practice or put in place agricultural farming strategies that are sustainable and environmentally friendly.

2.2.2 CHEMICAL USE – PESTICIDES, SYNTHETIC FERTILIZERS

The use of artificial fertilizers and pesticides can be beneficial good crop growth and protection from pest infestation respectively. However both chemicals seen as very useful can cause harm to the wider environment. When it rains pesticides and fertilizers are washed into the marine environment. Corals that depend on good water quality to survive are threatened. "The excess of nutrients within marine waters will cause the rapid growth of algae. When this occurs, the algae blocks sunlight from reaching corals and use up dissolved oxygen that corals need for respiration". (United States Environmental Protection Agency, 2018)

The excess of nutrients in marine waters may also result in the breeding of pathogenic fungi and bacteria which may cause ham to corals. The chain effects from chemicals from agriculture damaging corals can be disastrous to the fishing activities and tourism. If corals reefs are destroyed the fishing population will decrease as reefs are a habitat for fishes to live and reproduce. Therefore, it is important farmers use environmentally safe alternatives of improving yield and controlling pests.

3.0 CLIMATE CHANGE

The term climate can be coined as the average weather conditions of a region over a long period of time (usually over 30yrs). A country's climate is dependent on its location on the earth's surface. A country may be located in the temperate zone like much of United States of America or the tropical zone like Jamaica. Here in Jamaica we have a climate with two distinct wet seasons and one main dry period in July. However, the time has gotten considerably hotter, there has been less rainfall and the seasons are not as distinct as they were a decade ago. This is being attributed to climate variability and change.

3.1 CLIMATE CHANGE: A SIMPLE TERM, A SIMPLE

MEANING

Climate Change is defined as the shifting of earth's climate system. Simply put, it is a change in the normal climate experienced by countries. The term was coined to replace the more commonly used term "greenhouse effect" since confusion was arising. The greenhouse effect is a natural process of earth capturing the right amount of heat needed for living things to survive. However, human activities have resulted in the earth absorbing more heat than needed.

SOME CAUSES OF CLIMATE CHANGE

- ✓ Burning coal, oil or natural gas for energy.
- ✓ Removal of trees without replanting (deforestation).
- ✓ Intensive Agricultural Practices which results in the emission of greenhouse gasses such as methane and nitrous oxide

3.2 IMPACT OF CLIMATE CHANGE ON AGRICULTURE

LIVESTOCK

- *Heat stroke – heat affects especially pigs due to their physical anatomy. Other animals are equally threatened with high temperatures.*
- *Water deficiency: Droughts prevent this vital resource from being available for animal need.*
- *Food availability is also compromised. Pastures are drying up and grasses are dying so what will these animals eat?*
- *Farmers are faced with the challenge of more intense storms damaging infrastructure.*
- *Heat stress*
- *Affects egg production in layer hens*

CROPS

- *Natural water loss from plants alongside the lack of water to feed crops result in wilting and death of crops.*
- *A positive impact is the reduction in pest population. Many pests cannot thrive in very high temperatures;*
- *However, the unfavorable temperature that kills pest also kills micro-organisms that help to make the soil fertile.*
- *Reduction in rainfall events causes a build-up of salt in soil.*

4.0 COMBATING CLIMATE CHANGE: WATER CONSERVATION AND HARVESTING

Water conservation is the efficient use of water resources. Do you waste water? We have oftentimes took for granted the availability of water, those of us who have it at our disposal through pipes are to be highlighted. We may shower longer than necessary or brush our teeth while leaving the faucet running. However, these actions can be altered in a way that reduces water being wasted.

4.1 BENEFITS OF WATER CONSERVATION AND HARVESTING

Prevent Water shortage	*Reduce ground water consumption*
Sustained irrigation	*Maintain water quality*
Pest management	*Reduce flooding and erosion*
Ecosystem service	*Saving money*

4.2 CONSERVING WATER: DRIP IRRIGATION SYSTEM

A drip irrigation system (DIS) is a water and nutrient conservation technique that allows water to reach plants through slow drips. With this system, water is directly reaching plant roots as pipes are positioned directly above the soil or underground within the root zone. Two types of DIS have been examined: subsurface DIS and surface DIS.

Plate 4.2 showing a close up hydroponic system.

4.2.1 SURFACE DRIP IRRIGATION SYSTEM

Surface DIS enables water to be administered through pipes positioned directly over the soil inhabited by plants. For higher efficacy, the system's drip holes are in close proximity to the plant – the roots are able to capture the water. The disadvantages of surface DIS are that cultivation and tillage easily cause pipes to be damaged and water may easily evaporate from the surface.

4.2.2 SUBSURFACE DRIP IRRIGATION SYSTEM

They function similarly to surface irrigation systems but they are beneath the soil surface. Commercial farmers tend to gravitate towards this type of DIS because it proves to be more feasible. This irrigation type allows water to be administered directly into the root zone of plants while simultaneously reducing water wasting.

4.2.3 BENEFITS OF DRIP IRRIGATION SYSTEMS

Conserves Water	*Wastewater irrigation*
Reduces Nutrient Leaching	*Increased Productivity*
Weed control	

4.3 STORING WATER: RAINWATER HARVESTING SYSTEM

A rainwater harvesting system allows the collection, storage and distribution of rainwater for different purposes; it may be for domestic use or agriculture. A rainwater harvesting system (RWH) may be very simple with one or two components or it may be complex. Generally, RWH system has 4 main components:

1. Catchment area: an impermeable surface that allows surface run-off of rainwater. It may be a roof, concrete surface or other surfaces.
2. Conveyance system/conduit: drains or gutters and pipes that are connected to a storage system – water is able to be moved from the catchment area to storage through the conveyance system.
3. Storage: the storage is the core part of the system; rainwater is stored here. It may be a tank that is situated above or below ground.
4. Distribution system: enables the movement of water from the storage to the target area – crops, animal, housing, etc. Distribution system may be a simple container to extract the water or pipes leading to the target area.

