AGRICULTURAL SCIENCE FOR YEAR 12

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Year 12, which is based on the *Year 12 Agricultural Science Syllabus*, 2017.

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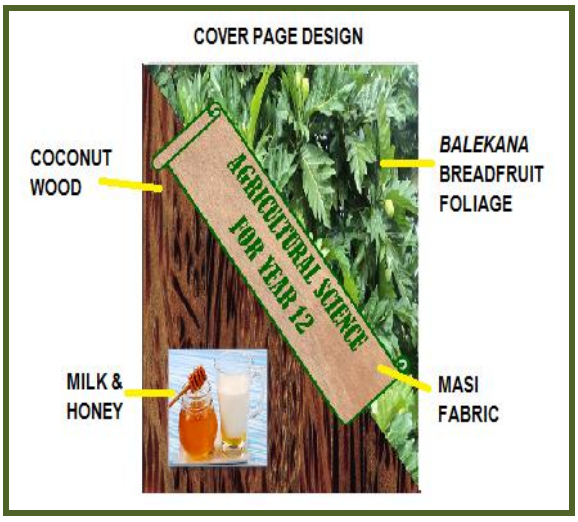

PREFACE

Welcome to *Agriculture for Year 12*.

This book was designed to complement lessons prepared by teachers for the learning and teaching of the *Year 12 Agricultural Science Syllabus* implemented in 2017.

Teachers are encouraged to use **other** resource materials to reinforce lesson content.

Ministry of Education
Suva
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ABOUT THIS BOOK

INTRODUCTION
This is a guide to the way in which the rest of the book is set up. It also contains suggestions on how the book is to be used.

The content of this book is based on the Year 12 *Agricultural Science Syllabus* prepared by the Technology and Employment Skills Training [TEST] Section of the Ministry of Education and implemented in 2017.

As a subject of the **Technology** Key Learning Area, this book contains concepts and skills which relate to real life situations. As such practical work is encouraged to ensure learning of these lifelong skills.

Like the respective syllabus, this book is divided into four strands and six sub-strands, details of which are:

STRAND	SUB-STRAND
AS 12.1 AGRICULTURAL CONCEPTS	**AS 12.1.1 Current Agricultural Issues** ❖ **AS 12.1.1.1** Environmental issues ❖ **AS 12.1.1.2** Modern practices ❖ **AS 12.1.1.3** Production
	AS 12.1.2 Careers
AS 12 .2 FARM MANAGEMENT	**AS 12.2.1 Physical Capital** ❖ **AS 12.2.1.1** Small farming machines
	AS 12.2.2. Financial Capital ❖ **AS 12.2.2.1** Management tools used for farm planning
AS 12.3 AGRONOMY	**AS 12.3.1 Soils** ❖ **AS 12.3.1.1** Soil biology
	AS 12.3.2 Horticulture ❖ **AS12.3.2.1** Plant improvement ❖ **AS 12.3.2.2** Forestry and Agroforestry ❖ **AS 12.3.2.3** Ornamental Horticulture ❖ **AS 12.3.2.4** Tree crops
AS 12.4. LIVESTOCK	**AS 12.4.1 Apiculture**
	AS 12.4.2 Cattle

The Content Learning Outcomes for each Sub-strand have been unpacked and presented as Lessons.

Lessons follow the format below:

LESSON and **LESSON OUTCOME**	Relate the content of the lesson to the Year 12 *Agricultural Science Syllabus*, 2017
	Lists and defines new words or jargon pertinent to the content of the lesson. To incorporate the words into their vocabulary, students and teachers are encouraged to use the words in sentences, activities, games, discussions and assessment.
	Highlights and provides background information on the main points. Teachers are advised to use student centred learning and teaching methods to assist the students to understand the concepts and in doing so simplify and summarise these notes. Students **should not** be required to copy these sections word for word into their note books.
	Teachers are encouraged to prepare their own learning and teaching strategies so students can put into practise and demonstrate what they have learnt during the lesson. Some suggested activities are included for each lesson.
	A brief summary of the main points of the lesson is provided. Students and teachers may extend the summary if they feel it is warranted.
	These are extra activities which students can use to gauge what they have learnt from the lesson. It also contains suggestions for practical work which will assist the students in learning and practising concepts for use in real life situations.

STRAND AS 12.1 AGRICULTURAL CONCEPTS	
SUB-STRAND 12.1.1 GENERAL AGRICULTURE	CLO 12.1.1.1 AGRICULTURAL ISSUES
	CLO 12.1.2.1 CAREERS

Destruction to farm after TC Winston in 2016

http://animalsindisasters.typepad.com

Organic rice farm in Navua

http://www.farmlandgrab.org

Introduction

This strand will facilitate the exploration of some current environmental issues, modern practices, production issues and careers relating to agriculture.

Students will be introduced to general concepts relating to pollution, climate change, genetically modified organisms, agricultural biotechnology, food security and zoonoses.

Students will be encouraged to research career opportunities in agricultural fields associated with the content of this syllabus.

SUBSTRAND AS 12.1.1 GENERAL AGRICULTURE

CONTENT LEARNING OUTCOME

AS 12.4.1.1 Recognise and study current agricultural issues by relating associated advantages and disadvantages to the response of the agricultural community.

LESSON 1: OVERVIEW OF CURRENT ISSUES THAT RELATE TO AGRICULTURE

LESSON OUTCOME: At the end of this lesson the student will identify some current issues that relate to agriculture.

'Since 1960, the world population has more than doubled, from approximately 2.9 billion in 1960 to more than 6.7 billion today. The demands placed on global agricultural production arising out of population and income growth almost tripled.

Global agriculture has been successful in meeting this increase in demand. Steady growth in agricultural output and a long-term decline in real commodity prices attest to this success. While the 820 million undernourished people in developing countries must not be forgotten, it should also be recognized that the proportion of people suffering from hunger has fallen by half since the 1960s, from more than one-in-three to one-in-six, even as the world's population has doubled. Progress is possible.

Agricultural growth contributes directly to food security, supports poverty reduction and acts as an engine of overall economic growth in much of the developing world"

Source: *htt://www. live.worldbank.org/world-development-report-2008 23/6/2016*

Agriculture is an essential component of Fiji's economy.
It affects and is affected by many sectors and issues in the country.
In this sub-strand, the following will be discussed:

i) environmental issues –pollution and climate change
ii) modern practices –genetically modified organisms and agricultural biotechnology
iii) production concerns –food security and zoonosis

LESSON 2: ENVIRONMENTAL ISSUES

LESSON OUTCOME: At the end of this lesson the student will discuss pollution and climate change.

Albedo - the reflecting power of a surface.

POLLUTION

Pollution is the contamination of air, water or soil by substances that are harmful to living organisms. Agricultural practices contribute to and are affected by various forms of pollution.

Effects of pollution include:

i) visible markings on the foliage or skin ii) reduced growth and yield iii) premature death
iv) siltation v) eutrophication vi) increased salinity and acidity of soil and water
vii) development of diseases viii) spread of pathogens and pests ix) new species

The development and severity of the injury or effect of pollution depends on:

i) concentration of the particular pollutant
ii) the length of exposure to the pollutant
iii) the species and its stage of development
iv) the environmental factors conducive to a build-up of the pollutant
v) preconditioning of the species, which makes it either susceptible or resistant to injury

http://vobmapping.vn

i) **Air pollution** – includes temperature, water vapour, movement [wind], oxygen and carbon dioxide. Air quality is affected by the introduction of contaminants. Contaminants added to air by agriculture include pesticides, odours, smoke, dust, allergenic pollens and trash. Contaminants added to air by other sources include acidic gases, products of combustion, products of reactions in air and miscellaneous effluents including greenhouse and other gases.

Soil & water pollution

http://ima.aws.livestronacdn.com

ii) **Soil and water pollution** – include sediment, plant nutrients, inorganic salts and minerals, organic wastes, infectious agents, industrial and agricultural chemicals, effluent and heat. Contaminants added to soil and water by agriculture include salts remaining after the evapotranspiration of irrigation water resulting in salinity; excess minerals from fertilising materials and effluents causing eutrophication and soil acidity; poor cultivation practices causing erosion and siltation; movement of pests and pathogens with irrigation water; increased water vapour from respiring and sweating animals. Contaminants added to soil and water by other sources include heated water, effluent, oil and fuel as well as factory and household waste water.

http://www.noisecontrol.com

iii) **Noise pollution** – includes sounds which disturb the environment. Contaminants added by agriculture include sounds made by farm animals; cultivation, harvesting and transportation machines; freezers and cooling facility engines; husbandry machines like chainsaws, brushcutters, chaffing machines, milking machines and milling facilities among others. Contaminants added by other sources include transport and factory noises; media noises and noises produced by human activity.

iv) **Other pollutants**

a) introduced species – including animals like rats, toxic weeds like lantana, *Lantana camara,* and invasive species like African tulip, *Spathodea campanulata.*

b) biological control agents –may become pests of other species e.g. fresh water carp eats all river organisms.

Advantage of pollution

Some pollutants may be diverted to be used as a resource e.g. effluent to be made into biogas; fresh water carp are fished and eaten.

Reaction of the farming community to pollution

i) organic farming – where farming inputs are natural and bio-degradable while methods used target the conservation of the quality and quantity of soil and water.
ii) new management techniques including composting, solid liquid segregation, conservation tillage etc.
iii) breeding and introduction of efficient species which use less resources and produce less waste.
iv) using pollutants as a resource including anaerobic digestion of effluent to produce biogas.
v) locating farms away from noise and from areas which would be affected by farm noises
vi) biosecurity services which help prevent the introduction of pests and pathogens
vii) extensive research to ensure any biological control agent introduced is species-specific.

i) Investigate and list the common pollutants which affect the school compound.
ii) Discuss the effect of these pollutants on crop and livestock enterprises.
iii) Recommend ways in which these pollutants can be minimised or controlled.
iv) Suggest ways in which these pollutants could be used to the advantage of the school community.

CLIMATE CHANGE

Climate is the composite or general prevailing weather conditions of a region, throughout the year, averaged over a series of years: this includes temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and wind.
Earth's climate is always changing so climate change is a natural phenomenon.

In the past, Earth's climate has gone through warmer and cooler periods, each lasting thousands of years.Since the last ice age, which ended about 11,000 years ago, Earth's climate has been relatively stable with global temperatures averaging about 14^{o} C.

Observations show that Earth's climate has been warming at an accelerated rate. Its average temperature has risen a little more than 0.89^{o} C during the past 100 years or so. This amount may not seem like much but small changes in Earth's average temperature can lead to big impacts.

Some causes of climate change are natural including changes in the earth's orbit, the amount of energy coming from the sun, changing albedo, ocean changes, plate tectonics and volcanic eruptions.
Most scientists think that recent warming cannot be explained by nature alone. It is very likely that most of the warming since the mid-1900s is due to human activities which produce greenhouse gases, like the burning of coal, oil and gas.
Climate change influences many factors relating to agriculture including higher annual temperatures, changing rainfall patterns, changes in seasons and sea level rises.

These in turn cause more:
i) intense rainstorms which cause floods
ii) intense adverse weather conditions like stronger cyclones and associated weather patterns
iii) frequent and severe heat waves and droughts
The planet's oceans and glaciers have also experienced some big changes - oceans are warming and becoming more acidic, ice caps are melting and sea levels are rising
Seasons are changing with shorter winters so the production of plant and animal species is affected

There are advantages and disadvantages associated with each change.
i) **Type and quantity of agricultural product**:

Advantage: the change in climatic conditions may make an area suitable for the production of new crops which have markets available e.g. warmer climate and higher rainfall may suit the production of oil palms, which produce commodities highly valued in the world market.

Disadvantage: These conditions can impact the production of traditional commodities negatively e.g. local vegetables and ground crops.

Adaptation: farmers must adopt animal species and breeds as well as crops or crop varieties which suit the changing climatic conditions.

ii) **Production season length**

Advantage: some areas will have a warmer and longer production season so may be able to produce a wider range and/or larger quantities of agricultural commodities e.g. fruit trees produce two or more batches of fruit per season.

Disadvantage: competition for markets between producers may lead to the reduction in price of commodities leading to a decrease in farm income e.g. fruit glut in the market decreases price.

Adaptation: farmers may find other uses for products or employ preservation methods e.g. pickling or juice making.

iii) **Soil salination**

Advantage: increases in salination due to rising sea levels and incidences of sea surges and spray may enhance some traditional crops like pandanus, mangrove species and coconut.

Disadvantage: many crops cannot survive in saline soils.

Adaptation: farmers must adopt crops or crop varieties which suit the changing soil salinity conditions. People are to use available commodities and their products.

iv) **Changing rainfall patterns**

Areas which used to receive marked dry and wet seasons may now experience longer months of average rainfall or prolonged drought.

Advantage: crops and livestock suitable for the rainfall patterns can be produced e.g. use of dairy cattle to eat sugarcane trash instead of burning.

Disadvantage: traditional crops and production systems may not suit the changing climate.

Adaptation: the farmers can now adopt husbandry methods that account for the changing rainfall patterns and amend the farm plans and schedule of work e.g. zero cultivation to reduce exposure of soil to drying and erosion, mulching instead of soil cultivation to control weeds on large farms.

v) **Rising sea levels**

- this is an issue that is affecting many low lying areas including coastal flats and river banks.

Advantages: other forms of farming can be encouraged e.g. areas which are experiencing high brackish water tables can farm crop species and animals which thrive in these conditions e.g. eels, crabs, pandanus.

Disadvantage: human activity and supporting infrastructure negatively impacted by sea flooding and sea encroachment.

Adaptation: all affected structures and activities need to relocate to higher ground.

Mitigation: human activities have accelerated the rate of climate change. Methods which may be employed by farmers to slow this phenomenon include:

1. employing husbandry methods which reduce the impact of human activities on accelerating climate change e.g. organic farming, conservation tillage, agroforestry etc.
   Many of these methods were used by the ancestors of Pacific Island Nations and must be retaught and employed.

2. producing commodities which suit the area e.g. producing local commodities like dryland rice instead of developing large irrigation networks for the production of irrigated rice**.**

3. using renewable resources like solar, wind and hydro power supplies; recycling by-products and finding uses for products and by-products of agricultural enterprises.

i) Investigate and list the ways in which climate change impacts the school compound and community.
ii) Discuss the effect of climate change on crop and livestock enterprises.
iii) Recommend ways in which these effects can be minimized or controlled.
iv) Suggest ways in which climate change could be used to the advantage of the school community

LESSON 3: MODERN PRACTICES

LESSON OUTCOME: At the end of this lesson the student will discuss genetically modified organisms, agricultural bio-technology and breeding.

'With an ever increasing global population, massive 3rd world hunger and with an estimation that a child dies for every two seconds worldwide from starvation and taking into account the number of people who are mal and undernourished, there is a great promise in the use of agro-biotechnology to benefit not only the farmers, but also societies worldwide.' *Source: htpp://www.greenfacts.org*

Modern agricultural practices have been developed with two related goals in mind:

i) to obtain the highest yields possible ii) to get the highest economic profit possible.

In pursuit of these goals, six basic practices have come to form the backbone of production:

i) intensive tillage and husbandry practices ii) monoculture iii) application of agro-chemicals
iv) irrigation v) agricultural bio-technology vi) genetic manipulation of crop plants.

But for almost every benefit of modern agriculture, there are usually problems.

GENETICALLY MODIFIED ORGANISMS

A genetically modified organism [GMO] is a plant, animal or micro-organism whose genetic material has been altered using genetic engineering techniques.

	Advantages of GMOs	Disadvantages of GMOs
Pest and disease resistance	Less use of bio-chemicals	Also kills other beneficial organisms like butterflies and spiders which feed or shelter on the crop
Yields	Higher yields from same land area	Traits of the commodity may be of lower quality e.g. colour, taste
Stronger crops	Can be engineered to withstand weather extremes	Genes may 'spill' into pests and pathogens and create super pests and pathogens
Environmental issues	Reduced greenhouse gas emissions, soil erosion and environmental pollution	Add foreign genes to traditional plants in the environment so reducing the value of these plants
Shelf life	Longer shelf life	May lead to new diseases in both the commodity and its consumer
Nutritional value	Can be enhanced like adding Vitamin A to rice	Allergic reactions of consumers to previously safe commodities
Antibiotic properties	Can be inbred so plants are disease resistant	Residual effect in consumers who then do not respond to medications when ill
Land use	Efficient use of land	Creation of oligopolies so small producers replaced
Commodity prices	Can be kept low due to fewer inputs	Tax placed on GMO crops causes price increases
Commodities	New products may be designed	Taint traditional species so reduce biodiversity

Based on the facts above, there are groups who lobby either for or against GMOs.
More research and understanding of the long term effects of adopting GMOs on the economic, health, social and natural environment is needed before adopting GMOs in Fiji.

i) Investigate and list the ways in which GMOs can improve food security.
ii) You are given a choice to grow either conventional or genetically modified crops or animals for your family's consumption. Discuss which you would choose.

AGRICULTURAL BIOTECHNOLOGY

All living organisms have the ability to improve themselves through natural means in order to adapt to changing environmental conditions. However, it takes hundreds of years before any detectable improvement is obtained.
People learned how to domesticate and breed plants in order to develop crops to their own liking and needs; the various methods used include biotechnology.

Biotechnology is defined as a set of tools that uses living organisms (or parts of organisms) to make or modify a product, improve plants, trees or animals, or develop microorganisms for specific uses. Biotechnology encompasses a number of tools and elements of conventional breeding techniques, bioinformatics, microbiology, molecular genetics, biochemistry, plant physiology and molecular biology.

Agricultural biotechnology is the term used in crop and livestock improvement through biotechnology tools.

Some applications of agro-biotechnology

1. **Vaccines**
   Oral vaccines have been used for many years as a possible solution to the spread of disease when widespread vaccination is too costly. Genetically engineered crops, usually fruits or vegetables, are designed to carry antigenic proteins from infectious pathogens which trigger an immune response when ingested. An example of this is a patient-specific vaccine for treating cancer. An anti-lymphoma vaccine has been made using tobacco plants carrying RNA from cloned malignant B-cells [cancer cells]. The resulting protein is then used to vaccinate the patient and boost their immune system against cancer.
   Tailor-made vaccines for cancer treatment have shown considerable promise in preliminary studies.

2. **Antibiotics**
   Plants are used to produce antibiotics for both human and animal use. Adding antibiotic proteins in food and livestock feed is less costly than traditional antibiotic production, but this practice raises many bioethics issues, because the result is widespread, possibly unnecessary use of antibiotics which may promote growth of antibiotic-resistant bacterial strains.

3. **Aesthetic applications**
   The use of gene identification and transfer techniques to **improve the color, smell, size** and other features of ornamental plants and animals including flowers, shrubs, trees and pets like goldfish.

4. **Biofuels**
   Renewable biofuels including bio-oil, bio-diesel and bio-ethanol are made by fermenting and refining plant tissue called feedstock. Genetic engineering and enzyme optimisation techniques are being used to develop better quality feedstock on farms for higher outputs of the resulting fuel products.

5. **Plant and Animal Breeding**
   Enhancing plant and animal traits by traditional methods like cross-pollination, grafting, budding and cross-breeding is time-consuming.
   Biotech advances allow for specific changes to be made quickly, on a molecular level through over-expression or deletion of genes, or the introduction of foreign genes.
   Tissue culture and artificial insemination are two breeding techniques used in Fiji.

6. **Pest Resistant Crops**

For years, the microbe *Bacillus thuringiensis* [Bt], which produces a protein toxic to insects like the European corn borer, was used to dust crops. Dusting spread the microbe so contaminating the ecosystem.

To eliminate the need for dusting, scientists first developed transgenic corn expressing Bt protein, followed by Bt potato and cotton. Bt protein is not toxic to humans, and transgenic crops make it easier for farmers to avoid costly infestations.

Controversy over Bt crops has focused on the development of insect resistance to Bt.

7. **Pesticide-Resistant Crops**

Pesticides are agro-chemicals which are applied to crops and livestock to kill pests e.g. Roundup is an herbicide which kills plants so both weeds and crops are killed by it.

Pesticide-tolerant crops allow farmers to selectively kill surrounding weeds without harming their crop.The benefits to this are savings in time and costs associated with conventional tillage to reduce weeds, or multiple applications of different types of herbicides to selectively eliminate specific species of weeds.

The possible drawbacks include all the controversial arguments against GMOs.

8. **Nutrient Supplementation**

In an effort to improve human health, particularly in underdeveloped countries, scientists are creating genetically altered foods that contain nutrients known to help fight disease or malnourishment. An example is when three genes where cloned into *Golden Rice*, a variety of rice developed to contain beta-carotene, the precursor for Vitamin A production in our bodies. People who eat the rice produce more Vitamin A, an essential nutrient lacking in the diets of many developing countries.

9. **Abiotic Stress Resistance**

Less than 20% of the earth is arable land but some crops have been genetically altered to make them more tolerant of conditions like salinity, cold and drought. The discovery of genes in plants responsible for sodium uptake has led to development of knock-out plants able to grow in high salt environments, while drought resistant plants are being developed too.

10. **Industrial Strength Fibers**

Spider silk is the strongest fiber known to man, stronger than kevlar (used to make bullet-proof vests), with a higher tensile strength than steel, however, silk is very difficult to mass produce from spiders. In August 2000, Canadian company Nexia announced development of transgenic goats that produced spider silk proteins in their milk.

While this solved the problem of mass-producing the proteins, the program was shelved when scientists could not figure out how to *spin* the proteins into fibers like spiders do. By 2005, the goats were up for sale to anyone who would take them. While it seems the spider silk idea has been put on the shelf for the time-being, it is a technology that is sure to appear again in the future, once more information is gathered on how the silks are woven.

The biotechnology tools that are important for agricultural biotechnology include:

i) conventional plant breeding
ii) tissue culture and micro-propagation
iii) molecular breeding or marker assisted selection
iv) genetic engineering and GM crops
v) molecular diagnostic tools

i) Investigate and list the ways in which agricultural bio-technology can improve food security.
ii) You are given a choice to produce either conventional or bio-technology enhanced crops or animals for your family's consumption. Discuss which you would choose.

LESSON 4: PRODUCTION ISSUES

LESSON OUTCOME: At the end of this lesson the student will discuss food security and zoonosis.

'Agriculture and food systems have changed very much over the last 50 years. Agricultural development has seen a rapid advance of agricultural technology in industrialised countries with the green revolution in the 1960s being counteracted by an increasing public awareness of environmental protection and sustainable development that evolved in the 1980's (FAO, 2000).
The years since 1990 has witnessed increasing globalisation made possible by technological breakthroughs in transportation and communication technologies (notably the Internet, mobile telephone technology and just-in-time systems) and affordable fuel.
Increases in long-distance food trade, global concentration in food processing and retail industries and diet change are signs of the globalisation of the food system (von Braun, 2003).'
Source: *http://ceep.udel.edu*

FOOD SECURITY

Food security is a condition related to the supply of food and individuals' access to it.

'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.' (World Food Summit, 1996) Source: *http://www.fao.org*

This widely accepted definition points to the following dimensions of food security:
i) **availability**: the availability of sufficient quantities of food of appropriate quality, supplied through domestic production and imports [including food aid].

ii) **access**: access by individuals to adequate resources for acquiring appropriate foods for a nutritious diet.

iii) **utilisation**: utilisation of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met.
This brings out the importance of non-food inputs in food security.

iv) **stability**: to be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity).
The concept of stability can therefore refer to both the availability and access dimensions of food security.

Concerns over food security have existed throughout history. There is evidence of granaries being in use over 10,000 years ago, with central authorities in civilisations including ancient China and ancient Egypt being known to release food from storage in times of famine.

Food **insecurity** results in chronic nutritional deficiencies which in turn lead to:

i) deficiencies in cognitive development.
ii) stunting.
iii) non-communicable diseases
iv) premature vital organ failure in adults.
v) death … and all the social problems associated malnutrition.

Challenges to achieving food security

i) water crisis – which can result from the over-extraction of groundwater for irrigation, human activities and sale.
ii) land degradation – due to poor farming practices.
iii) climate change – which impact type, quality and quantity of commodities produced.

Extreme climatic events like cyclones, floods and droughts also compound problems.

iv) agricultural diseases – can devastate crop and livestock production e.g. taro beetle and taro leaf blight.

v) political influences – Government decisions and standing with other nations can impact the import and export trade.

vi) food sovereignty – where large international corporations monopolise all aspects of the production, distribution and sale of a commodity, usually for financial gain.

Risks to food security

i) population growth and demand can outpace production.

ii) fossil fuel dependence - agrochemicals used in agricultural production like pesticides and fertilizing materials are derivatives [by-products] of fossil fuel.

iii) threat to biosecurity - plant breeding methods like hybridisation and genetic engineering negatively impact the biodiversity in Fiji.

iv) homogeneity of the global food supply - where once different countries had traditional foods, the global market has resulted in many countries changing their diets e.g. from eating fresh root crops, fish and vegetables, many families in Fiji now have a staple diet of rice, canned fish and dhal.

v) price setting - large organisations can set the price of commodities and either benefit or destroy small producers.

vi) land use change - from agricultural to non-agricultural uses.

vii) global catastrophic risks - adverse weather events [flood, cyclone, tsunami], volcanic eruptions, war, terrorism etc. affect production, distribution and availability of food.

Food security is a global issue and must be dealt with on all levels from individuals to the globally.

i) Investigate and list the ways in which food security is threatened in your locality.
ii) You are requested to explain the importance, challenges and risks of ensuring food security in Fiji to Year 9 students.
Prepare your presentation using aids and examples from your locality.

The Pathways to Zero Hunger is a United Nations Sponsored event, which was attended by Heads of State and Government, international institutions, non-governmental organisations, academic institutions, as well as others possessing the common goal of achieving Zero Hunger and the Sustainable Development Goals by 2030.

https://www.sharemeals.org

ZOONOSES

The World Health Organisation [WHO] defines zoonoses as diseases and infections that are naturally transmitted between vertebrate animals and humans.
A zoonotic agent may be a bacterium, a virus, a fungus or other communicable disease agent.
At least 61% of all human pathogens are zoonotic and have represented 75% of all emerging pathogens during the past decade.
Source: *http://www.who.int*

Over 200 diseases are currently classified as zoonoses.
Common examples include

i) wildlife-transmitted illnesses such as rabies from bats and dogs,
ii) farm animal transmitted diseases such as bovine tuberculosis from cattle; leptospirosis and mastitis from all mammals,
iii) mosquito-transmitted diseases such as malaria and yellow fever.

Many modern and epidemic diseases started out as zoonotic diseases. There is increasing evidence from DNA and RNA sequencing that HIV, measles, smallpox, influenza and diphtheria jumped from animals to humans. This is also true for various forms of the common cold and tuberculosis .

Zoonotic diseases can be global or they can be inherent to a specific region of the world.
The number of zoonotic diseases may increase as rates of worldwide travel, globalisation of markets and human destruction of animal habitat continue to rise.

Human-Animal Contact
Humans come into contact with animals in a number of ways:

i) domesticated animals kept for companionship and protection like dogs and cats
ii) animals for sport and transport like horses and bullocks
iii) farm animals for food and work like cattle, pigs, sheep, birds, horses
iv) exposure to animals at home, during nature hikes, trips to the park or beach, at farms, zoos or shows
v) pests like mice and rats, bats and wild animals

http://image.slidesharecdn.com

Children under 5, pregnant women, adults over the age of 65 and people with compromised immune systems are particularly susceptible to zoonotic diseases. Certain occupations such as farm workers, wildlife biologists, veterinarians or even construction workers building homes on newly cleared land are particularly susceptible. In addition, increased rates of globalisation and worldwide travel enable zoonotic diseases that may have once been limited to specific geographical locations to now appear all across the globe.

Transmission
Humans can become infected through:

i) a tick or mosquito bite
ii) handling or consuming undercooked or raw milk or meat
iii) coming into contact with the blood, urine or faeces of an infected animal

There are a number of **precautions** a person can take to protect themselves:
i) insect repellent - prevents mosquitoes and ticks from biting
ii) washing of hands and vegetables before, during and after meal preparation
iii) complete cooking of foods can limit food-borne infections
iv) thoroughly wash hands after visiting any facility where a person may touch animals

Farmers minimise the introduction of zoonoses from humans and other animals by:
i) limiting visitors to the farm
ii) enforcing the use of foot dips, where pathogens on shoes are killed, for all visitors to animal sheds
iii) ensuring wild animals cannot enter livestock sheds
iv) annual testing and culling of positive reactors
v) quarantining all new stock so that they are tested free of pathogens before being allowed to mingle with farm stock
vi) keeping up to date with vaccinations and medical advice from veterinarians
vii) ensuring all farm family members and workers are tested and treated for possible diseases each year

Zoonotic diseases are a worldwide public health risk. In developing countries, diseases such as malaria can greatly burden the public health care system and effect local economies. In addition, as food markets continue to globalise, food-born zoonotic diseases can limit agriculture, food production and international trade agreements. Across the world, antibiotic resistance to bacterial diseases is becoming a new global health threat.

The World Health Organisation has implemented several initiatives to help reduce the transmission of zoonoses. These include:
i) surveillance, tracking and reporting activities
ii) the development of preparedness and response plans in the event of epidemic infection
iii) public and professional education

Locally, veterinarians are required to report the incidence of some zoonotic diseases in order to limit or confine outbreaks.

i) Investigate and list the ways in which zoonosis may become a problem in your community.
ii) You are requested to explain the importance, challenges and risks of zoonosis in Fiji to Year 9 students.
Prepare your presentation using aids and examples from your locality.

CLO 12.1.2.1
AGRICULTURAL CAREERS

These are advocacy lessons to assist students to identify careers related to the content of this syllabus. It is not intended for examinations.

CONTENT LEARNING OUTCOME

Identify green jobs and careers related to the content of the Year 12 syllabus and prepare career pathways for discussion with the class. [**Not to be examined**]

LESSON 1: CAREERS RELATED TO THIS SYLLABUS

Lesson outcome:

At the end of this lesson the students will discuss possible green jobs and careers related to the concepts covered in the Year 12, 2017 Agricultural Science syllabus and this text book.

There are many concepts discussed in this textbook and its related syllabus and each concept relates to employment opportunities.

Green jobs are decent jobs that contribute to preserve or restore the environment, be they in traditional sectors such as manufacturing and construction or in new, emerging green sectors such as renewable energy and energy efficiency.

Green jobs help:

- improve energy and raw materials efficiency
- minimise waste and pollution
- support adaptation to the effects of climate change
- limit greenhouse gas emissions
- protect and restore ecosystems

In agriculture, green jobs are closely related to conservation and sustainable agricultural practises.

The concepts covered in this syllabus prepare students to work and study in many fields including:

1. **Advocacy and advisory work** – in the areas of environmental conservation, adaptation and mitigation to climate change.

2. **Management work** – the choosing, purchasing, use, maintenance and storage of farm machines and the preparation of farm budgets.

3. **Research work** – conducting research involving modern practices like genetically modifies organisms, agricultural biotechnology, food security and zoonosis.
   Analysing data collected and making recommendations to stakeholders.

4. **Production work** – the planning and production of agricultural enterprises related to the course content e.g. floriculture, plant improvement; lawn and hedge establishment and maintenance, raising ornamentals for sale as well as the raising of honey bees and cattle for commercial and environmental enhancement.

Each student is to identify careers related to the content of the syllabus and identify any two careers of interest to them.

LESSON 2: CAREER PATHWAY

LESSON OUTCOME:

At the end of this lesson the student will discuss a pathway for the career which they identified as interesting in Lesson One.

Choosing a career which interests you is only one step in finding enjoyable gainful employment in future. You must take into consideration the requirements of the career including:

1. **Nature of the work** – some jobs work with people while others work with animals, plants, machines or soil while some jobs work with a combination of these. Look for an occupation which involves activities which you enjoy and can do well.

2. **Working conditions** – this refers to the environment in which a particular job is done. It may be indoors or outdoors; involve high levels of dust, noise, physical hazards or mental stress; working alone or in groups; if hours are standard or flexible and the number of hours per day.

3. **Special abilities required** – some jobs call for aptitude with machines, animals, plants; artistic talent or other abilities and talents. You must match your aptitudes and talents to those requirements.

4. **Physical demands** – some occupations are physically demanding like lifting, operating large machines, herding and controlling animals, repetitive tasks, standing for long hours, keen vision. You must ensure that you are physically able to perform the tasks.

5. **Academic qualification** –the subject combination, level of education and grades you must attain to qualify for the job and to progress in the job hierarchy. How will you cover the costs of education?

6. **Chances of employment** – consider all the alternative jobs which you can possibly get if you train for a job but it is not available when you graduate.

7. **Probable earnings** – decide if the amount of money you can expect to earn from a job will be sufficient to support yourself and possible dependants.

8. **Social status** – what will your standing in the family and community be if you pursue this job?

9. **Timeline** – how long will it take before you are competent to begin work?

- Conduct research on the careers you identified in Lesson One.
- Prepare a career pathway using the template recommended by the counsellor or Careers teacher in the school.
- Discuss your findings with your parents, friends or classmates and begin preparing for your future career.

STRAND AS 12.2 FARM MANANGEMENT	
SUB-STRAND AS 12.2.1 PHYSICAL CAPITAL	CLO AS12.2.1.1 SMALL FARM MACHINES
SUB-STRAND AS 12.2.2 FINANCIAL CAPITAL	CLO AS 12.2.2.1 FARM PLANNING TOOLS

Portable milking machine

http://www.milkingmachine.maheshengworks.com

Introduction

This strand will facilitate the exploration of small farm machines and a selection of farm planning tools.

Students will be introduced to general concepts relating to the types, selection, use, maintenance and storage of some small machines used or suitable for use on farms in Fiji.

Preparing farm plans

http://img-aws.ehowcdn.com

They will also study and use selected farm management tools which are used in the preparation of farm plans.

SUBSTRAND AS 12.2.1 PHYSICAL CAPITAL

CONTENT LEARNING OUTCOME

AS 12.2.1.1 Deliberate on the function of small farm machines by identifying and discussing types, uses, maintenance and storage of small machines used on farms.

LESSON 1: OVERVIEW

LESSON OUTCOME:

At the end of this lesson the student will discuss the advantages and disadvantages of farm mechanisation.

Machine - a device consisting of fixed and moving parts that modifies mechanical energy and transmits it in a more useful form.

A machine is a device for transmitting or modifying force or energy.
It contains one or more parts that use energy to perform an intended action.
Farm machines are usually powered by mechanical, chemical, thermal or electrical means and are often motorised. Most machines used on farms in Fiji are powered by electricity produced by hydro-electricity plants or fossil fuels or have their own engines which run on fossil fuel.
Efforts are being made to develop and promote the use of machines which run on renewable energy like solar, wind and water.

Advantages of farm machines:

1. **Substitute for labour** - with increased educational levels and competition from other employment opportunities, farm labour is expensive, often unavailable, lacking in farming skills and do not have the strength and endurance for large scale production.

2. **Increased productivity** – machines can complete large amounts of work in specified time periods as well as handle large, delicate and specialised tasks without the need for training and rest.

3. **Cheaper storage and maintenance** – when not in use, a machine can be cleaned and stored. It does not need the daily feeding, housing, transport, health, education and social amenities that are needed by labourers.

4. **Transferable skills** – skills associated with machine operation, care and maintenance are transferable so the skilled machine operator can get better paying employment either on farms or in industry.

Disadvantages of farm machines:

1. **Redundancy** – machines replace people, many of them skilled in farm work.

2. **Costs** – machines are often expensive to buy, operate, maintain and store.
   Therefore machines which can be used for more than one task are better to buy.

3. **Breakdowns** – a job may be delayed by breakdowns which need parts or experts which are not readily available. This will delay the farm operations**.**

4. **Health and safety** – machine operation may cause health issues because of the dangers of moving parts and speed and well as the temperature, repetitive actions, noise, dust, smell and fumes associated.
   Safety equipment and working conditions are important.

5. **Environmental costs** – machines affect the environments in which they operate so soil compaction, pollution and heat generation are all issues to be considered.

6. **Loss of skill** – husbandry skills are not handed down from one generation to the next so may be lost.

There is a range of machines developed and used on farms. Some of the small machines which are used for clearing, tilling, transport and specific husbandry practices will be discussed.

Summarise the advantages and disadvantages of mechanisation of farms.

Farm mechanisation has advantages and disadvantages.

The diagrams below illustrate three methods in which rice can be harvested.

Hand harvesting	Mini cutters	Combine harvester
		
https://himienglishnews.files.wordpress.com	*https://www.google.com*	*https://livingintaiwan.files.wordpress.com*

Defend the choice of harvesting method you would recommend for a dry land rice farm in Fiji.

LESSON 2: SOME SMALL MACHINES USED FOR CLEARING

LESSON OUTCOME:

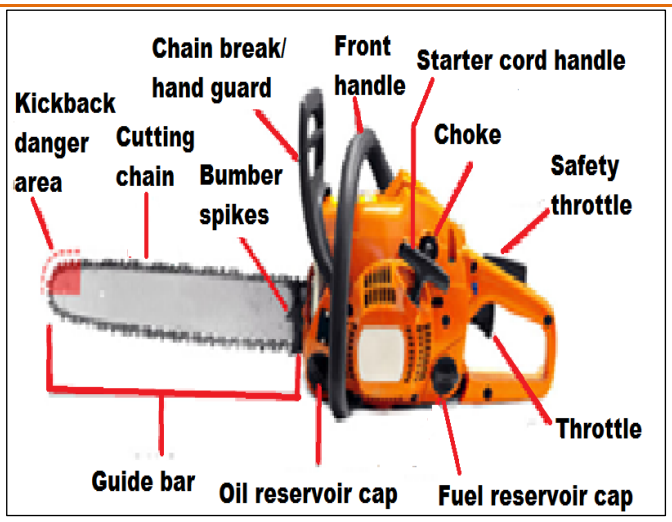
At the end of this lesson the student will discuss small machines used for clearing farmland.

Land clearing is the process of removing obstacles like trees, stumps, brush other vegetation and stones from an area to increase the size of the agricultural producing land base of an existing farm or to provide land for a new farm operation.

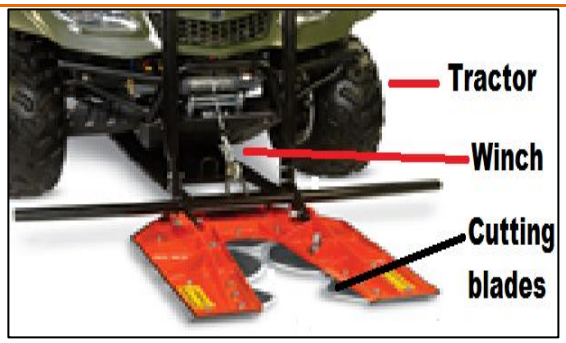
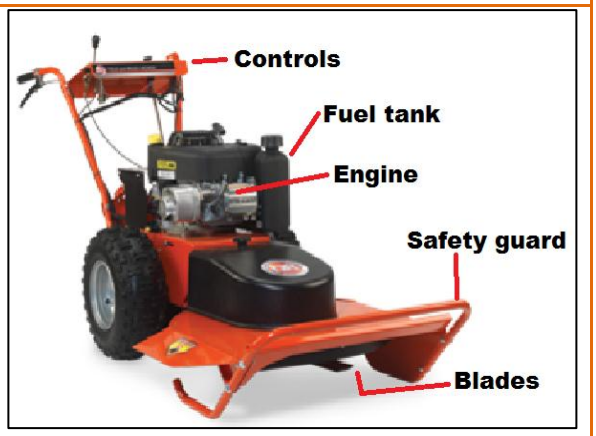
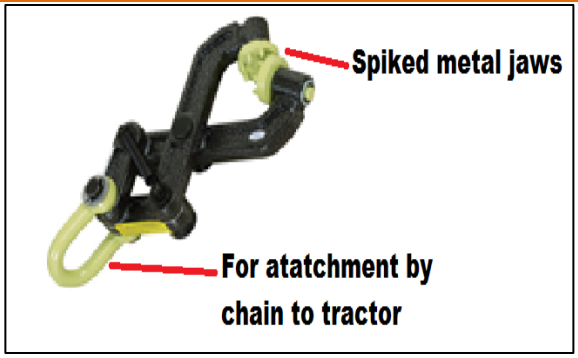
Some of the small machines used for land clearing include:

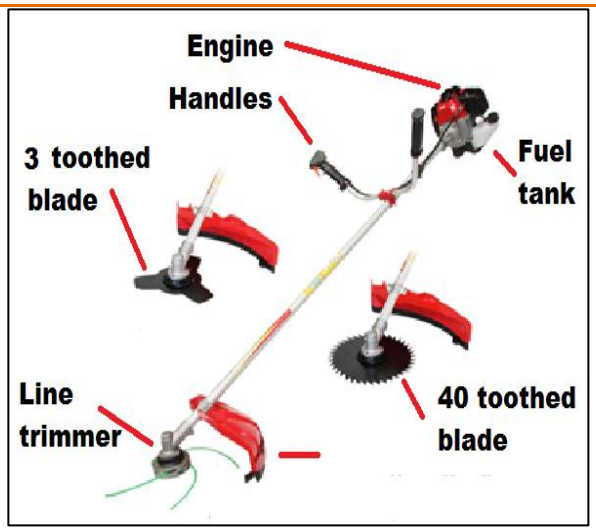
1 **Chain saw** a portable, mechanical saw which cuts with a set of teeth attached to a rotating chain that runs along a guide bar.