DID YOU KNOW?

Roofs are commonly used catchment area. However, roof coating that contains lead can be detrimental to plants and animals.

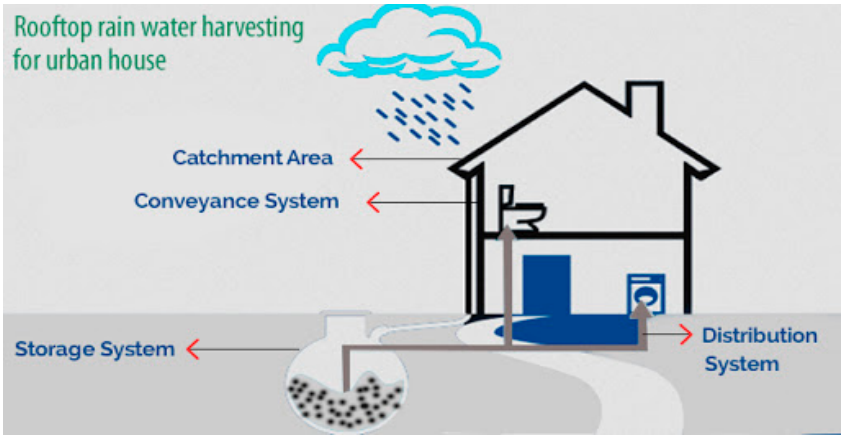


Figure 4.3 showing Simple Rainwater Harvesting System

Source: Homes for You

4.3.1 SIMPLE TYPES OF WATER COLLECTION AND STORAGE

4.3.1.1 ABOVE-GROUND TYPES

Plate 4.3.1.1.1 showing above ground Pond.

Plate 4.3.1.1.2 showing Water Tanks made from concrete.

i. Ponds

Earth ponds as they are often called requires an area of land with a slight depression. This area is coated with waterproof layers like plaster coating or other waterproof materials. A major disadvantage of earth ponds is its open surface that allows water to evaporate.

ii. Tanks

Unlike earth ponds, tanks are enclosed structures that limits water loss caused by evaporation. Masonry tanks are constructed from masonry blocks or solid case concrete. They are reliable but require maintenance after a period of time because water either starts to seep through or they become cracked.

Plastic tanks are more commonly used because they can be easily moved and they last longer under low maintenance. Molded plastic tanks are light weight and easily installed to harvest rainwater.

Plate 4.3.1.1.2 showing Plastic Water Tanks.

4.3.1.2 UNDERGROUND

iii. Cisterns

They are built in a hole-like foundation. A cistern is very much similar to a masonry tank except it is underground. With proper construction, this storage type is quite durable as it limits vertical and lateral water infiltration. However, there are disadvantages associated with cisterns – they crack easily from root growth, earthquakes or the material being unable to withstand water and soil pressure.

Plate 4.3.1.2.1 showing a photograph of a Cistern.

5.0 UNDERSTANDING SUSTAINABLE LAND MANAGEMENT

5.1 WHAT IS SUSTAINABLE LAND MANAGEMENT (SLM)?

Sustainable land management is the use and stewardship of land resources in a way and at a rate that allows it to be available in good quality and quantity for the future generations. SLM is an integrated land use approach that does not only focus on land. It recognizes the interconnectedness of land-related resources such as water resources and biodiversity.

5.2 AGRICULTURAL BENEFITS OF SLM

Maintains Fertile soil	*Limits Water Unavailability*
Limits soil erosion	*Carbon regulation*
Higher crop yield	*Improve farmers' marketability*
Reduces flooding	
Reduces soil degradation	

5.3 HOW TO SPOT UNSUSTAINABLE AGRICULTURAL LAND USE PRACTICES

Common Unsustainable Practices	**Environmental Effects**	**Effects on Flora and Fauna**
Slope Cultivation without soil conservation	▪ Soil erosion ▪ Soil infertility	Low crop yield Disturbancce of microbes biomass (living component of soil organic matter)
Deforesting watershed forests	▪ Reduction in groundwater ▪ River sedimentation ▪ Increased flash-floods ▪ Soil erosion ▪ Reduced water quality ▪ Waterlogging in floodplains ▪ Impact biodiversity	▪ Under-irrigation ▪ Water deficiency for livestock ▪ Reduced plant growth – reduced biomass. ▪ Habitat loss for plants and animals.

		▪ Reduction or killing off of pollinators.
Overgrazing	▪ Nutrient depletion in soil. ▪ Increase surface run-off/flooding ▪ Soil erosion	▪ Animal malnutrition ▪ Diseases in animals
Common Unsustainable Practices	**Environmental Effects**	**Effects on Flora and Fauna**
Frequent tillage	▪ Soil compaction/formation of crust. ▪ Reduced soil nutrient value ▪ Soil infertility	Low crop yield
Monoculture	Soil infertility	Low crop yield
Decreased Fallow period	Soil infertility	Low crop yield
Frequent use of pesticides/fertilizers	▪ Soil salinization ▪ Soil acidification ▪ Reduced water quality (eutrophication). ▪ Land pollution ▪ Marine pollution from water run-off	▪ Coral mortality ▪ Fish mortality/other aquatic animals. ▪ Recurring plant diseases.
Slash-and-burn	▪ High-risk for bushfires ▪ Associated deforestation effects – increased flash-flooding, groundwater depletion, habitat loss.	▪ Increases mortality of plants and animals. ▪ Reduces pest population

5.4 CORRECTING UNSUSTAINABLE AGRICULTURAL LAND USE PRACTICES

5.4.1 CONTOUR FARMING

Contour lines follow the same height so it neither falls down or rise up the hill. Contour planting involves planting crops along these consistent elevation to reduce soil erosion.