Uses: - felling trees, limbing, bucking, pruning, cutting fire breaks, fire suppression and to harvest firewood.



http://www.chainsawjournal.com

2	**Treechopper**	a tractor mounted set of 5 mechanical saws which can cut through trunks 10 to 15 cm in diameter. Uses: felling of trees at the level desired by the operator.	 *http://www.drpower.com*
3	**Stump grinder**	or stump cutter is a power tool or attachment that removes tree stumps by means of a rotating cutting disk that chips away the wood. Stump grinders can be the size of a lawn mower or as large as a truck.	 *http://i.ebayimg.com*
4	**Brush hog**	a rotary **mower** that has blades that are heavier but duller than a lawnmower blade so can cut through brush. Comes in walk behind and tow behind models **Uses**: for mowing down thick brush and vegetation over large areas.	 *http://www.drpower.com*
5	**Brush grubber**	A set of metal jaws with spikes that dig into a small tree or stump. A chain is attached to the other end and you use your truck or tractor to pull out the unwanted tree by its roots. The harder you pull, the harder the jaws grip the tree.	 *http://www.northerntool.com*

6	**Brush cutter**	A power tool worn on a shoulder harness consisting of a rotary head with a small circular saw or line trimmer at the end of a boom. **Uses:** for trimming grass, small bushes and undergrowth. *With the right accessories, the same machine can be used for trimming grass, clearing undergrowth and shrubs and for thinning out smaller trees.	 *http//:www.mydeal.com.au*

Summarise the uses of each clearing machine mentioned above.

Machines used in clearing farmland include tree felling, trunk removing and brush cutting machines.

You have been tasked to clear a natural forest to establish a family crop farm. Discuss the steps you would take and machines you would use.

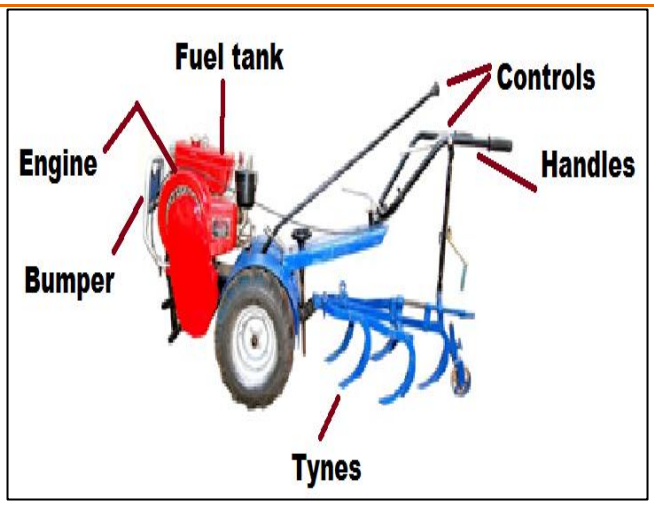
LESSON 3: SOME SMALL MACHINES USED FOR TILLING

LESSON OUTCOME:

At the end of this lesson the student will discuss small machines used for tilling farmland.

Land tilling is the process of turning over and breaking up the soil, usually for the establishment of crops.

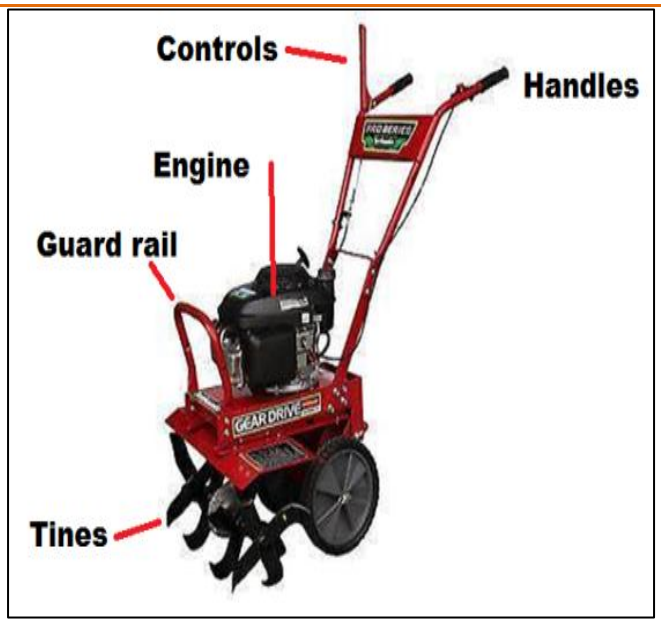
Some of the small machines used for tilling land include:

1.	**Power cultivator**	-turns and breaks up compacted soil.	 *http:www.indiamart.com*

2. **A rotary tiller**, also known as rotary hoe, power tiller or rotary plough, is a motorized cultivator that works the soil by means of rotating tines or blades.
Rotary tillers are either self-propelled or drawn as an attachment behind a tractor.

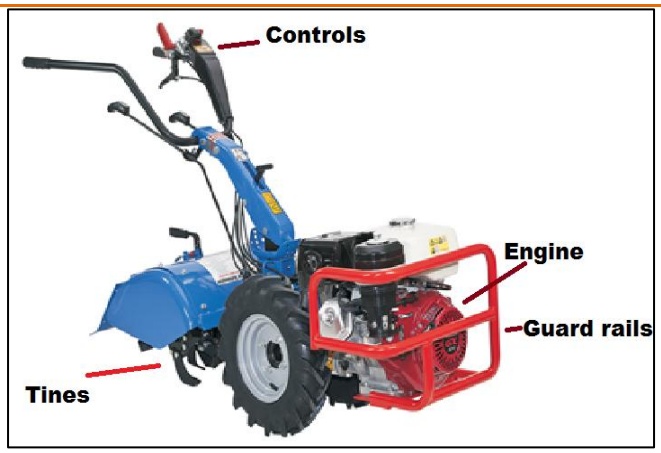
Some examples are:

a **Rototiller** - is propelled forward by the rotating tines while the wheels are used for transporting the machine.



http://i.ebayimg.com

b **Rotovator** -is propelled forward by tyres. The rotational speed of the tines remains constant which enables the operator to easily regulate the extent to which soil is worked.



http://www.tracmaster.co.uk

Differentiate among the types of small machines used for tilling soil.

Machines used in tilling farmland include power cultivators, rototillers and rotovators.

You have been tasked to prepare the soil which has been cleared for a crop farm
Discuss the steps you would take and machines you would use.

LESSON 4: SOME SMALL MACHINES USED FOR TRANSPORT AND CARTAGE

LESSON OUTCOME:

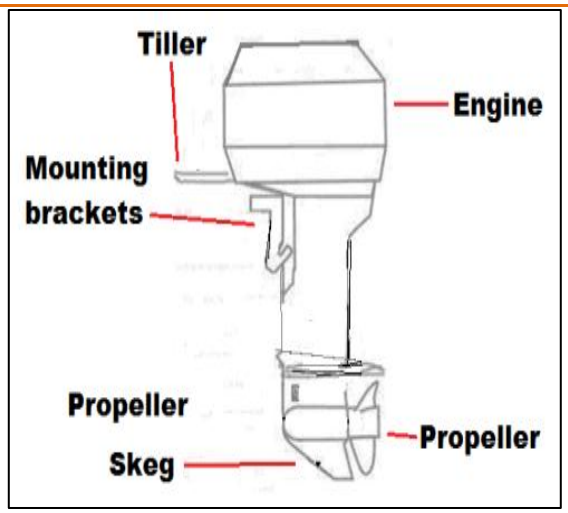
At the end of this lesson the student will discuss small machines used for transport and cartage on farms.

Moving raw materials, waste products, labourers and products around a farm or between the farm or fishing area and point of sale needs cartage and transport machines.Some of the small machines used for transport and cartage include:

1 **Outboard motor**

A propulsion system for boats, consisting of a self-contained unit that includes engine, gearbox and propeller or jet drive, designed to be affixed to the outside of a boat.

Uses: propelling boats.



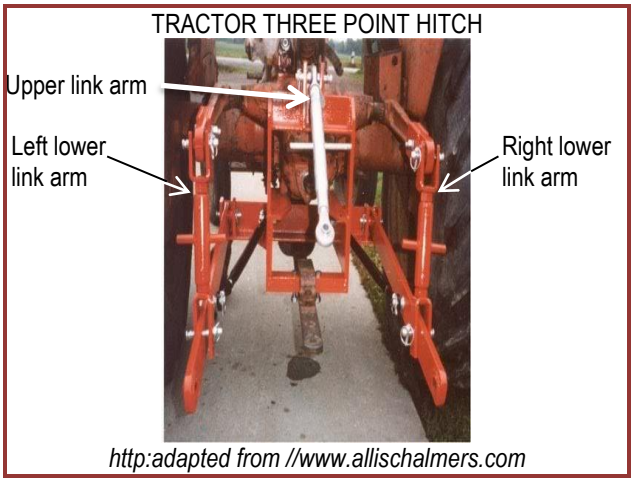
https://www.google.com

2 **Tractor and trailer**

A powerful motor vehicle with large rear wheels, used chiefly on farms for lifting, providing power to implements and hauling equipment and trailers.

http://www.farmtoysinc.com

Trailers which are used to cart many different items are attached to the three point hitch situated at the rear of the tractor and comprised of 3 link arms. Power is provided to attachments through the Power Take Off System.



http:adapted from //www.allischalmers.com

3	**Utility van**	A powerful vehicle for carrying lighter loads on and travelling on off road terrain.	 *http://2.bp.blogspot.com*

Differentiate among the types of small machines used for transport and cartage on a farm.

Machines used on farms for transport and cartage include outboard motors for boats; tractors and trailers; utility vans and carriers.

You have been tasked to transport sweet potatoes from the field to the homestead for packing. Discuss the mode of transport you would use.

LESSON 5: SOME SMALL MACHINES USED FOR HUSBANDRY PRACTICES

LESSON OUTCOME: At the end of this lesson the student will investigate and discuss some small machines used on farms for husbandry purposes.

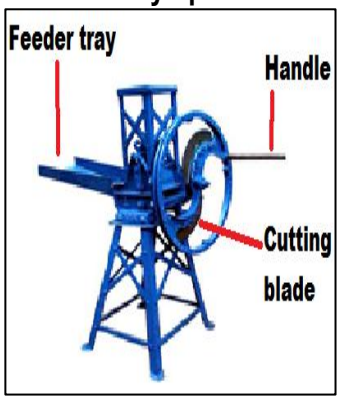
Many small machines are also used on livestock farms.

Below is a selection of these machines:

1. **Chaff cutter** – a mechanical device with sharp blades that cuts grass which is fed into it into small pieces.

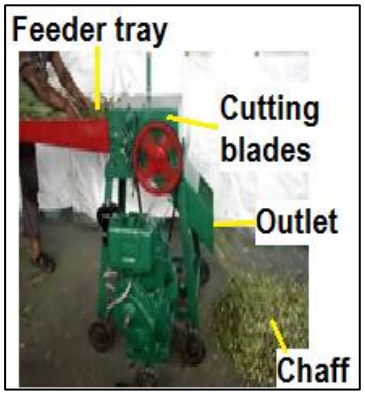
Use:
cutting up grass for animal feed

Manually operated



http://www.tradekey.com

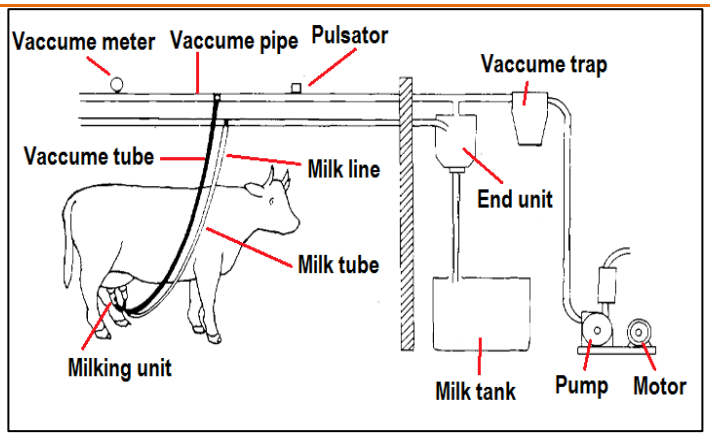
Motorised



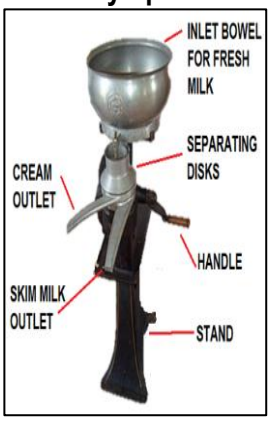
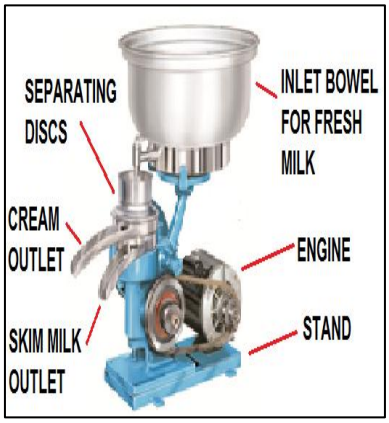
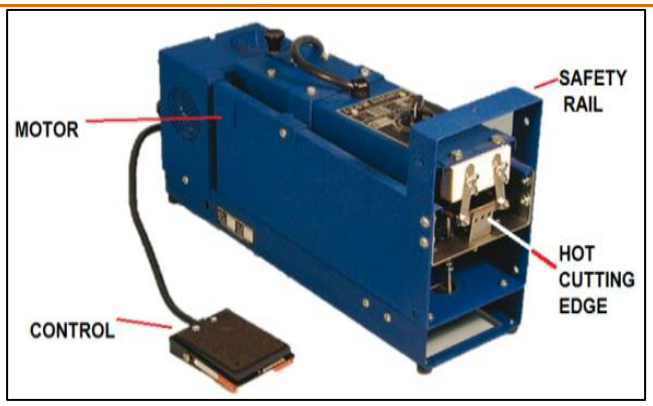
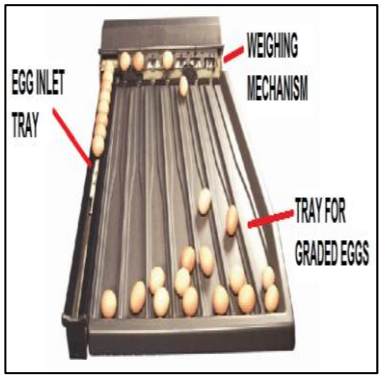
http://www.tradeindia.com

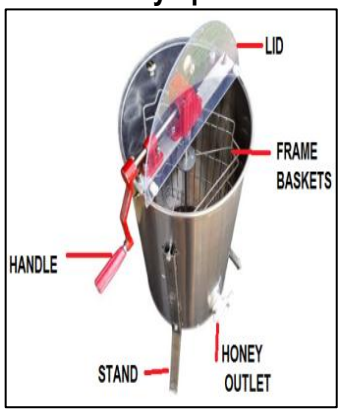
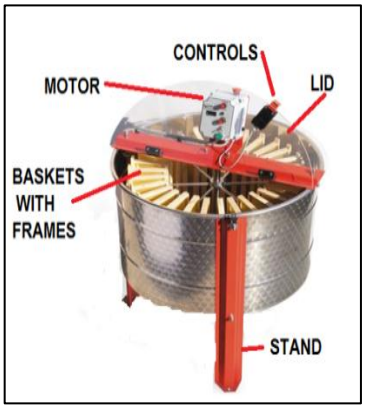
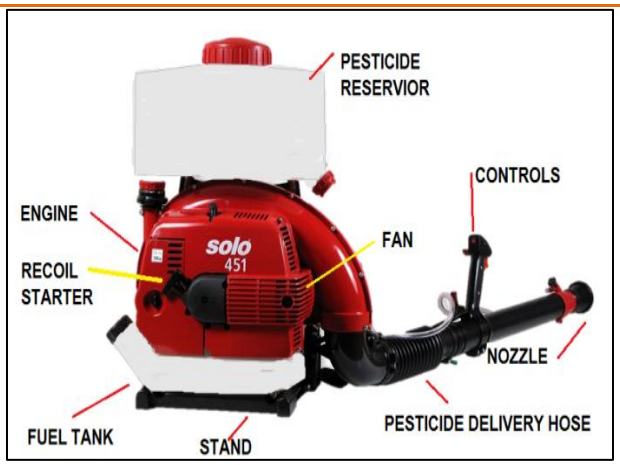
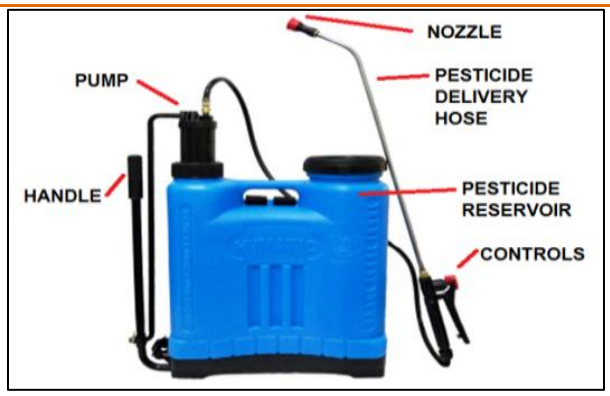
2. **Milking machine** – a mechanical suction apparatus for milking cows, goats and sheep.

Use:
removing milk from lactating dairy animals with minimum damage to the mammary system.



Adapted from: http://www.fao.org

3.	**Milk separator**	A centrifugal device which separates liquid mixtures based on weight. **Use**: separating milk into cream and skimmed milk while simultaneously removing solid contaminants.	**Manually operated**  *https://upload.wikimedia.org*	**Motorised**  *http://www.milkydairyequiptment.com*
4.	**Debeaking machine**	A machine which has a heated blade for slicing through cartilage. **Use**: debeaking and declawing poultry including chickens, quail and turkey.	 *http://www.poultryhub.org*	
5.	**Candling machine**	A device which passes eggs over a light source so that the content of shells can be viewed **Use**: detecting problems with egg shells and the content of eggs.	 *http://www.utube.com*	
6.	**Egg grader**	A device which separates eggs according to their weight. **Use**: sorting eggs into grades based on weight.	**Manual**  *http://missvictory.typepad.com*	**Automated**  *http://www.moba.net*

7	**Honey extractor**	A centrifugal device which extracts liquids from honeycomb. **Use**: Extraction of honey from conventional frames of honey comb.	**Manually operated**  Adapted from: *http://ecx.images-amazon.com*	**Motorised**  Adapted from: *http://www.ets-leygonie.net*
8	**Mist blower**	A portable motorized device which produces a fine mist. **Use**: Application of agrochemicals especially insecticides in trees and shrubs	 Adapted from: *http://mkrittenhouse.com*	
9	**Knapsack Sprayer**	A portable manually operated device which produces a spray. **Use**: Application of agrochemicals especially on low growing plants.	 *Adapted from : http://www.hymaticagro.com*	

Differentiate among the types of small machines used for husbandry practises on farms.

Machines used for husbandry practices on farms include chaff cutters, milking machines, candling machines, debeaking machines, egg graders and honey extractors.

You have been tasked to choose husbandry machines for a dairy farm.
Discuss the machines you would choose.

LESSON 6: CHOOSING SMALL MACHINES

LESSON OUTCOME: At the end of this lesson the student will investigate and discuss the factors to consider when choosing small machines for farms.

Before selecting a machine for the farm, a farmer must consider the following:

1. durability	5. ease of use for operators	9. the size of the job
2. brand	6. machine requirements	10. impact on the environment
3. spare parts	7. storage requirements	11. impact on present husbandry practises
4. technical support	8. usages/functions	12. cost to buy, use and maintain

Discuss why a manual honey extractor would be most suitable for a school apiary.

Many factors will determine a farmer's choice of small farm machine.

Discuss a scenario in which your farm would need a mist blower while the neighbour's farm would need a knapsack sprayer.

LESSON 7: USING, MAINTAINING AND STORING SMALL MACHINES

LESSON OUTCOME:

At the end of this lesson the student will investigate and discuss the factors to consider when using small farm machines.

The following factors are to be considered when using small farm machines.

1. Safety Guidelines	- the operating manual must be read and understood before the machine is used. - if unfamiliar with the workings of the machine, ask the dealer for a demonstration or designate a skilled person to operate the machine.
2. Proper usage	- use the machine for the purpose it was intended.
3. Machine needs	- provide all the needs of the machine including power source/fuel, lubrication, recommended rest/cooling down periods etc.
4. Environmental conditions	- use the machines when environmental conditions are suitable e.g. avoid use in rain or flooded conditions.

Although machine maintenance may be risky, it is essential to keep machines efficient and work environments safe.

Maintenance work includes: cleaning, inspecting, testing, detecting faults, adjusting, servicing, repairing and replacing parts, lubricating and painting. Many of these jobs may be carried out by the farmer on the farm.

However, it is advisable to adhere to instructions in respective machine manuals and to seek expert help for more sensitive repairs like electrical work and engine repair.

Once a machine has been cleaned and maintained, it should be put in a storage area which accommodates it well, is level, secure, clean and dry.

Discuss why farm machines should be maintained and stored well

Farm machines are expensive to replace so choosing, using, maintaining and storing farm machines must be taken seriously.

You have been requested by your family to recommend, purchase, use, maintain and store a farm machine suitable for weed control on the family's commercial vegetable garden. Discuss the factors which you would take into consideration.

SUB-STRAND AS 12.2.2 FINANCIAL CAPITAL

Recognise and use selected farm management tools which are used to prepare farm plans.

CONTENT LEARNING OUTCOME

AS 12.2.2 Identify, discuss and use selected farm management tools which are used to prepare farm plans.

LESSON 1 INTRODUCTION

LESSON OUTCOME

At the end of this lesson the student will distinguish between planning and evaluating a farm business.

Planning - a systematic process of envisioning a desired future, and translating this vision into broadly defined goals or objectives and a sequence of steps to achieve them.

Evaluating - to judge or calculate the quality, importance, amount or value of something

Farm managers make choices every day.
The choices made today may have an immediate impact on the business, or they may take much longer to have an effect. These decisions may involve any facet of the farm business, including—but not limited to—production, personnel or financing.
Irrespective of the size or scope of any single decision, nearly all decisions can have important implications for the immediate and future success of the farm business.
Because many decisions have such important impacts, farm managers need to analyse alternatives in a methodical fashion. Some alternatives are easily analysed, and a decision can be made quickly. In other cases, farm managers must take more time to recognise and evaluate all potential effects of a decision.
To do this, farm managers need a framework for analysing the relevant trade-offs.

Management is a dynamic process which needs information to be effective. Budgets can help a manger by providing economic information for decisions concerning a production period, an annual plan or a long term plan. Budgets are used in all phases of management including planning, implementing and controlling production.
Managing the finances of a farm is a continuous cycle: There are various tools and programmes available which farmers can use to assist with the planning and evaluation of the business enterprises on the farm.

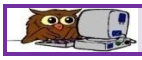
Adapted *from http://www.water.nsw.gov.au*

When **planning** the farm, the following tools are often used:

1) Whole farm budget	2) Enterprise budget
3) Partial farm budget	4) Gross margin
5) Returns to Labour	6) Returns to Capital

Once a financial year has been completed the farmer needs to **evaluate** the performance of each enterprise on the farm for comparison. This will assist farmers make informed decisions concerning the future of the farm.
Farm analysis tools include:

1) Profit and loss account	2) Balance sheet	3) Inventories
4) Depreciation calculations	5) Labour records	


Differentiate between budgeting and evaluation in relation to a farming enterprise.


Budgets deal with the financial aspects of planning. Evaluation judges the performance of a farming enterprise and allows the farmer to alter future plans.


Make a list of the planning and evaluation tools available on the internet for farmers to use. Why are most farmers in Fiji still using pen and paper to plan and evaluate their farming enterprises?

LESSON 2: FARM BUDGETS

LESSON OUTCOME: At the end of this lesson the student will list the four types of budgets prepared on farms.


Budget - summary of probable financial outlays and incomes over a specific period.


Budgeting can be defined in many ways including **an estimation of income and expenditure over a period of time.**

The primary problem faced by farmers is a limited supply of resources (land, labour, capital and technology) available to accomplish goals.

Farm managers include budgeting as part of their planning as budgets provide information which the farmer can use in the decision-making process. Budgets help the farmer evaluate the alternative plans and select the plan which has the potential to be the most profitable.

Purpose of budgeting

Budgets provide projected information which can be used to support a variety of management tasks. Budgeting provides projected information which:

1. helps the manger select the best crop, forage and livestock enterprise combinations for the farm.
2. can be used to refine organisational and operating structures; it also forces a manager to develop a production and marketing plan.
3. forces the manager to uncover cost items which might otherwise be overlooked.
4. allows the possible outcomes of a change to be studied before resources are actually committed to the change.
5. can be used to test the economic and financial feasibility of alternative production technologies and management practices.
6. can be used to develop and organise information which will be helpful to lending agencies when the business needs loans.
7. can help the manager select which enterprise to invest in by comparing investments and expected outcomes of each enterprise on the farm
8. provides information which the manager can use to compare the projected and actual results of implementing a plan.
9. provided the basic information for preparation of the farm cash flow and projected income statement.

The information gained from budgeting is used in budget reports so that it can be understood and properly used.

There are **four** types of budget reports:

i) **Whole farm budget** – summary of expected income, expenses and profit/loss for the entire farm over a financial year.

ii) **Enterprise Budget** – used by farmers to compare the costs and benefits of two separate enterprises on a per hectare basis e.g. comparing dalo faming and cassava farming.

iii) **Partial budget** - used by farmers to compare the costs and benefits of two farming operation alternatives e.g. to use labour or machines to harvest sugarcane.

iv) **Cash flow budget** – used to determine when cash receipts and expenses will be encountered for the whole farm, over a period in the future e.g. when will finances be needed and when will finances be available so that loans and loan repayments can be determined.

In budgets, a comparison is made between the income and expenditure to decide if the the enterprise or farm is expected to make a profit, loss or will break even.

Profit/Loss = Total returns – Total costs

Interpretation of results

+ means profit made	**0 means broken even**	- means loss made

The value of budget analysis is highly dependent upon the quality of the information used in the analysis.

Compare the use of the four types of budgets prepared on farms.

Information collected for and derived from farm budgets assists farmers in planning their farming enterprises.

Discuss the uses of budgets on a farm.

LESSON 3: WHOLE FARM BUDGETS

LESSON OUTCOME: At the end of this lesson the student will discuss whole farm budgets.

Livestock - farm animals regarded as an asset.
Dead stock - machinery and stored produce

Whole farm budgets are also referred to as complete budgets or total budgets. They deal with the **estimation** of **all** income and expenditure of a farm for an entire financial year and is the best tool to analyse the farm business and the impacts of the goals and objectives.

Whole farm budgets are used for:

i) calculating tax
ii) assessing the farm's financial situation
iii) requesting financial assistance from lending agencies
iv) assessing the impact of changes involving the whole farm e.g. introduction of tractors on a crop farm

To develop a whole-farm budget:

i) list the goals and objectives of the farm
ii) inventory the resources available for use in production
iii) determine physical production data that will be used in the input/output process
iv) identify reliable input and output prices
v) calculate the expected variable and fixed costs and all returns

There are a number of components to a whole farm budget:

1. **Capital value of the property**: the farmer estimates the amount of capital invested in the operation by calculating the value of the land, equipment and improvements including water supplies, fencing, buildings, standing crops, livestock and dead stock on the farm.
2. **Assumed annual returns**: the farmer estimates the income of the farm in the next 12 months based on relevant farm records and adjustments for taxes and inflation.
3. **Assumed annual costs**: the farmer estimates the costs that the farm will incur in the next 12 months based on relevant farm records and adjustments for taxes and inflation.
4. **Profit/loss** – the farmer uses the assumed annual returns and the assumed annual costs to calculate the expected profit/loss of the farm.

The Whole Farm Budget should help formulate a plan that can provide direction for the farmer and family to follow in maximising the returns to owned resources.
An example of a Whole Farm Budget of a beef cattle property which also has dairy cattle and sheep

1 **Capital investment in property**	**$**
Land	388 000
Buildings	224 000
Stock value	165 000
Total	**777 000**

2. Anticipated income	**$**
Sale of sheep	2 400
Sale of cattle	35 000
Sale of wool	1 100
Milk sales	47 400
Hiring out of machines	5 800
Total	**91 700**

3. Anticipated expenses					**Total**
Fixed expenses	**$**		**Variable expenses**	**$**	**$**
Equipment depreciation	6 300		Pasture costs	15 000	
Lease and land tax	8 800		Wages	15 000	
Salaries	23 000		Transport	2 000	
Insurance, interest on loans	1 200		Fuel	3 000	
			Veterinary fees	2 500	
			Power	750	
Total	**39 300**		**Total**	**38 250**	**77 550**

4. Profit /loss statement
Profit = Total returns - Total costs
= $ 91 700 - 77 550
= $ 14 150

This informs the farmer that the farm can be expected to make a profit of $ 14 150 for the financial year ahead.


Discuss the advantages of preparing a whole farm budget.


Whole farm budgets deals with the estimation of all income and expenditure for the farm for a whole year.


Obtain figures from a farm and prepare a whole farm budget.

LESSON 4: ENTERPRISE BUDGETS

LESSON OUTCOME: At the end of this lesson the student will discuss enterprise budgets.

Enterprise budget - refers to a listing of all estimated costs and returns and net income of one enterprise on the farm

As part of planning, farmers often have to decide between enterprises for the farm e.g. should the farm raise cows or ewes. The farmer prepares budgets for each of the enterprises of interest. The results are compared and the farmer can make an informed decision.

An example of two enterprise budgets: The farmer has to decide whether to keep raising 60 cows or to switch to 600 ewes.

Present activity: 60 cows			**Proposed activity : 600 ewes**	
Annual income	**$**		**Estimated annual income**	**$**
Cfa cows	1350		Wool	7725
Cfa bull	200		Cfa ewes	1800
Vealers	11 880		Cfa rams	45
			Lambs	10 560
Total	**14 430**		**Total**	**20 130**
Annual running costs			**Estimated annual running costs**	
Husbandry	360		Shearing	1 150
Cow replacements	2500		Husbandry	1 280
Bull replacements	500		Ewe replacements	3 564
			Ram replacements	360
Total	**3360**		**Total**	**13 776**
Annual profit	**10 070**		**Estimated annual profit**	**13776**
Expected difference in profit:		**$3706.00**		

Cfa means cast for age or sold because of old age

The calculations above have shown that the farmer will make an increased profit if the farm switches from raising 60 cows to raising 600 ewes.

It must be remembered that the farmer must also take into consideration many other factors like market agreements [does the farmer have a contract to supply cattle products to a buyer?], structures on the farm [does the farm have fencing suitable for sheep?] etc.

Discuss the advantages of preparing enterprise budgets.

Enterprise budgets deal with the estimation of income and expenditure for an enterprise.

Obtain figures from a farm and prepare a whole farm budget.

LESSON 5: PARTIAL FARM BUDGETS

LESSON OUTCOME: At the end of this lesson the student will discuss partial farm budgets.

Partial budget	-	refers to a listing of all estimated costs and returns and net income of one change made to an enterprise on the farm

A farmer may want to make changes to one enterprise on the farm. This change may impact the income and expenditure of the enterprise. Partial budgeting is a planning and decision-making framework used to compare the costs and benefits of **alternatives** faced by a farm enterprise e.g. the changes that occur to the income and expenditure of a farm if heifers are bought instead of being raised on the farm. It focuses only on the changes in income and expenses that would result from implementing a specific alternative. Thus, all aspects of farm profits that are unchanged by the decision can be safely ignored.

Advantages:

- the technique is simple (it can be performed with a hand calculator)
- it examines only net changes in costs and benefits; therefore it is effective for assessing economic viability of single interventions and technologies.
- it requires less data than whole farm budgeting since fixed costs are not examined.
- the data required for partial budget analysis are collected for almost all other economic analyses.
- it allows early conclusions about the adaptability of new technology.

Disadvantages

- There is a danger of forgetting that farmer's resources are limited and sometimes knowledge about the resource base may be lacking; this happens as most new technologies require an increase in purchased inputs and additional labour.
- The partial view of a farming system might obscure the secondary character of a given farm component.

Example of partial budget: The example below illustrates how a partial budget can be used to **analyse the decision to purchase replacements for a cow-calf herd rather than raise them**. Heifer calves that would have been held back for the herd can now be sold, resulting in additional income. Some costs for developing the heifers will no longer be incurred, such as feed, health and labour costs. Other costs, such as land ownership and depreciation on facilities, would probably not change, so they can be omitted from the budget. On the negative side, the cost of purchasing a bred heifer appears as an added cost. There is no reduced income entry, since cull cow sales would be the same for either alternative.

Added income due to change:	**$**	**Added cost due to change:**	**$**
Sell raised heifer calf	600.00	Purchase bred heifer	1 200.00
Reduced cost due to change		**Reduced income due to change**	
Pasture maintenance	20.00	None	0
Grain feed	40.00		
Supplement and minerals	45.00		
Health, utilities and other costs	55.00		
Labour	50.00		
Subtotal	810.00		1200.00

Net change: Subtotal from column 1 *minus* subtotal from column 2
$810.00 - $1200.00 = $ -310.00

https://www.extension.iastate.edu

Interpretation: the projected net change is negative; therefore it is more profitable to continue raising replacement heifers on the farm, unless a cheaper source of replacement heifers is found.

Discuss the advantages of preparing a partial farm budget.

A partial farm budget is a planning and decision-making framework used to compare the costs and benefits of one alternative faced by a farming business.

Obtain figures from a farm and prepare a partial farm budget.

LESSON 6: CASH FLOW BUDGET

LESSON OUTCOME: At the end of this lesson the student will discuss partial farm budgets

Cash Flow budget - the chronological overview of expected income and expenses over a given period of time.

How much money will the farm business need this year? When will money be needed and from where will it come? These questions are reasons why cash flow budgets are prepared by farmers. It predicts and provides a forecast of cash inflows and outflows over specific periods e.g. daily, weekly, monthly or annually.

The cash flow budget is a useful tool because it:

- forces a farmer to think through the farm's yearly plan
- tests the farm plan to see if the finance will be available when needed
- projects how much operating capital is needed and when loans can be repaid
- provides a guide against which actual cash flows can be compared
- helps the famer explain the credit needs and repayment ability to financing agents [bank]

An example of a cash flow budget for a farm for January to June

	Jan	Feb	March	April	May	June
	$	$	$	$	$	$
Opening Balance	1 000	-4 680	-3,160	- 1 540	180	1 650
Income						
Cash sales	4 000	3 700	3 900	3 800	4 000	4 200
Credit sales	0	3 700	3 900	3 800	1 400	1 500
Loan	7 000	0	0	0	0	0
Total Income	11 000	5 400	5 800	5 600	5 400	5 700
Expenditure						
Rent	800	800	800	800	800	800
Electricity	80	80	80	80	30	30
Purchases	5 600	1 900	2 000	1 800	1 900	1 800
Wages	1 200	1 100	1 300	1 200	1 200	1 200
Equipment	9 000	0	0	0	0	0
Total Expenditure	16 680	3 880	4 180	3 880	3 930	3 830
Net Cash Flow	- 5 680	1 520	1 620	1 720	1 470	1 870
Closing Balance	- 4 680	-3 160	-1 540	180	1 650	1 870

Adapted from http://www.2.bp.blogspot.com

Interpretation: The farmer would need to plan to have finance available in January, February and March as he has negative closing balances for those months.

When a cash flow budget indicates that there will be a lack of cash in the coming month, the farmer can obtain the money that is needed by one or more of the following:

* borrowing money from lending institutions
* arranging earlier payment from debtors
* arranging delayed payment to suppliers
* cutting down expenses
* postponing large investments
* cutting down on personal drawings
* introducing 'cash on delivery' for customers

Discus the main reason why famers prepare cash flow budgets.

A cash flow budget is a planning and decision-making framework used to forecast when a farm will receive income and incur expenses over a period of time. It allows the farmer to arrange for extra finance and repayments so that finance is available for use when needed.

Obtain figures from a farm and prepare a cash flow budget.

LESSON 7: DECIDING WHICH ENTERPRISE TO ENGAGE IN ON THE FARM

LESSON OUTCOME: At the end of this lesson the student will differentiate between the tools to use depending on a farm's limiting resource.

Competency - a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organisation) to act effectively in a job or situation.

Farm resources may be used for different enterprises on a farm and the farmer needs to choose one or a mixture of enterprises to engage in.

Some factors which influence his decision include:

i) available market
ii) competition from other producers and imports
iii) religious, cultural or legal taboos
iv) competency in raising that crop or livestock
v) limiting factors like land, labour and capital

The following methods are used to help the farmer determine which enterprise to engage in depending on the limiting resource:

i) Gross Margin – used when land is the limiting factor
ii) Return to Capital – used when capital is the limiting factor
iii) Return to Labour – used when labour is limiting factor

List factors which determine the enterprise or mix of enterprises which a farmer will raise on the farm.

A farmer must carefully consider which enterprise or mix of enterprises to raise on his farm.

Differentiate among Gross Margin, Return to Capital and Return to Labour.

LESSON 8 GROSS MARGIN

LESSON OUTCOME:

At the end of this lesson the student will discuss, calculate and interpret Gross Margins.

Gross margin - a tool used to show relative returns for enterprises when **land** is the limiting factor.

Gross margin is also known as the gross profit margin or gross profit rate for an enterprise. It is a simplified method of showing relative returns for activities so that direct comparisons can be made. The farmer can then decide which enterprise to choose based on **land** limitations.

A gross margin is **not profit** because it **does not include fixed or overhead costs** such as depreciation, interest payments, rates and permanent labour, which have to be met regardless of the size of the enterprise.

The Gross margin is used to:

i) compare relative costs and returns for similar farm activities
ii) determine the viability of each enterprise
iii) compare the historic performance of activities or to predict the performance of potential alternative activities.
iv) provide useful information for planning and budgeting the farm enterprise mix
v) provide information for predicting the future and direct management decisions
vi) determine production levels for each enterprise.

Limitations of gross margin

Gross margin have some limitations and should **not** be the sole determinant of a farm enterprise mix, as they:

- exclude overhead costs/fixed cost, so they do not supply enough information if cost of production is required;
- do not take account of the need for rotations to control disease, weed and pest risks
- take no account of risk management related to factors such as market prices, crop failure and input cost volatility
- do not allocate permanent labour costs to enterprises
- do not easily take into account dual enterprise benefits - e.g. stubble grazing value of crops
- do not consider future benefits and interactions, as they are a single season analysis

Gross margin = Total Revenue – Variable Costs

Total revenue is the income generated by the sale of a product.

Total revenue = Quantity x Price

Variable costs vary with the level of output. Examples of variable costs		Fixed costs remain constant whatever the quantity of goods or services produced. Examples of fixed costs
Crop related	**Livestock related**	
▪ Planting material [like seeds] ▪ Fertilizing material ▪ Agrochemicals ▪ Fuel and lubricants ▪ Repairs and maintenance ▪ Contract workers ▪ Casual labourers ▪ Transport and cartage ▪ Water and power	▪ Feed ▪ Agro chemicals ▪ Casual labourers ▪ Fuel and lubricants ▪ Repairs and maintenance ▪ Contract workers ▪ Casual labourers ▪ Transport and cartage ▪ Animal insurance and health	▪ Administration – accounting, telephone, postage ▪ Rates and rents ▪ Depreciation of machinery and equipment ▪ General farm insurance and worker's compensation ▪ Loan and interest payments ▪ Salaries of permanent staff ▪ Annual maintenance ▪ Taxation payments ▪ Lease payments

An example of Gross Margin calculations:

	Dalo	Cassava	Yam
Total revenue/ha ($)	4 050	3 000	4 500
Variable costs /ha ($)			
Cultivation	90	113	82
Planting material	500	28	200
Fertilizing material	90	33	157
Agrochemicals	15	10	19
Sacks	50	40	40
Transportation	50	55	60
Staking wire and string	0	0	261
Total variable cost	**795**	**279**	**819**

The Labour requirements in man days per hectare are:
Cassava – 200
Dalo - 210
Yams - 274

Gross margin for each crop:

Dalo	Cassava	Yams
GM = TR – VC = 4050 – 795 = 3255 = $ 3255.00/ha	GM = TR – VC = 3000 - 279 = 2721 = $ 2721.00/ha	GM = TR – VC = 4500 - 819 = 3681 = $ 3681.00 /ha

Interpretation – Where there is a **shortage of land**, the best crop to choose is yams as it has the highest Gross margin when compared to cassava and dalo.

Discuss the advantages of preparing Gross Margins for farm enterprises.

Gross Margin is a tool used to show relative returns for enterprises so that direct comparisons can be made. This is taken into consideration when deciding on the enterprise to conduct on a farm when land is the limiting factor.

Obtain figures from a farm and prepare Gross Margin for the enterprises.

LESSON 9 RETURNS TO LABOUR

LESSON OUTCOME:

At the end of this lesson the student will discuss, calculate and interpret Return to Labour

Returns to Labour - a tool used to show relative returns for enterprises when labour is the limiting factor

Returns to Labour is a simplified method of showing relative returns for activities based on labour so that direct comparisons can be made.
The farmer can then decide which enterprise to choose based on labour.

Returns to Labour characterises the productivity of labour over a period. It reflects the return to an individual's involvement (mental or physical) in the creation or realisation of goods or services.

Returns to Labour = $\frac{\text{Gross Margin}}{\text{Labour costs or man days}}$	Interpretation– the enterprise with the highest returns to labour should be invested in when labour is the limiting factor.

Example from previous lesson continued:

Comparing	**Dalo**	**Cassava**	**Yams**
Gross margin [Return to land] [GM/ha]	GM = TR – VC = 4050 – 795 = 3255 = $ 3255.00/ha	GM = TR – VC = 3000 - 279 = 2721 = $ 2721.00/ha	GM = TR – VC = 4500 - 819 = 3681 = $ 3681.00 /ha
Labour requirements [man days/ha]	210	200	274
Return to Labour	RtL = GM ÷ man days = 3255.50 ÷ 210 = 15.50	RtL = GM ÷ man days = 2721.00 ÷ 200 = 13.61	RtL = GM ÷ man days = 3681 ÷ 274 = 13.43
Interpretation: For every $1.00 invested in labour	Dalo will make $15.50	Cassava will make $ 13.61	Yams will make $ 13.43

Discuss the advantages of preparing Returns to Labour for farm enterprises.

Returns to Labour is a tool used to show relative returns for enterprises so that direct comparisons can be made. This is taken into consideration when deciding on the enterprise to conduct on a farm when labour is limited.

Obtain figures from a farm, calculate and interpret Returns to Labour.

LESSON 8 RETURNS TO CAPITAL

LESSON OUTCOME:

At the end of this lesson the student will discuss, calculate and interpret Returns to Capital.

Returns to Capital - a tool used to show relative returns for enterprises when capital is the limiting factor

Returns to Capital is a simplified method of showing relative returns for activities based on capital so that direct comparisons can be made.

Returns on capital invested is a profitability ratio. It allows the farmer to compare the performance of various investment opportunities so that the farmer can decide whether to continue with the plan or to consider other options like banking the money and gaining interest.

Returns to Capital = $\frac{\text{Gross margin}}{\text{Variable Cost}}$ Interpretation– the enterprise with the highest Return to Capital should be invested in when capital is the limiting factor.

Example from previous lesson continued:

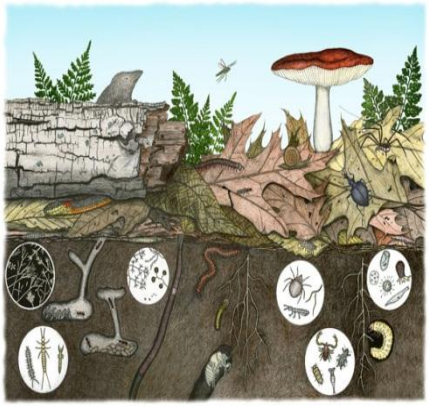
Comparing	**Dalo**	**Cassava**	**Yams**
Gross margin [GM/ha] [Return to land]	GM = TR – VC = 4050 – 795 = 3255	GM = TR – VC = 3000 - 279 = 2721	GM = TR – VC = 4500 - 819 = 3681
Interpretation: For every hectare of land used	Dalo will make $3255.00/ha	Cassava will make $ 2721.00/ha	Yams will make $ 3681.00 /ha
Labour requirements [man days/ha]	210	200	274
Returns to Labour	RtoL = GM ÷ man days = 3255.50 ÷ 210 = 15.50	RtoL = GM ÷ man days = 2721.00 ÷ 200 = 13.61	RtoL = GM ÷ man days = 3681 ÷ 274 = 13.43
Interpretation: For every man hour invested	Dalo will make $15.50	Cassava will make $ 13.61	Yams will make $ 13.43
Variable costs $/ha	**795**	**279**	**819**
Returns to Capital	RtoC = GM ÷ VC = 3255 ÷ 795 = 4.09	RtoC = GM ÷ VC = 2721 ÷ 279 = 9.75	RtoC = GM ÷ VC = 3681 ÷ 819 = 4.49
Interpretation: For every $1.00 invested	Dalo will make $4.09	Cassava will make $9.75	Yams will make $4.49

Discuss the advantages of preparing Returns to Capital for farm enterprises.

Returns to Capital is a tool used to show relative returns for enterprises so that direct comparisons can be made. This is taken into consideration when deciding on the enterprise to conduct on a farm when capital is a limiting factor.

Obtain figures from a farm, calculate and interpret Returns to Capital.

STRAND AS 12.3 AGRONOMY	
SUB-STRAND 12.3.1 SOILS	CLO 12.3.1.1 BIOLOGICAL PROPERTIES
SUB-STRAND 12.3.2 HORTICULTRE	CLO 12.3.2.1 PLANTIMPROVEMENT
	CLO 12.3.2.2 FORESTRY AND AGROFORESTRY
	CLO12.3.2.3 ORNAMENTAL HORTICULTURE
	CLO 12.3.2.4 TREE CROPS



http://www.inhs.illinois.edu

https://www.fruitsaladtrees.com

Introduction

This strand will facilitate the exploration of the biological properties of soil, plant improvement, forestry, agroforestry, ornamental horticulture and tree crops.

Students will be introduced to concepts relating to the relationship of the biological properties of soil to use and husbandry practises employed.

They will also study methods of plant improvement, types of forestry and agroforestry, ornamental horticulture and the production of tree crops.

SUBSTRAND AS 12.3.1 SOILS

CONTENT LEARNING OUTCOME

At the end of these lessons, the student will recognize and evaluate soil by identifying and describing the role of soil biota in relation to soil health, use, husbandry practices and enhancement.

Nature has endowed the Earth with glorious wonders and vast resources that man may use for his own ends. Regardless of our tastes or our way of living, there are none that present more variations to tax our imagination than the soil, and certainly none so important to our ancestors, to ourselves and to our children" *Charles Kellogg, The Soils That Support Us, 1956*

AS 12.3.1.1 Recognise and evaluate soil by identifying and describing the role of soil biota in relation to soil health, use, husbandry practises and enhancement.

LESSON 1: IMPORTANCE OF SOIL ORGANISMS

LESSON OUTCOME: At the end of this lesson the student will highlight the importance of soil organisms.

Exudate - a substance that is emitted or released

Glomalin - glycoprotein produced by the hyphae of mycorrhizae fungi.

Carbon sequestration - a process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form

Soil contains a dynamic living ecosystem which is made up of organisms, some of which spend their whole life in soil while others spend part of their life cycle in soil.

Soil microbiology is the branch of science concerned with soil inhabiting microorganisms, their functions and activities.

The importance of soil organisms is still being discovered and includes:

i) **weathering** – soil organisms influence the breakdown of rocks into soil by burrowing into soft rocks and by extracting nutrients which destabilises the structure of rocks

ii) **biodiversity** – soil is the home to the largest proportion of the world's biodiversity, an estimated 1% of which have been identified

iii) **mineral cycling** – soil organisms break down organic matter, making nutrients available for uptake by plants and other organisms e.g. nitrogen, phosphorus, sulphur and carbon

iv) **nutrient storage** – the nutrients stored in the bodies of soil organisms are **not** removed from soil through leaching or sublimation

v) **influencing soil structure** – organism exudates have an adhesive quality which hold soil particles together

vi) **bioturbation** - as soil organisms burrow, they turn and mix sediments, stir and aerate soil and so influence the infiltration and movement of water in the soil

vii) **glomalin production** – soil organisms produce this type of soil glue which binds mineral particles together, improves soil quality and carbon sequestration.

viii) **toxin degradation** – soil organisms break down toxins like pesticides and fuel so reduce pollution.

ix) **storing toxins** – soil absorbs toxins and chemicals which would otherwise be carried into waterways.

x) **suppressing pathogenic microorganisms** that cause diseases by competing with them.

Soil organisms are also a source of industrial products including enzymes, antibodies vitamins, hormones and organic acids.

Discuss the importance of soil organisms.

Soil is the habitat for a vast array of organisms which in turn influence the physical and chemical properties of soil.

Discuss the effect that soil organisms on soil.

LESSON 2: TYPES OF SOIL ORGANISMS

LESSON OUTCOME:

At the end of this lesson the student will distinguish between the types of soil oganisms.

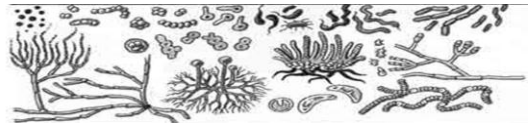
Soil zoology - the study of animals living fully or partially in the soil (soil fauna)

The community of soil organisms is varied, versatile and adaptable to changing conditions and food supplies.

Soil biota is commonly divided into two arbitrary groups according to their function in the soil:

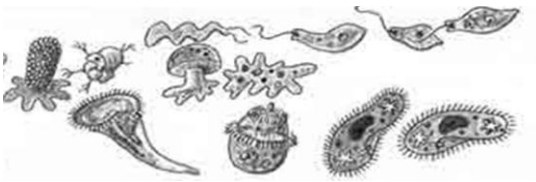
1. Soil flora – the plants and organisms with plant-like features which inhabit the soil. They are listed in order from smallest to largest:
   a) Micro –flora includes bacteria, fungi, actinomycetes and algae.
   b) Macro- flora includes roots of higher plants.

2. Soil fauna – the animals and organisms with animal-like features which inhabit the soil. They are listed from smallest to largest:
   a) Micro fauna include protozoa, small mites, tardigrades and copepod crustaceans



http://hypersoil.uni-muenster.de

   b) Mesofauna include mites and springtails, small araneidae, nematodes, rotifers, pseudoscorpions, opiliones, enchytraeids, insect larvae, small isopods and myriapods.

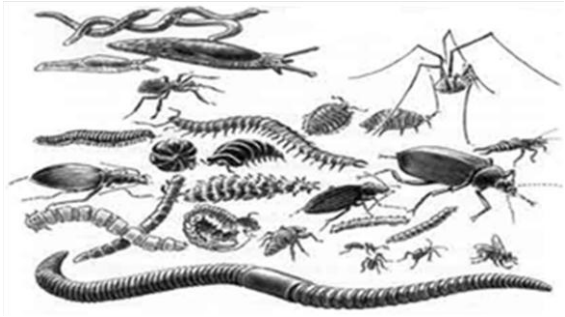


http://hypersoil.uni-muenster.de

   c) Macro fauna include smaller earthworms, gastropods, isopods, myriapods, some araneidae and the majority of insects.

http://hypersoil.uni-muenster.de

   d) Mega fauna include large earthworms, snails, myriapods, small rodents, reptiles and amphibians.



http://hypersoil.uni-muenster.de

Differentiate between soil micro and mega fauna.

Soil organisms can be grouped according to their size.

Why are soil organism classified according to size?

LESSON 3: ENCOURAGING SOIL ORGANISM POPULATIONS

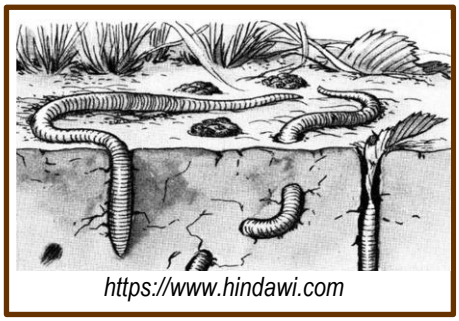
LESSON OUTCOME:

At the end of this lesson the student will discuss the needs of soil organisms.

Mulch	-	materials placed on the surface of the soil
Soil amendments	-	materials mixed into the soil.
Vermiculture	-	the raising and production of earthworms and their by-products

Soil organisms are vital to the productivity of soil so care must be taken to encourage populations.Creating a favorable environment for soil organisms improves plant growth and reduces crop maintenance.

Soil organisms require the following to survive and multiply:



https://www.hindawi.com

i) **stable environment** – continual disturbance of the topsoil may disrupt the life cycle of soil organisms.

ii) **light-** light directly affects those organisms living on or just below the surface and indirectly by heating the soil surface. Phototrophs such as plants, algae and cyanobacteria use the energy from sunlight to synthesis carbohydrates.
Parts of the light spectrum are more damaging to organisms than others. Ultraviolet light can damage DNA which induces mutations in the organisms resulting in death of the organism or biochemical changes, for example changes of enzymes and metabolic pathways.
Photochemical degradation will lead to structural changes in organic molecules making them more or less easy to be degraded.

iii) **food source** – which is usually organic matter or mineral matter.

iv) **water source** – soil moisture affects the soil biota in two ways. Biologically water is essential for life and for enzyme activity and metabolism and is a solvent for biological nutrients and other chemicals. Physically, soil moisture affects soil temperature (water is a good conductor of heat) and soil aeration. The degree at which soil pores are filled affects the movement and predation of microorganisms in soil. A damp environment is most suitable.

v) **air source** – although some soil organisms are anaerobic, other soil organisms require oxygen so will inhabit the litter layer and upper layer of the topsoil.

vi) **suitable temperature** – temperature directly affects the activity of the soil biota by determining the rate of physiological activity such as enzyme activity and indirectly by affecting physico-chemical properties such as diffusion & solubility of nutrients, mineral weathering and evaporation rates etc. soil organisms survive within a temperature range so altering temperature drastically impacts on their survival.

vii) **suitable pH** – soil organisms tolerate a range of soil pH by need to maintain their internal body pH of 7. Soil pH directly affects the solubility of elements. At acidic pH, aluminium becomes more soluble and hence more available to the organisms with increased toxicity. Essential minerals can become unavailable at extremes of pH. For example, phosphorous and manganese become increasingly unavailable at high pH values.

The following husbandry practices assist colonies of soil organisms grow:

I. **Add organic matter to the soil**.
Soil organisms require a food source from soil amendments including compost and crop residues and/or organic mulch. Organic mulch stabilizes soil moisture and temperature, adds organic matter, prevents soil compaction and protects soil oxygen levels needed by soil organisms and roots.

II. **Water effectively.**
Soil organisms require an environment that is damp (like a wrung out sponge) but not soggy. Soil organism activity may be reduced due to dry soil conditions during winter and drought. Avoid over-irrigation because water-logged soils will be harmful to beneficial soil organisms.

III. **Avoid unnecessary tillage**, as it will destroy the mycorrhizae and soil structure. Instead of tilling, mulch for weed control.

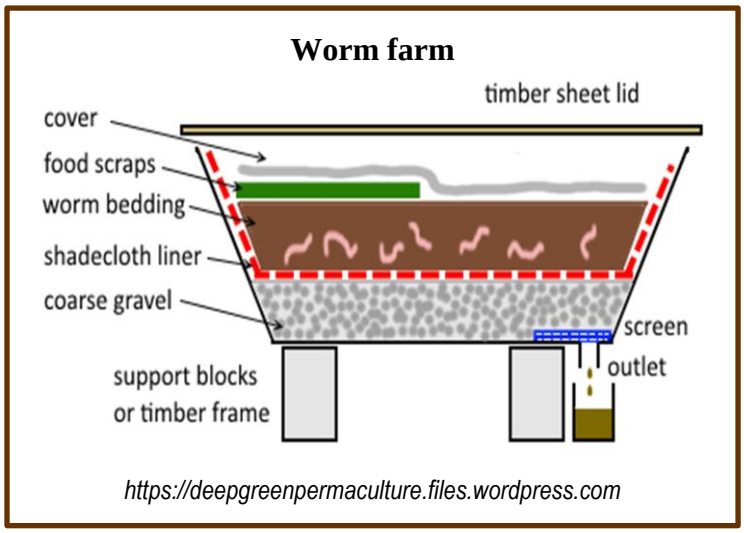
IV. **Avoid unwarranted pesticide applications**. Some fungicides, insecticides and herbicides are harmful to various types of soil organisms.

V. **Avoid plastic sheets mulch**. This practice discourages microorganism activity by reducing water and air movement and preventing the incorporation of organic matter.

VI. **Avoid burning** – soil organisms in the Pacific thrive within a temperature range of 10 to 32^{O} Celsius. Heat from fires on the surface of soil often penetrates to where soil organisms live and kill them. Exposing the surface of the soil to scorching heat has the same effect.

VII. **Maintain soil pH** – soil organisms favour a pH range between 6.5 and 7.5. Many agricultural practices impact the pH of soil so adjusting pH to levels favoured by soil organisms is recommended.

VIII. **Adding soil organisms** – if the resources required by soil organisms are present, farmers can add soil organisms. This is most common with macro fauna like earthworms. Farming earthworms, **vermiculture**, is a growing business in many countries because many farmers buy earthworms and their casts to add to the farm's soil.




Discuss the needs of sol organisms.


To encourage soil organism populations, farmers provide suitable environments and use husbandry practices which enhance populations.


Discuss husbandry practices conducive to the growth of microorganisms which can be adopted and used on the school farm.

LESSON 4: OBSERVING SOIL ORGANISMS

LESSON OUTCOME: At the end of this lesson the student will discuss methods used to determine if soil organisms are present in soil.

A variety of methods are used to determine if microorganisms are present in soil.

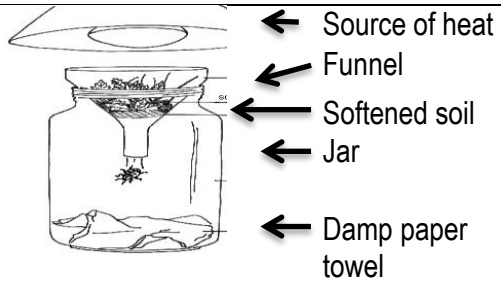
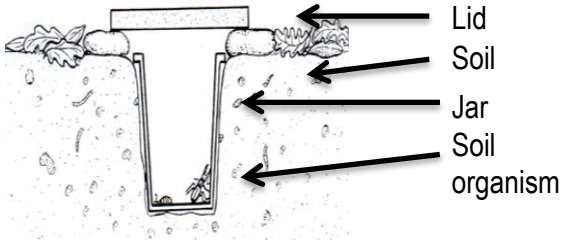
1. Direct observation of the soil
   some soil organisms and their remains are easy to see like earthworms and their casts, mushrooms, algae etc.

Earthworm casts

https://commons.wikimedia.org

2. Traps can be set to capture soil organisms e.g. pitfall traps, pheromone traps.

3. Extracting organisms from soil sample:
   i) heat can be used to dry out soil and cause soil organisms to move out of the spoil sample e.g. Berlese funnel.
   ii) the sample can be stirred in water to allow the organisms to float in the water.
   iii) elutriation – where the flooded soil is spun, causing the soil organisms to separate out.

Berlese funnel.	**Pitfall trap**
	
http://kelsohighschool.org.uk	*http://publicschools.manchesterct.gov/*

4. Lime water test - the carbon dioxide produced by soil organisms will turn limewater milky.

5. Microscopes - individual microbes are impossible to see without a powerful microscope but extensive colonies of microbes can be observed under school microscopes. These colonies can be grown in the labs.

6. Laboratory tests including functional assays and molecular fingerprinting are also used.
   Both methods require laboratory facilities and give very accurate data concerning the type and number of micro-organisms present in a soil.

Prepare a pitfall trap and observe then let go any soil organisms which are caught.

There are a number of methods used to determine and observe the organisms present in soil. These range from observing macro-fauna to micro flora.

Construct a **Berlese** funnel or culture a colony of soil micro-organisms and discuss the pros and cons of using either method.

SUB- STRAND AS 12.3.2 HORTICULTURE

> "Someone is sitting in the shade today because someone planted a tree a long time ago."
> Warren Buffett

CLO 12.3.2.1 PLANT IMPROVEMENT

CONTENT LEARNING OUTCOME

At the end of these lessons, the student will investigate, select and practice appropriate improvement methods on established plants.

AS 12.3.2.1.1 Explore, compare and match improvement methods to crops in the locality.

LESSON 1: INTRODUCTION

Lesson outcome: At the end of this lesson the student will discuss the history and importance of plant improvement.

Variety - taxonomic category where members of a species differ from others of the same subspecies or species in minor but permanent or heritable characteristics.
Improved variety - superior to other varieties of the same crop.

About 10,000 years BC, people harvested their food from the natural biological diversity that surrounded them.
According to the "dump heap hypothesis", wandering peoples discarded remains of plant foods in piles in cleared areas, then returned to the sites and discovered that the same types of plants they had eaten the year before were growing where rubbish had been piled.

Eventually, people connected the leaving of seeds one season to finding of edible plants the next. Farming began when people intentionally saved and planted seeds of their favourite plants.

Over time, people selected better plant materials for propagation and animals for breeding, initially unwittingly, but ultimately with the intention of developing improved food crops and livestock. Over thousands of years farmers selected for desirable traits in crops, and thus improved plants for agricultural purposes.

Plants are the basis of all human life; they provide food and feed, medicine and drugs, and raw materials for clothing, housing and energy production.

Due to global change, the role of crop plants as the foundation of human civilisation becomes threatened by:

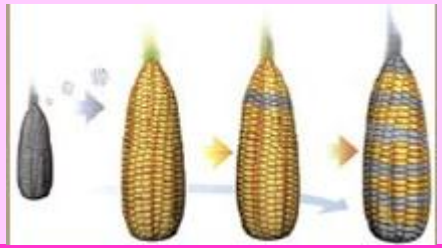
i) the increasing need to feed the world's population, predicted to reach over 9 billion by 2050
ii) an ever greater demand for a balanced and healthy diet
iii) the limited availability of farm land for crop production, which has remained around 660 million hectares for the past 50 years
iv) the fact that much of the world's best soils are already in use and others are protected because of environmental concerns
v) the use of marginal lands for which stress-tolerant crops need to be developed
vi) the need to respond and adapt to issues related to changing climatic conditions like rising sea levels, changing climatic conditions and soil salination

Therefore, innovative strategies for crop improvement are required that aim at enhancing crop productivity while minimizing resource requirements. Crop improvement is one method used.

Discuss the role of plant improvement in in human history.

Plant improvement began when people began farming.
Due to the need of the growing world population, plants have been selected and modified to improve the quantity and quality of harvest from the same area of land.

The diagram below illustrates the development of maize over time.



Discuss the reasons for this development.

http://museumtamal.org

LESSON 2: PLANT IMPROVEMENT

Lesson outcome:

At the end of this lesson the student will discuss the main methods used to produce superior crops.

Germplasm	-	the genetic material of a plant and animal species or other related group of organisms, collected for use in study, conservation, and breeding such as seeds or tissue
Heterosis	-	hybrid vigour, or outbreeding enhancement, is the improved or increased function of any biological quality in a hybrid offspring
Gene redundancy	-	two or more genes are performing the same function and that inactivation of one of these genes has little or no effect on the biological phenotype

Over time, people have chosen to produce superior crops.
They have selected and developed crops with:

1. high yield
2. better quality of products
3. increased tolerance to environmental stress
4. increased tolerance to pests
5. range of products e.g. grain, fodder and fertilizer
6. resistance to pathogens
7. resistance to lodging
8. reduced growing period
9. adaptability to climate change

Some methods used for improving plants in an area:

1. **Altering growing crops** – some crops take a long time to establish and begin to produce products so are altered by trimming off unproductive parts.
2. **Improving existing crops**
   Grafting and budding are horticultural techniques used to join parts with desired phenotypes from two or more plants so that they grow as a single plant.
   This will lead to a plant which:
   - produces the desired foliage, flowers and fruit of the parent of the **scion or bud**
   - has the desired robust rooting system of the **rootstock**

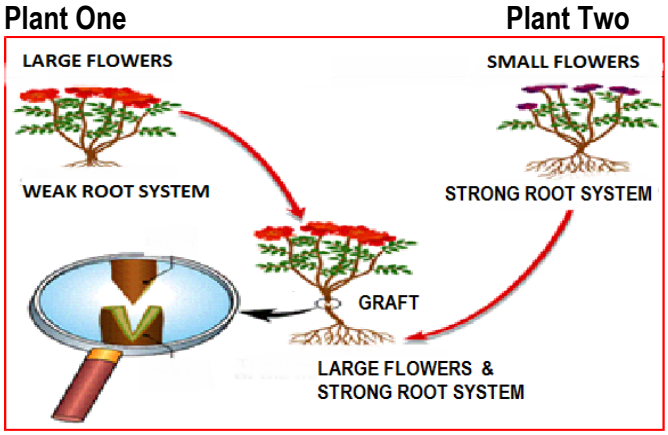
One bougainvillea plant with grafted branches bearing different coloured flowers.

https://s-media-cache-ak0.pinimg.com

For example: A farmer has two rose plants.

- Plant **one** produces large flowers but has a weak root system.
- Plant **two** produces small flowers but has a strong root system.

The farmer wishes to have a plant with large flowers and a strong root system and decides to join the scion from root one with the root stock of plant two through grafting, as illustrated.

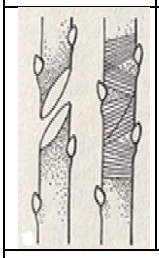
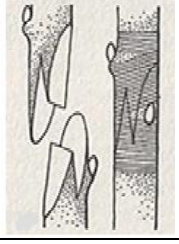
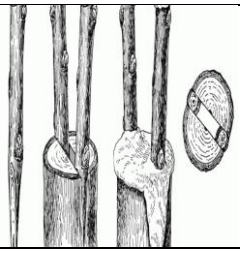
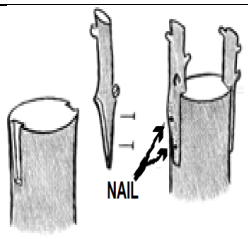


http://leavingbio.net

The **resulting** daughter plant now has large flowers and a strong root system.

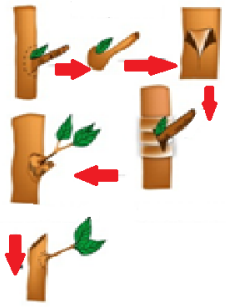
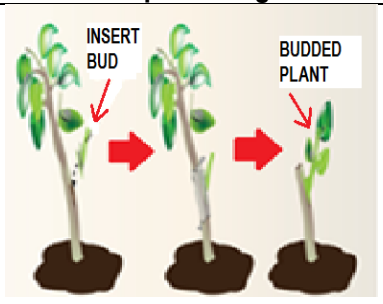
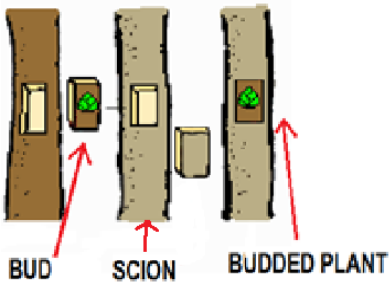
a) **Grafting** - insert a **scion** of one plant into the **root stock** of a plant of the same species.

Types of grafting

1. Whip	2. Rind	3. Whip and tongue	4. Saddle	5. Cleft grafting	6. Bark Grafting
					
http://www.gardeninginfozone.com				*http://growingsociety.com*	*http://www.blockhill.co.nz*

b) **Budding** - insert a **bud** from one plant into the root stock of another plant of the same species.

Types of budding

T-budding	Top budding	Patch budding
		
http://www.kcse-online.info		*http://generalhorticulture.tamu.edu*

3. Introduction and preservation of plants with traits which are considered better

Conventional plant breeding has been practised since the beginning of human civilisation with recorded evidence of plant breeding dating back to 9,000 years ago.
Most present day crops are the result of domestication in ancient times. Today, all our major food crops are derived from domesticated varieties.

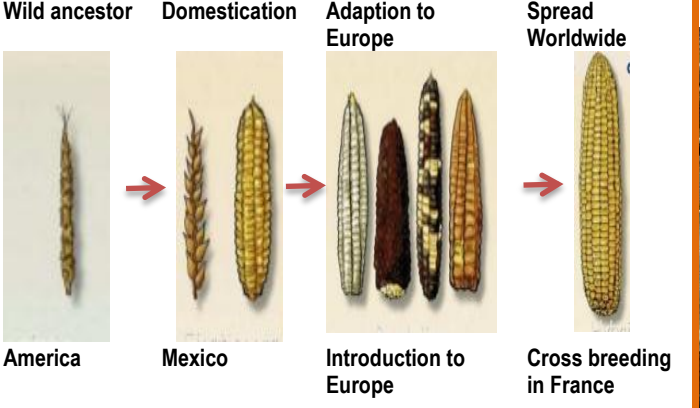
a) **Domestication** - the process of adapting wild plants and animals for human use. These organisms provide a new source of products and are usually hardier than present crops.

b) **Germplasm collection** - where samples of plant and animal tissue are preserved, as in seed collections stored in seed banks, trees growing in nurseries, animal breeding lines maintained in animal breeding programs or gene banks, etc. The collections can range from collections of wild species to elite, domesticated breeding lines that have undergone extensive human selection. They are then available for study and use in breeding programmes.

c) **Plant introduction** – introducing a new plant species or variety to an area where it acclimatises.

d) **Tissue culture –** an asexual method of plant propagation where cells derived from living tissue are grown in an artificial medium. The progeny are identical.

4. **Plant breeding** –the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.



https://iowaagliteracy.files.wordpress.com

Maize seeds at CIMMYT Germplasm Bank,/Mexico City


http://www.abc.net.au


Why have successive generations of farmers improved crops?


Some methods used to produce superior crops include altering growing crops, improving existing crops, introducing and preserving plants with traits which are considered better and plant breeding.


List and compare the main methods used to improve plants.

CLO 12.3.2.2 FORESTRY & AGROFORESTRY

CONTENT LEARNING OUTCOME

AS 12.3.2.2 Research and elaborate on the role of forests .

The United Nations declared March 21st "The International Day of Forests"

> **"What we are doing to the forests of the world is but a mirror reflection of what we are doing to ourselves and to one another" Mahatma Gandhi**

LESSON 1: TYPES OF FORESTS

LESSON OUTCOME

At the end of this lesson, the student will differentiate among the types of forests in Fiji.

Forest	- a large area covered chiefly with trees and undergrowth.
Primary forest	- untouched, pristine forest that exists in its original condition
Secondary forest	- forest that has been disturbed in some way

Environmental activists consider forests one of the top five natural resources on earth. There is more to forests than just a collection of trees. It is a natural, complex ecosystem, made up of a wide variety of trees that support a massive range of life forms.

These forests include plants, mainly trees, the soils that support the trees, the water bodies that run through the area and even the atmosphere (air) around them.

According to the UN, FAO, in 2010, **56%** or 1,014,000 ha of Fiji was covered by forests.

Moist tropical forests occur as lowland rain forests, mountain rain forests and cloud forests in Fiji and Rotuma.

Types of Forests.

Forests may be classified according to:

1. reproduction and management purpose
2. mangroves and agroforestry

1. Classification by reproduction and management:

a. Natural Forest

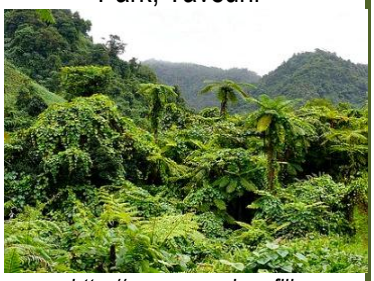
A forest which has spontaneously generated itself in an area and consists of naturally immigrant tree species is classified as a natural forest. These forests can be influenced by culture, like logging, but must **no**t have been subject to regeneration by sowing or planting.

Fiji's natural forests are divided into:

i) Primary forest – 449 000 ha of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.

ii) Other naturally regenerated forests – 388, 000 ha of native tree species which have naturally regenerated after human intervention.

Bouma Heritage National Park, Taveuni



http://www.amazing .fiji-vacations.com

Teak plantation in Tova, Ra

http://www.fdb.com.fj

b. Plantation Forest

Plantation forest production is the cultivation and long-term management of trees on marginal agricultural land. Trees are generally even-aged, planted and managed in rows, consist of a single species (sometimes two or three) and cover an area large enough to provide a suitable return on investment e.g. pine, mahogany and teak forests.

Mangrove forests are also being established along the coastal areas which are prone to the effects of climate change.
According to the UNFAO, in 2010, Fiji has 177 000 ha of plantation forests.

2. Classification by purpose

a. Production forests

These are forests which produce goods for subsistence or commercial use.
Although some natural forests may be classified in this category, the majority of production forests are plantation forests e.g. Caribbean pine, coconut groves, mahogany and teak.
Sandalwood forests are also being established.

Mahogany logs

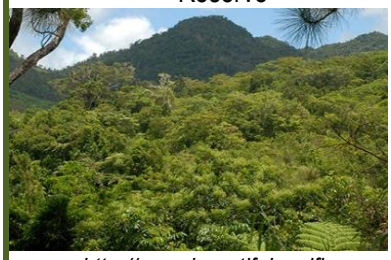
http://www.touchwoodfiii.com

b. Protection forestry

These are forests which are maintained to:

- control soil degradation like erosion and loss of fertility
- mitigate or prevent the impact of a natural hazards, including rock falls, erosion, landslides, land slips, debris flow or flooding
- mitigate the effects of climate change e.g. mangrove forests planted to build up the coastline and for protection from sea spray, rising sea levels and sea flooding
- preserve the water catchment area
- provide habitats for the conservation of fauna and fauna

Mount Tomaniviti Nature Reserve



http://www.beautifulpacific.co

Fiji has some 164 known species of amphibians, birds, mammals and reptiles according to figures from the World Conservation Monitoring Centre. Of these, 28.7% are endemic, meaning they exist in no other country, and 15.2% are threatened.
Fiji is home to at least 1518 species of vascular plants, of which 50.1% are endemic.
According to the International Tropical Timber Organisation, in 2011, Fiji had 241,000 ha of protection forest in reserves including Mount Tomaniviti Nature Reserve on Viti Levu.

c. <u>Amenity forestry</u>

These are forests which are managed for recreation purposes often in a way that is compatible with environmental conservation and/ or commercial production. Some recreational pursuits afforded by amenity forests include bird watching, photography, painting, observing organisms in their natural habitat, walking, hiking, cycling, zip lining, picnics, camping and white water rafting, among others.

Zip lining in Fiji

http:// bestfijiguide.com

3. <u>Special forests</u>

Mangroves and agro-forestry are important forests which will be discussed in later notes.

Discuss the difference between natural and plantation forests.

More than one half of the land area in Fiji is covered in forests.

Visit a forest near your school and discuss the type of forest that it is.

LESSON 2 ROLES OF FORESTS.

LESSON OUTCOME: At the end of this lesson the student will discuss the role of forests.

Biophilia - the urge to affiliate with other forms of life

The forest grows slowly. A newly exposed area of land will first be colonised by a few plants which are very strong and can live on bare rock. Slowly other plants and animals follow. Over thousands of years the plants and animals of the forest establish themselves and build a living cover of green. The forest which covers the land today may be thousands of years old.

The roles of forests can be divided into the following categories:

i) **Source/conservation of resources** – including food, fodder, medicine, water, timber, fuel and gene pool.
ii) **Source of cultural non-material benefits** – spiritual enrichment, cognitive development, reflection, recreation, green space and visual aesthetics
iii) **Supporting services to the ecosystem** – recycling of air, water and minerals; soil formation and conservation
iv) **Influences** temperature, quality of air and water, odour, dust and noise reduction
v) **Habitat for wildlife**; endemic flora and fauna, biodiversity and gene pool
vi) **Adaptation to climate change** - carbon sequestration.

1. **The forest makes soil**. The soil on the land is weathered rock material mixed with the dead plants of the forest and micro-organisms which live in the soil. Forests made most of the soil on the planet.

2. **The forest protects the soil**. It holds the soil with its roots. If the trees are cut down and no gardens are planted the soil gets hard and dry and is no longer good for gardens. If heavy rains come and there are no trees, the soil gets muddy and washes away, polluting streams, rivers and the sea. The eroded soil is gone and gardens will not grow on the remaining hard rock.

3. **The forest shelters and protects**. Strong winds can damage crops, cause erosion and dry out the soil. Near the coast, salt spray can poison the soil or harm crops. Forests act as windbreaks so slow down and divert the wind over farms and buildings.

4. **The forest holds and purifies water**. Trees and the soil they make store water. The forest controls the flow of water over the land and during heavy rains trees help trap water in the soil. Trees hold water in their branches, trunks, roots and leaves. When the land is dry, the water from the forest keeps the land green.

5. **The forest makes clouds and rain**. Trees transpire and this water vapour is picked up by wind. Heat from the sun causes the wet air to rise and form clouds.

6. **The forest controls garden pests**. Insects, birds and other animals live in a balanced system in forests and are predators of pests like insects. If the forest is destroyed, many of the forest organisms turn to crops for habitats and food, so competing with humans.

7. **The forest is the heritage of the local people**. Many people have sacred ties to trees. Forests are part of their traditional cultures so are important to them.

8. **The forest influences the local climate** and reduces the impacts of gas emissions. Through the control of wind velocity and air flow, the forest influences local air circulation and can filter air masses and retain contaminants. This capacity is useful in the protection of inhabited areas that adjoin industrial zones.

9. **The forest helps conserve** natural habitats and biological diversity. The forest offers a habitat to flora and fauna. Owing to its size and structural diversity, more animal species are found in the forest than in any other ecosystem.

10. **The forest helps us explore and relax**. Our innate attraction to forests is part of a phenomenon known as biophilia which draws humans to water, forests and other natural scenery. Exposure to forests has been shown to boost creativity and cognitive development, suppress certain diseases, speed up recovery and encourage meditation and mindfulness. It may even help us live longer.

11. **The forest improves food security**. On a subsistence level, wild foods like fruit, nuts, leaves, roots, bark and water inhabitants are important for food security and nutrition.

12. **The forest is a gene bank.** Many organisms in the forest can be studied and used to genetically improve local breeds and varieties.

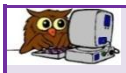
13. **The forest provides wood** for people to use for lumber and fuel.

14. **The forest has many plants which may be of great economic value**. Trees, vegetables, spices and medicinal plants grow in the forest and many cannot survive outside the forest environment. Some of the plants killed when forest trees are harvested may be worth more than the trees. Habitat destruction may result in the permanent loss of these plants.

15. **The forest converts carbon dioxide to oxygen**. In one year, one adult leafy tree can produce the amount of oxygen needed by 10 people in the same time period.

16. **The forest acts as a carbon sink**. Trees absorb the carbon dioxide which causes global warming and stores the carbon in wood, leaves and soil, often for centuries.

17. **The forest muffles noise pollution**. Sound fades in forests, making trees a popular natural noise barrier. The muffling effect is largely due to rustling leaves and other woodland white noise, like bird songs so just a few well-placed trees can cut background sound by 5 to 10 decibels, or about 50 percent as heard by human ears.



Divide the roles of forests into the following categories:

i) source/conservation of resources
ii) source of cultural non- material benefits
iii) supporting service to the ecosystem
iv) influence
v) habitat
vi) adaptation to climate change

NB – some categories may overlap.

Forests have diverse roles which plants and animals rely on for survival.

1. Explain why forests are referred to as the 'lungs of the earth'.
2. Discuss the relationship between forests and climate change.

LESSON 3: MANGROVES

LESSON OUTCOME: At the end of this lesson the student will discuss the importance of mangrove forests in relation to agriculture in Fiji.

Mangrove - a shrub or small tree that grows in coastal saline or brackish water.

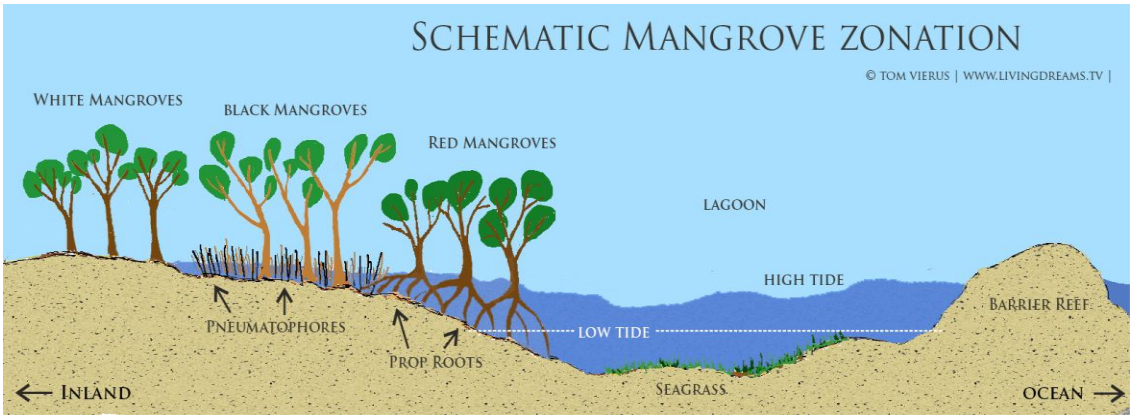
Mangroves are groups of trees and shrubs that live in the coastal intertidal zone of marine coastal environments and estuarine margins.
A mangrove forest is the tidal habitat comprising such trees and shrubs.
There are about 80 different species of mangrove trees. All of these trees grow in areas with low-oxygen soil, where slow-moving waters allow fine sediments to accumulate.