Plate 5.4.1.1 showing photograph of Contouring Farming.

5.4.2 AGROFORESTRY

Agroforestry represents a system where timber plants are cultivated with crops, crops with pastures or forage and livestock with trees/woody perennials. The integrated system allows farmers to subscribe to a SLM system that benefits them simultaneously.

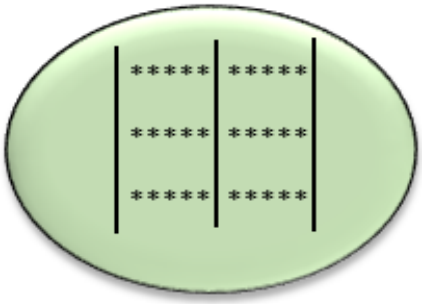
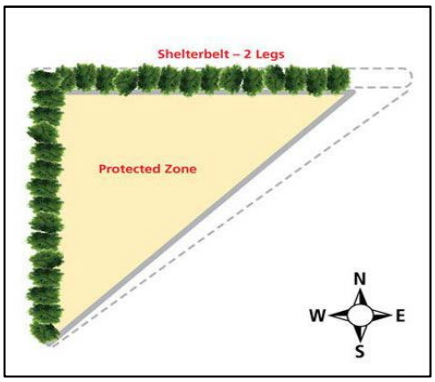
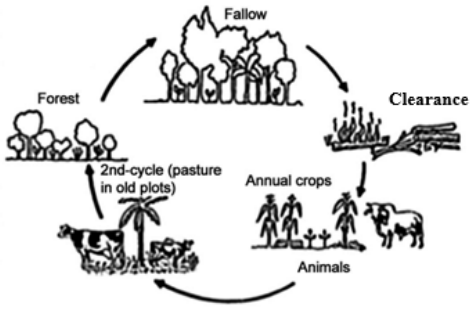
5.4.2.1 CLASSIFICATION OF AGROFORESTRY SYSTEMS

i. **Agrisilviculture:** the cultivation and management of woody perennials with crops. They can be fruit trees or timber species trees.

ii. **Agrosilvopastoral:** this system enables the management of lands with forage/pasture, animals and crops.

iii. **Silvopastoral:** Livestock rearing and management is integrated with woody perennials.

5.4.2.2 EXAMPLES OF AGROFORESTRY SYSTEM TYPES

Type	Description	Major Benefit
Alley Cropping 	Planting crops between rows of trees or taller plants. Example: Rows of banana 3-6 feet apart, pineapple planted in between.	✓ Reduce wind speed, therefore they limit soil erosion caused by wind. ✓ Increase cropland biodiversity – this makes it more resilient to diseases.
Windbreak/Shelterbelt 	Planting trees that are resilient to wind perpendicular to the prevailing wind. It may be a 2 leg wind break or 1 leg based on wind direction. Example of windbreak trees: coconut, mango, moringa, papaya. Best spacing is at least 2 feet apart.	✓ Reduce soil erosion caused by wind ✓ Reduce odor associated with animals. ✓ Add financial value (fruits can be sold or timber from timber species tree). ✓ Add biodiversity to farmland.
Improving fallow in shifting cultivation 	Shifting cultivation: clearing vegetated land for agriculture; clearing crops to allow natural vegetation to regenerate. Fallow: the period that the land is left unattended. Best fallow period is 5-20 years.	✓ Improve soil fertility/regenerate soil nutrients. ✓ Regenerate physical component of soil. ✓ Improve crop yield potential on second cycle of cultivation (cultivation after fallow).

5.4.3 MINIMUM TILLAGE

Tillage is a process of preparing the land for growing crops. In the process, soil structure and soil microorganisms are disturbed, thereby reducing soil fertility. Reducing tillage or having no-till production where applicable helps to conserve the soil structure and nutrient value. When this is paired with mulching, soil fertility is maintained.

Plastic row covers (mulching) used in hot pepper cultivation.

5.4.5 RAINWATER HARVESTING

Some types of rainwater harvesting systems reduce flooding and water-induced soil erosion by controlling the movement and flow of rainwater over land.

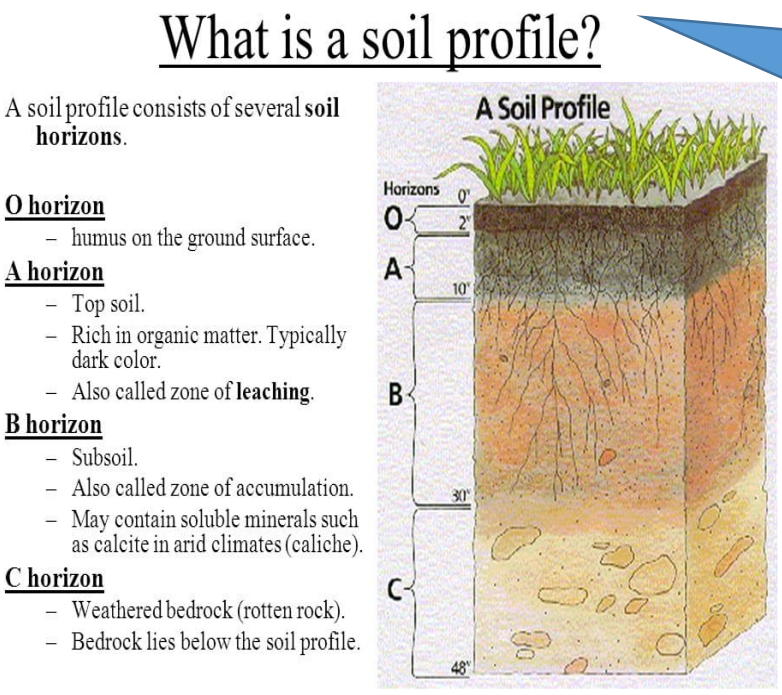
6.0 SOIL CONSERVATION

Soil conservation is the application of practices and techniques that preserve the soil quality. The practices may be for the conservation of nutrient, water holding capacity, organic component or physical structure, all of which are essential for soil to sustain plant life and agricultural productivity.

6.1 WHAT IS SOIL?

We see it every day, but what really is soil? Soil is the loose, brown surface material that combines inorganic particles with organic materials to cover most of the land surface we see. Inorganic components of soil include the minerals in soil like potassium, magnesium and calcium that all contribute to the growth of plants. Organic matter makes the soil the dynamic medium that it proves to be (e.g. texture, porosity); it comes from the break-down of dead plants and animals by soil organisms.

6.2 DO YOU KNOW YOUR SOIL PROFILE?



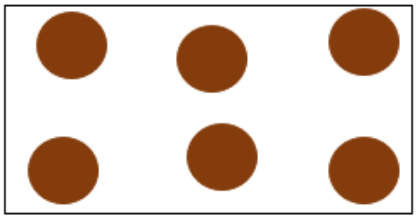
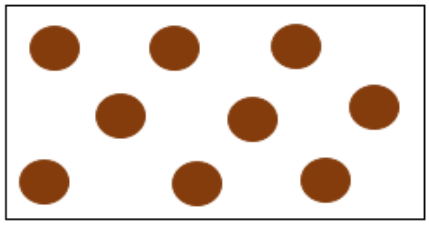
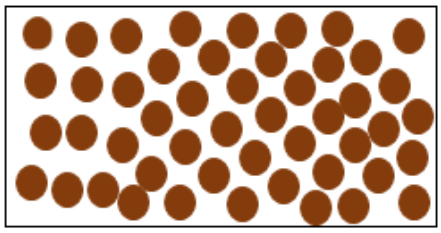
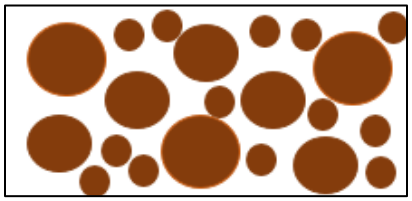
A Soil Profile is a vertical cross-section of the soil showing all of its horizons from the surface all the way down to the bedrock.

Figure 6.3.1 showing cross-section of a Soil Profile.

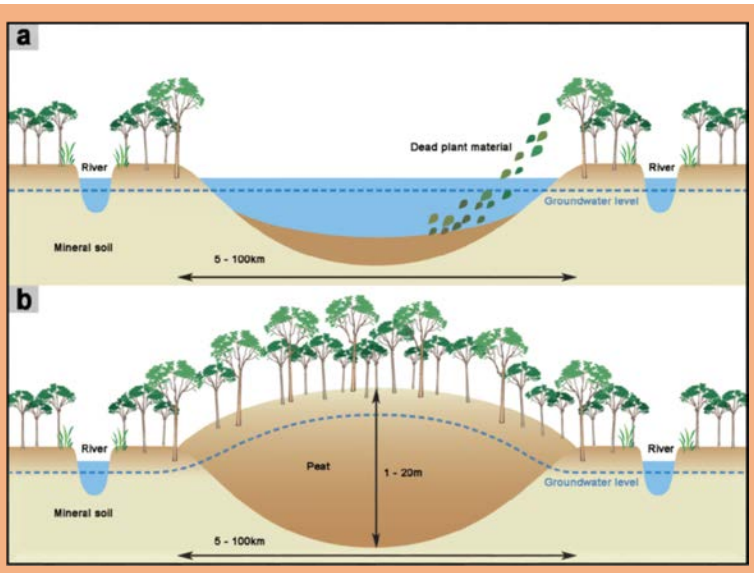
https://thelawnforum.com/

6.3 KNOW YOUR SOIL TEXTURE TYPE

Table 6.3.1 Showing Soil Types and their Characteristics

i. Sand 	Large, porous particles that allows water to drain easily through it – low water retention capacity. Particle size: Coarse sand: between 2 millimeters to greater than 0.2 millimeters in diameter Fine sand: between 0.2 millimeters and 0.02 millimeters in diameter.
ii. Silt 	Has little chemical activity and is easily compacted under pressure. Water retention capacity is moderate – greater than that of sand. Particle size Diameter of between 0.2 millimeters and 0.002 millimeters.
iii. Clay 	High water retention capacity; low porosity. Clay is nutrient-rich. Particle size: A diameter of less than 0.002 millimeters.
iv. Loam 	Most farmers use this type of soil – it is a mixture of clay, sand and silt but at different volumes. Loam crumbles easily and feels relatively soft.