Mangroves in Fiji

https://cmsdata.iucn.org

Mangroves are important to agriculture and fisheries in Fiji because they:

1. **form a natural wind break** – this reduces the impact of strong winds and sea spray on agricultural crops and buildings too.
2. **retain sediments** – soil particles washed down from land and brought in by waves are trapped by the roots of mangroves. This results in the buildup of the coast line in direct response to rising sea levels.
3. **form a natural breakwater** – waves are broken by the roots of the mangroves, reducing their impact on land.
4. **provide a habitat and nursery** for many organisms- mangroves are a unique habitat which hosts full time resident inhabitants like crabs and birds as well as juvenile fish which later swim back out to sea.
   These organisms are a source of food and are important for the biodiversity of the country.
5. **provide other materials** like dye, fuel and medications as well as fodder for animals like goats.



http://livingdreams.tv

Differentiate between the two meanings of the word **mangrove.**

Mangroves are important to the agriculture and fisheries sectors of Fiji.

Discuss why mangroves are being re-planted in Fiji.

AGROFORESTRY

CONTENT LEARNING OUTCOME

AS 12.3.2 Evaluate the types of agroforestry systems by examining and comparing the roles, types, advantages and disadvantages of each.

LESSON 1: Advantages and disadvantages of agroforestry

LESSON OUTCOME:

At the end of this lesson the student will discuss the advantages and disadvantages of agroforestry.

Agroforestry - the deliberate incorporation of trees and other woody species of plants into other types of agricultural activities.

Agroforestry is a very old practice that likely grew out of necessity as primitive farmers carved crop land out of forested areas. In these earlier times, the availability of wild foodstuff, as well as wood for fuel and construction, was very important to the survival of individuals, families and entire cultures. The principles of agroforestry have been in use for centuries, most commonly in tropical and subtropical regions.

Agroforestry is a collective name for land-use systems involving trees combined with crops and/or animals on the same unit of land.

Agroforestry:

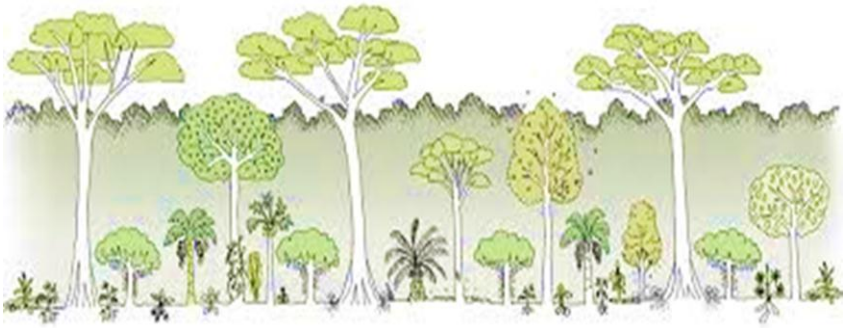
1) combines production of multiple outputs with protection of the resource base
2) places emphasis on the use of multiple indigenous trees and shrubs
3) is particularly suitable for low input conditions and fragile environments
4) involves the interplay of socio-cultural values more than in most other land-use systems
5) is structurally and functionally more complex than monoculture

Agroforestry practices have multiple impacts in a land-use system:

1) protection of topsoil, crops, animals and people
2) increase in productivity of crops
3) reduction of chemical, physical and biological energy inputs
4) increase in water-use efficiency of plants and animals
5) improvement of water quality
6) diversification of local and regional economies
7) enhancement of biodiversity and landscape heterogeneity

Adapted from *https://www.nal.usda.gov*

Plants require differing amounts of sunlight and their roots grow and function at different depths in soil.



https://www.google.com

Advantages

A) Environmental benefits

1) reduction of pressure on natural forests
2) more efficient recycling of nutrients by deep rooted trees on the site
3) better protection of ecological systems
4) reduction of surface run-off, nutrient leaching and soil erosion through the impeding effect of tree roots and stems on these processes
5) improvement of microclimate, such as lowering of soil surface temperature and reduction of evaporation of soil moisture through a combination of mulching and shading
6) increment in soil nutrients through addition and decomposition of litter fall
7) improvement of soil structure through the constant addition of organic matter from decomposed litter.
8) watershed improvement (stability, erosion control, water production)
9) more efficient use of space (more levels used, instead of single crops at one level)
10) shelter/habitat for wildlife

B) Economic benefits

1) Increment in an outputs of food, fuel wood, fodder, fertilizer and lumber
2) Reduction in incidence of total crop failure, which is common to single cropping or monoculture systems
3) Increase in levels of farm income due to improved and sustained productivity
4) Sustained, year-round production
5) Crop diversity and reduced risk

C) Social benefits

1) Improvement in rural living standards from sustained employment and higher income
2) Improvement in nutrition and health due to increased quality and diversity of food outputs
3) Stabilisation and improvement of communities through elimination of the need to shift farming sites

Disadvantages

1) Trees viewed as permanent
2) Long-term returns from trees difficult to predict
3) New systems often less readily adopted by farmers
4) Crop yield may decrease if system is not well planned and maintained
5) Requires education of farmers and help from extension agents
6) Commitment of national and local governments is necessary
7) Initial capital expenditure may be required.

These advantages and disadvantages should be understood by individuals or community groups who may be considering an agroforestry system. It could be that what technical people see as advantages, local farmers may perceive as problematic e.g. the protection of a wildlife habitat may be seen as providing a haven for pests such as rodents. Year-round production may be an unwanted benefit if people enjoy a break from the rigors of farming or take on outside work.

Discus the role of agroforestry in the conservation of Fiji's biodiversity.

Agroforestry is a collective name for land-use systems involving trees combined with crops and/or animals on the same unit of land. Its advantages and disadvantages depend on the view of the local community.

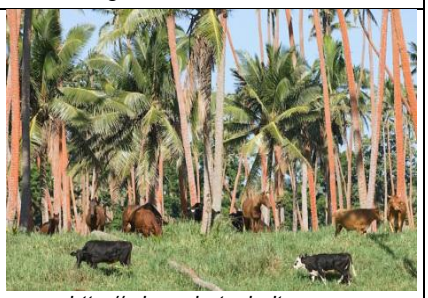
Discuss the advantages and disadvantages of agroforestry from:
a) a conservation point of view b) a commercial point of view

LESSON 2: AGROFORESTRY SYSTEMS

LESSON OUTCOME: At the end of this lesson, the student will compare agroforestry systems.

Agroforestry denotes a **sustainable** land and crop management system that strives to increase yields on a continuing basis, by combining the production of woody forestry crops with arable or field crops and/or animals simultaneously or sequentially on the same unit of land, and applying management practices that are compatible with the cultural practices of the local population.Due to its long history and the diverse regions in which agro-forestry has been practiced and developed, there are many versions of this farming system. Modern agroforestry incorporates legume trees with crops with which the trees do not compete.

Agroforestry can be divided into three main systems:

i) **Agrosilvicultural**	ii) **Silvopastoral**	iii) **Agrosilvopastoral**
simultaneously growing **crops and trees** on the same piece of land e.g. alley cropping	simultaneously grazing **livestock** and growing **trees** on the same piece of land e.g. cattle under ***Gliricidia sepium***	simultaneously growing of **crops, trees,** and **livestock** in the same piece of land e.g. cattle grazing in coconut groves
		
http://nac.unl.edu	*http://www.agribenchmark.org*	*http://cdn.c.photoshelter.com*

Some other systems include:

iv) **Apiculture with trees** - various nectar producing trees frequently visited by honeybees are planted on the boundary of the agricultural fields and sustain the bee populations between the pollination periods of the crops.

v) **Aqua forestry** - various trees and shrubs preferred by fish are planted on the boundary and around fish ponds. As well as providing shade, the leaves of these trees are used as feed for fish while roots stabilise bunds.

vi) **Riparian forest buffers** - forests are established along the side of streams. Their main function is to reduce the impact of pollution from agricultural operations, reduce river bank erosion, protect aquatic environments from nutrients and sedimentation, enhance wildlife and increase biodiversity.

vii) **Forest farming** - the cultivation of high value non-timber crops under the protection of a forest canopy that has been modified to provide the shade level appropriate for the special crop e.g. cocoa, wild decorative or edible ferns.

Agroforestry systems have two functions:

1. **Productive functions** – where goods are produced for harvesting e.g. food, fodder, fuel wood, lumber
2. **Protective function** – for the conservation of resources e.g. water and soil conservation, windbreaks, shelter belts

Evaluate the suitability of agroforestry to the agricultural gardens in your school.

Incorporating the production of crops and livestock with trees has been practiced throughout the world since farming began. Agroforestry can be classified into various systems depending on the products produced.

Differentiate among the types of systems of agroforestry.

CONTENT LEARNING OUTCOME

Discuss the harvesting, post-harvest treatment uses and potential uses of forest products and by-products.

LESSON 1: HARVESTING PLANTATION FORESTS

LESSON OUTCOME

At the end of this lesson, the student will discuss the harvesting of plantation forests

Lumber	-timber sawed or split into planks, boards, etc.
Sawtimber	- trees large enough to be cut into lumber.
Understory	-a layer of vegetation beneath the main canopy of a forest.

Trees are long term crops which may take from 15 to 100 or more years from planting to harvest.
One crop may be all that a farmer sees in his lifetime.

Harvesting is the method of removing products from a forest to make room for a new generation of trees. There are a few methods of harvesting trees from plantation forests.

1. **Thinning Harvest**

   Trees which are crowded together are in greater competition for sunlight, nutrients and water. As a result, they tend to be less healthy and to grow less vigorously. The forest is 'thinned' by taking out a certain percentage of the trees. The remaining trees will grow faster, stronger and larger. Thinning also improves the growth of the forest's understory such as wildflowers and native weeds by increasing the amount of sunlight that reaches the forest floor. This growth provides more food and shelter for animals such pigs, birds, bees and other wildlife.

   This type of harvest is typically referred to as a "pre-commercial" harvest since the costs associated with the forest management (road maintenance, harvesting, etc.) often equal or outweigh the money earned on the harvested trees for the landowners. These types of harvests result in fence post and pulpwood size trees, which are smaller in diameter than trees that would be made into lumber.

2. **Clear-cut Harvest**

   Clear-cutting removes all the trees in a given area.

   It is used most frequently in pine and mahogany forests, which require full sunlight to grow.

   Clear-cutting as a silviculture treatment has several characteristics:

   - it causes a sudden environmental change
   - it removes the seed source from the regeneration area
   - the configuration of the clear-cut may affect seed dispersal
   - it begins a new rotation
   - it will eliminate some pests that require forest cover

   Overall, it temporarily removes the forest cover, transforming the forest community and environment.

   Clear-cutting followed by artificial (seeded or planted) regeneration has several advantages.

   It allows:

   - rapid restocking of the site
   - the introduction of a selected species, seed source and genotype
   - controlled arrangement and spacing
   - uniformity in the new stand

   A clear-cut harvest will produce a mixture of pulpwood and sawtimber products based on the size of the trees and whether the trees are softwood or hardwood. The smaller diameter trees, typically called pulpwood, will head to a chipping or pulping facility. The larger diameter trees, typically referred to as sawtimber, will be sent to sawmills.

3. **Shelterwood Harvest**

In a shelterwood cut, mature trees are removed in two or three harvests over a period of 10 to 15 years. The shelterwood method serves three basic purposes:

i) to prepare the stand for production of abundant seed
ii) to modify the environment in a way that promotes germination and survival of the selected species
iii) to build up the amount and size of advance regeneration to ensure the prompt restocking of the new stand following over story removal.

The residual trees in the shelter wood must:

* be sturdy and resistant to wind damage
* be able to survive exposure
* flower and reproduce seed
* be the ***best*** trees of the mature stand

This method allows regeneration of medium to low shade-tolerant species because a "shelter" is left to protect them. Many hardwoods can produce and maintain seedlings or sprout in light shade under a partially cut stand. However, the young trees will not grow and develop fully until the remaining overstory trees are removed.

One benefit to shelterwood harvests is that they provide cover and early successional food sources for wildlife. However, this method of harvest is not recommended for trees with shallow root systems because:

* the remaining trees are more susceptible to wind damage after neighboring trees are removed
* more roads are needed to be built through the forest
* it results in an increased risk of soil disturbance
* of damage to the remaining trees during harvesting.

4. **Seed Tree Harvest**

In a seed tree harvest, five or more scattered trees per hectare are left in the harvested area to provide seeds for a new forest stand. The trees which are left must :

- be genetically superior trees of the selected species (**dominants)**.
- be sturdy and wind firm
- be able to survive exposure
- flower and produce abundant seed
- be the **very best** trees of the mature stand

The number of seed trees to leave will depend on the following factors:

- the amount of seed each tree provides
- the expected survival of germinated seed
- the size of the area to be regenerated

Wildlife benefit from seed tree harvests in much the same way as they do from a clear-cut harvest, except that they also reap the benefits of the seed trees themselves. Seed trees are also excellent food sources and nesting sites for birds and other wildlife.

One disadvantage to seed tree harvests is that the remaining trees are at increased risk of damage from wind, lightening, insect attack and logging of nearby trees. This type of harvest may also require the landowner to make future investments in thinning and competition control because of uncontrolled reseeding.

5. **Group Selection Harvest**

Group selection is essentially a small-scale clear-cut where groups of trees in a given area are harvested over many years so that the entire stand has been cut within 40 to 50 years. This method is used primarily on bottomland hardwood stands to harvest high-quality, top dollar logs. The size of the group cut determines the tree species that are likely to return after the harvest.

Openings that are less than half a hectare favour shade-tolerant species and larger openings favor sun-loving species.

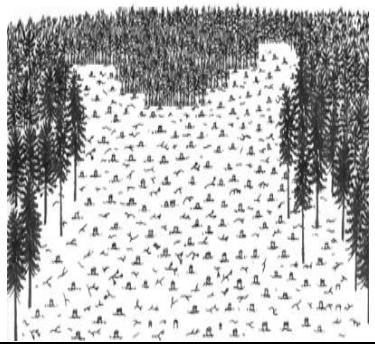
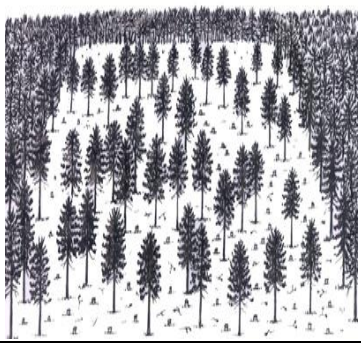
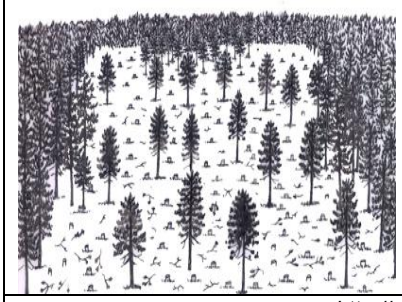
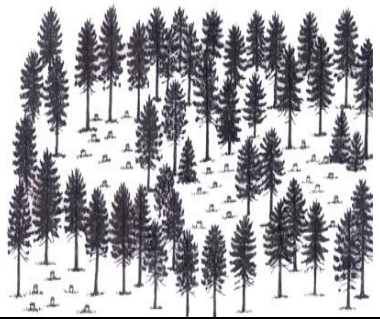
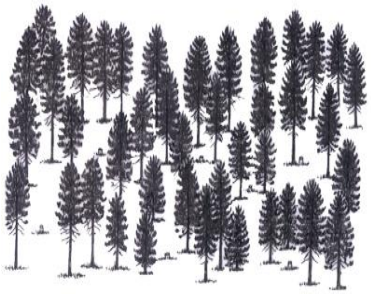
Group selection provides ideal pockets of young vegetation but because it requires intensive management and frequent access to all areas of the property, it can be an expensive forest regeneration method.

6. Single-Tree Selection Harvest

Single-tree selection removes individual trees that are ready for harvest, of low value or in competition with other trees. With single-tree selection, the forest continuously produces timber and constantly has new seedlings emerging to take the place of harvested trees. Single-tree selection maintains a late succession forest that benefits many wildlife species.

Single-tree selection harvesting is best in small or confined areas for a variety of reasons:

i) requires more roads
ii) surrounding trees can be damaged during harvests
iii) frequent use of logging equipment in a given area may compact the soil
iv) sun-loving trees, which are an important source of food for wildlife, do not regenerate well with single-tree selection, so forest managers must use mechanical or chemical control methods to prevent shade-tolerant species from taking over the site

<table>
<tr><td>Thinning
 
https://americanalps.files.wordpress.com</td><td>Clear cutting
  </td><td>Shelterwood
  </td></tr>
<tr><td>Seed tree
  </td><td>Group selection
  </td><td>Single tree selection
  </td></tr>
<tr><td colspan="3">http://www.nrs.fs.fed.us/fmg/nfmg/fm101/silv/index.htm</td></tr>
</table>

Which the tree harvesting methods listed above would you prefer to be used in Fiji and explain why?

Due to the length of time that tree crops take from planting to maturity, a farmer may only harvest one or two crops in his lifetime. Various harvesting methods have been developed to ensure that the best trees are grown to full maturity while securing the production of quality seeds and replacement trees.

Discuss the advantages and disadvantages of each of the tree harvesting methods.

LESSON 2: FORESTRY POLICIES

LESSON OUTCOME: At the end of this lesson, the student will discuss the reasons for forestry policies in Fiji.

Forest policy - is what a government chooses to do or not do about forests within their jurisdiction

Act - a bill which has passed through the various legislative steps required for it and which has become law

In 1950, the Legislative Council laid down the original **Forestry Policy** which included the protection and development of Fiji's forests.

This policy aimed to:

1. continue with the planting programmes for future benefits
2. encourage private planting schemes
3. increase timber exploitation and increase exports
4. encourage better processing of lumber
5. encourage the use of a wider range of local timber species
6. study problems of land acquisition
7. conduct intensive research
8. accelerate training of local personnel at all levels
9. provide amenities and recreational facilities.

This Policy gave rise to the 1953 **Forest Act**, which placed forestry primarily in the context of forest management for lumber production.

Many changes have taken place since the 1950s, resulting in making a review necessary to:

- address the changing demands on Fiji's forests, in terms of balancing the country's economic, social and environmental needs.
- address Fiji's obligations under the various international agreements and conventions that it has signed.
- be more broad-based than the 1950 policy.

A **new Forest Policy** for Fiji was endorsed by Cabinet in November **2007.**

Its main thrusts are as follows:

- change from forest sector planning to integrated natural resources management
- transition from lumber exploitation to sustainable forest management
- empowerment of land owners to adopt sustainable management practices

Based on the 2007 policy, new forestry legislation was formulated to replace the existing Forest Decree 1992.

Why was a Forestry Policy developed in 1950 and renewed in 2007?

A Forest policy has been developed to safeguard and guide the development and growth of the forestry sector.

Discuss the advantages and disadvantages having a Forestry Policy in Fiji.

CLO: AS 12.3.2.3 ORNAMENTAL HORTICULTURE

Deliberate on Ornamental Horticulture by investigating, selecting and practicing appropriate husbandry methods on selected ornamental plants.

LESSON 1: INTRODUCTION

LESSON OUTCOME:

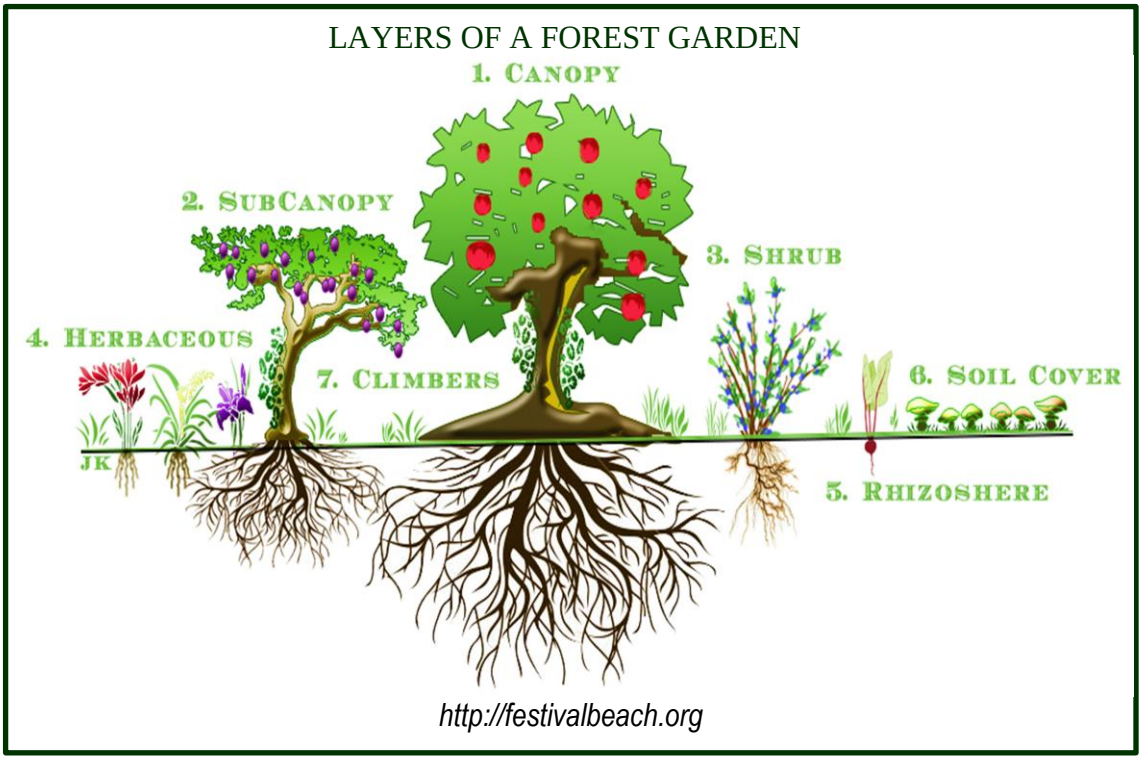
At the end of this lesson, the student will discuss the origins of ornamental horticulture.

Forest gardening	- a food production and land management system based on replicating woodland ecosystems, in which trees and plants have been replaced by fruit and nut trees, bushes, shrubs, herbs and vegetables which have yields directly useful to humans.
Ornamental horticulture	- growing, arranging and marketing plants for decorative and aesthetic purposes including floriculture, floral arrangements and landscaping

Ornamental plants are grown for decorative purposes in gardens, landscape design projects, as houseplants, for cut flowers and for specimen display. The cultivation of these plants is called ornamental horticulture.

Ornamental horticulture is believed to have developed from forest gardening around 10 000 BC when families identified, protected and improved useful plant species while eliminating undesirable species.

Ornamental trees, palms, shrubs, herbs, creepers, vines and grasses are plants used as part of a garden or landscape setting, for their flowers, their texture, form and shape, and other aesthetic characteristics



http://festivalbeach.org

LESSON 2: CLASSIFICATION OF HORTICULTURAL PLANTS

LESSON OUTCOME

At the end of this lesson, the student will discuss some ways in which horticultural plants are classified.

Xerophyte	- plant which stores water in its leaves and stems so is adapted to live in arid environments.
Hydrophyte	- a plant that grows only in or on water.
Mesophyte	- a plant needing only a moderate amount of water

Plants are classified in a number of ways, some of which are listed below:

1. **by growth habit**

a) **Herbaceous or herbs** - succulent seed plants possessing self-supporting stems

b) **Climbing plant** - a climbing or trailing plant. It may be soft stemmed [vine] or hard stemmed [liana].

c) **Trees** - plants having a single central axis

d) **Shrubs** - plant having several upright stems

Herbaceous Celery	Climbing plant Bougainvillea	Tree Coral tree [Drala]	Shrub Hibiscus
			
http://www.almanac.com	*http://www.joyusgarden.com*	*http://static.panoramio.com*	*http://charlie-cook.com*

2. by leaf drop:

a) **Deciduous** - plants which seasonally lose leaves e.g. Kapok tree

b) **Evergreen** - plants which retain functional leaves throughout the year e.g. Sandalwood

Deciduous		**Evergreen**
Kapok Tree *Ceiba pentandra* Dormant season	Growing season	**Sandalwood tree** *Santalum yasi*
		
http://www.2Fwww.flickr.com	*http://www.tropicalfloridagardens.com*	*http://sandalwoodoilspecialist.com*

3. **by life span:**
   a) **Annual** - a plant that completes its life cycle, from germination to the production of seed, within one year, and then dies. (lettuce, watermelon, marigold)
   b) **Biennial** - a flowering plant that takes two years to complete its biological lifecycle
   c) **Perennial** –a plant that lives for more than two years

Annual	Biennial	Perennial
Common Sunflower *Helianthus annuus*  *http://nhanongviet.vn*	Anthurium *Anthurium andraeanum*  *http://g01.a.alicdn.com*	Frangipani *Plumeria rubra*  *https://ae01.alicdn.com*

4. **by temperature tolerance:**
   a) **Tender plant** - damaged or killed by large temperature variations.
   b) **Hardy plant** – a plant that withstands changes in temperature.

Tender plant	Hardy plant	Cool-season plant	Warm-season plant
Sunset bells *Chrysothemis pulchella*  *https://en.wikipedia.org*	Eastern woodfern *Dryopteris marginalis*  *http://www.northcreeknurseries.com*	Broccoli *Brassica oleracea var. italica*  *https://bonnieplants.com*	Aubergine *Solanum melongena*  *http://suburbantomato.com*

5. **by temperature requirements:**
   a) **Cool-season plant** - prefers cool temperatures (peas, lettuce, cole crops)
   b) **Warm-season plant** - prefers warm temperatures (pepper, eggplants (aubergine))

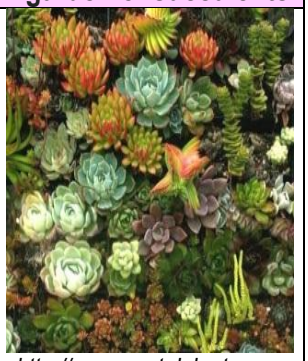
6. **by sunlight intensity requirements**
   a) **Photophilous Plant**- is receptive to, seeks and thrives in direct sunlight.
   b) **Sciophilous Plant**- is receptive to, seeks and thrives in less direct sunlight or shade

Examples of photophilous plants		Examples of Sciophilous plants	
Barrel Cactus	Aloe vera	Paphiopedilum orchid	Edible fern "Lalabe"
			
https://en.wikipedia.org	*http://netra-agro.com/aloe-vera*	*https://www.google.com*	*http://blogspot.tepapa.govt.nz*

7. by habitat or site preference:

a) **Xerophytes –** plants that have adapted to survive in an environment with little water, such as a desert or an ice- or snow-covered region. The xerophytes are succulents.

Cacti are a group of succulents but are often discussed as a separate group.

Xerophyte	Cactus	Succulent	A garden of Caccti	A garden of succulents
Leaves	does not have leaves but instead has sharp spines to minimise water loss and deter animals from eating it.	has fleshy leaves or stems that store water	 *http://ornamentalplantsnewblogspot.com*	 *http://ornamentalplantsnew blogspot.com*
Roots	Have long roots to get more water.			
Water	Store water during the wet season			
Reproduction	Seed and asexually			

b) **Hydrophytes -** plants that grow partly or wholly in water whether rooted in the mud, as a lotus, or floating without anchorage. The hydrophytes can be divided into the following categories: floating plants, deep water plants, marginal plants and oxygenating plants.

Floating plants have roots that hang in the water from the floating green portions.	Water hyacinth  *http://www. flickr.com*	**Marginal plants** grow in shallow water or in moist soil around the perimeter of water.	Water sedge  *http://knutsonandshawgrowers.ca*
Deep water plants have roots which are anchored on the river or pond bed.	Gloriosa [water lily]  *https://gardendrama.wordpress.com*	**Oxygenating plants** are submerged aquatic plants that release oxygen into the water.	Ancharis in an aquarium  *http://water-garden-blog.com*

c) **Mesophytes** - terrestrial plants which are adapted to moderate water conditions: neither a particularly dry nor particularly wet environment.

i) **Tree** – a woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground.

ii) **Palm** - any plant of the family Palmae having an unbranched trunk crowned by large pinnate or palmate leaves.

iii) **Grass** – monocotyledonous, usually herbaceous plants with narrow leaves growing from their bases.

Flamboyant Tree	Majesty Palm	Red Hook Sedge
		*Uncinia rubra* 
https://s-media-cache-k0.pinimg.com	*http://demostore.modularmerchant.com*	*https://nboldblog.files.wordpress.com*

8. pH preference

The majority of plants grow best in neutral soil. However, some plants prefer soil of specific pH levels.

a) Acid tolerant – certain plants tolerate a range of soil pH values.

Hydrangea flowers change colour according to the pH value of soil

http://wallacesnews.com

b) Salt tolerant plants

i) **Halophytes** - plants that grow in waters of high salinity, coming into contact with saline water through roots or by salt spray, such as in saline semi-deserts, mangrove swamps, marshes, sloughs and seashores.

ii) **Glycophytes** – plants that will only grow healthily in soils with low content of sodium salts

Saline tolerant / Saline intolerant	Halophyte	Glycophyte
	Red mangrove *Rhizophora mangle* 	White mangrove *Teruntum merah* [Sagali] 
http://www.knowledgebank.irri.org	*http://mangrovesforfiji.com*	*http://www.theonlinecitizen.com*

Explain the importance of developing salt tolerant plants.

Plants are classified according to various features and uses.
Each of these specialised plants can be further divided into groups and has a part to play in ornamental horticulture.

Make a list of the plants growing in the school compound and classify them according to their growth habit, life span and habitat preference.

LESSON 3: TYPES OF ORNAMENTAL PLANTS

LESSON OUTCOME

At the end of this lesson, the student will describe the types of ornamental plants used in Fiji.

Floriculture	- the cultivation of flowers.
Floristry	- the production, commerce and trade in flowers.
Horticulture	- the science and art of growing fruits, vegetables, flowers, or ornamental plants
Olericulture	- The science and practice of growing, harvesting, storing, processing and marketing vegetables.

Ornamental horticulture is a growing industry in Fiji.
These plants can be divided into the following categories:

a) **Florist crops** - the cultivation of flowering and ornamental plants for gardens and for floristry.

i) **Cut flower plant** – plants are grown for the production of flowers or flower buds (often with some stem and leaf) for use in vase displays, wreaths and garlands.
ii) **Pot plant -** a plant grown in a pot or container, usually indoors.
iii) **Foliage plant -** any plant grown chiefly for its attractive leaves.
iv) **Bedding plant -** any plant that has been grown to blooming or near-blooming size before being planted in a garden for the display of colorful flowers or foliage.

Cut Flowers	Pot Plant	Foliage plant	Bedding plants
			
http://2.bp.blogspot.com	*https://s-media-cache-ak0.pinimg.com*	*http://www.pursel.org*	*http://www.summerhillgardencentre.co.uk*

b) **Landscape plants** – plants which are used to improve the esthetic value of a landscape e.g. trees, shrubs, flowering plants, herbaceous plants, climbing plants and ground cover plants.

c) **Lawn and turf plants** – plants, like grass, which are planted in an area of soil-covered land, which are maintained at a short height with a lawnmower and used for aesthetic and recreational purposes.

http://physictourism.com

Differentiate among cut plants, landscape plants and lawn and turf plants.

Ornamental plants can be divided into florist plants, landscape plants and lawn and turf plants according to their intended use.

Make a list of the ornamental plants growing in the school compound and classify them according to their water adaptation.

LESSON 4: COMMON ORNAMENTAL TREES

LESSON OUTCOME: At the end of this lesson, the student will identify some types of ornamental trees.

Weeping Ornamental Trees	-characterized by soft, limp twigs
Evergreen Ornamental Trees	-do not lose their leaves and remain green year round.
Sessional Ornamental Trees	-produce foliage and flowers in certain seasons.
Palms	-any tropical or subtropical tree of the family Palmaceae.

Ornamental trees are species cultivated for gardens, parks and landscape settings, for their shade, flowers, texture, form, shape, and other aesthetic characteristics.

Weeping Ornamental Trees

Any tree which has a bent crown and pendulous branches that can cascade to the ground.

1. Vossi Golden Chain Tree.
Laburnum x waterier

onlinetrees.com.au

2. Nokonoko tree
Casuarina equisetifolia

http://bugwoodcloud.org

3. False Ashoka Tree
Polyalthia longifolia

http://bimamugi.blogspot.in

Evergreen Ornamental Trees

Any tree having green leaves throughout the entire year, the leaves of the past season not being shed until after the new foliage has been completely formed.

1. Screw pine
Pandanus utilis

http://www.vanabode.com

2. Rain tree
Albizia saman

http://photos.cntraveler.com

3. Banyan tree
Fiscus benghalensis

http://www.babasigablogspot.com

Seasonal Ornamental Trees

Any tree producing leaves and flowers in different seasons in relation to favorable climatic conditions.

1. Flamboyant tree
   Delonix regia

https://www.google.com

2. Golden showers tree
   Cassia fistula

sushlaventulip06.blogs...

3. Yland-Ylang tree **"Makosoi"**
   Cananga odorata

en.wikipedia.org

Differentiate between evergreen, seasonal and weeping trees.

Ornamental trees are species cultivated for gardens, parks and landscape setting, for their shade, flowers, texture, form, shape, and other aesthetic characteristics.

1. Identify trees in the school compound or surrounding area.
2. Classify and describe each tree.
3. Discuss methods which are used to propagate these trees.

LESSON 5: COMMON ORNAMENTAL PALMS

LESSON OUTCOME: At the end of this lesson, the student will identify some types of ornamental palms.

Palm	- any tropical or subtropical tree of the family Palmaceae.
Solitary palm	- are single stemmed.
Clustering palm	- are multiple stemmed.
Aerial branching palms	- have branches.
Subterranean branching palm	- lateral branching takes place in the underground meristem.
Climbing palm	- where the stem initially grows erect then seeks taller trees to grow on to reach the canopy of the forest for sunlight, like canes and rattans.

Palms are perennial monocotyledons belonging to the family Palmaceae**.**
Palms, which make beautiful ornamental plants, are divided into five groups.

1. Solitary palms
   e.g. *Coopernicia prunifera*

hppt://2.bp.blogspot.com

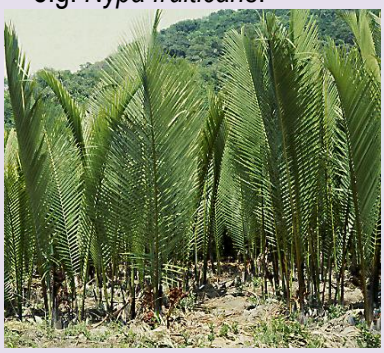
2. Clustering palms
   e.g *Cyrtostachys renda*

http://www.florida-palm-trees.com

3. Aerial branching palm
   e.g. *Hyphaene compressa*

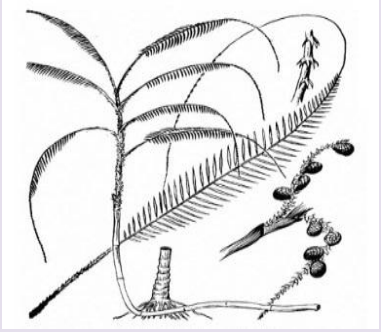
http://hyphaene.turbosquid.com

4. Subterranean branching palms
   e.g. *Nypa fruiticans*.



http://www.botany.hawaii.edu

5. Climbing palm
   e.g. *Calamus rotang* [rattan palm]



http://www.lonesentry.com

There are also plants which are classified as false palms because although they do not belong to the Palmaceae family they are called palms.

1. Panama Hat palm
   Carludovica palmate.

http://www.twooba.com

2. Sago palm
   Cycas revoluta

http://www.desi88.com

3. Palm lily or Ti palm
   Cardyline australis

http://www.canterbury nature.org

4. Palm grass
   Setaria palmifolia

http://keyserver.lucidcentral .org

5. Travelers palm
   Ravenala madagascariensis

http:www.123rf.com

Some palms used for ornamental purposes in Fiji are:

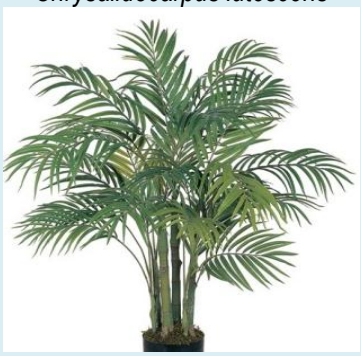
1. Fiji Fan Palm
Pritchardia pacifica

http://olabrisagardens.com

2. Lipstick Palm
Cyrtostachys renda

http://www.palmpedia.net

3. Areca Palm
Chrysalidocarpus lutescens



http://www.armandgilbert.com

4. Royal Palm
Roystonea regia

https://heathcotebotanicalgardens.org

5. Cuban petticoat palm
Copernicia macroglossa

http://www.fairchildgarden.org

6. Cabbage palm
Sabal palmetto

http://www.3dcadbrowser.com

7. Beetle nut palm
Areca catechu

http://www.palmnutpages.com

8. True Date Palm
Phoenix dactylifera

florida-palm-trees.com

9. Coconut palm
Cocos nucifera

http://4.bp.blogspot.com

Fiji sago palm, *Metroxylon vitiense*, is a threatened species which is endemic to Fiji.
Discuss how threatened species can be saved from extinction.

http://www.pacsoa.org.au/wiki/Metroxylon_vitiense

Palms are perennial monocotyledons belonging to the family Palmaceae. Fiji is blessed with many species of palms which make beautiful ornamental plants.

1. Identify species of palms in the school compound or surrounding area.
2. Classify and describe the palms.
3. Discuss how palms are propagated.

LESSON 6: COMMON ORNAMENTAL SHRUBS AND HERBS

LESSON OUTCOME

At the end of this lesson, the student will identify some ornamental shrubs and herbs grown in Fiji.

Herb -any seed-bearing plant that does not have a woody stem and dies down to the ground after flowering.

Shrub -woody plant that is smaller than a tree and has several main stems arising at or near the ground.

Flowering shrubs provide a long-lived, low-fuss, eye-fetching framework in any garden design with their rich array of form, foliage, fruit and flowers.

1. Gardenia *Gardenia jasminoides Glazeri*  *http://municoatepeque.gob.gt*	2 . Crape Jasmine *Tabernaemontana divaricata*  *http://plants.usda.gov*	3. Poinsettia *Euphorbia pulcherrima*  *https://upload.wikimedia.org*	4. Golden butterfly *Allamanda eathartica*  *htp://www.naplesnursery.com*
5. White Ixora [Sinu] *Ixora finlaysoniana Wall*  *http//:www.flickerriver.com*	6. Bua ni Viti *Fagraea berteriana*  *http://www.geocities.jp*	7. Frangipani *Plumeria sp*  *https://s-media-cache-ak0.pinimg.com*	8. Hydrangea *Hydrangea macrophylla*  *http://www.almanac.com*
9. Lollipop Plant *Pachystachys lutea*  *http://www.thelovelyplants.com*	10. Candle-Bush *Senna-alata*  *https://mauimike.smugmug.com*	11. Lantana *Lantana camara*  *http://statebystategardening.com*	12. Hibiscus *Hibiscus rosa sinensis*  *https://upload.wikimedia.org*

Many shrubs are also cultivated for their leaves.

1.Croton Mammy *Codiaeum variegatum mammy*  *http://www.miamitropicalplants.com*	2. Ti Tree *Cordyline terminalis*  *http://www.plantinfo.co.za*	3. Coleus *Coleus forskohili*  *http://cushfood.com*
4. Bitter Cassava *Manihot esculenta 'Variegata'*  *https://photoplusbyritasim.wordpress.com*	5. Sheena's Gold *Duranta erecta*  *http://www.plantinfo.co.za*	6. Little Leaf Boxwood Buxus microphylla  *http://www.gardentoday.com*

Herbaceous plants (in botanical use frequently simply called herbs) are plants which have no persistent woody stem above ground. Herbaceous plants may be annuals, biennials or perennials.

1)**Hamging lobster claw** *Heliconia rostrata*  *http://wildlifeofhawaii.com*	2) **Parrots beak** *Heliconia psittacorum*  *https://commons.wikimedia.org*	3)**Orange Ginger lily** *Hedychium coccineum*  *http://img1.coastalliving.timeinc.net*	4) **Canna** *Canna sp*  *http://www.bulbsareeasy.com*

Edible herbs and flowers - plants with leaves that are used as medicines, for seasoning dishes, as fragrance in perfumes, candles, dried floral arrangements, sachets etc. and their dried seeds are used as spices. Some of the common herbs are spearmint, fennel, coriander, basil, parsley, thyme, rosemary and celery.