6.4.1 PEAT



Source: www.researchgate.net

Figure 6.4.1.1 showing the formation of Peat Soil build up overtime.

Peat can be found in the Negril Great Morass. In fact in the 1950's a peat mining exploration was done for use of peat as a fuel source. There was however a community led effort which objected to the peat mining efforts and it was subsequently discontinued. That peat exploration activity led to the development of the Negril Royal Palm Reserve. Peat can be defined as a soft dark substance that is formed from generations of dead and partially decaying organic matter. Unlike other soil types however, peat requires areas of waterlogging, oxygen absence, low nutrient availability and high acidity (International Peatland Society, n.d.).

6.4.1.1 FORMATION

1. Plants in waterlogged areas or land with high water table begins to experience decay.
2. With the low nutrient level, low oxygen availability and low pH, suitable condition is created for the dead materials to continue breaking down.
3. These materials decay and build up as peat. The fertile peatland undergoes what is known as succession which is a process of plants inhabiting virgin lands.

6.4.1.2 AGRICULTURAL BENEFITS OF PEAT

High Crop Yield	Peat is a very fertile soil type that holds nutrients required by plants
Sustained soil fertility	Because of the nutrient holding capacity of peat, cultivation on peatland hardly requires extensive soil conservation strategies.
Irrigation	It has the potential for subsurface drip irrigation systems from ground water that is highly accessible.

6.4.1.2 THE PROBLEM

Peat being located close to marine environment creates high pollution risk associated with agriculture. In addition, peat-land that accommodates agriculture requires vegetation clearing and sometimes drainage. Many farmers use the slash and burn method and the highly flammable soil type causes uncontrollable forest fires.

6.5 SOIL CONSERVATION METHODS

6.5.1 CHECK DAM

Blocks or stones are used around the edges and floor of a hole that retards water from run-off. The hole may be dug to a depth of 2 feet for greater efficacy and is within a drainage ditch/gully. In a loose-stone check dam the stones are packed without the use of any adhesive agent like cement. Sediments that accumulate in the check dam is the nutrient-rich top soil.

Plate 6.5.1 Showing stones used in creating small dams.

6.5.2 CONTOUR FARMING /CONTOURING

i. Vetiver Grass: widely used in soil conservation because of its structure. Their roots spread widely while going a depth of up to 3 meters in the soil. The vetiver grass helps with erosion control and increasing groundwater retention.

Plate 6.5.2.1 Showing vetiver grass (*Chrysopogon zizanioides*).

ii. Terracing, also done along slope contours. Terracing are narrow step-like structures that reduce top-soil disposition as well as run-off.

Plate 6.5.2.2 Showing Terracing method of soil conservation.

iii. Hillside ditch: channels that are constructed along slope contours. They divert run-off to more stable parts of the slope.

Plate 6.5.2.3. Showing Hillside Ditch used in re-routing of run-off.

iv. Dead barriers help with erosion control and stabilizing the slope. Barriers could be made from bamboo or wood combined with other debris. They are also established along slope contour

Plate 6.5.2.4. Showing Bamboo barrier used to stabilize slope.

6.5.3 DRAINS/DIVERSION DITCHES

Drains are built at areas on land where water normally builds up or travels in a channel-like manner. These structures are effective in soil erosion control especially when used with check-dams.

6.5.4 ROTATIONAL GRAZING

In livestock rearing, rotational grazing is a method of allowing soil nutrients to regenerate. In essence, grazing animals will use an alternate pasture and this will be done in a cyclical manner.

6.5.5 RETENTION WALLS/GABION BASKET

Plate 6.5.5.1 Showing Retention Walls constructed to combat Soil Erosion.

Soil on slope is always moving downhill under the pulling force of gravity in a process called soil creep. Soil erosion on the other hand occurs due to rain and wind displacing topsoil. Retention walls or gabion baskets help to stabilize steep slopes and reduce erosion.

6.5.6 CROP ROTATION

Mainly small scale farmers practice crop rotation. It involves the cultivation of different crops throughout different growing seasons. In essence, soil nutrients are prevented from being depleted to a stage where the soil becomes infertile or desertification takes place.

Plate 6.5.6.1. Showing two plots of land which are used to rotate crops.

Table 6.5.6.1 showing example of crop rotation across four plots over four years.

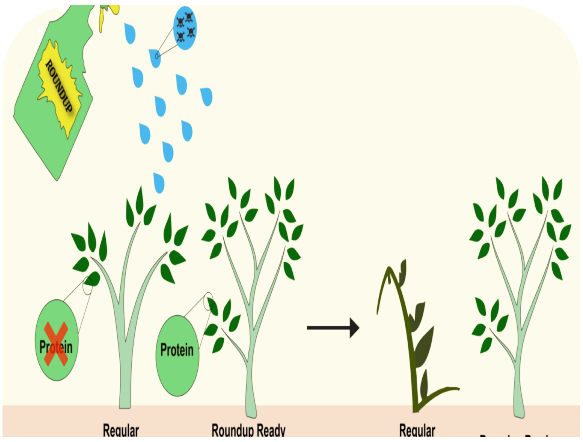
Time (years)	Plot 1	Plot 2	Plot 3	Plot 4
1	Tomato, cucumbers, melon, okra	Onion, garlic, scallion, carrot	Red peas, gungo peas	Lettuce, cabbage, callaloo
2	Onion, garlic, scallion, carrot	Red peas, gungo peas	Lettuce, cabbage, callaloo	Tomato, cucumbers, melon, okra
3	Lettuce, cabbage, callaloo	Tomato, cucumbers, melon, okra	Onion, garlic, scallion, carrot	Red peas, gungo peas
4	Red peas, gungo peas	Lettuce, cabbage, callaloo	Tomato, cucumber, melon, okra	Onion, garlic, scallion, carrot

6.5.7 COVER CROP

Crops like pumpkin and watermelon are good cover crops. They act as a "living mulch" that protects the soil from direct impact of water and wind. With the presence of cover crops their roots compacts the soil to prevent the erosion of top soil by water and wind. The use of cover crops as mulch is quite conventional as it increases soil fertility through moisture retention and add organic matter to the soil. "Cover crops also helps maintain soil humidity through shading and control of the thermal regime (lowers temperature, therefore reduces evaporation of water from the soil and increases water infiltration)." (Food and Agriculture Organization, 2011)

Plate 6.5.7 Showing Pumpkin used as cover crops.