1. **Spearmint** *Metha spicata*  *http://loghouseplants.com*	2. **Fennel** *Foeniculum vulgare*  *http://gardeningsolutions.ifas.ufl.edu*	3. **Coriander** *Corandrum sativum*  *http://bisettosfreshproduce.com*	4. **Basil** *Ocimum basilicum*  *http://bohemianmojo.com*
5. **Garden Parsley** *Petroselinum crispum*  *http://www.womendailymagazine com*	6. **Thyme** *Thymus vulgaris*  *http://www.womansense.org/imgdata*	7. **Rosemary** *Rosmarinus officinalis*  *http://www.homeremediesweb.com*	8. **Celery** *Apium graveolens*  *http://g01.a.alicdn.com*

EDIBLE HERB GARDENS

http://1.bp.blogspot.com

https://nelsonsherbs.files.wordpress.com

Differentiate between a shrub and an herb.
Differentiate between an herb and an edible herb.

Shrubs and herbs are commonly planted as ornamentals.

1. Identify species of shrubs and herbs in the school compound or surrounding area.
2. Classify and describe the plants.
3. Discuss the roles which the shrubs and herbs play.

LESSON 7: COMMON ORNAMENTAL GRASSES

LESSON OUTCOME

At the end of this lesson the student will distinguish among the three grass families and identify some ornamental grasses.

Grass	-vegetation consisting of typically short plants with long narrow leaves, growing wild or cultivated on lawns and pasture, and as a fodder crop.
Sedges	-a grass-like plant with triangular stems and inconspicuous flowers, growing typically in wet ground
Rushes	- a grass-like flowering plant distinguished by cylindrical stalks and hollow, stem-like leaves.

Ornamental grasses add color, flowers and texture to an area.
There are five families of grasses which are primarily used in ornamental grass gardening.

They are
i) the Poaceae family (true grasses)
ii) the Cyperaceae family (sedges)
iii) the Juncaceae family (rushes).
v) the Restionaceae family (restios)
iv) the Typhaceae family (cattails)

Poaceae family	Cyperaceae family	Juncaceae family	Restionaceae family	Typhaceae family
Lemon grass *Cymbopogon citratus*  *http://latierraspirit.org*	Umbrella Plant *Cyperus alternifolius*  *http://www.horticulture.lsu.edu*	Tall spike rush [Kuta] *Eleocharis sphacelata*  *http://www.bluedale.com.au*	Hollow reed *Elegia fistulosa Kunth*  *http://www.plantzafrica.com*	Common cattail *Typha latifolia*  *http://www.weedalogue.com*

Differentiate among grasses, sedges and rushes.

Grasses, sedges and rushes are ornamental plants which add color, flowers and texture to an area.

1. Identify species of ornamental grasses in the school compound or surrounding area.
2. Classify and describe the plants.
3. Discuss the roles which the ornamental grasses play.

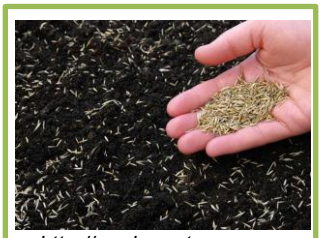
LESSON 8: ESTABLISHING LAWNS

LESSON OUTCOME: At the end of this lesson, the student will discuss methods used to establish lawns.

Sod - a piece of grass-covered surface soil held together by matted roots

Before lawns are established, the site must be cleared, finely tilled, leveled and fertilizing material applied.

The following methods are used to plant lawns:



http://yardcare.toro.com

1. **Seeding**

Broadcasting seeds over the site is the most common method of growing turf because:

i) it is considerably cheaper than any other method of establishment
ii) seeds are also available in endless species, varieties, and cultivars
iii) seeding can be carried out on any site.

The biggest drawbacks of seed establishment are:

i) the time spent preparing the seedbed, spreading seed and the germination of seedlings
ii) labour involved with the initial establishment and care
iii) seeds will germinate where they land so uneven establishment may occur.

2. **Hydromulching**

Hydromulching or hydroseeding, is very similar to seeding, except the seed is mixed with water and a paper mulch material before being sprayed onto the site by a hydromulcher.
The paper mulch material will help reduce erosion, and protect the seed until germination.
The cost of this process will fall somewhere in between the cost of sod and the cost of seeding.
The disadvantage is that water, paper mulch and spraying equipment are needed for this process.

http://www.aquaseeding.com.au

3. **Sod Establishment**

Sod is carefully harvested, rolled up then transported to the new site where it is unrolled**.** Laying sod is the:

i) quickest method of establishing lawn as turf is instant
ii) easiest method of establishing a lawn as turf is unrolled
iii) least labour intensive

The biggest drawback to sod is the high price. Buying and installing of sod can cost five to seven times as much as seeding would.

http://www.deerwood.bc.ca

4**. Sprigging**

Sprigging is a form of vegetative propagation that is commonly used in place of seeding, for those stoloniferous grass varieties that produce poor quality seed or insufficient amounts of seed.
Sprigs are pieces of rhizomes or stolons, cut into small pieces that have at least two nodes on them. The sprigs are placed in the soil manually or mechanically, leaving about 25% of the sprig remaining above the soil surface, to encourage top growth.

http://s218.photobucket.com

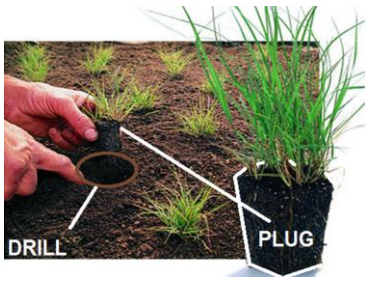
5. **Stolonizing**

Stolonizing is a form of sprigging that involves broadcasting sprigs or stolons over moist soil. The sprigs are then pressed into the soil, again leaving about 25% of the sprig's length exposed.

This process can also be used with a hydromulcher, where sprigs are mixed with mulch and broadcasted over the site as a spray and is often referred to as **hydrosprigging.**

6. **Plugging**

Plugging involves placing mature pieces or plugs of turf into the soil. The plugs are usually up to 10 cm deep and 5 cm wide. The plugs are usually planted at a 10cm by 10 cm spacing, but the spacing can vary depending on plug size. Plugging is often done to repair small areas of damaged turf, and often utilised on a golf course, especially in repairing damage to the putting greens. Plugging can also be used to establish an entire lawn.



http://img1.sunset.timeinc.net


Differentiate among the types of lawn establishment.


Once a site has been prepared, lawn can be established.


You have been approached by the Principal of your school to plan and supervise the establishment of a lawn on an overgrown sloping area of the school compound. Discuss what you would do.

LESSON 9: MAINTAINING LAWNS

LESSON OUTCOME: At the end of this lesson, the student will discuss methods used to maintain lawns.


A vigorous, healthy lawn enhances any environment.

Lawn maintenance includes:

i) **mowing** – although taller grass promotes better root development, shades the ground so the temperature is constant, lessens dehydration and blocks the sun that weed seeds require to germinate, weeds become a problem if lawns are not well maintained. Regular mowing controls many weeds especially broadleaf weeds.

It is best to ensure that lawn grass is at least 5 cm tall **after** mowing to maintain the rooting system. Cut off 1/3 of the top of the lawn grass as cutting too low will stress the plants and may end up in bald patches. The type of machine used for mowing depends on the size of the lawn.

Push mower	**Motorised push mower**	**Motorised ride on mower**
		
http://ak1.ostkcdn.com	*http://www.google.com*	*http://www.mowdoctor.com*

Weeds can also be pulled out of lawns before flowering and seed production.

ii) **feeding –** increases lawn vigour and helps prevent weeds and moss from establishing.
Mix fertilizing material with soil before applying to ensure even distribution and avoid scorching the grass.
Apply the mixture in cool, moist conditions and lightly water it in.
a) apply poultry manure and work into the soil prior to planting.
b) if grass is losing vigour, broadcast sulphate of ammonia at a rate of 15 g per m^2 or chicken manure
c) if grass blades are fading from green to yellow [chlorosis] soak urea in water and spray it on in the cool evening.

iii) **water control**
Lawn grasses have fibrous roots which feed in the top soil. Water availability is crucial to the survival of the grass, however; waterlogging will cause rotting of roots and competition from moss. Sprinkle water onto the lawn once the top 5 cm of soil is dry.

iv) **scarifying**
Grass clippings and humus accumulate, smothering plants and harboring pests and diseases. As well as removing the grass clippings, organic matter and moss, raking also physically disturbs pests and diseases and so promotes better lawn growth.

Feeding	Weed control	Water control	Scarifying
			
http://cimg0.ibsrv.net	*http://wwwchicagotonight.wtw.com*	*http://www. onestarirrigation.com*	*www.utube.com*

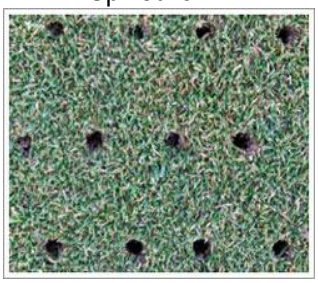
v) **edging**
A clean line is created where lawn meets other surfaces, structures or plants. Edging gives the lawn a more professional look and stops the lawn grass from growing into or over the other surface e.g. along paths or gardens. The edge can be made by cutting along the line using a sharp blade like a cane knife or brush cutter or an artificial edge may be made e.g. concrete edging.

Edging along a footpath	*Pathway edging*
	
http://image2.gardenersworld.com	*http://www.aboutthatlawn.com.au*

vi) spiking

The surface of the soil often becomes hard due to dehydration and compression from use and vehicle movement. To allow water infiltration and aeration, small holes are made in the soil surface with prongs like that of a digging fork.

Spiked lawn



http://www.lawn-craft.co.uk

Using digging fork

http://www.lawnsmith.co.uk

Lawn Aerator Shoes

http://ebay.com

Push lawn aerator

http://www.coopersofstortford.co.uk

Differentiate among the methods used to maintain established lawns.

Once a lawn has been established, it needs to be maintained.

You have been approached by the Principal of your school to plan and supervise the maintenance of a lawn near the entrance to the school. Discuss what you would do.

LESSON 10: METHODS OF RAISING ORNAMENTAL PLANTS IN CONTAINERS

LESSON OUTCOME

At the end of this lesson the student will discuss and practice some methods used for growing plants in containers.

Pot plants	-	a plant grown in medium which is confined in a container
Bonsai plants	-	an ornamental tree or shrub grown in a pot and artificially prevented from reaching its normal size
Terrarium	-	terrarium is an enclosed, indoor garden, usually small and made of glass so that you can see your collection of plants
Growing medium	-	a substance through which roots grow and extract water and nutrients.

Ornamental plants need to be propagated and cared for just like any crop however, the methods used depends on the type, planting material, purpose, size and intended use of the plants. Potted plants need special attention.

Some methods used for growing plants in containers are:

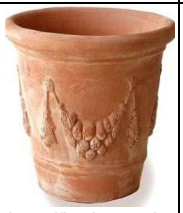
i) pot plant – where a plant is grown in a container of planting medium.
ii) bonsai – growing ornamental, artificially dwarfed trees or shrubs.
iii) terrarium garden – growing plants in a covered or closed container, usually made of glass.
iv) dish gardens - plants growing in a shallow **dish** or bowl for a container

Potted plant	Bonsai plant	Terrarium garden	Dish garden
Citrus plant  *https://s-media-cache-ak0.pinimg.com*	55 year old, 48 cm tall Kuromatsu tree  *http://bonsai.shikoku-np.co.jp*	Terrarium of succulents  *http://www.realestate.com.au*	 *http://teleflora.edgesuite.net*

Anything that holds soil and has drainage holes in the bottom may be transformed into a container garden for terrestrial plants. When choosing containers ensure that the container is affordable and has:

1. drainage holes
2. eye appeal
3. durability
4. adequate space for roots and growing medium

Pots may be ceramic, clay, wooden, metal, plastic or recycled containers.

Ceramic	Terracotta	Metal	Wooden	Plastic	Old shoes
 *https://s-media-cacheak0.pinimg.com*	 *http://i.telegraph.co.uk*	 *https://s-media-cache-ak0.pinimg.com*	 *http://guideimg.alibaba.com*	 *https://s-media-cache-ak0.pinimg.com*	 *https://s-media-cache-ak0.pinimg.com*

Differentiate between a terrarium garden and a dish garden.

Any vessel which can hold plant growth medium and has drainage holes can be used to grow plants.

1. Analyse possible containers which can be used for plant pots which are available at your home and in the school compound.
2. Get permission to use the pot and secure plants to grow in it.

LESSON 11: POTTING MIXES

LESSON OUTCOME; At the end of this lesson the student will discuss the role of and ingredients used in potting mixes and prepare appropriate potting mixes for selected plants.

Potting mix - also known as potting soil or potting compost, is the medium in which to grow plants, herbs and vegetables in a pot or other durable container.

Coir - fiber from the outer husk of the coconut, used for making ropes and matting.

Vermiculite - yellow or brown mineral used as a moisture-retentive medium for growing plants.

Perlite - a volcanic rock that has been heated and expanded.

The potting mix used to propagate ornamentals differs according to the type of plant. However, the potting mix must provide the plant with:

1. air circulation 2. favourable moisture content 3. nutrient needs 4. anchorage 5. pathogen free medium.

Below are some **ingredients** used as growth medium or as ingredients in potting mixes:

1. **Tree fern** or 'balabala' is suitable for plants which need a porous medium which is well aerated e.g. Vanda orchids. It may be used as a growth medium or as an ingredient in a potting mix.

2. **Sphagnum peat moss** is a stable organic material that holds 15 to 30 times its weight in water and decomposes very slowly.

3. **Wood charcoal**- allows air circulation; maintains consistent moisture content; is inert so does not decay; anchors plants; readily available; absorbs and slowly releases nutrients.

4. **Coir** is a waste product of the coconut industry. It has physical properties much like peat but pH of about 6. It holds up to nine times its weight in water. It can have a high salt content so should be washed in fresh water before use.

5. **Vermiculite** helps hold water and fertilizer in the potting mix and contains some calcium and magnesium. It has a pH near neutral. Vermiculite comes in different grades; medium grade is usually used for starting seeds, a coarse grade may be used for larger plants.

6. **Perlite** is lightweight, sterile and has a neutral pH. It can be used to reduce the weight of a potting mix and increase its aeration and drainage.

7. **Coarse washed sand** also called builder's sand can be used to add air space to the potting mix and increase its weight. It has a neutral pH and provides almost no fertility to plants. Sand may be used when added weight is needed for growing tall or top heavy plants that might fall over if grown in a lightweight mix.

8. **Limestone** is either calcitic (high calcium) or dolomitic (high magnesium); both are used to increase the pH of a mix but dolomite is preferable for supplying both Calcium and Magnesium.
9. **Compost** is rarely used by itself as a potting medium. Compost alone does not have the optimal water holding characteristics, and soluble salt levels may be higher than optimal for potting mix.

Fern tree roots [balabala]	Sphagnum peat moss	Wood charcoal	Coir
 *https://www.orchidgrowingsupplies.com*	 *https://myfirstorchid.files.wordpress.com*	 *http://1.imimg.com*	 *http://3.imimg.com*
Vermiculite	**Perlite**	**Coarse washed sand**	**Limestone**
 *http://fertilefibre.com*	 *http://lghttp.17653.nexcesscdn.net*	 *http://www.dreamstime.com*	 *http://www.ced.ltd.uk*

Discuss the features of a suitable potting mix for a succulent plant.

A potting mix must provide a plant with air circulation, optimum moisture conditions, nutrients, anchorage and pest and disease free growing conditions.

1. Choose an ornamental to plant in the pot you have chosen.
2. Determine the most suitable potting mix for the plant.
3. Prepare the potting mix, using ingredients which are available locally.

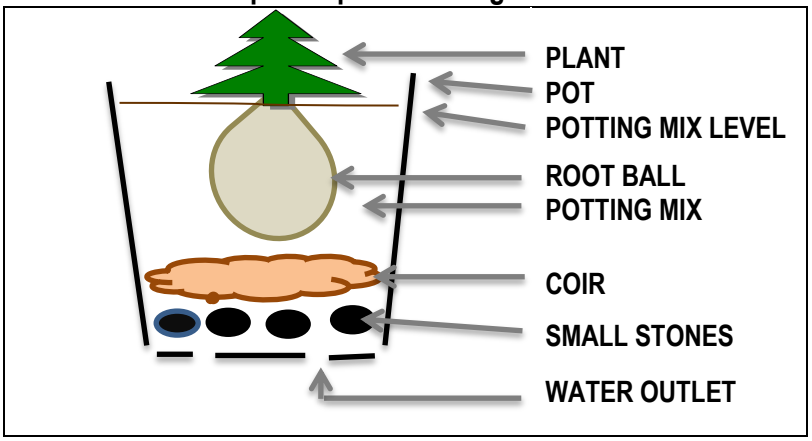
LESSON 12: PLANTING IN POTS

LESSON OUTCOME: At the end this lesson the student will plant plants into pots

Potted plants are usually planted using seedlings or vegetative plant parts.
Below are listed the basic steps used in potting plants.

i) Choose a suitable pot.
ii) Place a thin layer of drainage material in the bottom of the pot
iii) Place a thin layer of material to stop the soil from being washed out and pests from entering the potting mix e.g. coir or dress fabric.
iv) Place a layer of potting mix over the drainage material.
v) Position the planting material.
vi) Fill in the rest of the pot with potting mix to about 5 cm from the brim of the pot.
vii) Mulch with pebbles, marbles or perlite to reduce evaporation and pests.
viii) Irrigate the pot to saturation.
ix) Place the potted plant in the shade until the plant is established.

Cross section of a potted pine seedling



Source: *Author, 19/02/2016*

Prepare a pot to receive an ornamental plant.
Prepare the planting material for the ornamental plant.

Before potting a plant, the planting material, pot and potting mix must be chosen and prepared.

Plant the ornamental plant in a pot.

LESSON 13: CARE OF POT PLANTS

LESSON OUTCOME: At the end of this lesson the student will discuss and practice some care for potted plants.

Rootbound - roots begin to become crowded or grow out of the bottom of the container

Potted plants may be placed outdoors, grown in plant raising structures like shade houses or grown indoors.

To keep the plants vibrant, care is given to the plant. Some methods include:

1. **Light control**: each plant has its own lighting requirements. Plants which require:
   a) full light should be placed outdoors
   b) longer hours of light should be provided with artificial light
   c) less intense light should be planted and raised indoors or in suitable shade.

Outdoor pot plants	Indoor pot plants
	
http://cind.carnegiemtg.com	*http://vsekolembydleni.cz*

Study pot plants placed indifferent ligh intensity e.g. outside the buildings, inside the buildings and in the shade house. Compare their lighting requirements.

2. **Water control**: each plant has its own water and humidity requirements but the general rule is:
   i) irrigate potted plants early in the morning.
   ii) apply water to the soil as water damages flowers and encourages pathogens to develop on leaves.
   iii) water pot plants from the base to discourage leaching.

Plants which require:

a) **Moist soil**: use more water absorbent material, like sphagnum peat moss and coir, in the potting mix to maintain the water holding capacity of the growing medium. Irrigate when the soil surface is dry.

b) **Dry soil**: place more water draining material, like vermiculite and perlite, in the pot to encourage the draining of water and aeration of soil.

Methods used to irrigate pot plants include:

i) **Dipping method** – the pot plant is submerged in a bucket containing water. When there are no more bubbles, the pot is taken out and left to drain naturally. Suitable for the weekly watering of succulents

ii) **Reservoir method** – a small container with a hole in the bottom, is buried in the center of the container, level with the soil. It is filled with water every day or two, and has the effect of watering from the bottom of the container.

iii) **Wick watering method** – two pots are used. The first pot is partially filled with water. The second pot which contains the pot plant has a hole in the bottom, through which wicks hang. When the second pot is sat in the top of the first container, the wicks transfer water from container 1 to container 2 according to the needs of the plant.

iv) **Misting method** – where water is sprayed onto the foliage and surroundings of the plant.

Dip method	Reservoir method	Wick method	Misting
			
http://www.gardengrapevine.com	*http://www.improvisedlife.com*	*http://www.livemans.com*	*https://s-media-cachek0.pinimg.com*

1. In the pot which you have prepared for planting, insert a reservoir method of irrigation.
2. Prepare a model of the wick method of irrigating pot plants.
3. Practice the dip, mist, overhead and bucket methods of irrigation on pot plants in the school.

3.Fertilizer application

Houseplant fertilizers come in a number of formulations including:

a) wettable powders and concentrated liquids that are diluted with water then applied to the potted plant.
b) coated pellets and spikes are time release fertilizers which are applied to the potting soil.
c) premixed fertilizers are applied directly to the potting soil.

As a general rule, foliage houseplants appreciate fertilizers high in nitrogen while flowering plants respond best to those with higher phosphorus content.

Excess nutrients in the potting soil will desiccate or burn tender roots.

High concentrations of nutrient salts also prevent the plant from taking up water so wilting is observed.

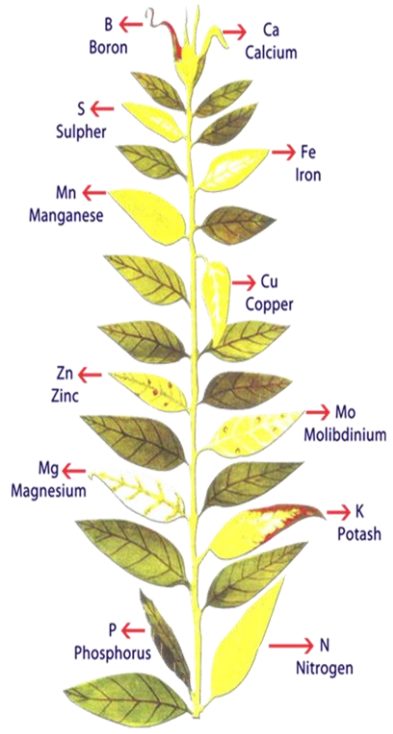
Signs that a pot plant has been over fertilized include:

i) browning roots and leaf tips,
ii) wilting because tender roots are burnt by the excess nutrients.
iii) poorly shaped leaves and
iv) a white crust on pot rims.

If signs of excess nutrients are seen:

i) add a lot of water to the potting medium to leach nutrients.
ii) repot the plant and replace the old mixture with fresh medium.

Nutrient deficiency symptoms



Source: *http://www.floragaroferti.com*

Wettable power	Concentrated liquids	Coated pellets
		
https://www.handypantry.com	*http://www.aboutfertilizer.com*	*http://file.scirp.org*

Determine the type of fertilizing material needed by pot plants in the school.
Apply fertilizing material to available pot plants.

4. **Weed control** – weeds compete with and often kill pot plants so the following methods are used to prevent and control weed infestations.
   i) **Sanitation** – fresh potting mixes must be free from parts of weeds which can germinate like seeds and stolons. The environment in which the pot plant is kept is also kept free of weeds which can contaminate the pots.
   ii) **Chemical barrier** – pre-emergent herbicides are sprayed on the surface of the pot plants to stop weeds from germinating
   iii) **Hand pulling** – any germinating weed is removed from the pot.

Determine the method to use to control weeds in available pot plants.
Control weeds affecting available pot plants.

5. Pest Control

Pot plants suffer from an array of pests including:
   i) **Insects** like White fly, ants, scale insects, aphids, spider mites, mealy bugs, thrips, leaf hoppers, grass hopers and beetles – control using insect soup or traps
   ii) **Molluscs** like snails and slugs – use beer bait.
   iii) **Worms -** fumigate soil before potting.

6. **Pruning** – pot plants sometimes outgrow the pot in which they are growing and need to be pruned.

Identify potted plants which need pruning and prune them.

7. **Re-potting -** a plant needs repotting when it becomes rootbound because its ability to take up water and nutrients is impaired. This usually results in poor vigor and overall health.

STEPS IN REPOTTING

a) New pot
   i) select a new pot which is free from used soil, salt residues and other organic matter. The pot's size, color, and material should complement the size of the plant, leaf texture and leaf and flower color.
   ii) disinfect the container by soaking it in a solution of 1 part bleach to 9 parts water for 15 minutes.

b) Potting mix – prepare the potting mix that suits the plant

c) Remove the plant from the original pot.
   i) wet the soil thoroughly to soften it and allow plants to rehydrate.
   ii) place the hand over the media, straddling the plant between the fore and middle fingers.
   iii) turn the pot over and tap the lip against a hard surface until the plant slips out.

Straddle the plant	Turn pot over	Tap lip	Slide plant out of pot	Trim plant
				

Adapted from *http://media.wiley.com*

d) Trim the plant–remove excess roots, dead and diseased vegetative parts as well as daughter plants like suckers.

e) Place material for **soil drainage/water retention** in the bottom of the pot.

f) Place a layer of **potting mix** into the pot.

g) **Position the root ball** so that the soil surface will be the same level as the original pot.

h) **Fill in the sides** with potting mix while lightly firming the soil.

i) **Mulch** the surface of the potting mix and water thoroughly.

Adding drainage materials	Adding potting mix	Placing plant	Filling and firming potting mix
			
http://kb.thegardener.co.za		*http://hgtvhome.sndimg.com*	*http://www.missouribotanicalgarden.org*

Repot available pot plants

Discuss the care of a flowering and a foliage pot plant.

Potted plants need extra care as they depend on limited growth medium to provide the water and nutrients which they need.

Maintain pot plants in the classroom, shade house and school compound.

LESSON 14: HARVESTING and SALE of FLORIST CROPS

LESSON OUTCOME: At the end of this lesson the student will discuss the sale of pot plants.

Abscission	-	loss of buds, petals, flowers, fruit, leaves and/or branches
	-	is also called shattering or shredding
Senescence	-	the process of growing old

The trade in florist crops is growing in Fiji. It is important to use methods which will prolong the shelf life and value of ornamental plants which decrease due to:

1. **Wilting** – results from the removal of the plant part from the environment and/or parent plant resulting in stress and a break in the natural water supply for the plant. This is countered by providing the plants with shaded, cool travelling, storage and selling conditions and keeping the plants hydrated.

2. **Abscission** – in this natural process, plant parts fall off due to dehydration, heat, excess movement, overcrowding and the buildup of ethylene gas.
   This can be prevented by keeping the environment cool, careful packaging of plants, providing moisture for the plants, minimizing the movement of the plants during transport and maintaining adequate aeration to minimize the buildup of ethylene gas.

3. **Flower senescence –** plant parts, like flowers and leaves, begin to get old as soon as they are removed from the parent plant. The stem of plants should be soaked in flower preservatives to provide nourishment and control the action of microorganisms.

4. **Yellowing –** pollinated flowers begin to lose their colour and turn yellow. Remove the stigma of flowers to prevent pollination and add cut flower preservatives to the water in the vase.

As well as cleaning, sorting, grading, weighing and packaging, the following methods are practiced:

i) Before harvesting, the plants are heavily **irrigated** to ensure that the parts to be harvested are well hydrated.

ii) **Cut flowers** – once removed from the stem most flowers being to wilt, therefore flowers are cut with long stems attached. The stems are then placed in water and recut underwater to remove air bubbles which have entered the xylem. Cotton wool is soaked in water and wrapped around the base of each stem to reduce water loss too.

iii) **Pot plants –** pot plants are either sold in plastic bags or cheap pots in which they are growing to minimize damage to the root system during movement.
iv) **Foliage plants –** Foliage leaves are usually sold attached to stems**.**
The same process is used as with cut flowers.
v) **Bedding plants -** these plants are sold in pots so are transferred to pots prior to flowering.
vi) Some ornamentals are sold as **planting material** like Sun flower seeds, seedlings like palms, Heliconias rhizomes and hibiscus branches etc.


Observe and discuss the treatment of florist plants which are for sale.


The trade in florist crops is growing in Fiji so it is important to use methods which will prolong the shelf life and value of ornamental plants.


Prepare florist plants, which you have produced, for sale.

LESSON 15: FLORAL DESIGNS and FLOWER ARRANGEMENTS

LESSON OUTCOME: At the end of this lesson the student will identify, discuss and practice designing flower arrangements.


Ikebana - Japanese art of flower arrangement which draws emphasis towards shape, line and form and emphasizes flowers, stems and leaves.


Floral designs include arrangements which are used for a wide range of purposes including: i) decoration of offices and homes ii) weddings, funerals and church services iii) gifts iv) decoration of venues for events lie parties, graduations etc

The success of floral arrangements depends on its construction. Using proper tools, choosing the right container and knowing how to put the arrangement together are essential in creating pleasing floral arrangements.

Tools used for floral designs include:
i. **Knives**: a sharp knife is needed for cutting the stems of flowers and foliage before they are inserted into a design.
ii. **Pruning shears**: are used for cutting or trimming thicker flower and foliage stems
iii. **A pair of scissors**: is used for cutting ribbons, lace, thin wires, plastic wraps and thin stems.
iv. **Floral foam**: which is also called oasis [brand name] is the spongy material into which the elements are stuck. Wet floral foam is used to hold fresh elements. Dry floral foam is used to hold artificial elements.
v. **Floral tape**: may be green or clear. Green floral tape is used to secure the foam in the container.
Clear floral tape is crisscrossed over the opening of the container to make grids so the designers can insert the flowers in the spaces between the pieces of tape.
vi. **Flower Preservative**: provide flowers with water and food and contains a disinfectant to prevent bacteria from growing.
vii. **Containers**: hold the flower arrangements. Containers which are available in a wide variety of shapes, sizes, styles, material and prices are chosen to complement the flowers, and where the flower will be placed. The container should be both visually and physically compatible with the entire design and setting.

Knife	Shears	Scissors	Floral tape	Floral foam
				
www.123rf.com	*http://www.vertextools.com*	*http://lghttp.17653.nexcesscdn.net*	*http://cheyennebirminghamfloraldesign.weebly.com*	*https://www.google.com*

Cut Flower Preservatives

Recipe #1	Recipe #2	Recipe #3
• 2 cups lemon-lime carbonated beverage (e.g.Sprite™ or 7-Up™) • 1/2 teaspoon bleach • 2 cups warm water	• 1 tablespoon sugar • 1/2 teaspoon bleach • 1 quart warm water	• 2 tablespoons white vinegar • 2 tablespoons sugar • 1/2 teaspoon bleach • 1 quart warm water
http://chemistry.about.com		

Design Principals

1. **Balance** – the various elements including the container, flowers, foliage and accessories - need to fit with one another visually as well as physically.
   i) **physical balance-** the floral arrangement needs to be mechanically sound so that it can stand on its own without falling over. This is achieved by placing equal amounts and weights of flowers and foliage on each side of the container.
   ii) **visual balance –** when the arrangement looks like it will not fall over.
   There are four types of visual balance:
   a) **symmetrical balance** – when identical flowers and foliage are arranged and repeated in the same position on either side of the design, resulting in one side mirroring the other.
   b) **asymmetrical balance** – when unequal visual weight is placed on each side of the design.
   c) **radial balance** – when all elements of a floral design radiate or circle out from the common central point like rays of the sun.
   d) **open balance** – uses material throughout the arrangement in a relaxed, unstructured manner.

Symmetrical balance	Asymmetrical balance	Radial balance	Open balance
			
http://ladanmoshiri.com	*http://ep.yimg.com*	*www.allensflowers.com*	*http://www.debraprinzing.com*

2. **Focal point** – the focal point creates the accent and interest of the arrangement and so catches the eye of the viewer.
   This is created by using unusual flowers or objects e.g. different coloured or larger flower, bow etc.
3. **Proportion** – used to keep relative size, colour and texture of flowers in proportion to the container.
   Rule of thumb - keep the arrangement 1½ to 2 times the height or width of the container.
   The container used should be in proportion to the area.
4. **Accent** – used to draw attention to the design e.g. using flowers that contrast with the environment: bright red flowers against a white wall.
5. **Repetition** – using one or two coloured flowers throughout the design e.g. only heliconias.

6. **Rhythm** – creates a sense of continuity among the shapes, colours and textures so that the viewer feels that everything is flowing together.
7. **Harmony –** gives a completed look to the arrangement.
8. **Unity –** when the arrangement flows together and is not segmented. The components of the arrangement complement each other in size, colour and shape.

Design materials

There are four basic design materials used in floral arrangements:

i) **line flowers or foliage –** establish the outer framework of the arrangement
ii) **massing flowers or foliage –** have the flower head on the terminal end of the stem and are used to create the design principals and to accent the focal point e.g. roses
iii) **form flowers –** flowers with a unique shape or form which are used to create the accent or focal point of the arrangement e.g. orchids, lily
iv) **filler flowers or foliage –** used to tie the arrangement together by filling in gaps and covering up the mechanics of the arrangements e.g. fine ferns, crotons, baby's breath etc.

Types of floral arrangements

Flowers are arranged for various purposes including:

1. **bouquet** - a bunch of arranged flowers which can be held or presented as a gift.
2. **wreath**- a circular band of flowers, foliage or any ornamental work for any decorative purpose including wreaths for funerals and for placing on a grave.
3. **corsage**- is a small bouquet of flowers worn on a woman's dress or worn around her **wrist** to a formal occasion.
4. **buttonniere** - a flower or small bouquet worn, usually by a man, in the buttonhole of a lapel.
5. **swag** - a decorative garland or chain of flowers, foliage, or fruit fastened so as to hang in a drooping curve.
6. **garland -** is any series of objects, including flowers and foliage, strung together with the intent to be worn.

Bouquet	**Corsages**	**Buttonniere**
		
https://s-media-cache-ak0.pinimg.com	*https://s-media-cache-ak0.pinimg.com*	*https://upload.wikimedia.org*
Garland	**Wreath**	**Swag**
		
https://www.pinterest com/suelawe/my-fiji	*http://m4.i.pbase.com*	*http://dotcomwomen.com*

Flower arrangements come in many forms and some basic designs are illustrated below:

Vertical	**Inverted T**	**L-shaped**
		
http://www.flowerarranging.me.uk	*http://pds70.cafe.daum.net*	*https://www.google.com*
Equilateral triangle	**Oval**	**Round**
		
https://s-media-cache-ak0.pinimgcom	*http://agritech.tnau.ac.in*	
Fan shaped	**Crescent**	***Ikebana***
		
http://cdn2-b.examiner.com	*http: clayflowerdesigns.com*	

List the types of floral arrangements and discuss where each is used.

Flowers are complemented by foliage, ribbons and lace to make bouquets, wreaths, boutonnieres, corsages, swags and garlands. Each has a range of designs and colour combinations and potential for income.

Divide the class into groups and organize a flower arrangement competition.

SUBSTRAND AS 12.3.2 HORTICULTURE
CLO AS 12.3.2.4 TREE CROPS
CONTENT LEARNING OUTCOME
AS 12.3.2.4 Research and elaborate on the production of tree crops.

LESSON 1: INTRODUCTION
LESSON OUTCOME
At the end of this lesson, the student will differentiate among the main uses of trees in Fiji.

Arboriculture - is the study of the selection, planting, care, and removal of individual trees, shrubs, vines, and other perennial woody plants.

A tree is a woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground. Tree crops usually refer to groves or orchards of trees grown for some type of economic or environmental benefit. In Fiji, trees are valued for:

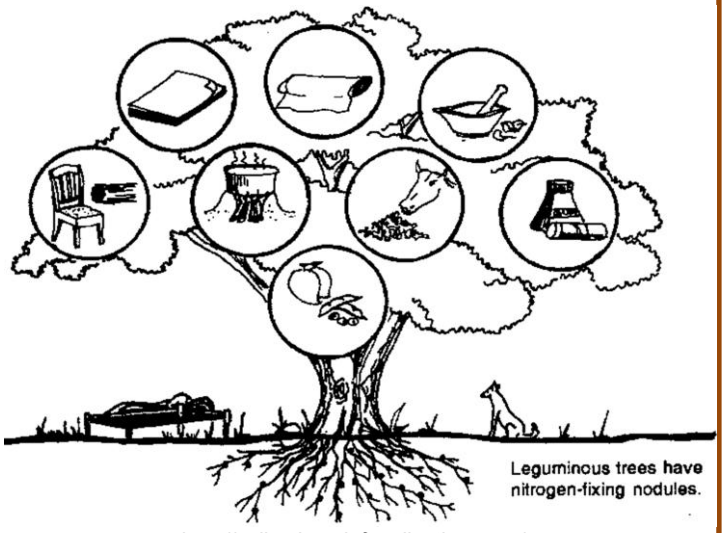
i) **food** – these trees may grow for many years, providing food either all year round or in certain seasons.
ii) **non-food materials** like wood and medicine – these trees are often harvested once they are mature
iii) **horticultural purposes** – these trees are grown for their aesthetic value and for the preservation of wildlife.
iv) **shade**
v) **boundary markers**
vi) **environmental purposes** – to preserve soil and prevent soil movement like landslides and erosion.

Discuss the roles that trees have in Fiji.

Trees are tall perennial plants which have a single stem or trunk and bear lateral branches some distance from the ground.
They are grown for a number of purposes.

Discuss the roles that a tree within or close to the school compound has.

Some uses of trees



http://collections.infocollections.org/

12.3.2.4. TREE CROPS IN FIJI

a) List some of the tree crops found in Fiji.

LESSON1: TREE CROPS IN FIJI

At the end of this lesson, the student will differentiate among the types of tree crops in Fiji.

Hardwood	- the wood of an angiosperm tree and is relatively heavy and hard
Softwood	- the wood of a coniferous tree and is relatively light and soft.

Although some tree crops are planted in forests and orchids in Fiji, many valuable trees are found growing naturally or are planted as single trees on homesteads and farms. These trees can be divided using many criteria but will be studied under the following categories:

1. **Food and beverage producing trees**

a) the Moraceae family include trees like the:

1. **Breadfruit**
Artocarpus altilis

http://www.pyratenterprises.com

2. **Jackfruit**
Artocarpus heterophyllus

http://www.beabeeinc.com

b) the Arecaceae or palm family includes

3. **Coconut palm**
Cocos nucifera

https://upload.wikimedia.org

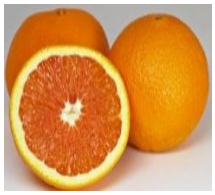
4. **Betel nut palm**
Areca catechu

https://upload.wikimedia.org

c) the Rutaceae or citrus family include trees like the:

http://static1.evermotion.org

5. **Sweet orange**
Citrus sinensis



http://botanyphoto.botanicalgarden.ubc.ca

6. **Grapefruit**
Citrus paradisi

https://www.organicfacts.net

7. **Lemon**
Citrus limon

http://www.natures-health-foods.com

8. **Lime**
Citrus aurantifolia

http://www.dbrexportsindia.com

9. **Shaddock**
Citrus maxima

http://meogiamcan.com

10. **Tangerine**
Citurus nobilis

http://essentialhealth.com

11. **Mandarin**
Citrus reticulata

https://orienteocidente.files.wordpress.com

12. **Kumquat**
Citrus sensu lato.

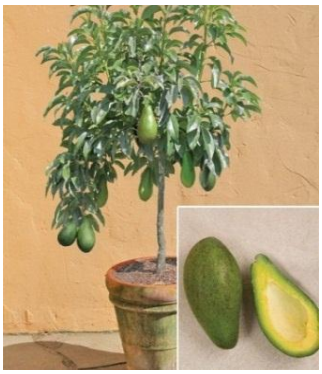
https://www.lifetimestyls.com

d) other fruit trees including:

13. **Mango**
Mangifera indica

http://www.sharpes.org.uk

14. **Avocado**
Persea americana



http://www.coolhealthyrecipes.com

15. **Pawpaw**
Carica papaya

https://upload.wikimedia.org

16. **Malay apple [*kavika*]**
Syzygium malaccense

http://www.prota4u.org

17. **Tahitian Chestnut *[ivi]***
Inocarpus fagifer

http://cookislands.bishopmuseum.org

18. **Coffee**
Coffea arabica

http://www.livingrainforest.org

19. **Cocoa**
Theobroma cacao

http://www.epicurus.com

20. **Soursop**
Annona muricata

https://hort.purdue.edu

21. **Dragon plum [tarawau]**
Dracontomelon vitiense

http://plantjdx.com

22. **Oceanic lychee [*dawa*]**
Pometia pinnata

http://s31.photobucket.com

23. **Cutnut [*vutu kana*]**
Barringtonia adulis

http://ink.springer.com

24. **Polynesian plum [*wi*]**
Spondias dulcis

http://www.wellgrowhorti.com

c) Although not trees, the Musa family is included in this section, and include;

http://www.highqualitytextures.com

25. **Banana**
Musa acuminate

https://thebesthealthyhabits.com

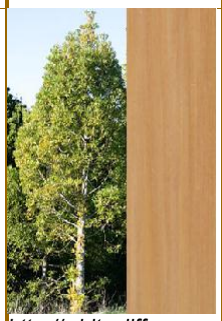
26. **Plantain** [vudi]
Musa paradisiaca

https://en.wikipedia.org

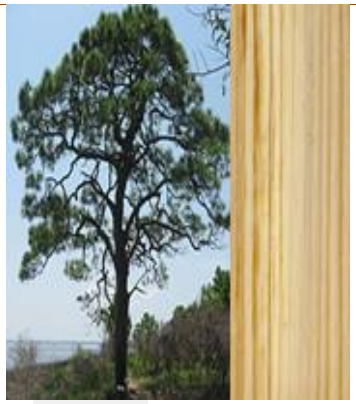
2. **Wood producing trees:**

'Sandalwood, *Santalum yasi*, which was found on the Bua and Lekutu coasts in 1802, brought trading ships from America, Australia and India to the 'Sandalwood Island", the name given to Vanua Levu by the traders.
Trees have played a significant part in the life of Fijians, supplying wood and materials for:
i) traditional dwellings ii) domestic items iii) tools
iv) the large canoes which were the only means of communication and travel between the islands.
The lumber was fashioned with adzes, hardwood hammers and spitting wedges.
Shells were used as scrapers, shark and ray skins as well as coral as rasps and pumice for final sanding.' Adapted from A.S. Alston's 1982 *Timbers of Fiji* p 7

a) some endemic hardwood trees				
Common name	**1. Yasiyasi**	**2. Coconut**	**3. Vesi**	**4. Damanu**
Scientific name	Cleistocaltx ellipticus	Cocos nucifera	Intsia bijuga	Calophyllum neo-ebudicum
Tree and wood	 http://www.woodworkerssource.com	 http://www.wowwow.com.sg	 http://jjdoreau.fr	 http://whitecliffs.co.nz
Uses	Heavy construction, decking, flooring, stairs, door and window sills.	Flooring, furniture, paneling, carvings, construction.	Heavy construction, beams, doors and window sills, poles, sleepers, wharves, bridges, boat framing, heavy duty flooring	General construction, interior stairs, veneer, mouldings, house frames and weatherboards.

b) some endemic softwood trees					
Common name	**1. Dakua makadre**	**2. Dakua salusalu**	**3. Yaka**	**4. Kauvula**	**5. Rosawa**
Scientific name	*Agathis vitiensis*	Decussocarpus vitiensis	Dacrydium nidulum	Endospermum macrophyllum	Gmelina vitiensis
Tree and wood	 *http://whitecliffs.co.nz*	 *ww.amazon.co.uk*	 *http://whitecliffs.co.nz*	 *http://www.justtimberandpanels.info*	 *http://whitecliffs.co.nz*
Uses	Household items like vats, tanks, carvings, furniture, as well as masts, oars, spars and decking	Interior finishing, window frames, doors, furniture, cabinets, weather boards and mouldings.	Furniture, lining, decorative paneling, polished flooring, plywood, sliced veneer.	Interior finishing, furniture, joinery, fruit crates, weatherboard.	Boat building, decking, oars, diving boards, carving, food manufacturing equipment.

c) some exotic hardwood trees			
Common name	**1. Mahogany**	**2. Anthocephalus**	**3. Cordia**
Scientific name	*Swietenia macrophylla*	*Anthocephalus chinensis*	*Cordia alliodora*
Tree and wood	 *http://uforest.org*	 *http://images.wisegeek.com*	 *www.tropicaltimber.info*
Uses	General joinery work furniture, carvings, construction	Interior finishing, matches, linings, plywood, boxing,	Furniture, cabinet making, joinery, paneling, lining, carving
Common name	**4. Lemon scented gum**	**5. Rainbow gum**	**6. Raintree**
Scientific name	*Eucalyptus citriodora*	*Eucalyptus daglupta*	*Samaneaa saman*
Tree and wood	 *ttp://rarewoodsandveneers.com*	 *www.curiousplants.co.uk*	 *www.hobbithouseinc.com*
Uses	Flooring, house frames, posts, poles, general construction	Furniture, interior joinery, paneling	Furniture, paneling, carvings, slice veneer

d) some exotic softwood trees		
Common name	**1. Caribbean pine**	**2. Slash pine**
Scientific name	*Pinus caribea var.hondurensis*	Pinus elliotti Engelm
Tree and wood	 www.prota4u.org	 www.ipef.br
Uses	Posts and poles, flooring and walls, furniture, joinery, paneling, plywood, boxing.	Introduced to Nadarivatu Highlands Posts and poles

3.Although classified as shrubs, the two important mulberries are:

Common name	1. Beach mulberry *Kura*	2. Paper mulberry *Masi*
Scientific name	*Morinda citrifloria*	*Broussonetia papyriflera*
Tree and product	 http://www.goodnoni.cn	Leaves and tapa fabric  www.loupiote.com
Uses	Medicinal plant	Bark used to produce tapa

Differentiate between an endemic and an exotic tree.

Although Fiji has introduced exotic tree species especially for the production of wood, she has many unique species of her own.

You have been asked to choose a tree species for lumber to upgrade the school reception area.
Explain which of the species above you would choose.

12.3.2.4. TREE CROPS IN FIJI

b) Elaborate on the cultivation of tree crops.

LESSON 1: MATCHING TREE TO SITE

LESSON OUTCOME

At the end of this lesson, the student will discuss factors to consider when matching a tree to a site.

Trees are long term crops which usually grow to considerable height and size both above and below ground.

The following consideration must be taken into account when deciding on a site to plant a tree:

http://www.yourleaf.org

1. **Size of the tree** – trees are large plants
   - is there area to accommodate the number of trees to be planted?
   - is the soil deep enough to anchor the tree?
   - where are utilities located including electric lines, water and sewage lines as well as foot paths, house foundations and roads and will the growing tree affect them ?
2. **Life span of the tree species** – trees have a longer life span than most other plants.
   - does the farmer have long term tenure to the land e.g. 80 or more years for mahogany?
   - who will inherit the crop if the trees outlive the farmer?
3. **Main product**
   - what is the tree being planted for?
   - how long will the product take to mature?
   - distance and accessibility to intended market?
4. **Requirements of the tree**
   - will the tree adapt to the precipitation, wind, cloud cover and temperature of the site?
   - will the husbandry and harvesting practices be affected by the topography of the area?
   - are there transport facilities like roads, shipping services and ports?
   - can the soil provide the nutrients, water and temperature that the tree requires?
5. **Number of trees**
   - are saplings available for the number of trees to be planted?
   - is it economically viable to grow the trees at the location for so long or can the area be used for high value short term crops?
6. **Environmental considerations**

   – will the trees benefit or harm the local species and wildlife?
   - is the area a commercial or protected zone?
   - will husbandry and harvesting operations:
     * affect a water catchment area?
     * cause land degradation like erosion and landslides?
     * impact communities nearby?

Once the site has been looked at, the tree species must also be considered:

1. **Height.** Will the tree hinder anything when it is fully grown e.g. utilities, house, roads and paths?
2. **Canopy spread.** How wide will the tree grow?
3. **Is the tree deciduous or coniferous?** Will it lose its leaves in the winter?
4. **Form or shape.** A columnar tree will grow in less space.
   Round and V-Shaped species provide the most shade.
5. **Growth rate.** How long will it take for your tree to reach its full height?

Slow growing species typically live longer than fast growing species.

6. **Soil, sun, and moisture** requirements.
7. **Flowers and fruit**- will the blooms and fruit attract animals like bees and bats? Will the flowers and fruit fall onto roofs and cause rusting or paths and make a mess?

List the factors which are to be considered when matching a tree to a site.

Trees are long term crops which usually grow to considerable height and size. Careful consideration must be made when matching a tree to a site.

You have been requested to plant a tree in the school compound for arbour day. Match a tree to a site within the school compound and explain the factors which you took into consideration.

LESSON 2: TRANSPLANTING SAPLINGS

LESSON OUTCOME

At the end of this lesson, the student will discuss land preparation for tree planting.

Grove - a group of trees planted and cultivated to bear fruit, nuts, etc.; **orchard**
Sapling - a young tree, especially one with a slender trunk.

Whether one tree or one thousand trees are to be planted, land must be carefully prepared beforehand.

Large trees which will damage or compete with the tree crop are removed.

Lines along which to plant saplings are marked out and vegetation is cut in a process called brushing down. The rest of the vegetation may be trimmed to reduce competition and pests, however, clearing all vegetation is not recommended as erosion and drying of soil can occur.

The positions of the planting drills are determined along the cleared lines, with the spacing required for the species taken into account.

Two types of seedlings sold by nurseries

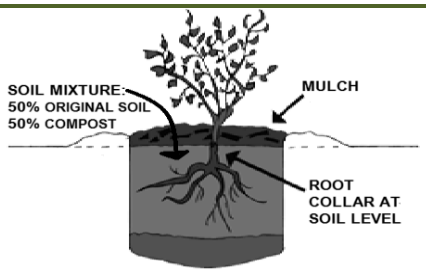
Bare root seedling **Containerised seedling**

http://extensionpublications.unl.edu

At each planting drill, the vegetation is cleared and the drill prepared.

Seedlings and saplings may be planted using various methods:

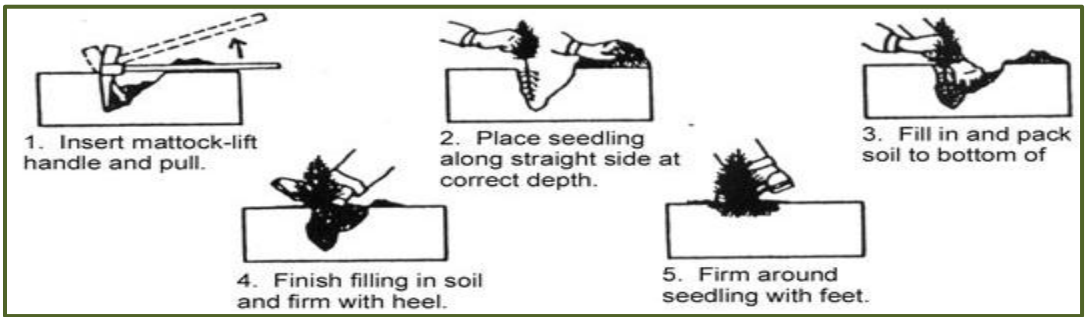
A. **HOLE PLANTING:** suitable when transplanting a few saplings



http://www.dragontrees.com

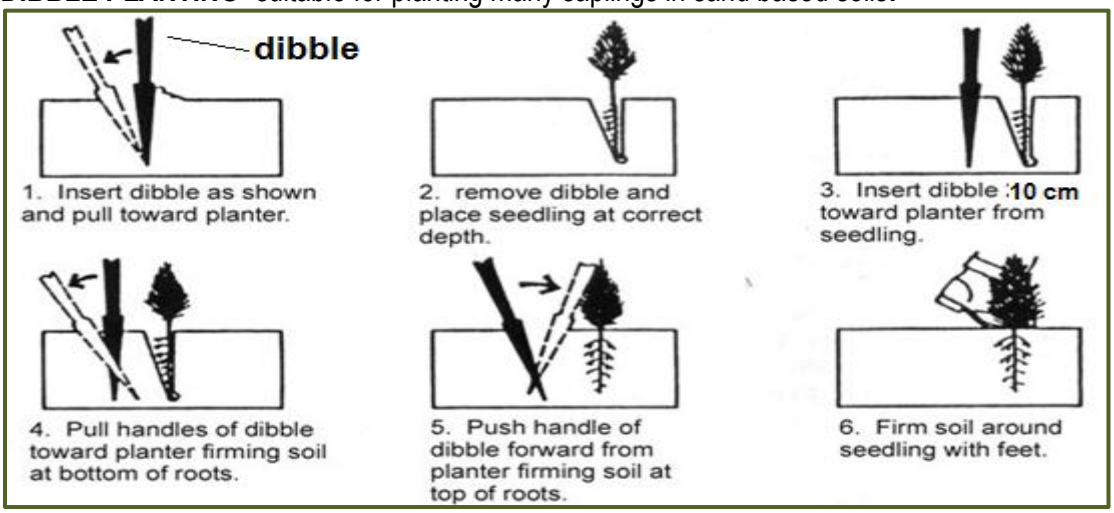
1. Dig a hole twice the size of the roots and deep enough to hold all of the roots.
2. Place the tree seedling or sapling in the planting hole being careful to keep the roots spread out.
3. Fill in the planting hole with soil around the roots.
4. Mulch
5. Irrigate well

B. **MATTOCK or HOE PLANTING –** suitable for planting many saplings in clay based soils.



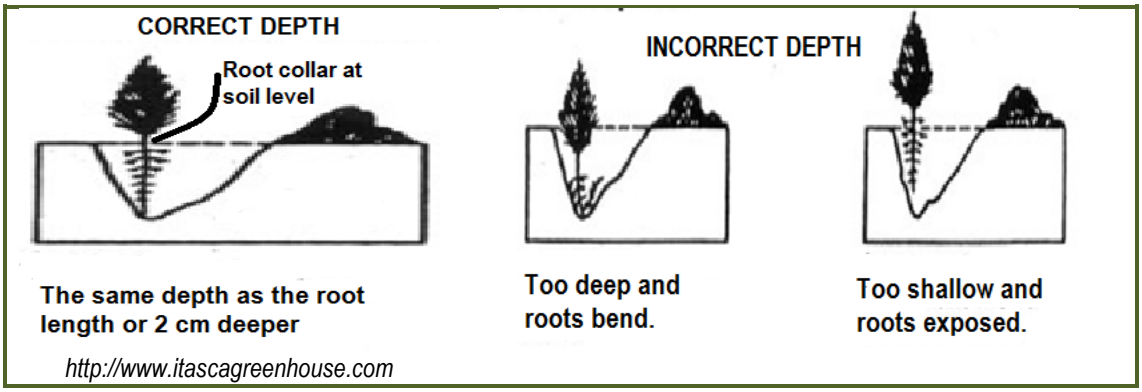
http://www.itascagreenhouse.com

C. **DIBBLE PLANTING-** suitable for planting many saplings in sand based soils**.**



http://www.itascagreenhouse.com

When transplanting a tree seedlings or sapling, care must be taken with its placement in the planting drill.



http://www.itascagreenhouse.com

Differentiate among the three methods of transplanting saplings discussed above.

The method chosen for the transplanting of tree seedlings or saplings depends on the soil type and number of plants to be transplanted.

You have been requested to plant a tree in the school compound for arbour day. Describe the planting method you would use and explain why you have chosen that method. Plant a tree in or near the school compound.

LESSON 3: TREE CARE

LESSON OUTCOME

At the end of this lesson, the student will discuss the care of a tree crop.

Like other crops, tree crops require mulching, feeding and pruning.
However, special requirements of trees will be discussed in this section.
Being long term crops, the needs and wellbeing of trees must be provided.

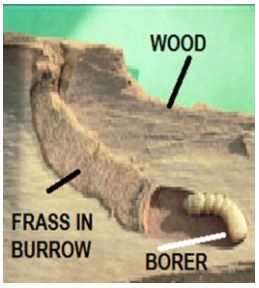
1. Weather phenomena: the occurrence of damaging weather phenomena is usually unpredictable. Little can be done to protect forest plantations against the damage caused by weather, except to grow tree and shrub species known to be resistant to the detrimental effects of local weather patterns, or locating the stands of trees or shrubs in sheltered areas. Some tree and shrub species are more wind-firm than others or are less prone to crowns and branches breaking off in high winds. Other species are more tolerant to salt spray and, therefore, can be used for planting in belts along exposed seaward flanks to give protection to other less tolerant species forming the main plantation. Thin-barked species are more susceptible to damage and to subsequent attacks by insects or fungi than are other species.

forum.weatherzone.com.au

2. Fire: damage by fire imposes a serious threat to plantations and should be a major consideration from the early stages of plantation development.
Fires can originate from natural causes, such as lightning, but many occur as a result of the activities of man including fires spreading from farmland on the perimeter, from the activities of hunters and hikers as well as instances of deliberate burning.
It is not possible to prevent a climatic build-up of fire hazard conditions, but much can be done to minimize the risk of fire through public education and involving local people in forestry.
A main principle in protecting forest plantations against fire is that, where there is insufficient combustible material to allow a ground fire to develop, there is little or no fire risk. Dangerous and damaging plantation fires can only develop when fire is able to occur at ground level.

http://kenmalgren.com

3. Insects and fungi: most insects and fungi are selective of the host species. In their natural environment, trees and shrubs normally attain a state of equilibrium with indigenous pests. However, when exotic trees and shrubs are planted, exotic pests can also be introduced. Quite often, these exotic pests readily adapt themselves to the conditions of their new habitat.
In general, the risk of damage from pests is higher when the plants are physiologically weakened from planting on unsuitable sites, improper site preparation, inefficient planting, adverse climatic conditions or neglect of weed control and other maintenance operations. But even healthy trees and shrubs are attacked at times. For many insects and fungi, no control measures are available; when this is the case, the best precaution is to plant tree and shrub species or varieties known to be resistant to the pests.
Care taken in establishment and maintenance operations during the early years of a plantation (resulting in healthy vigorous young trees or shrubs) can help to make a plantation more resistant to insects and fungi.



http://itc2.utk.edu

However, when evidence of pest attack appears, it should be investigated promptly and the cause identified.

Various control measures are available; these may be silvicultural, chemical, biological, or mechanical.

i) **Silvicultural measures** include well timed, careful thinning after establishment of the forest plantation. Through thinning, poor and suppressed stems are eliminated, maintaining the plantation in a thrifty and vigorous growing condition.

In young plantations, prompt removal and destruction of infested trees and shrubs can be effective in preventing the spread of pest attacks to the rest of the plantation.

ii) **Insects and fungi** can often be checked by applications of appropriate chemical insecticides or fungicides. Usually, these chemicals are available as liquids (or wettable powder), dusts, or smokes. Spraying with hand-operated spray guns or portable mist-blowers is frequently used to control attacks in young plantations. With canopy closure, aerial spraying and dusting or smoking can be more effective and cheaper.

-Biological control of insects has been employed with success in some situations; in most instances, the introduction of a parasite to control the insects is required. The greatest success in biological control is usually achieved after the problem has grown to epidemic proportions.

-Mechanical control, either by physically removing and destroying the pests or by eliminating the alternative hosts, can be effective.

4. **Wild animals**: damage to forest plantations by wild animals mainly takes the form of tree browsing or de-barking. In general, the wild animals responsible for damage include rats and mice, pigs, goats, horses and cattle. The principal methods of controlling damage by wild animals involve the use of fences, hedges or ditches, trapping and removal and poison baits.

www.dreamstime.com

5. **Domestic animals**: grazing or browsing by sheep, goats and cattle can be a menace to young plantations. At times, hedges and fences are used to prevent intrusion by domestic animals. Where fencing costs are high, trespass by livestock can be controlled by guards.

Cultural treatments

Cultural operations are required to promote the conditions that are favorable to the survival and subsequent
growth and yield of the trees or shrubs in the plantation.

1. Weed control: controlling weeds is a cultural operation that eliminates or suppresses undesirable vegetation which, if no actions were taken, would impair the growth of the plantation crop. This undesirable vegetation competes with trees and shrubs for light, water, and nutrients; a primary objective of weed control is to promote growth and development of the plantation crop, while keeping the costs of the operation within acceptable limits.

A main factor affecting the intensity and duration of weed control measures is the relationship between the tree or shrub crop and the weeds.

-On some sites, the plantation crop eventually grows through the weeds, dominates the site, and becomes established; on such sites, the function of weed control is to increase crop uniformity and speed up the process of establishment and growth.

-On other sites, the type or density of the weed growth is such that, in the early stage of a forest plantation, it may suppress and kill some or all of the planted trees or shrubs; in such areas, the main purpose of weed
control is to reduce mortality and maintain an adequate stocking of trees or shrubs.

Weed control methods either suppress or eliminate the competing vegetation.

- **Weed suppression** consists of physically beating down, crushing, or cutting the weeds back at or above ground level. Animals can graze on the weeds too.
- **Weed elimination** can be achieved by killing the weeds, destroying the whole plant either by cultivation or by the use of chemicals. Weed elimination may be total or partial.

2. Thinning: thinning of forest plantations, particularly those established for wood production, may be required to obtain the desired spacing between the trees. In general, this spacing is a compromise between a "wide" spacing to reduce planting costs and inter-tree competition in times of drought, and a "close" spacing to attain early canopy closure, the suppression of weeds, the reduction of weed control costs and natural pruning of branches through shading.

3 Irrigation : often, forest plantations need periodic irrigation during the first growing season to obtain a satisfactory survival rate. Before each watering, the area around the tree should be cleared of weeds, and a shallow basin should be made around the stem of each sapling to collect as much water as possible.

Watering can become an expensive operation, especially on terrain too steep or too rough for the passage of tank vehicles. Pack animals may be required to carry drums of water to the plantation site. Watering can be uneconomic for large forest plantations, particularly when the source of water is a long distance from the plantation, but it may be justified in the case of small plantations.

In some instances, regular weed control during the first growing season, is sufficient to conserve soil moisture for satisfactory survival of the plants, eliminating the need for irrigation.

Discuss the special consideration and care needed by tree crops.

The care and maintenance of tree crops are a bit more involved than other crops due to the size of the individual trees and growing time involved.

You have been requested to assist in the care and maintenance of an orchard of trees in the school compound.
Prepare a schedule of work for this task.
Find and care for trees growing in the school compound.

12.3.2.4. TREE CROPS IN FIJI

c) Discuss the harvesting, post-harvest treatment and uses of products and by-products of fruit trees.

LESSON 1: HARVEST AND POST-HARVEST TREATMENT OF TREE FRUIT

LESSON OUTCOME: At the end of this lesson, the student will discuss;

i) the signs that fruit is ready for harvesting from trees,
ii) harvesting methods used,
iii) post-harvest treatment of fruit.

Fruit trees in Fiji fall into two categories; trees which bear fruit:
i) all year round – like the jackfruit tree and coconut palm
ii) in season – like the breadfruit and mango trees.

Insects lay eggs in the fruit so that the larvae can hatch when the fruit is ripe and have a food supply. Bats, birds, rodents and insects will detect and eat fruit as they ripen.
To minimise loss, farmers pick the fruit when signs of maturity appear.

Signs that fruit are ready for harvest include;

i) change in colour – often from green to yellow, orange or red – pawpaw, citrus and betel nut
ii) the appearance of small drops of latex on the surface – breadfruit
iii) fruit fall off the tree – coconuts and Tahitian chestnut
iv) smell of ripe fruit – jackfruit
v) bats visiting trees at night – most sweet fruit
vi) appearance of swarms of fruit flies – mangoes and sour sop

Many fruit have soft skins and easily bruised flesh so fruit must be harvested with care.
Some farmers simply shake the fruit off the trees onto a tarpaulin.
For the picking of individual or clusters of fruit, the fruit must be held and twisted until the stalk breaks. The picker may hold and harvest fruit with:

i) their hand	ii) a twister fruit picker	iii) a telescoping pole pruner	iv) a fruit-picker basket.
			
www.gardeningknowhow.com	*www.twisterfruit picker.com*	*http://www.leevalley.com*	*www.oregonlive.com*

Design a device for picking fruit from a tree near your school or home.
Discuss the workings of the device with your classmates.

Mature fruit must be harvested and prepared for market carefully to avoid spoilage.

Choose one fruit produced by trees in or near your school.
Discuss the treatment of the fruit under the following headings:
harvesting, in-field packing, transport to packing house, cleaning, sorting, grading, package, storage and sale.

LESSON 2: USE OF THE PRODUCTS AND BY-PRODUCTS of FRUIT TREES

LESSON OUTCOME: At the end of this lesson, the student will discuss the use of the products and by-products and fruit preservation methods.

Caulk -a waterproof filler and sealant, used in building work and repairs.
Latex -a milky fluid found in many plants, that exudes when the plant is cut and coagulates on exposure to the air.

The products and by-products of trees are used for various purposes.
Since there are so many tree species, the **breadfruit tree** will be used as an example.

1) fruit – is eaten either raw, fermented or cooked and is rich in energy, Vitamin C and fibres.
2) seeds – are also eaten raw, fermented or cooked and are rich in protein and Vitamin B.
3) leaves – young leaves are a source of Vitamin C, iron, and calcium.
   -mature leaves are used as platters for food, wrapping food for cooking and as fans.
4) dried male flowers – are lit to repel insects like mosquitoes.
5) sticky white latex – is present in all parts of the tree and is used for glue, caulk and even chewing gum.

6) latex droplets from the surface of fruit – are harvested by honey bees.
7) inner bark, called bast, is made into bark cloth [tapa] and cordage [cords and rope].
8) leaves, bark, latex, sap and roots – are used for traditional cures and medicine.
9) wood – the trunk resists termites and marine worms so is used to construct houses and canoes, surfboards, eating utensils and carvings.

Beams in Samoan *fale*  *http://ntbg.org*	Traditional Samoan fale  *http://ntbg.org*	Canoe from Papua New Guinea  *http://1.bp.blogspot.com*	Burning male flowers  *https://cabiplantwise.files .wordpress.com*
Fish served on leaves  *http://ntbg.org*	Bowl from Yap  *http://ntbg.org*	Tapa from Marquesas Islands  *http://ntbg.org*	Cooked fruit and seeds  *www.imagala.com*

Make a list of all products used in your home which originated from a food producing tree.

Each fruit producing tree has many uses.

Research a totem tree of the locality and discuss its many uses.

LESSON 3: PRESERVATION

LESSON OUTCOME: At the end of this lesson, the student will discuss the preservation of breadfruit.

During the fruiting season of many trees, fruit is available in abundance and are processed.There are many processing methods so the methods used for the **preservation of breadfruit** will be discussed.

Soaking breadfruit

https://www.leaf.tv

1. **Short term storage**: when storing breadfruit for a short period of time, keep it in a cool and dark place until needed.
   If it is to be stored overnight, submerge the whole breadfruit in water.

Sun dried breadfruit

enjoyindianfood.blogspot.com

2**. Long term storage**- breadfruit is preserved by drying, burying, or freezing.

a) **Drying** can done by the sun or in a very slow oven (50°C).

Pre-drying:

i) wash mature breadfruit and cut it into pieces.
ii) peel and core it.

Drying:

i) Slice very thinly, place on racks, and put in the sun to dry.
When well dried, wrap in plastic bags or leaves so as to keep out moisture.

Or iv) Cook breadfruit first and then mash it into a paste.
Dry the paste in the sun and store in airtight containers.

Breadfruit flour

http://globalmana.org

b) Breadfruit flour is made from dried breadfruit, by pounding or by grinding.
Sift and repeat the process until all of the flour is sifted.
Store the flour in an airtight jar.
Breadfruit flour can be used instead of wheat flour in many recipes.

Breadfruit ready for freezing

http://1.bp.blogspot.com

d) Freezing breadfruit also preserves it. Boiled, baked, or roasted breadfruit can be frozen.
Cut the fruit into thin slices, wrap in grease-proof paper, and then package in plastic bags.
It is more convenient for use if frozen in small amounts.
Reheat over steam or use in stews or soups.
Once thawed, it can be fried.

Fermented breadfruit

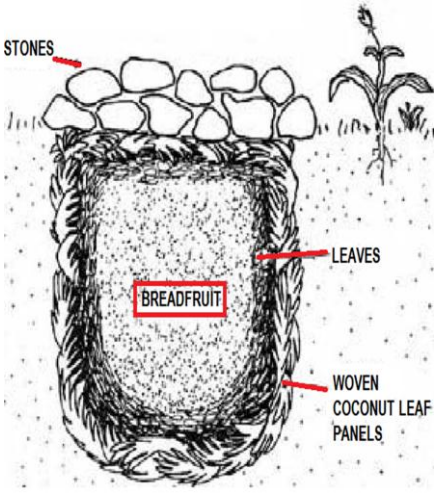
https://www.google.com

c) Burying breadfruit is a preservation method used in some parts of the Pacific.
Fruit are peeled, cored, and cut into small pieces.
A pit is lined with banana leaves or breadfruit leaves and the breadfruit is put inside before being covered with more leaves, old sacks, earth, and a layer of stones.

After two months, the breadfruit is fermented and is ready to eat, although it may be kept this way for a year.

When the breadfruit is dug up, it is put into sacks and rinsed with water until the sour-smelling liquid is removed. Then it is mixed with coconut cream and baked. Mashed bananas may also be added to the mixture before baking.

Breadfruit preservation pit



http://www.agriculturesnetwork.org

Discuss the advantages and disadvantages of preserving fruit.

Breadfruit is preserved to ensure there is food security during the offseason.

Research and try one method of preserving fruit from trees in your locality.

12.3.2.4. TREE CROPS IN FIJI

d) Discuss the harvesting, post-harvest treatment and uses of products and by-products of wood producing trees.

LESSON 1: HARVEST AND POST-HARVEST TREATMENT OF TIMBER TREES

LESSON OUTCOME: At the end of this lesson, the student will discuss:

i) logging
ii) post-harvest treatment of wood

Logging - the cutting, skidding, on-site processing and loading of logs onto trucks for transport to further processing.
Slash - coarse and fine woody debris generated during logging operations.
Timber - trees that are grown in order to produce wood.
Lumber - timber sawed or split into planks, boards, etc.

Foresters choose trees to be harvested based on the age of the tree, the diameter of the trunk and the use that the tree will be put to.

The production of sawn timber or lumber is discussed below.

Felling

http://treebiztreeservices.com.au

Step 1: Logging

(i) **Felling** – where trees are cut.

(ii) **Cleaning** logs of branches and leaves **–**

a) **Limbing** - where the larger branches are removed.
b) **Snedding** - where small shoots and side limbs are cut off trees. - This is sometimes carried out before a tree is felled.
c) **Topping** - where the top of the tree is cut off
d) **Bucking** - where the bottom of the log is cut off. This is sometimes done just before loading the log onto transport.

Limbing

http://www.apolloiec.com

Snedding

http://saveourwoods.co.uk

Topping

data:image/jpeg;base64

Bucking

http://www.forestbusinessnetwork.com

Slash is spread on the ground to facilitate the movement of logging machines and vehicles. It is then collected into heaps to minimise burning hazards and can also be used to produce wood chips or burnt as firewood.

(iii) **Skidding** – moving logs from where they are felled to the landing where they will be loaded for transport.

(iv) **Loading** – the logs are loaded onto trucks using lifting equipment.
(v) **Transporting** – the logs are either transported to the sawmill for the production of sawn timber wood chips, plywood or particle board.

Slash	Skidding	Loading	Transporting
			
http://www.territorialmente.it	*http://www.fototime.com*	*http://barons-court.com*	*https://format-com-cld-res.cloudinary.com*

Step 2: Sawn timber

i) **Log sorting -** on arrival at the mill's storage yard, logs are sorted according to species, diameter, length and end-use.

ii) **Debarking –** the bark is removed to reduce wear on blades and to allow the evaluation of the logs.

iii) **Washing** – logs are washed to remove dirt and debris

iv) **Log sawing or breakdown** – there are three ways in which logs are sawn into lumber of the required shapes: plain sawn, true quarter sawn, quarter and rift sawn.

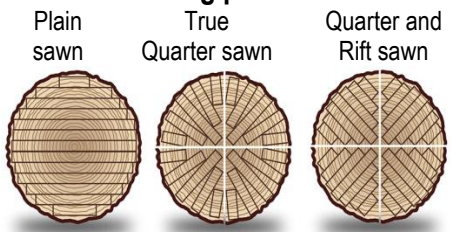
Log Sorting

http://2.bp.blogspot.com

Debarking

http://home.mindspring.com

Sawing patterns



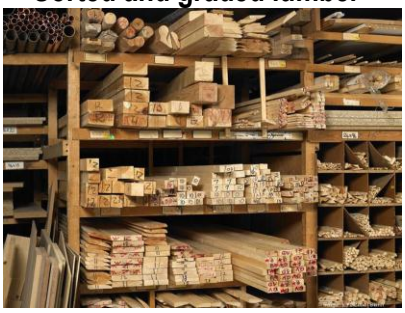
http://www.core77.com

v) **Lumber sorting -** the sawn and trimmed lumber is sorted according to thickness, width, length, quality, grade and species depending on the market requirements

vi) **Grading -** the lumber is further segregated according to the overall quality, direction of grain, presence of knots and defects, as well as general appearance.
Each quality class is designed for a particular end use.

vii) **Seasoning -** lumber is dried to moisture content of between 25 and 30% to reduce shrinkage and warping, improve strength and colour, reduce weight and deter pests.

Sorted and graded lumber

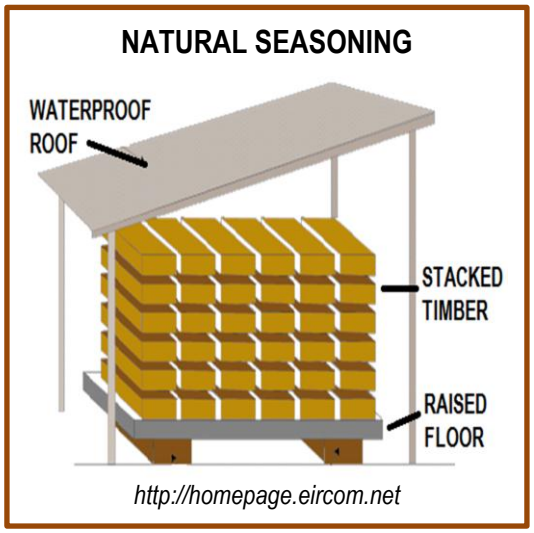


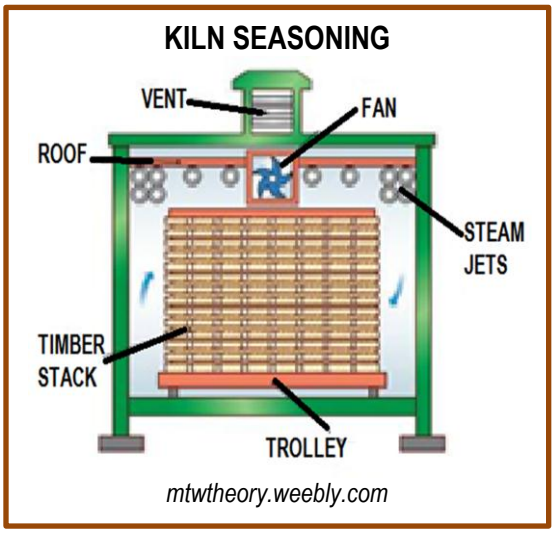
http://www.olx.ph

There are two types of drying used:

a) natural seasoning – also called air drying **-** storing lumber in a clean, dry, warm and shady area by stacking it on raised foundations and separating each level This allows air to blow through the lumber gradually, the wood's moisture content will become level with that of the surrounding area.
This process may take time.

b) kiln seasoning – also called kiln drying **-** the lumber is passed through a specialized oven created within a thermally insulated chamber, that extracts the water vapour from the wood.



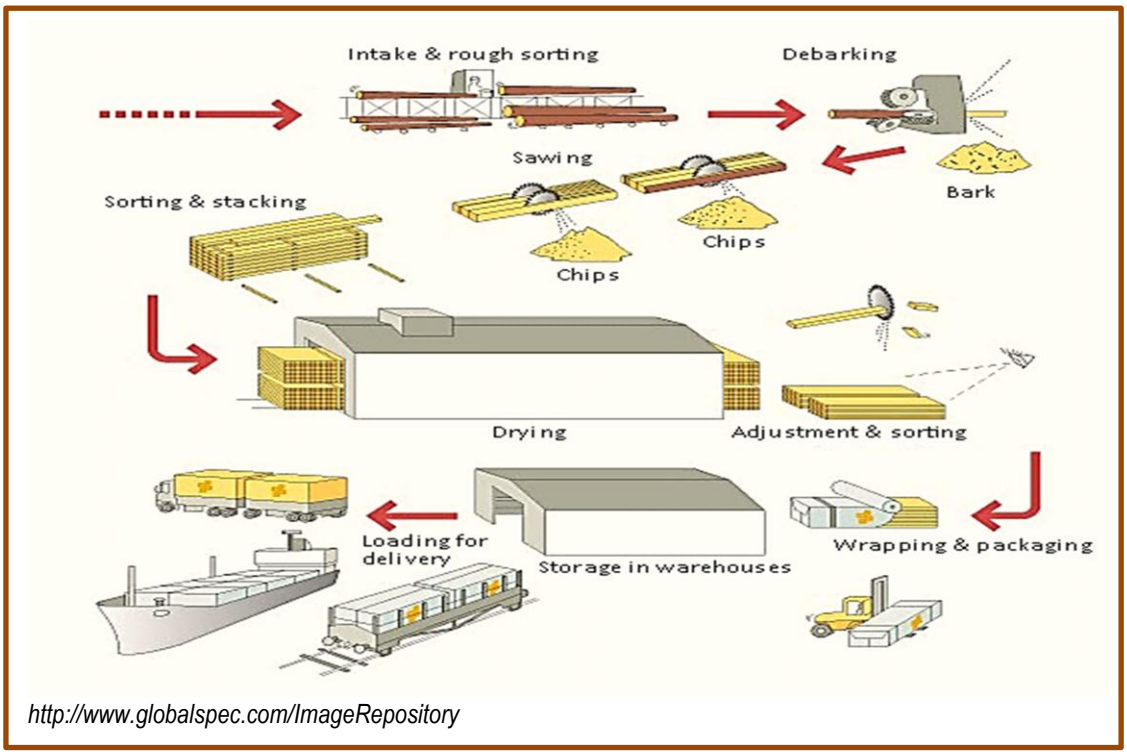


viii) **Preservative treatment**- where the lumber is impregnated with chemicals to reduce attack from insects, fungi and marine borers

ix) **Regrading and surfacing**

Before stacking the lumber for storage, it is normally inspected for any defects which may have resulted during the drying process, such as split-ends and loose knots.
These may be removed by trimming and planing and so upgrading the value of the lumber.

The lumber is now ready for sale and use.



STRAND AS 12.4
LIVESTOCK PRODUCTION

SUB-STRAND 12.4.1
APICULTURE

http://www.addictioncam.com

SUB-STRAND 12.4.2
CATTLE

https://s-media-cache-ak0.pinimg.com

Introduction

This strand will facilitate the exploration of apiculture and cattle farming.

Students will be introduced to general concepts relating to raising honey bees and cattle then will investigate the history, importance, products and by-products of apiculture, dairy cattle and beef cattle.

SUBSTRAND AS 12.4.1 APICULTURE

CONTENT LEARNING OUTCOME

AS 12.4.1.1 Research and elaborate on the history and importance of honey bees.

LESSON 1: OVERVIEW OF APICULTURE

LESSON OUTCOME: At the end of this lesson the student will distinguish between honey bees, wasps and mud daubers and discuss their role in agriculture.

Eusocial - animal species, especially insects, which show an advanced level of social organisation, in which a single female or caste produces the offspring and non- reproductive individuals cooperate in caring for the young.

Melittology - a branch of entomology concerning the scientific study of bees.

Bees, wasps and hornets are all eusocial insects which belong to the Hymenoptera insect classification. They live in well organised colonies with very specific hierarchy and all three help mankind in their own way.

Common name	**Honey bee**	**Wasp [includes hornets]**	**Mud dauber**
Scientific name	Apis mellifera	Vespula species	*Sceliphronc aementarium*
Live in	Nest of wax [hive]	Nest of paper	Nest of mud
No# species	Seven	Hundreds of thousands	Thirty
Feed on	Pollen and nectar	Other insects Lay eggs in the larvae of other insects	Other insects and spiders
Advantage to agriculture	Produces honey, wax and propolis Pollinates crops	Pest control	Pest control
	 *http://evanslab.org.uk/wp-content*	 *http://atomicottercinema.blogspot.com*	 *https://edkingart.wordpress.com*

Discuss the roles that honey bees, hornets and wasps have on a farm.

Honey bees, wasps and mud daubers are insects which have important functions on farms.

Why should you keep calm and use gentle movements if a honey bee, hornet or wasp comes towards you?

LESSON 2: HISTORY OF APICULTURE

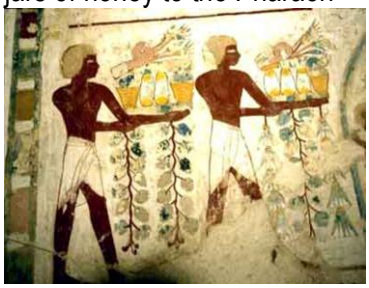
LESSON OUTCOME: At the end of this lesson the student will outline the history of apiculture.

Apiculture	- the maintenance of honey bee colonies, commonly in hives, by humans.
Apiarist	- a person who cares for and raises bees for commercial or agricultural purposes. Also called *beekeeper*.
Apiary	- a collection of hives or colonies of bees kept for their honey
Apiology	- the study of honey bees.
Colony	- a group of honey bees, usually the descendants of one queen, which inhabit the same hive.
Pantothenic acid	- a vitamin of the B complex, found in rice, bran, and many other foods, and essential for the oxidation of fats and carbohydrates.

The word *apiculture* derives from *Apis*, the Latin word for bee. Depictions of humans collecting honey from wild bees date to 15,000 years ago, while 9,000 year old Middle Eastern poetry provides evidence of beekeeping activities. Efforts to domesticate honey bees are shown in 4,500 year old Egyptian art. Simple hives and smoke were used to extract honey from wild hives and honey was stored in jars, some of which are said to have been found in the tombs of Egyptian pharaohs such as Tutankhamun.

It wasn't until the 18th century and the advancement of apiology that bee farming began.

Painting of servants offering jars of honey to the Pharaoh



http://travelswithmyhat.com

Traditional bee hive

http://buzzaboutbees.net

European understanding of the colonies and biology of bees allowed the construction of the moveable comb hive so that honey could be harvested without destroying the entire colony. So began apiculture.

Records of the history of beekeeping in Fiji are scare.