7.0 INTEGRATED PEST MANAGEMENT



7.1 WHAT IS A PEST?

Any plant or animal that is harmful to human health, food or living conditions is considered a pest. Animal pests:

a. Are disease-carrying organisms – the disease can be transmitted from host to humans.

b. Attack or feed on crops, whether fruits or vegetables.

c. Attack or feed on livestock or pets.

d. Damage infrastructure. For example, termites burrow through timber buildings.

e. Bite people causing discomfort or even infections.

7.2 COMMON PESTS IN AGRICULTURE

Table 7.2.1 showing some Pests and their effects on Crops.

Scientific Name	Common Name	Effects on Crops/Plants
Spodptera exigua	Beet army worm	✓ Main hosts include leafy vegetables. ✓ Burrow large holes into plant leaves and skeletonize foliage.
Plutella xylostella	Diamondback moth	✓ Burrow holes into forage ✓ In leafy vegetable like cabbage, they distort plants.
Aleyrodidiae spp.	White fly	✓ Main hosts include agriculture crops. ✓ Suck on plant content using mouth parts – they leave a white residue known as honeydue (can cause fungus development)
Meloidogyne spp.	Root knot nematode	✓ Nematodes inhabit soils and affects plant roots ✓ Damages plant roots
Metamasius spp.	Weevil	✓ Main hosts include banana, yam, pineapple ✓ Tunnel into fruits or plant stalk, causing the plant to be weakened
Diabrotica spp.	Beetle	✓ Main hosts include Susumba leaf, cucumber, pumpkin etc. ✓ Foliage feeders
Paracoccus marginatus	Papaya Mealybug	✓ Host plant is papaya, sweet pepper, sweet potato, and some ornamental plants ✓ Their piercing and sucking nature affects plant content ✓ Sooty mold on leaves reduce photosynthesis.
Thrips tabaci	Onion thrips	✓ Main hosts include scallions.

		✓ Feed by piercing and rasping with their mouth part, ✓ Suck up plant content
Liriomyza trifolii	Leafminer	✓ Mains hosts include scallion and other crops ✓ Feed on leaf tissue ✓ Large populations bring more harm
Anastrepha obliqua	West Indian Fruit Fly	✓ Main hosts include mangoes, plums and apples ✓ Burrows into fruits and suck contents ✓ Reduce marketability of fruits.
Peronospora destructor	Downy Mildew	✓ Host plant is pumpkins, scallion. ✓ Discoloration of leaves affect photosynthesis capability
Stemphyllium vesicarium	Powdery mildew	✓ Host plant is scallion ✓ Discoloration of leaves affect photosynthesis capability

Source: Ministry of Industry, Commerce, Agriculture and Fisheries

7.2.1 YOU MAY HAVE SEEN THESE COMMON PESTS/SYMPTOMS

1. **Beet armyworm (*Spodoptera exigua)*** - Juvenile and Adult respectively

2. **Diamondback moth (*Plutella xylostella)*** – juvenile and adult respectively

3. **Whitefly (*Aleyrodidiae spp)*** -

Adult

4. **Root knot nematode (*Meloidogyne spp)* –** symptom

5. **Weevil (*Metamasius spp.)*** – adult

6. **Papaya Mealybug** *(Paracoccus marginatus)* – symptom

7. **Leafminer (***Liriomyza trifolii*) - symptom

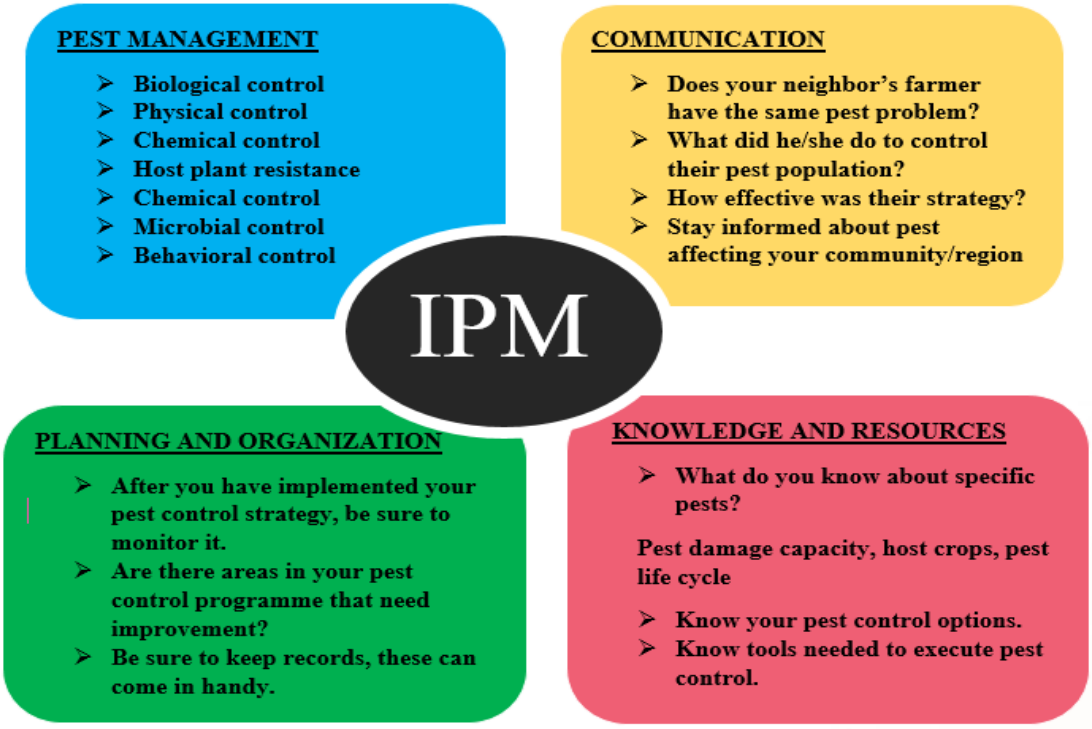
8. **Beetle (***Diabrotica spp.)* **–** adult