However, according to verbal history, European missionaries probably first introduced honey bees to the Pacific in the mid-19th century, for the production of honey and wax and to pollinate their crops.

There is evidence of bee keeping activities in 1872 while records by Laurier Parham include the importation of queen bees in 1924.

Early attempts to establish national apiculture industries in the South Pacific were largely unsuccessful until the 1970's when projects were initiated in Niue, Papua New Guinea, Samoa and Fiji. The apiculture industry has grown over the last 40 years.

Why did early missionaries introduce bee keeping to Fiji?
Where do you think they got the first colonies of bees?

Honey has been valued by humans for thousands of years.
The results of apiology has resulted in the development of apiairies and production of honey and the by-products of the colony of bees inhabiting a hive.
Although apiculture is well suited to the Pacific, there are disadvantages associated with raising honey bees.

Identify an apiary in or near your school and discuss its history.

LESSON 3: ADVANTAGES AND DISADVANTAGES OF APICULTURE

LESSON OUTCOME:

At the end of this lesson the student will discuss the advantages and disadvantages of apiculture.

Allergy - a damaging immune response by the body to a substance.
Antihistamine - drugs that combat histamine which is released during an allergic reaction by blocking the action of the histamine on body tissue.

The advantages of beekeeping in the Pacific are:

1. relatively low technology requirements
2. beekeeping basics are easy to master
3. low initial costs for set up
4. men, women, elderly and youth can participate
5. provides employment
6. there is opportunity for quick return on investment
7. minimal land requirements
8. environmentally acceptable farming practice
9. promotion of greater viable food crop yield through bee pollination
10. most bee products have a long shelf life

Allergic reaction

http://howtogetridofbeestings.blogspot.com

The disadvantages of beekeeping in the Pacific are:

1. **Allergies** to stings can be fatal - though deaths are rare. Antihistamines can be taken to alleviate allergy symptoms.
2. **Land ownership** may be an issue as bees may become a nuisance. Arrangements can be made with farmers where hives are placed on farms where they provide free pollination, crop sharing or rental fees.
3. Weak hives are often subjected to **"theft"** where other bees raid the hive for honey, often killing the resident bees in the process.
4. Bee **diseases** are a concern as many bee diseases are contagious (none affect humans)
5. **Predation** from wasps, birds and toads which result in weak hives can be addressed by placing hives on stands up to 50 cm above ground level.
6. **Strong winds** can knock over hives and damage the bees' nectar sources, as honey crops may be affected for up to one year after a cyclone.
7. **Infestation and robbing** by mice, ants, hornets, termites and wax moths occur if the hive is weak.
8. **Rotting** of hive parts, especially if made from softwoods, shortens the economic life of the wooden parts of the hive. Local hardwoods may be more resistant but can also double the weight of an empty hive box.
9. **Transport** is always a concern in the Pacific and as beehives, honey and wax weigh a lot, access to effective transport is required if development beyond subsistence level is the focus. Freight is expensive and may mean honey cannot be retailed economically in some island groups.
10. **Swarming** bees become a nuisance when people lose interest in beekeeping and neglect hives.

Hive which has fallen over

http://africanbeekeepingjpg

Cane toad

http://www.rollitup.org

Elaborate on the pros and cons of raising honey bees in Fiji.

Although apiculture is well suited to the Pacific, there are disadvantages associated with raising honey bees.

Discuss how a bee sting should be treated.

CONTENT LEARNING OUTCOME

AS 12.1.1.1 b Identify and compare the breeds and castes of honeybees.

LESSON 1: BREEDS OF HONEY BEES

LESSON OUTCOME: At the end of this lesson, the student will identify and describe the characteristics of four breeds of honey bees.

Temperament	-	disposition of an animal.
Comb	-	a back-to-back arrangement of a series of hexagonal wax cells in a bee hive.
Swarm	-	a group of worker bees and a queen that leave the hive to establish a new colony.

Honey bees, like all other living things, vary among themselves in traits such as temperament, disease resistance, and productivity. The environment has a large effect on differences among bee colonies (for example, plants in different areas yield different honey crops), but the genetic makeup of a colony can also impact the characteristics that define a particular group.

Below are four breeds of domesticated honey bees:

Breeds	Characteristics	Pros	Cons
Italian honey bee  **Apis mellifera ligustica** is a sub-species of the western honey bee (**Apis mellifera**)	• produces good comb • has a large brood & quick growth of the colony • over the winter, the colony requires a lot of food. • this is probably the most common type of honey bee kept by beekeeper	• great beginner bee • gentle • good honey producer	• swarms easily • if pollen scarce, brood rearing decreases dramatically
Carnolian honey bee  Apis mellifera carnica	• originally from Austria and Yugoslavia. • swarms readily • maintains a small winter colony, so requires less food than other types to get through the winter.	• quick buildup extremely gentle • good comb producers • can forage on colder and wetter days	• prone to robbing other hives sometimes drift between hives and can't find their home
Caucasian honey bee  Apis mellifera caucasia is a sub-species of the western honeybee.	• originally from Caucasian Mountains near the Black Sea. • Caucasians are very adaptable to harsh weather, use lots of propolis, and like to rob honey from other hives.	• large, strong population • longer tongue allows them to make use of more nectar sources • forages earlier and on cooler days	• slow spring startup • produces a lot of propolis, • although generally calm, when alarmed they do not calm back down easily
Russian honey bee  Apis mellifera is a hybrid that originated in the Primorsky Krai region of Russia	• in the 1990s, while trying to develop a strain of bees resistant to the Varroa mite, Russians produced this breed.	• natural resistance to Varroa mites • resistant to tracheal mites • quick buildup in spring • winter well in colder climates	• extremely prone to swarming • can be very expensive

Compare the four breeds of bees highlighted in the notes.

Of the many breeds of honey bees, four have been discussed for their temperament, resistance to pests and diseases and ability to produce large quantities of honey.

Identify the breed of bee raised in the apiary near your school and discuss its pros and cons.

LESSON 2: CASTES OF HONEY BEES

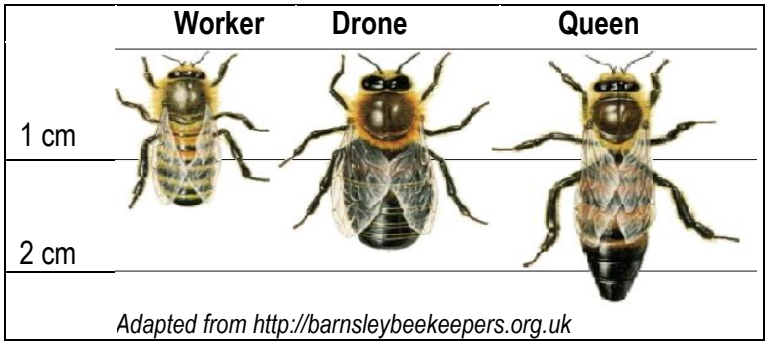
LESSON OUTCOME

At the end of this lesson the student will identify and discuss the different castes of honey bees.

Caste	-	a different form, morphologically or reproductively, within the same sex of a species
Temperament	-	a person's or animal's nature, especially as it permanently affects their behavior.
Undertaking	-	removing corpses of their nest mates from inside the hive
Corbiculum	-	pollen basket
Spermatheca	-	a specialised bag on the queen bee which stores sperm after mating.

Honey bees are social insects that live in colonies which consist of:
i) a single queen ii) hundreds of male drones iii) 20,000 to 80,000 female worker bees
iv) eggs v) larvae v) pupae.

Three castes of bees live in a hive: queen, worker and drone



Adapted from http://barnsleybeekeepers.org.uk

Each of the three castes of bees has a role to play in the bee colony.

Queen


http://www.roysfarm.com

- the reproductive female.
- created by feeding larva only royal jelly throughout its development
- queens are produced in oversized cells and develop in only 16 days
- in addition to the greater size of the queen, she has a functional set of ovaries, and a spermatheca
- queens' stings are not barbed like a worker's sting and queens lack the glands that produce beeswax
- once mated, queens may lay up 1 million eggs; [2,000 eggs per day for 5 to 6 years]
- she produces a variety of pheromones, called the queen substance, which regulates behavior of workers and helps a swarm track the queen's location during the migratory phase

Worker

http://www.pestanators.com

- workers are female bees which are produced from eggs that the queen has fertilized from stored sperm
- workers develop in 21 days
- a typical colony may contain as many as 60,000 worker bees
- workers' duties change with their age:
  - cell cleaning (days 1 & 2) -brood cells must be cleaned before the next use. Cells will be inspected by the queen and if unsatisfactory it will not be used so the worker bee must clean it again and again, until the queen is satisfied
  - nurse bee (days 3–11) -feed the worker larvae worker jelly
  - advanced nurse bees (days 6–11) -feed royal jelly to queen larva while drone larvae receive worker jelly for 1 to 3 days then honey and pollen
  - wax producers (days 12–17) **-**honey bees use wax to build cells, repair old cells and to store nectar and pollen brought in by other workers. Eight paired glands on the underside of the abdomen of the youngest bees produce wax droplets, which harden into flakes when exposed to air and is used by older bees to construct comb in the hive
  - nectar receivers -receive nectar from the foraging bees for storage
  - pollen packers -pollen brought into the hive for feeding the brood is packed firmly into comb cells and mixed with a small amount of honey so that it will not spoil.
  - honey sealing -mature honey, sufficiently dried, is sealed tightly with wax to prevent absorption of moisture from the air
  - cleaners -clean the hive of waste and debris
  - propolizers -the walls of the hive are covered with a thin coating of propolis, a resinous substance obtained from plants in combination with enzymes added by the worker. Propolis has antibacterial and antifungal properties and is used to aid with ventilation and at the entrances of hives.
  - temperature controllers -ensure the hive temperature is maintained at 33^{o} C. When the hive is cold, they cluster around the queen, insulating her from the outside cold. If the hive is too hot, they fan the air within the hive with their wings, keeping the queen and brood from overheating
  - queen's attendant workers -bathe and feed her
  - construction workers -soften the wax flakes in their mouths into a workable construction material for building the comb in which the queen lays eggs and the workers store honey and pollen
  - guards – protect the hive from predators and thieves
  - foragers -collect and carrying water and pollen back to the hive in their corbiculum to feed the entire colony
  - undertakers – carry the dead from the hive
- a worker may develop ovaries and lay eggs that produce drones if the hive is queen-less

Drone

http://typesofbees.info

- males or drones are typically haploid, having only one set of chromosomes. Drones are produced by the queen if she chooses not to fertilize an egg; or by an unfertilized laying worker.
- drones take 24 days to develop and do not have a sting
- drones have large eyes used to locate queens during mating flights
- male honey bees serve only one purpose: fertilize queens from **other** hives about a week after emerging from their cells, the drones are ready to mate. Once they have fulfilled that purpose, they die.

Compare the function of each caste within a bee colony.

Honey bees are social animals which live in colonies.
The inhabitants of each colony are divided into 3 castes; queen, worker and drone. Each hive member has its own role to play in the survival, growth and development of the colony .

The diagram below illustrates the life cycle of a worker bee.

http://www.hyehoney.com

Discuss the life story of a typical worker bee.

CONTENT LEARNING OUTCOME
AS 12.1.1.1 DESCRIBE THE IMPORTANCE OF HONEY BEES.

LESSON 1 ROLE OF HONEY BEES IN AGRICULTURE

LESSON OUTCOME:

At the end of this lesson the student will discuss the role which honey bees play in agriculture.

Sting - a bee's chief weapon; venom is injected through the modified ovipositor resulting in a burning, itching, swollen lesion.

Carbon sinks - anything that absorbs more **carbon** that it releases

Honey bees are known for their stings but they are arguably the most beneficial insect on the planet.

Collecting pollen

http://a57.foxnews.com

1. Bees are pollinators vital to our food chain. It is estimated that one third of the food we eat is pollinated by honey bees.
2. Pollination by bees is important for genetic biodiversity and sustainability. Cross pollination by bees leads to hybrid plants which contribute to positive outcomes such as soil and water retention, local area cooling and carbon sinks.
3. Bees, like other insects, are part of a food chain. They are a source of food for predators including toads, birds, spiders and lizards.
4. The social life of the honey bee colony is studied and compared to the structure of human societies.
5. The limbs and mouthparts of bees have been studies by engineers and concepts used to develop many tools and machines.
6. Honey bees produce honey, pollen, wax and propolis which are harvested for nutritional, craft, manufacturing and medical applications.

Discuss the relationship between honey bees and biodiversity.

Honey bees play a major role in biodiversity, sustainabiity and agricultural production.

Elaborate on the importance of honey bees to Fiji.

CONTENT LEARNING OUTCOME
AS 12.4.1.2 EXPLORE THE MAJOR SYSTEMS IN WHICH HONEY BEES LIVE.

LESSON 1: REQUIREMENTS OF HONEY BEES.
LESSON OUTCOME:
At the end of this lesson the student will discuss the requirements of honey bees.

Clustering - the form in which bees cling together after swarming or during cold weather
Dysentery - a condition in adult bees resulting from an accumulation of faeces.

Honey bees are social insects so surviving and growing the colony takes the effort of every member of the colony. Individual honey bees cannot survive alone.
To survive, honey bees need the following:

WATER
Honey bees drinking water

https://s-media-cache-ak0.pinimg.com

Water is used to dilute honey and to cool the hive during hot weather.
- If water is nearby, bees can spend more time gathering nectar and less time collecting water.
- If necessary, a dripping garden hose or water trough filled with coarse gravel may be placed near the hive as bees will drown in deep open water containers.

CORRECT TEMPERATURE
Fanning the hive entrance

http://d31l02nbp0owa.cloudfront.net

Honey bees work best at a temperature of 33^{O} C so will spend time trying to maintain that temperature in the hive.
- Worker bees do this by fanning when the hive is hot and clustering when the hive is cold.
- Bees cannot fly when the temperature is below12^{O} C
- They rarely work when the temperature is below 14^{O} C or above 38^{O} C.
- On very hot days, honey bees cluster outside un-shaded hives and do not work.
- However, too much shade makes bees irritable.

WINDBREAK

https://vynegardensnt.files.wordpress.com

- Windbreaks provide some protection from cold winter winds.
- Bees eat more stores and are more susceptible to dysentery when located where cold winds hit the hive.
- Strong winds tire and blow honey bees away from their path home.

SUNSHINE
Hive in the morning sun

http://www.honeybeesuite.com

- Field bees orient themselves with the sun and usually fly from mid-morning to mid-afternoon.
- Avoid placing hives on the sides of buildings which are shaded in the morning.
- Orient the hive entrance away from prevailing winds, which can cool the hives.
- Bees like the warming sun on cooler, overcast mornings but require shade on sunny, hot days.
- Place hives where they will get the morning sun but are shaded when the day heats up.

SECURITY

Raised hives

https://cdn.discourse.org

- Toads, birds, lizards and spiders eat honey bees while dogs and goats will eat honey comb and honey.
- The bees will locate the colony in a hive beyond the reach of toads, dogs and goats and will fend off birds, lizards, spiders and ants.

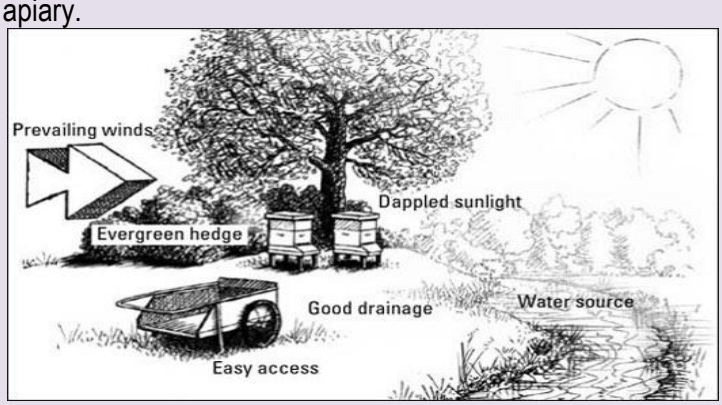
FOOD SOURCE

Honey bee carrying sacs of pollen

http://www.hainaut-terredegouts.be

- Nectar is sucked up through the proboscis, mixed with enzymes in the stomach, and carried back to the hive, where it is stored in wax cells and evaporated into honey.
- Due to the amount of work that bees do and the weight of the pollen they carry, bees try to locate their hives close to various food sources.
- Bees will fly two miles in any direction over level ground for nectar, but honey production increases if nectar is closer.
- Bees within a half mile of wide rivers often drop into the water and drown when returning home tired and loaded with nectar so avoid having food sources across large water ways including rivers.
- Place the hives where the bee flight paths do not interfere with people and animals- do not let the honey bees fly across play grounds and roads.

With reference to the illustration below, describe a suitable place to set up an apiary.



http://media.wiley.com

Honey bees need the following to survive: clean shallow water source; temperature of 33^{O}C; gentle breezes and windbreaks in windy, cold areas; morning sunlight to allow them to navigate; security from predators and a constant food source.

Imagine that you were a queen bee and had to relocate your colony within the school compound.
Discuss the place you would choose.

LESSON 2: IDENTIFY THE MAJOR MODELS OF HONEY BEES HIVES

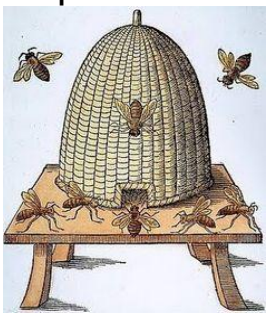
LESSON OUTCOME:

At the end of this lesson the student will discuss some ancient, traditional and modern honey bee hives.

Bee tree - a hollow tree occupied by a colony of bees.
Holy Land - Israel

Honey Bees live in the wild but have also been raised in hives.

1. **Natural hives** – colonies of bees use caves, rock cavities and bee trees as natural nesting sites.
2. **Ancient artificial hives** – the remains of honey bee hives found in the Holy Land are believed to be 3000 years old and are made of straw and unbaked clay.
3. **Traditional artificial hives** – hollow containers like logs, skeps and pots were provided for the bees to build their colonies in and are classified as fixed frame hives. The honey was extracted by squeezing the wax, resulting in the destruction of the comb, which was also a source of wax.
4. **Bee gums** - sections of hollow gum logs, with a wooden 'roof' were set up in 'bee yards' or apiaries until the 20th century.

Natural hives	Remains of ancient artificial hives in Israel	Skep	Bee gums
			
http://static.wixstatic.com	*www.pinterest.com*	*https://s-media-cache-ak0.pinimg.com*	*https://grossmannsbees.files.wordpress.com*

5. **Modern artificial hives** – provide a box with removable lid and base. Some examples are:

a) **<u>Langstroth hive</u> –** supers with four sided frames that support foundation wax are provided. Honey bees build comb on the foundation wax for the storage of honey, pollen, propolis and brood. Frames are removed and taken for the extraction of honey, then replaced, as the combs are seldom destroyed.

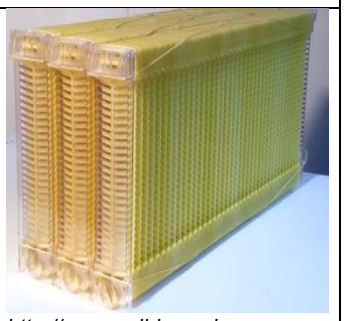
b) **<u>Top bar hive</u>**- bars are places across the top of the supers for the bees to develop their combs. Bars of comb are removed for the extraction of honey, which usually destroys the wax.

d) **<u>Flow Hives</u>** – where the comb is provided for the bees. Once filled with honey, a metal bar is inserted into the frame and twisted, causing the wax walls to realign, allowing the h

e) oney to flow down into collection tubes and out of the hive.

MODERN ARTIFICIAL HIVES

	Langstroth hive	Top bar hive	Flow Hives
Hive			
	http://www.beethinking.com	*http://www.bamboohollow.com*	*http://www.hollywoodtohills.com*

	Langstroth hive	Top bar hive	Flow Hives
Inside hive	 *http://www.keeping-honey-bees.com*	 *http://www.bamboohollow.com*	 *http://beehiveframes.biz*
Support for comb	Frame with foundation wax  *http://www.wildbunchbees.com*	Top bars on an open hive.  *https://honeysunapiary.files.wordpress.com*	 *http://www.solidsmack.com*
Capped honey comb	 *http://www.personal.psu.edu*	 *https://s-media-cache-ak0.pinimg.com*	 *http://www.youtube.com*

Honey bees set up hives in hollow logs. Differentiate between a natural hive and a bee gum.

Honey bee colonies set up hives in the wild. Over time, people have provided various types of hives for the bees so that they can extract honey for their own use.

Differentiate among a Langstroth hive, a top bar hive and a flow hive.

LESSON 3: IDENTIFY THE TOOLS AND EQUIPMENT NEEDED FOR RAISING HONEY BEES.

LESSON OUTCOME:

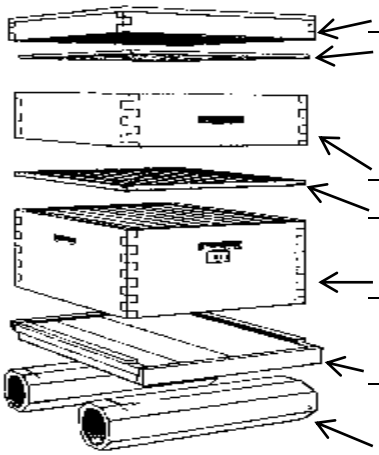
At the end of this lesson the student will identify and discuss the type and use of apiculture equipment.

Bee space - the crawl space, between 6 and 9 mm, that bees create in a natural hive to enable them to pass freely around their nest.

Propolis - bee glue; a reddish brown resinous material collected by bees from tree buds and used to seal unwanted open spaces and crevices in the hive and to varnish honey comb.

The tools and equipment used by apiculturists are aimed at reducing challenges faced when raising bees and extracting honey.

1. **Challenge** – accessibility to honey
   Solution – the modern hive – [the Langstroth hive is being used as the example]

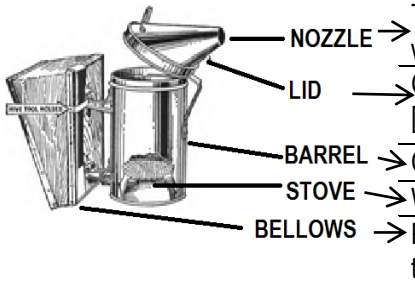
Langstroth hive	Component	Importance
 *https://www.uky.edu*	Hive cover	a waterproof lid preserves the inner cover
	Inner cover	flat piece of wood with an oblong hole in the center for the placement of a bee escape, provides ventilation and to puff smoke through when opening the hive.
	Super	Box of frames for the storage of honey
	Queen excluder	placed above the brood chamber to keep the queen in the brood chamber
	Brood chamber	bee nursery, pantry, kitchen, living room, dining room, bedroom, and workshop.
	Bottom Board	the base of the hive which also provides a landing platform and entrance for the bees
	Hive stand	keeps the hive off the ground so it is less likely to rot, flood, or be invaded by pests.

2. **Challenge** –destruction of comb during extraction of honey
   Solution – the frame which supports the comb.

Frame with foundation	Component	Importance
 *http://1.bp.blogspot.com*	Top bar	For hanging the frame inside the super For lifting out the frame
	Bars Sides & bottom	For supporting the foundation wax and comb
	Foundation	Wax or plastic sheet with hexagonal cells for the development of comb
	Side support staple or Metal wire	Provides added support for foundation wax.

3. **Challenge** – angry bees defending hive
   Solutions – i) working early in the morning when the bees are foraging so fewer bees are in the hive.
   ii) working on calm, warm days when bees are foraging
   [on cold, wet days or in the evening, bees are in the hive and easily get upset]
   iii) applying cool, clean smoke inside the hive to distract the bees as smoke:
   a) causes the bees to think there is a fire nearby so they gorge honey and nectar.
   b) disrupts the pheromone which warns the bees of intruders.

Smoke is produced by a bee smoker.

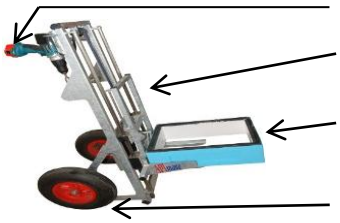
Bee smoker	Importance
	Through which smoke leaves smoker and is directed to where it is needed
	Opens for loading and lighting fuel [Jute bag, cardboard, dry grass/ pine needles/leaves]
	Contains the stove
	Where the fuel is burnt to produce smoke.
	Pumps air into barrel & controls amount of smoke leaving the nozzle

Adapted from *http://www.chestofbooks.com*

4. **Challenge**: weight of hive supers

   Solutions: i) Use of a hive hand truck – which allows two people to carry the boxes

   ii) using hive lifters- which can raise and lower boxes and also transport boxes

Hive hand truck	Hive lifter	Component	Importance
		Handles	To steer hive lifter
		Lifting mechanism	For raising and lowering
		Platform	For placing hives
		Wheels	For moving hives
http://media.wiley.com	*http://www.wilara.lt*		

5. **Challenge:** access to bee supers: the Langstroth hive is placed on a stand and supers containing frames of honey are placed above the brood chamber. A healthy hive may be 3 or more supers high, making access to supers difficult.

   Solutions: i) maintain two super hives

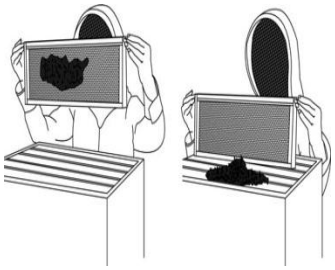
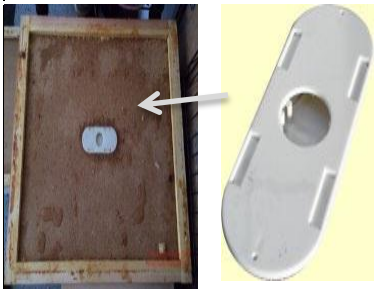
   ii) use specially made ladders to reach top boxes

   iii) use the long hive – a modified Langstroth hive where the components of the hive are arranged horizontally. The box is divided into the brood chamber and supers using queen excluders.

Tall hive [10 supers]	Two super hive	Long hive [open]
		
http://3.bp.blogspot.com	*http://www.thebeeplace.com*	*http://www.beebehavior.com*

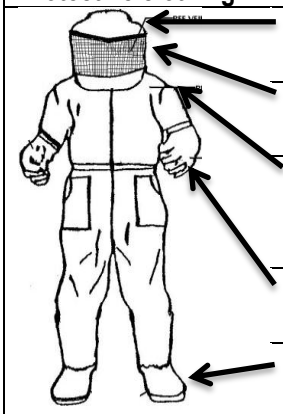
6. **Challenge**: bees on the comb or frames being removed for extraction

Solutions:

i) shaking frames	ii) bee escape board	iii) brush bees into hive
Bees fall into hive	Bees can pass through only one way	Brush gently upwards to minimise injury.
		
http:/www.dummies.com	*http://www.motherearthnews.com*	*http://non-secateur.blogspot.com*

7. **Challenge**: angry bees

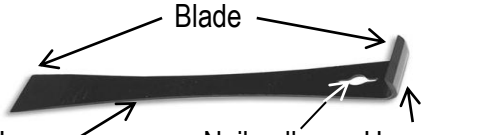
Solutions: i) wearing white or light coloured clothes – bees will be less aggressive,
ii) wearing less shiny jewelry and accessories – as shiny articles attract bees,
ii) wear clean clothing and avoid perfume as bees have a keen sense of smell,
iii) gentle movement – so bees are not alarmed and threatened,
iv) less noise – keep noise from vehicle engines, music, talking etc. low, calm and to a minimum,
v) less disturbance to hives – do not leave a hive open unless working in it,
vi) protective clothing – worn by beekeepers to minimise the effect of stings.

Protective clothing		
	Head gear	Firm and light to protect from sun and rain and hold the veil off the face.
	Veil	Metal or hard plastic mesh to protect the head, face and neck while allowing ventilation and vision
	Coveralls	Thick, zip front overalls which cover the wearers clothing and prevents bees from contact with the body as well as preventing stings from reaching the skin
	Gloves	Thick leather or fabric used to protect the hands and wrist without restricting movement.
	Footwear	Used to protect the feet and ankles.
http://2.bp.blogspot.com		

8. **Challenge**: hive components stuck together with wax, comb and propolis.

Solutions: i) **bee space** – providing a hive which closely resembles the dimensions found in natural hives.

ii) **hive tool** – using tools A hive tool is designed for working in hives and is used to open hives, lever frames out of boxes, hammer wood and nails into place, kill pests, remove burning fuel from bee smokers, remove stingers and scrape off propolis and comb used by bees to seal unwanted gaps in the hive.

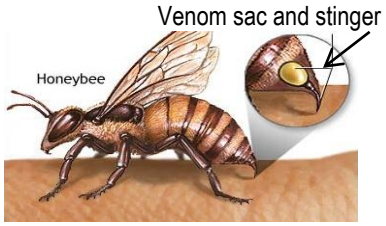
Standard hive tool	**J shaped hive tool**
	
http://media.wiley.com	*http://www.dhgate.com*

9. Challenge: bee sting - when bees sting, the stinger lodges and pumps venom into the skin, causing swelling, pain and redness. As they sting, worker bees release an alarm pheromone which causes other bees to attack and sting the same site.

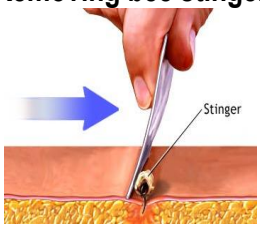
Solutions:

i) remove the stinger as soon as possible and apply smoke to the site to camouflage pheromone.
ii) wash sting site with soap and water to remove the alarm pheromone.
iii) apply ice to the site to slow down the swelling.
If swelling persists, visit a doctor for antihistamine

Bee stinging



Removing bee stinger



http://bee-stings.net/bee_stinger1.jpg

10. Challenge: theft from hives.

Solutions:

i) provide fenced compounds with locked gates
ii) arrange hives on stands which can be locked.

Fenced apiaries	**Hives on locked stand**
	
http://www.hillsidebees.com	*https://upload.wikimedia.org*

11. Challenge: starving colonies

Solution:

Feeding – honey bees store honey for their food supply when food is scarce. A colony may need feeding if too much honey is extracted, there is no pollen and nectar available and the hive is new or is weak due to swarming or disease.
Honey, sugar and water syrup or dry sugar is placed in feeders within hives for bees to eat.

Bee feeder	Component	Importance
	Tank	For feed storage
	Base	Opening for tank [when inverted]
	Feeding platform	Feed is dribbled out of the tank Bees access feed from this platform
http://www.cornishhoney.co.uk		

Feeding often encourages swarming in response to pests like ants and mice; bees drown if the feed is too deep; bees from other colonies are attracted to the feed and rob the hive, often killing the colony members.

12 **Challenge**: space for storage of materials, equipment, records and honey as well as extraction area which is bee safe.

Solution: construct a stand-alone, bee proof structure with adequate storage space, extraction area, loading ramp, road access, water and power source, some distance from the apiary to discourage robbing.

Examine the challenges discussed and analyse the solutions suggested.

As apiculture has developed, materials, equipment, tools and husbandry practices have also developed, mainly to address challenges faced by apiculturists

Observe and practice solutions to challenges that a local apiary uses.

The extraction section of a honey house

https://glaciercountyhoney.files.wordpress.com

CONTENT LEARNING OUTCOME
AS 12.4.1.3 RAISING HONEY BEES IN APIARIES
LESSON 1: SETTING UP
LESSON OUTCOME:

At the end of this lesson the student will discuss how a new hive is established.

Nuc - nucleus

Swarm - a body of honeybees that emigrate from a hive and fly off together, accompanied by a queen, to start a new colony

The following are necessary when establishing an apiary:

1. choose, clear and fence a suitable site to locate the hives.
2. choose and purchase equipment, tools and materials needed for the farm.
3. set up a bee house in which to store records, tools, equipment and materials as well as extract and store honey.
4. construct a hive and frames and place it on a stand in the apiary.
5. secure colonies and introduce them to the hive[s] by one of the following methods:
   a) buy two **established colonies** from a reputable beekeeper which:
      i. are housed in clean supers
      ii. have capped brood [a new queen may need to be installed]
      iii. have calm bees between combs [indicating that a queen is present]
      iv. have no symptoms of disease or damage

Established colony

http://walterswholesomegoods.com

   b) capture a **swarm of honey bees** – locate the swarm and spread a white sheet on the ground below it. Lightly spray a thin mixture of sugar and water on the bees. Place a container like a carton around the swarm and encourage the bees to transfer into the container by shaking or lightly nudging the swarm. If the queen, which is usually in the middle of the swarm, has been moved into the container, the rest of the bees will transfer into the container and stay there. Place the container on the sheet and leave it partially open for ventilation and to encourage straggling bees to enter.

c) buy a **nucleus colony of bees** [nuc] from a reputed supplier- this contains four to five frames of brood, honey and bees, plus an actively laying queen in a nuc box. Transfer the frames (bees and all) from the nucleus box into your own hive.
The box usually goes back to the supplier.

d) established beekeepers may **split a strong colony into two**.
This means introducing a new queen into one of the colonies.

Capturing a swarm	Nucleus colony	Splitting a colony
		
https://sites.google.com	http://nunleybeeempire.com/	http://www.frenchbeefarm.com

Discuss the challenges associated with capturing a swarm of bees.

Once a site for a hive has been set up, a colony must be secured and introduced to the hive.

Discuss and participate in the setting up an apiary.

LESSON 2: HIVE CARE

LESSON OUTCOME: At the end of this lesson the student will discuss the care of an established hive.

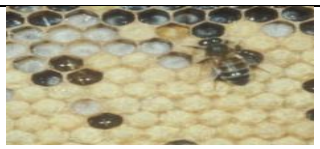
Push mower - a machine without an engine, which has rotating blades for cutting grass
- suitable for apiaries as it is less disturbing to the bees.

Brood - the eggs and larvae of insects.

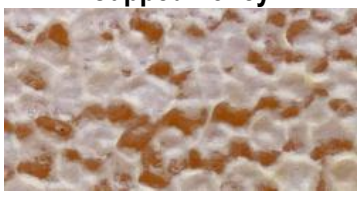
A hive and its surrounding are to be cared for so that bees have an environment conducive to production.

1. **Weed control** – the weeds growing around the hives may harbour pests like mice and toads. Just before daybreak, close the entrance to the hives using rolled up newspaper and use a cane knife or push mower to trim weeds.
   A brush cutter is only used if the apiary is very large or other equipment is not available. Remove part of the newspaper and allow the bees out.

2. **Inspection** – although the hives are inspected at regular intervals, the entrance has to be observed to ensure that the hive is healthy. A busy but calm hive indicates that a strong colony. The beekeeper is looking for evidence of:
   i) **Brood** –
   Queen brood indicates that the hive needs a new queen.
   Viable worker brood of different stages of development indicates that the queen is laying eggs.
   Drone brood indicates that the queen is growing old and needs replacement or that a worker bee has taken the role of the queen, in her absence**.**

Queen brood	Worker brood	Drone brood
		
Cup shaped cells	Flat top cells	Domed topped cells.
http://youtube.com	*http://missapismellifera.com*	*http://www.acbees.org*

ii) **Honey and pollen stores-** the presence of honey in the brood chamber and supers shows that the bees are foraging. Lack of honey may indicate problems like disease, robbing, swarming and queen problems.

Uncapped honey	Capped honey	Pollen
		
https://rebeccainthewoods.files.wordpress.com	*https://basilandbees.files.wordpress.com*	*http://cache4.asset-cache.net*

iii) **Pests** – small pests can enter the hive, damage comb, steal and taint honey and may cause the bees to swarm in search of a new home. The apiculturist may find:

a) mummified pests – the bees cover the pests in propolis, so the dead carcass does not taint the hive.

b) presence of pests – pests may be found in or near the hive

Mummified mouse	Ants in the hive	Toads under hive entrance
		
http://www.propolis.fr	*http://images.sodahead.com*	*https://www.gunsamerica.com*

3. **Maintenance** of the hives and surroundings–
   i. repairing or changing rotten hive components, ii) feeding starving bees,
   ii. mending fences and access roads iv) controlling weeds,

4. **Re-queening**

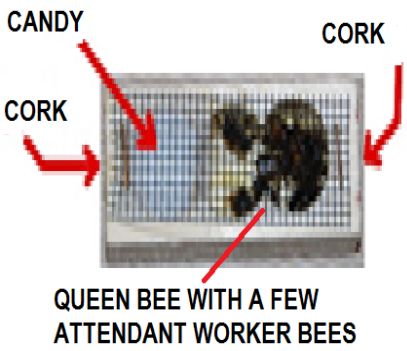
There are three reasons why a hive is re-queened:

i) **old queen –** although a queen can live for 5 years, her laying capacity decreases over time. Most beekeepers change the queen every second year to ensure the hive has a healthy, young and productive queen.

ii) **no queen** – if the queen cannot be seen and there is a lack of eggs and larvae, a new queen needs to be introduced before a worker begins laying drone brood.

iii) **poorly laying queen –** the hive is weak and brood is not consistent, then the queen may be diseases or of poor quality.

Queen cage

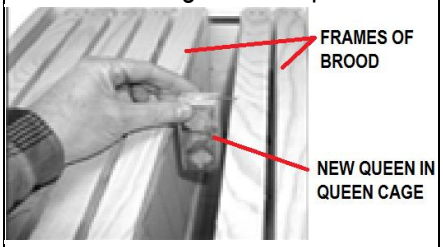


http://www.sustainlife.org

Often the three situations above will manifest as:

- aggressive bees,
- diseases such as chalk brood and stone brood,
- unhygienic behaviour,
- poor productivity,
- formation of new queen cells,
- swarming since a colony headed by a young queen is less likely to swarm.

Introducing the new queen



http://media.wiley.com

Requeening

1. Find and kill the old queen to make sure that the hive is queenless and destroy any queen cells present in the brood chamber – worker bees will kill a new queen if the old queen is still around.
2. Remove the cork plug and place the new queen cage between two frames of brood to allow the nurse bees to get used to the new queen's pheromones before they chew though the candy and release her from the cage.
3. Check the hive after 10 days for signs that the queen has been released from the cage and is laying.


Discuss ways in which honey bees deal with pests


Once set up, honey bees should be left alone. However the hives must be inspected and cared for and the environment kept clean of weeds and pests.


Visit and participate in the care of hives in an apiary.

LESSON 3: DISEASES OF HONEY BEES

LESSON OUTCOME:

At the end of this lesson the student will discuss the main diseases which affect honey bees.


Perforated - having a hole or series of holes


Beekeepers must be vigilant to prevent, identify and control diseases because honey bee brood and adults are attacked by bacteria, viruses, protozoa's, fungi and parasitic mites.

Some of these diseases include:

A. Viral Diseases

1. Sacbrood – a disease caused by the virus *Morator aetatulas.* This disease is commonly seen in poorly managed and stressed bee hives. It is spread within the hive by nurse bees that contract the virus while trying to remove dead brood.

The main symptom is perforated sealed brood, pupa present with undeveloped head and the colour develops from pearly white to pale yellow to brown and eventually to black. When it is in scale form it is brittle and easily removed.

Sacbrood in cell

http://fitzbrown12.wikis.birmingham.k12.mi.us

Re-queen the hive and remove stress factors as strong hives can recover.

B. Fungal Diseases

1. **Stone brood** – a rare disease of brood and adult bees caused by the fungi *Aspergillus flavus*, *Aspergillus fumigatu* and *Aspergillus niger* which are found in soil.
   Ingested spores germinate in the alimentary canal, causing breathing problems. Infected larvae become white and fluffy and die after the cells are capped. Eventually the fungus erupts from the larval remains and forms a false 'skin' which turns first yellow and then green as the bee's body becomes covered with powdery fruiting fungal spores. At first stone brood has a similar look to chalk brood. However, after death stone brood infected larvae become hard and difficult to crush (hence the name 'stone brood'). In contrast chalk brood mummies can be crumbled easily using your fingers. Spores are spread by bees and on equipment. There is no control so infected hives are burnt. Keep frames off the soil.

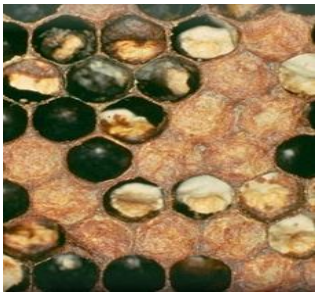
Stone brood

http://fitzbrown12.wikis.birmingham.k12.mi.us

   The Aspergilles fungus can also infect other animal species such as birds, and cause breathing problems for humans.

2. **Chalkbrood** - a disease of 3 to 4 day old brood caused by the fungus *Ascosphaera apis.* This disease, though not present in Fiji apiaries, is serious in New Zealand.
   The infected larvae die when the cell is capped, turn a chalky white color and rattle when the comb is shaken.
   Chalkbrood is most frequent during damp conditions.
   Colonies usually recover but it is recommended that infected hives be burnt.