9. **Onion thrips** (*Thrips tabaci*) – symptom and adult respectively

10. **West-Indian Fruit Fly** *(Anastrepha obliqua*) - adult

7.3 WHAT IS INTEGRATED PEST MANAGEMENT (IPM)?

Integrated pest management combines the use of biological, cultural and chemical practices to control insect pests in agricultural production**.**



7.4 AGRICULTURAL BENEFITS OF IPM

Improved Crop Yield:	Plants and fruits will have minimal limitations caused by pests and diseases.
Improves Marketability:	Crops and animals can be marketed to commercial entities.
Increases income:	Farmers are able to earn more money from quality produce.
Saves money:	Reduces the amount being spent of rehabilitating damages.
Lessens labor:	Requires only occasional monitoring and corrective action.
Food security:	Families and the nation on a whole benefits from the access to increased productivity in agriculture.
Limits environmental impact of agriculture:	Allows farmers to employ more environmentally-safe pest control strategies rather than the use chemicals.

7.5 IPM STRATEGIES

Table 7.5.1. Showing Integrated Pest Management Strategies.

Method	**Description**	**Pest problem/disease (example)**	**IPM Application (example)**
Host Plant Resistance	The host plant may either damage the pest become unattractive to the pest or have good yield regardless of pest presence.	Whitefly	Cottons have hair-like structures called 'trichomes' growing out of their leaves. These make them resistant to whitefly infestation.
Cultural Control	i. Adjust planting space ii. Crop rotation iii. Sanitation (pruning, foot baths, removing debris) iv. Modifying irrigation practices v. Modifying sowing and harvesting cycles vi. Sowing spaces vii. Intercropping resistant crops with vulnerable crops. viii. Terminating waterlogged sites	Mealybug Powdery mildew Onion thrips Rats	Prune affected papaya to limit contact with unaffected plants. Use subsurface irrigation or apply irrigation in early mornings so that leaves can dry off. Plant scallions/onions mainly in rainy seasons. Intercrop peppermint with pineapple – peppermint acts as a natural repellant for rats.
Physical/mechanical Control	i. Traps ii. Manual removal (handpicking or vacuuming) iii. Weed control iv. Mulching	Pineapple Weevil Whiteflies	Keep pineapple fields weed free Yellow sticky traps

	v. Regulating irrigation and temperature (greenhouse farming)		
Biological Control	Applying the use of natural enemies/predators to reduce pest population.	Beet armyworm	Example of natural predators are wasps and flies
Behavioral Control	Exercising the use of disruptive innovations for pest mating and reproduction. It could be the use of baits and traps that lure and kill adult pests or attractants/pheromones.	West-Indian Fruit fly, thrips (other winged pests) Beet Armyworm	Yellow sticky traps attract and kill these pests upon capture. Ask your local farm store about synthetic sex pheromones (e.g. checkmate)
Microbial Control	The use bacteria, virus, fungus or nematodes against plant pests.	Black Sigatoka disease	*Trichoderma spp.* is a fungus found in most soil types. It does not negatively affect plants but destroys most other disease causing fungi.
Chemical Control	The use of synthetic chemicals as well as chemical from plants and animals. It is encouraged as the last resort (only if necessary or if all else fails).	Downy Mildew Powdery Mildew Melon warm	Ridomil MZ® Topsin M® Dipel®, Xentari®, Agree® and New Bt® these are environmentally-safe/selective. Neem oil is a natural alternative that repels insect pests. For more information visit: www.micaf.gov.jm

8.0 INNOVATIVE AGRICULTURE

8.1 GREENHOUSE FARMING

Greenhouse farming has been adapted to as a climate change mitigation method in agriculture. It has also been used as an efficient pest management technique.

Unlike traditional plots that have been cultivated, greenhouse requires a suitable irrigation system for even more efficiency.

Plate 8.1.1.Showing Photograph of the interior of a Greenhouse.

8.1.1 BENEFITS OF GREENHOUSE

Increased Crop Yield	Good conditions that allow crops to have optimal production.
Reduced Pest Infestation	Controlled environment for plant growth diminishes conditions that pest thrive in.
Consistent Crop quality	Crops can have sustained production (quality and quantity is maintained).
Water Conservation and land management	The use of irrigation systems is a water conservation technique. Land management is manifested through the reduction in chemical use and physical activities that degrade land.
Reduced vulnerability to severe weather conditions/natural hazards	Heavy rainfall, extreme temperature and natural hazards like tropical storms and hurricanes are buffered by greenhouse shelters.

8.1.2 GREENHOUSE LOCATION: THINGS TO CONSIDER

1. Access to market
2. Good drainage: avoid water logged areas or dry areas
3. Gentle slope or flat land
4. General weather conditions – is there frequent heavy rainfall or consistently high temperature?
5. Proximity to coastal zone – coastal lands are flat but the seawater poses a risk to crops.
6. Quality soil (if planting directly on the soil)

8.2 HYDROPONICS SYSTEM

Plants being grown in a soilless medium where nutrient rich and oxygen concentrated solution is being made available is called hydroponics. Hydroponics represent modern era agriculture; it represents contemporary recognition of innovative ways to control the input that ultimately maximizes the output.

Plate 8.2.1.Showing a Hydroponics System.

8.2.1 BENEFITS OF HYDROPONICS

Increased Crop Yield	Absence of conditions that hinder plant productivity.
Climate Control	It enables the control of temperature that plants receive
Maximized space	Containers can be erected vertically or horizontally in layers.
Water Conservation	Water in hydroponic systems are oftentimes recycled.
Reduced Pest Infestation	Weed and other conditions that are absent create an unfavorable conditions for pests to thrive in.
Financial Gains	Increased yield place a demand on crops
Food Security	A sustained crop production regime benefits consumers.

8.3 HYDROPONICS INTEGRATED WITH GREENHOUSE

The benefits are a shared combination between the benefits of greenhouse farming and the benefits of hydroponics. While the system requires high initial investment cost, it can prove to be a solution to many problems facing agriculture.

Plate 8.3.1. Showing a Hydroponic Systems incorporated into a Greenhouse.

- ✓ Land Degradation: the reduction in soil use, chemical fertilizers and soil erosion are associated with greenhouse-hydroponic systems.
- ✓ Climate Change: Temperature increase for example that affects plant growth and water retention capacity can be controlled.
- ✓ Water Scarcity: With water conservation being paramount, greenhouse-hydroponic system enables less use of water resources through water recycling.
- ✓ Threat to biodiversity: this problem is manifested in different forms, whether through deforestation, land degradation or pollution. Utilizing a controlled environment that lessens certain demands is one way of minimizing the threat to biodiversity.

9.0 CONCLUSION

WHAT HAVE YOU LEARNED?

- Negril EPA is an area of water and land spanning Hanover and Westmoreland. The 271 square kilometers of protected area consists of the Great Morass, Negril Hills, Fish River Hills and Negril Marine Park.
- Agriculture is a major industry in Jamaica that supports the economy – job creation and GDP – and food security.
- Climate Change is the change in the normal climatic conditions that countries experience.
- Agriculture contributes to climate change through deforestation and the use of chemicals (fertilizers, pesticides, insecticides).
- Climate Change affects crops and livestock by causing water deficiency, heat stroke in animals and wilting in crops.
- Four (4) major components manage the interaction between agriculture and climate change:
    - **i.** Water Conservation: application of methods that reduce water consumption. Drip Irrigation System is an example. Rainwater harvesting systems limit water scarcity caused by climate change.
    - **ii.** Sustainable Land Management (SLM): stewardship and use of land in a way that preserves livelihood and land quality for access by the future generations. SLM promotes practices that preserve a resource being threatened by climate change.
    - **iii.** Soil Conservation: the application of techniques that preserve soil quality. Soil conservation preserves an important resource that is being threatened by climate change.
    - **iv.** Integrated Pest Management (IPM): management of pest population that affect plant and animals. IPM enables the reduction in challenges facing agriculture. It discourages chemical use as a prevalent pest control technique.
- Greenhouse Farming is a way of establishing a favorable environment in an unfavorable one created by climate change.
- Hydroponic system relates to the growth of crops in a soilless medium.
- Hydroponic-greenhouse system represents a modern opportunity in agriculture. It creates an alternative farming technique that enable farmers to maximize crop production regardless of the negative implications of climate.

GLOSSARY OF TERMS

1. **Aquifer:** underground layer of water-holding rocks.
2. **Biodiversity:** a variety of plants and animals in a particular habitat.
3. **Carbon sequestration:** carbon being stored in living things for a long-time.
4. **Carbon sink:** a natural or artificial reservoir that absorbs and stores the atmosphere's carbon.
5. **Deforestation:** the permanent clearance of forests to make space for another land use.
6. **Desertification:** soil that has lost all fertility capabilities to become a desert.
7. **Ecosystem:** a community of living and non-living things interacting.
8. **Endangered:** species population at risk for complete population elimination.
9. **Endemic**: plants or animals that only naturally exist in a particular space.
10. **Eutrophication:** excess accumulation of nutrients in a water body.
11. **Fauna:** the animals in a particular location or geographic region.
12. **Floodplains:** the area of land existing beside a river or stream.
13. **Flora:** plants in a particular region or geographic location.
14. **Gross Domestic Product:** monetary value of goods and services produced in a specific time.
15. **Pheromones:** chemical produced by an animal. This chemical affects the behaviors of the same species
16. **Reforestation:** populating a land space with trees/replanting trees.
17. **Salinization:** soil being concentrated with excess salts.
18. **Species:** a group of animals or plants that can reproduce with each other to produce fertile offspring.
19. **Watershed:** an area of land collecting and draining all water into a common outlet like a river or stream.

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