Chalkbrood



http://www.cornwallhoney.co.uk

3. **Nosema** – a disease of adult bees caused by a fungus called *Nosema apis* which is ingested by adult bees during wet and cold weather. It thrives in hives with poor ventilation.
   In spring, infected colonies build up very slowly or not at all.
   Bees appear weak and may crawl around the front of the hive, have increased girth of the abdomen, missing sting reflex and wet yellowish dysentery.
   Treat Nosema by feeding the drug Fumidil® B in sugar syrup.
   Do not feed the medication immediately before or during a nectar flow.

Nosema symptom
Dysentery on hive

https://www.google.com

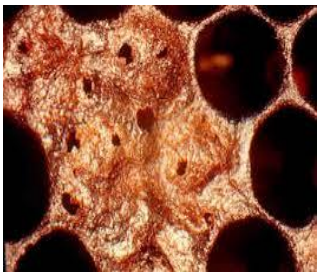
C. Bacterial Diseases

1. **American Foulbrood** - (AFB) is a disease of young larvae and pupae caused by the bacterium *Paenibacillus larvae.* It is rapidly spread through spores carried by adult bees and on contaminated equipment. Infected larvae emit a foul smell, change color from a healthy pearly white to dark brown and die after they are capped. Cappings of dead brood sink inward and are often perforated.

   Check for AFB by thrusting a small stick or toothpick into the dead brood, mixing it then withdrawing the mass. Dead larvae are stringy.

   Colonies with AFB must be burned.

American foulbrood



http://articles.extension.org

To control AFB, destroy any infected hives and bees, sterilise equipment, do not mix frames and supers and feed colonies the antibiotic Terramycin® according to label instructions.

2. **European Foulbrood** - (EFB) is a disease of larvae caused by the bacteria *Melissococcus pluton*, which is not believed to be in Fiji. Unlike with AFB, larvae infected with EFB die before they are capped.
   Infected larvae are twisted in the bottoms of their cells, change to a creamy color which gradually turns rubbery and have a smooth "melted" appearance. Because EFB bacteria do not form persistent spores, this disease is not as dangerous as AFB. Colonies with EFB will sometimes recover after a good nectar flow begins.
   To prevent EFB, treat colonies with Terramycin® as described above.

European foulbrood

http://teca.fao.org

Differentiate among the 4 diseases of honey bee brood mentioned above.

Honey bee larva are susceptable to diseases caused by fungi, virus and bacteria. Beekeepers must be able to identify the disease and intervene if the bees cannot overcome the infestation.

Visit an apiary and discuss disease problems which it has had in the past. Inspect and treat the hives for diseases.

LESSON 3: PESTS OF HONEY BEES

LESSON OUTCOME:

At the end of this lesson the student will discuss the main pests of apiaries

Honey is very attractive to a wide range of animals, including humans.

Some pests are attracted to honey:

1. **robber bees** – bees from other hives often raid weaker hives and steal honey. The solution is to ensure that all hives are strong and healthy.
2. **ants** – enter and taint the hive as well as steal honey. The solution is to paint kerosene around the foot of the hive stand to repel the ants.
3. **mice** – enter the hive and destroy comb as well as taint and build nests inside the hive. Ensure that the entrance is small enough for the bees to guard, place rodenticide near the hive to poison rats and keep the apiary clear of weeds which mice can use as cover.

Attack by robber bees

www.youtube.com

Some pests are attracted to honey, wax and pollen

1. **Wax moths** – come in two main types
   i. **Grater wax moth** –
      Galleria mellonella – which is pale brown to grey, 20mm long with grey wings. Lays pinkish white eggs in clusters in hive
   ii. **Lesser wax moth** –
      Achroia grisella – which is silver grey to yellow, slender 13 mm long. Lays solitary eggs in the hive.

These notorious pests enter the hives at night and lay eggs near wax combs The larvae hatch and begin burrowing through the combs to eat honey, pollen, beeswax and debris in the cells. Moth larvae ruin combs and plaster them with webbing and faeces.

Honey bees are usually very good at protecting their colonies from moth larvae. If moth damage is found in a colony, there was some other problem (usually queen loss) that weakened the colony first.
Clean the hives and destroy all eggs and burn infected comb. Moth damage is most common in stored supers of comb
Protect stored supers by stacking them no higher than five hive bodies. Tape shut all cracks; put Paradichlorobenzene crystals at the top of the stack then cover the stack with a lid. Replenish the crystals as they evaporate.
Do not place Paradichlorobenzene crystals inside the hives as it kills bees too.

Wax moth		
Adult	Eggs and larva	Damage caused by wax moth
Greater wax moth  *http://bugguide.net*	 *http://ucanr.edu*	 *http://agriculture.vic.gov.au*
Lesser wax moth  *https://upload.wikimedia.org*		

Some pests are attracted to bees:

2. **Tracheal Mites** – *Acarapis woodi* are microscopic mites that enter the tracheae (breathing tubes) of young bees. Inside the tracheae, mites block air exchange and pierce the walls of the tubes to suck blood. Symptoms resemble those of Nosema. Bees become weak, crawl at the hive entrance and sometimes uncouple their wings so that all four wings are visible. Colony death rates are highest during winter. Infested colonies are treated with Miticur® or special formulations of menthol.

Tracheal mite

http://www.delange.org

3. **Varroa Mites** -
Varroa destuctor mites are about the size of a pin head and are copper in color. Female mites cling to adult bees and suck their blood. Females then enter a bee brood cell and
produce several offspring which, in turn, suck the blood of the developing bee. Infested colonies almost always die within three to four years unless they are treated.
Colonies are treated with Apistan®, a formulation of fluvalinate.

Varroa mite on bee larva

http://www.beekeepingadvice.co.uk

4. **Toads, lizards and birds –**
usually wait outside the hive and eat bees at the entrance.
Keep the bees out of reach of the pests so raise hives about knee height off the soil.
Keep the apiary free of weeds so there are less hiding places for these pests.
Fence the apiary or hives with chicken mesh and remove toads from the area.

Some pests are curious

1. **Cattle, goats, horses, pigs –** are either attracted to the smell of honey, use the hives to scratch against or are just plain curious. They knock over the hives especially if stung, causing the bees to swarm. These pests will sometimes return to the abandoned hive and eat the comb.

2. **Children –** play games which anger the bees and will often end in stings and unnecessary stress for the bees. Education, fences and experience helps.


Describe the effect that each of the pests of bees cause to an apiary.


Pests are attracted to bees to eat honey, wax, pollen and bees or out of curiosity. To minimise the effect of the pests, beekeepers must identify the pests, decide if the colony needs assistance in its control and implement methods to control the pests and prevent future infections.


Visit an apiary and discuss pest problems which it has had in the past. Inspect and treat the hives for pests.

CONTENT LEARNING OUTCOME
AS 12.4.1.4 DESCRIBE THE HARVESTING, POST HARVEST TREATMENT AND USE OF THE PRODUCTS AND BY-PRODUCTS OF APICULTURE

LESSON 1: EXTRACTING HONEY
LESSON OUTCOME:
At the end of this lesson the student will discuss when honey is ready for harvesting.


Curing honey - reducing the moisture content of nectar from 80% to 18% or less to produce honey.


Honey is cured nectar and is made by worker bees.

According to *http://www.beemaid.com/how-is-honey-made* 7/3/2016 ,

"Worker honeybees visit thousands of flowers, and collect nectar from them, storing it inside their bodies in a special "honey stomach". While inside the bee, the nectar mixes with a number of proteins and enzymes produced by the bees, starting the honey-making process. When the worker honeybees return to the hive, they transfer the nectar into the beeswax comb, and repeat the process until the combs are full. The bees then fan the air around the stored nectar with their wings, drying the moisture out of it and preparing it for long-term storage: during this process the nectar thickens and eventually transforms into what we recognize as honey. When this is done, the bees cap the honeycomb with wax and move on to the next empty combs, beginning all over again."

Honey is harvested from hives which are strong.
Harvesting from weak hives results in starvation of the colony members.

Honey can be harvested from the honey suppers if:

1. **combs are capped** – this honey has been cured and stored by the bees for future use, so is ready for extraction.

2. **uncapped honey is cured** – turn the frame so that the uncapped cells of honey are facing the ground and tap gently.
   Cured honey will not leak out and can be harvested, although this is not advisable. If the content of the cell leaks out, it is nectar that hasn't been cured. The water content is too high for it to be considered honey. Attempting to bottle this nectar results in watery syrup that is likely to ferment and spoil.

Worker bees curing nectar	Frame of capped honey
	
http://www.alexanderwild.com	*http://www.saveourbees.com.au*

Harvesting honey from capped combs

1. Open the Hive The first step in the honey harvest process is to open the beehive. Beekeepers use smokers around the entrance of the beehive to subdue the bees. The beekeeper then removes the top of the hive and smokes the bees down to the lower end of the hive. This results in fewer bees on the frames of honey.	 *http://www.coxshoney.com*
2. Choose capped frames and remove bees Each frame in the honey super is inspected and frames of capped honey are brushed clean of bees and placed in an empty super. Uncapped honey and frames from the brood chamber are left untouched.	 *http://www.coxshoney.com*
2. Uncap the Honeycomb The super of selected frames are taken to the honey house for extraction of honey. The honeycomb is uncapped using a sharp knife or an electric knife. The wax is stored separately. The honey is removed usually by squeezing the wax and the wax is rendered.	 *http://mainebeekeepers.org*

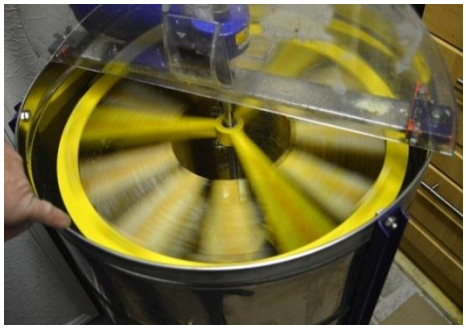
3. Extract the Honey from the Honeycomb

The uncapped frames of honeycomb are placed in baskets in an extractor. Using centrifugal force, the frames are spun, removing the honey from the combs and throwing it against the walls of the extractor, where it runs down and collects at the bottom of the extractor. The frame baskets are turned and then spun again so all honey is removed.

Placing uncapped frames in extractor baskets

http://3.bp.blogspot.com

Spinning baskets extracting honey



http://2.bp.blogspot.com

5. Filter honey

Most extractors have a spigot at the bottom for draining honey. The honey is strained in order to remove any debris, such as wax, bee parts, etc.

http://2.bp.blogspot.com

6. Stand extracted honey

Leave the honey in a closed container for around 12 hours to expel air bubbles before bottling.

Bubbles on surface of standing honey

https://morningsidehoney.files.wordpress.com

7. Bottle honey

Honey is filled into sterilized containers which are closed, labeled and packed ready for use or sale.

Bottling honey

http://2.bp.blogspot.com

Bottles of honey

http://mindbodyandsoleonline.com

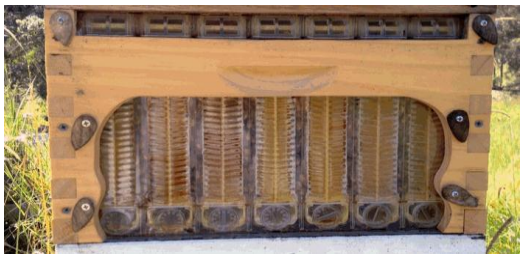
8. Return the frames to the hives

The frames are returned to the honey supers from which they were taken.

Harvesting honey from flow hives

1. Determine which frames are ready for extraction

The beekeeper views that frames through a glass window to determine which frames are ready for extraction. [N.B. frames are not removed from hives]



http://big.assets.huffingtonpost.com

2. Attach the tube

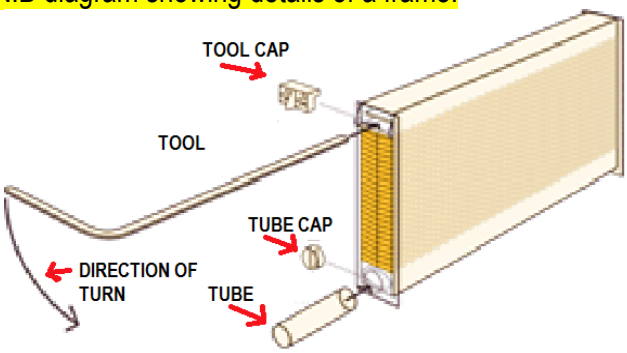
Remove the tube cap from the flow frame and insert one end of the tube with the other end placed in the collection container.

http://s1.dmcdn.net/JGcjQ/1280x720-Zi6.jpg

3. Insert the tool

Remove the tool cap from the flow frame which is inside the hive. Insert the tool into the slot.

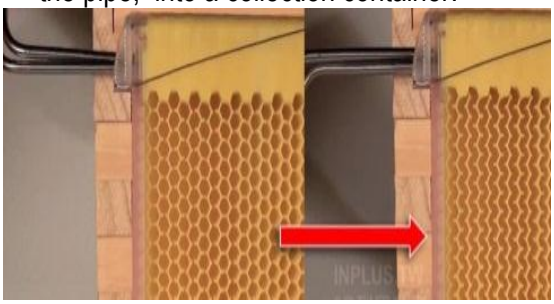
N.B diagram showing details of a frame.



https://3dprint.com

4. The flow frame is adjusted to release honey

The tool is turned 90 degrees, causing the comb to realign and allowing the honey to flow down the centre of the comb and out the pipe, into a collection container.



https://3dprint.com

5. The honey is collected

The collected honey can now be taken for settling to remove the air bubbles and for bottling too.

http://www.thisiscolossal.com

6. The flow frame is readjusted

The tool is turned back so that the comb is returned to its original shape.
The bees can now uncap the combs and begin to refill it with honey.

Compare harvesting honey from a conventional frame and a flow frame.

Honey bees collect nectar from flowers; add proteins and enzymes; place it in the cells of combs then dehydrate it so it matures into honey. Once the honey is mature, it is capped and can be extracted.
The method of extraction used depends on the type of frame.

Visit an apiary and discuss the honey extraction method used by the beekeeper. Take part in the extraction of honey.

LESSON 4: PRODUCTS AND BY-PRODUCTS OF APICULTURE

LESSON OUTCOME:

At the end of this lesson the student will discuss the uses of the products and by-products of apiculture.

Beekeeping produces many primary products with the main one being honey. The lower the water contents of honey, the higher its quality.

1. **Raw honey** in its natural form:
   i. is a rich source of natural sugars as it contains 80% fructose and glucose.
   ii. can last for a long period of time as honey with a water content of 18% or less will not ferment.
   iii. contains 2% minerals, vitamins, proteins and pollen.
   iv. contains vitamins B6, thiamine, niacin, riboflavin, pantothenic acid
   v. contains the minerals calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium and zinc.
   vi. contains no fat nor cholesterol

Raw honey in comb

http://www.hibeautiful.net

Honey is used for:

i. food and as a food ingredient and preservative
ii. medicine and as a medicine ingredient
iii. improving and preserving the aroma and humidity of tobacco;
iv. cosmetics as a skin treatment, moisturiser,softener; in creams, soaps, shampoos and lipsticks.
v. embalming in ancient civilisations.

2. **Beeswax** is a natural secretion from wax glands on the undersides of the body of honey bees. It is used primarily as a building block for the bees' honeycomb cells in which the young are raised and honey and pollen are stored. To stimulate the production of beeswax, the honey bees eat honey and huddle together to raise the temperature of the cluster.

After honey is extracted, beeswax is collected and cleaned and used for many purposes including:

Beeswax

http://www.swebeeusa.com

i. making candle cosmetics and hygiene items
ii. food processing including coatings on cheese
iii. lubricants on zips, hinges, metal and wood joints
iv. varnishes and polish for granite, metals, leather and wood surfaces
v. preventing metals rusting and tarnishing
vi. coating nails and screws to prevent wood splintering
vii. printing in fabric [batik] and egg art
viii. medicines
ix. art supplies including crayons, modeling wax etc.
x. embalming and many more

3. **Bee pollen** is the male gamete of a flower blossom which is collected by honey bees and mixed with the bees' digestive enzymes. It is low in calories but rich in proteins, amino acids, vitamins, minerals, enzymes, beneficial fatty acids, carbohydrates; high in bioflavonoids which are anti-viral, antibacterial, anti-fungal, anti-inflammatory and antioxidant; helpful in lowering cholesterol as well as stabilising and strengthening capillaries. It is harvested from hives and used in:

Bee pollen

http://purebeeworks.com

i) medicine ii) food supplement iii) hygiene products
iv) cosmetics v) feed supplement

4. **Propolis** is a resinous mixture that honey bees have made by combining sap from trees and flowers with saliva and beeswax. They use propolis to:
   i) reinforce the structural stability of the hive;
   ii) reduce vibration;
   iii) make the hive more defensible by sealing alternative entrances and cracks;
   iv) prevent diseases and parasites from entering the hive
   v) inhibit fungal and bacterial growth;
   vi) prevent putrefaction within the hive. Bees usually carry waste out of and away from the hive. However, if a small lizard or mouse, for example, finds its way into the hive and dies there, bees may be unable to carry it out through the hive entrance. In that case, they would attempt instead to seal the carcass in propolis, essentially mummifying it and making it odorless and harmless.

Propolis

http://www.stupinabuciuman.ro

Propolis is harvested from the hive and used for:
i) food like propolis chewing gum ii) car wax iii) varnish for the strings of musical instruments
iv) local anesthetics v) cosmetics vi) medicine kills bacteria, virus, fungi and yeast

5. **Royal jelly** is a milky-white viscous substance which worker bees produce by mixing honey and bee pollen with enzymes in the glands of their throats. They secrete royal jelly from the pharyngeal glands and feed it to all larvae during their first few days. However, it is continually fed to larvae selected to be queens. Royal jelly contains high concentration of vitamins B5, B6, and amino acids and is believed to be a potent antioxidant.
   Royal jelly is harvested from the hive and used for**:**
   i) medicines ii) cosmetics iii) energy tonics iv) food supplements

Royal jelly

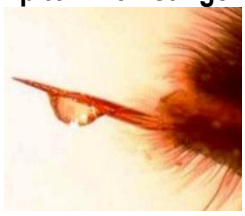
http://static1.squarespace.com

6. **Pollination services** – where colonies of bees from beekeepers are hired by farmers for the purpose of pollinating their crops.

7. **Hive stock** – the raising of queens and nuclear colonies for sale.

8. **Apitoxin** is the bitter colourless honey bee venom, which causes local inflammation and acts as an anticoagulant.
   Honey bees produce this venom when they sting, as a form of defense. This venom can be collected and injected to treat rheumatoid arthritis, neuralgia [nerve pain], multiple sclerosis [MS], desensitising against bee stings, tendonitis [swollen tendons], and muscle conditions such as fibromyosis [inflammation] and enthesitis [inflammation of the sites where tendons or ligaments insert into the bone].

Apitoxin on stinger



http://keepingbee.org

List the products and by-products of apiculture and discuss the uses for each.

Apiculture produces raw honey, beeswax, bee pollen, propolis, royal jelly, apitoxin and hive stock. It also provides pollination services for farms.

Discuss the products and by-products produced by the apiary you have visited and discuss why other by-products and services are not being provided.

SUB- STRAND AS 12.4.2 CATTLE

Content Learning Outcome:

The student will explore, discuss, practice and evaluate livestock concepts and relate them to practices in Fiji.

AS 12.4.2.1: Students will research and elaborate on the history and importance of cattle.

LESSON 1: INTRODUCTION:

LESSON OUTCOME:

At the end of this lesson, the student will discuss the origins of domesticated cattle.

Bovidae - the family of wild and domesticated mammals including 140 species including antelopes, cattle, gazelles, goats and sheep

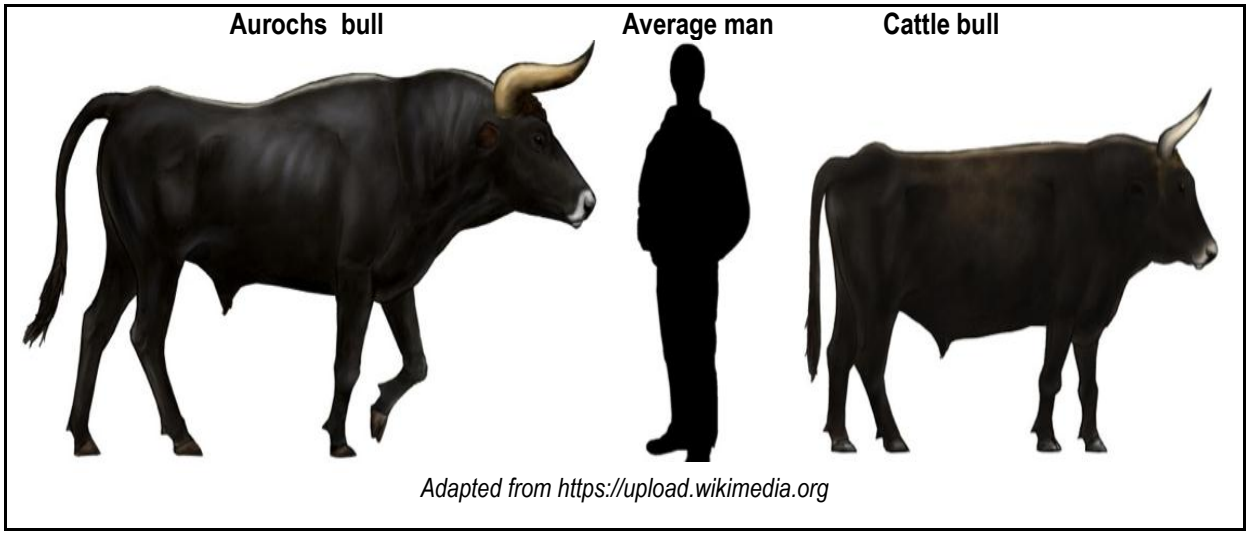
Draft animal - domesticated animal used in drawing heavy loads

Cattle are members if the Bovidae family and are descendants of the aurochs, *Bos primigenius*, a wild ox which lived in Europe, Asia and North Africa.

Neolithic farmers began to herd wild aurochs10, 500 years ago for easy access to milk and meat. The dung was used as fuel and building material while the hide, bones and sinew was used for clothing, buildings and tools. These animals were very strong so were used as draft animals which pulled ploughs, carts and carriages.

The remains of domesticated cattle dating to 6,500 B.C. have been found in Turkey and other sites in the Near East.

The selection and breeding of animals which were docile and produced quality beef, veal or milk resulted in the modern domesticated cow.
Aurochs survived in Europe until the last recorded aurochs died in the Jaktorów Forest, Poland in 1627.



Adapted from https://upload.wikimedia.org

It is estimated that there are 1.5 billion cattle in 2016 with 264 million dairy cattle producing 600 million tons of milk each year.

LESSON 2: HISTORY OF CATTLE IN FIJI

LESSON OUTCOME:

At the end of this lesson, the student will investigate and outline the history of cattle in Fiji.

Skim milk - milk from which cream has been removed

Cattle are not endemic to Fiji.
They are believed to have been introduced to the country by indentured Indian labourers.

Pre- Commercial cattle rearing in Fiji

The first indentured Indian labourers who arrived in Fiji the late 1870's to work on the sugar plantations could not find a source of milk.
They are believed to have imported the first cattle during the late 19th and early 20th centuries for the provision of milk and leather as well as to pull their ploughs, sleds and carts.
These animals also provided dung for fuel and building material.
Cattle are also of religious significance to the Hindus.

Commercial cattle rearing in Fiji

The cattle industry grew out of small holder farms with farmers producing milk for the family while selling the excess milk and animals.

Twenty soldiers returning from World War One [1914 to 1918] were rewarded with 20 head of shorthorn cattle and land to farm in Tailevu. As there were no roads and electricity, these farmers hand milked the cows and separated the milk. In 1920, the skim milk was fed to pigs while the cream was churned into butter in a factory located in Korovou, Tailevu.
In the 1930's butter was being exported to Canada and England.

The Rewa Co-operative Dairy Company Limited was established in Waila, Nausori in 1924 and relocated to Nabua in 1958. The installation of sterilising facilities in 1978 saw the bottling and sale of liquid milk.
The excess cattle were sold or slaughtered for beef.

The Government of Fiji has assisted the development of the dairy and beef sectors by:

- setting up cattle research units at the Koronivia and Nacocolevu Research Stations
- importing improved breeders and semen to upgrade herds
- subsidising farm inputs including fencing materials and medications
- providing free testing and culling services for major diseases
- providing extension services which advise and train farmers in husbandry skills
- developing abattoirs and meat inspection for quality beef production

Discuss the development of the cattle industry from pre-commercial to commercial production in Fiji.

Cattle are not endemic to Fiji but were introduced by indentured Indian labourers. They were raised for milk, meat, draft and religious purposes. The beef and dairy industries have developed, with the help of Government research, into successful commercial sectors of agriculture in Fiji.

Explain why cattle are raised throughout Fiji.

AS 12.4.2.2 Explore the major systems and enterprises in which cattle live.
a) Students will identify and compare the breeds and castes of cattle in Fiji.

LESSON 1: BREEDS OF DAIRY CATTLE IN FIJI

LESSON OUTCOME:

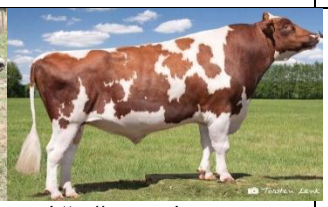
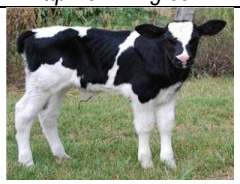
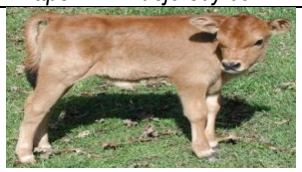
At the end of this lesson, the student will investigate and discuss the breeds of **dairy** cattle raised in Fiji.

Over 800 breeds of cattle are recognized worldwide, some of which adapted to the local climate, others which were bred by humans for specialised uses. All cattle breeds produce milk, meat and hide but some breeds have been bred because of the quantity and quality of a certain product.

Cattle breeds which produce high quality and quantity milk are termed dairy breeds of which there are approximately 400 in the world.

Cattle have an average life span of 15 years but most dairy cattle have a productive life of less than 10 years.

A cow will produce large amounts of milk over her lifetime. Certain breeds produce more milk than others; however, different breeds produce within a range of around 6,800 to 17,000 kg of milk per lactation.

Breed	**Holstein Friesian**	**Ayrshire**	**Jersey**
Origin	Netherlands	Scotland	England
Characteristics	- usually black and white - docile and heat resistant - large animal with good quality meat	- usually red and white - alert vigorous animal showing strong character - hardy and smaller animal	- fawn with black or white switch - aggressive bulls - hardy - smallest animal
Milk quantity	12, 700 litres per lactation Highest of any breed	8,500 litres per lactation	7,260 litres per lactation
Milk quality	High	High	High
Milk butterfat content	3.6%	3.9%	4.9%
Milk protein content	3.2%	3.3%	3.7%
Bull	 *http://lic.co.nz*	 *http://m.accelgen.com*	 *http://m.accelgen.com*
Cow	 *http://3.imimg.com*	 *http://www.usayrshire.com*	 *https://www.usjersey.com*
Calf	 *https://www.rightpet.com*	 *https://thedairymaid.files.wordpress.com*	 *http://www.missouridairygoats.com*

If you were requested by your family to develop a dairy cattle herd, explain which breed you would raise.

There are over 800 distinct breeds of cattle in the world with each breed raised for its meat, milk and hide. Of the many breeds which have been introduced to upgrade the productivity of the Fiji herds three are discussed above.

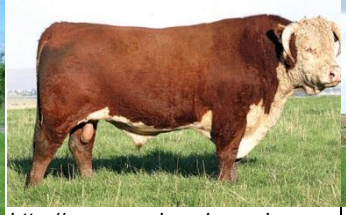
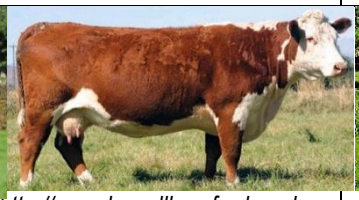
Discuss why farmers favour dairy cattle which produce quality meat as well as milk.

LESSON 2: BREEDS OF BEEF CATTLE IN FIJI

LESSON OUTCOME:

At the end of this lesson, the student will investigate and discuss the breeds of **beef** cattle raised in Fiji.

Breeds which produce high quality and quantity meat are termed beef breeds of which there are approximately 250 in the world.
Three of the many breeds introduced to Fiji are discussed below.

Breed	**Limousine**	**Hereford**	**Brahman**
Origin	Limousin, France	Herefordshire, England	Bred from Indian Zebu cattle
Characteristics	Golden red or black Hardy Docile Naturally horned	Red with white face, socks, underbelly, and switch Docile Naturally horned	Grey Hardy and heat tolerant Naturally horned Reacts to the way it is treated
Birth weight	Low	Low	Low
Feed conversion efficiency	High	High	Very high
Dress weight	High	High	Medium
Meat quality	Lean and tender	Lean	Lean
Cross breeding	With Angus, Hereford and Shorthorn		Used to improve European breeds
Bull	 *http://www.roscommonmart.ie*	 *http://www.mackenzieranch.com*	 *http://www.studstock.net*
Cow	 *http://3.bp.blogspot.com*	 *http://www.harrellherefordranch.com*	 *http://www.ansi.okstate.edu*
Bull calf	 *http://www.pedigreelimousincattle.co.uk*	 *http://www.motherearthnews.com*	 *http://tritonfarms.com*

If you were requested by your family to develop a beef herd, explain which breed you would raise.

Of the many breeds which have been introduced to upgrade the productivity of the cattle herds in Fiji three are discussed above.

Discuss why it is an advantage to raise beef breeds which produce calves with low birth weights?

b) Students will identify the major systems in which cattle are raised and describe how the systems provide the basic requirements of cattle.

LESSON 1: BASIC REQUIREMENTS AND SYSTEMS OF PRODUCTION

LESSON OUTCOME: At the end of this lesson the student will identify the basic systems in which cattle are raised and describe how each system provides the basic requirements of these livestock.

Cattle will produce quality products when managed well as they require the following:

Basic requirements of cattle

Space - pollution, disease and pest free
Shelter - protection form wind, rain and sunlight
Security - safe both day and night
Temperature - minimise fluctuations
Light - for feeding and security of calves
Water - clean and readily available
Feed - nutritious, fresh and readily available

Cattle raised in sheds

http://www.ciwf.org.uk

Cattle are social animals which thrive when raised in groups.
There are four distinct systems under which cattle are raised in Fiji.

	Extensive	Semi-intensive	Intensive	Tethered
Area of farm	Largest [browsing or foraging]	Medium sized	Smallest	Small
Animals/ unit area	Low	More	Most	Lowest ≤10 animals/farm
Labour	Farmer or family members	Farmer and family members or few labourers	Farm manager and hired skilled labourers	Farm family members
Inputs used	Minimal From the farm	Medium From farm and bought	Maximum Latest recommended Mainly bought	Animals moved to feed Medications Water
Housing	Minimal or absent Classes seldom separated	Sheds for night and unsuitable weather Classes kept separated	Animals kept indoors High standard housing Kept in sheds Classes separated	Tethered in pasture during day and in safety at night
Capital invested	Low	More	Most	Low
Environment	Minimal pollution All wastes naturally recycled	More pollution Wastes recycled	Most pollution Wastes recycled	More pollution Wastes recycled on farm

Management level	Lowest	Higher	Highest	High individual animal care provided
Records kept	Few	More	Detailed	Seldom
Use of produce	Home use and occasional scales	Sales	Sales	Home use and sale
Number of farms in Fiji	Many	Many	Few	Most
Location of farms	Remote and outer islands	Areas were land is not limited	Areas where land is limited	Throughout Fiji
Tenure system	Freehold, Crown & Native land	Freehold Native land	Freehold Native land	Freehold, Crown & Native land

Discuss the importance of each basic requirement of cattle.

To produce to their potential, cattle require water, lights, shade/shelter, food, temperature control, security and pollution/disease/pest free space.
Cattle can be kept in extensive, semi-intensive, intensive or tethered production systems depending on the number of animals, intended use of the animals and the availability of land.

Differentiate among the four management systems used to raise livestock in Fiji.

AS 12.4.2.3. Research and discuss the solutions suggested to deal with challenges facing the rearing of cattle in Fiji.

a) Students will explore and discuss the challenges facing the cattle industry in Fiji and suggest possible solutions.

LESSON 1: CHALLENGES & SUGGESTED SOLUTIONS.

LESSON OUTCOME: At the end of this lesson the student will discuss the challenges facing cattle farming in Fiji and evaluate suggested solutions to each challenge.

Acclimatisation – to adjust or adapt to a new climate, place, or situation.

Predators – an animal that lives by killing and eating other animals

Cattle farmers are faced with many challenges each of which is dealt with by farmers. Below are some of these challenges:

	Challenge	Solutions
1	Land -tenure, area topography	Government has set up beef farming schemes Intensive farming may be considered
2	Acclimatisation	Cross breeds which adapt to and produce well in local climatic conditions
3	Feed -quality and cost	Use local feed ingredients which will lower production costs and increase efficiency [planted pasture, legumes, molasses, coconut meal, mill mix]
4	Water	Have reliable water supply at all times
5	Security	Secure sheds, locked and safe for calves; fences for cows and bulls
6	Adverse weather	Practice semi-intensive and intensive farming during the hot and wet season
7	Competition from imports	Improve milk production per cow and beef carcasses quality to satisfy the consumers
8	Disease, predators, pests	Minimising visitors, frequent health checks, fencing out pests, drenching

Discuss in groups how a farmer can solve the challenges of high feed cost and poor cattle growth rates.

Farmers face many challenges when raising cattle.
Each challenge is dealt with by the farmers and successful methods are adopted as solutions.

Discuss the challenges facing cattle farming in Fiji and recommend possible solutions.

b) Students will explore and explain methods used to grow and sustain cattle in Fiji.

LESSON 1: HOUSING CATTLE

LESSON OUTCOME: At the end of this lesson, the student will discuss calf housing.

Pen - an enclosure for confining livestock
Drench - administer a drug in liquid form orally to an animal

Cattle are seldom housed in Fiji except for calves weaned from dairy cattle.
Calf housing should be:

i) warm
ii) dry
iii) well ventilated
iv) shaded form sun and rain
v) protected from wind draft
vi) secure from predators and thieves
vii) have access to water and feed
viii) cleaned daily

Calf housing is usually divided into pens so that calves can be kept separate especially if they are of different ages or are sick. Calf pens may accommodate only one animal or a number of animals of the same age.

One-calf pens	Pen for many calves
	
http://www.gea.com	*http://www.hoards.com*

Explain why cattle other than dairy calves are seldom housed in Fiji.

Dairy calves are the class of cattle which is usually housed in Fiji.

Discuss the advantages and disadvantages of housing calves in one calf pens and in pens for many calves.

LESSON 2: NUTRITIONAL NEEDS

LESSON OUTCOME:

At the end of this lesson the student will discuss the nutritional needs of cattle.

Pasture	-	plants, usually a combination of grass and legumes, grown for the feeding of grazing animals.
Concentrate feed	-	a feed used with another to improve the nutritive value
Fibre	-	**or roughage** is the indigestible portion of food derived from plants.

Cattle need a balanced diet to thrive. The types and amount of feed given to an individual animal depends on the age, type and intended purpose of the animal.
The main component of cattle diet is pasture made up of grass and legumes.
However, concentrate feeds and mineral licks are also provided for certain classes of cattle.
Cattle require five major classes of feeds: water, energy, protein, vitamins and minerals.
Being ruminants, cattle ferment cud so are able to utilise roughage with high fibre content.
They produce protein as well as Vitamins B and K in the rumen.

Water

All cattle need large quantities of fresh, clean water.
Farmers usually provide a stream for day time drinking and bathing and water troughs in night paddocks and milking parlours.

Cattle drinking from a stream

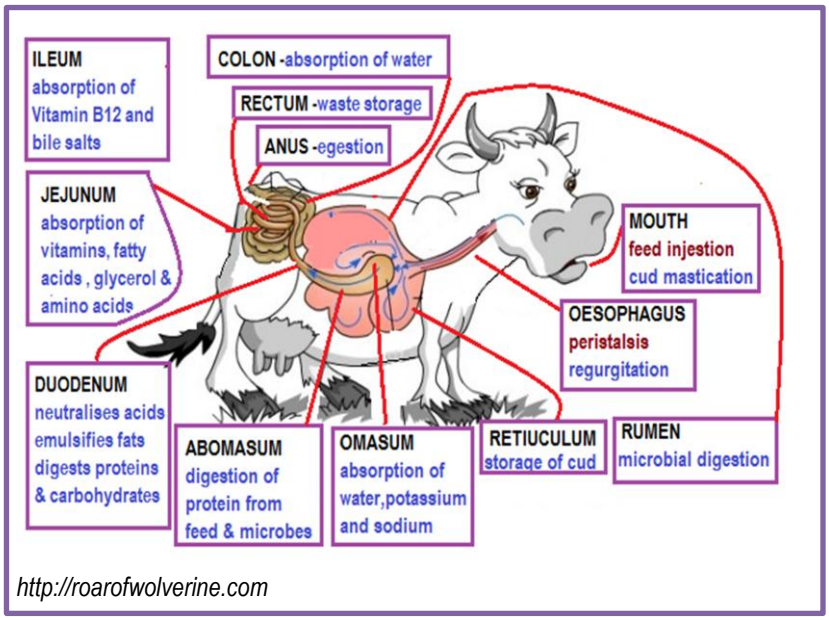
http://hobbyfarms.com.s3-us-west-2.amazonaws.com

Energy

Energy is not considered a nutrient but can be derived from the breakdown of several nutrients, including fat, protein and carbohydrates. It is usually expressed as % Total Digestible Nutrients (%TDN).
Energy is the nutrient required by cattle in the greatest amount. The primary sources of energy for cattle are cellulose and hemicellulose from roughage as well as starch from grains.
Fats and oils have high energy content but usually make up only a small part of the diet.
An energy shortage will result in weight loss, low productivity, reproductive failure, increased mortality, increased susceptibility to diseases and parasites and the ultimate death of an animal.

Protein

Protein is one of the main building blocks of the body. It is usually measured as % Crude Protein (%CP).
It is a major component of muscles, the nervous system and connective tissue.
Protein is composed of chains of amino acids.
Adequate dietary protein is essential for maintenance, growth, lactation and reproduction. Protein is composed of several fractions which vary in their solubility in the rumen.



http://roarofwolverine.com

Rumen soluble protein is digested by microbes in the rumen.
Rumen insoluble protein passes intact through the rumen to the lower digestive tract. A portion of this bypass (or escape) protein is digested in the small intestine.
The major sources of protein are legumes, fresh pasture and concentrates.
A protein shortage will result in slow repair of old and injured tissues, poor skin and fur, reduced milk and meat production and poor body condition.

Vitamins
Vitamins are biological compounds which are active in extremely small amounts.
Vitamins of concern in beef cattle nutrition include Vitamin A, Vitamin D and Vitamin E. They are usually reported in International Units (IU's). Fresh forage is a good source of Vitamins A, D and E.

Vitamin A is essential for normal growth, reproduction and maintenance. Insufficient Vitamin A is associated with lowered fertility in both bulls and cows.

Vitamin D is required for proper development of bone. Vitamin D deficiency in calves results in bowing of the leg bones (rickets). In older animals bones become weak and easily fracture.

Vitamin E, along with selenium, are required for proper development of muscle tissue. Lack of Vitamin E and/or selenium causes nutritional muscular dystrophy, commonly called white muscle disease. It is most common in young calves. Prevention of white muscle disease may be achieved by injecting calves with Vitamin E/selenium at birth, injecting pregnant cows with Vitamin E/selenium, or feeding cows supplementary Vitamin E and selenium.

The level of **B vitamins** in cattle diets is not usually of concern, although some special situations exist. The rumen microbes manufacture large amounts of these vitamins, which are then available for absorption by the animal. The B vitamins are of importance in the young calf which has not yet developed a functional rumen. Cattle which have been severely stressed have a depleted rumen microbe population and may benefit from supplemental B vitamins.

Minerals
Various minerals are required for growth, bone formation, reproduction and many other body functions.
Those that are required in fairly large amounts are called macro-minerals. They include sodium (salt), calcium, phosphorous, magnesium and potassium.
Those that are required in very small amounts (micro or trace minerals) include iodine, copper, zinc, sulphur and selenium.
Mineral content is affected by the type and quality of the feedstuff. Adding supplementary minerals to the ration is usually required to ensure that the proper amounts of these elements are available to the animal.
Problems caused by deficiencies of some minerals are shown in the table.

Mineral	Deficiency Symptoms
Calcium	• poor growth • bowed leg bones • brittle bones
Phosphorous	• poor growth • craving for wood, hair, soil • poor conception rates
Magnesium	• muscle tremors • staggering, convulsions (grass tetany)
Sodium (salt)	• poor growth • chewing or licking of wood
Selenium	• weakness, inability to stand

Feedstuff

Cattle can utilize a wide variety of feedstuff. Feeds are classified into groups based on their nutrient content and physical form.

Most common feeds can be placed in one of the following groups:

1. **Forage crops** - examples are grasses and legumes grown in pasture
   - High in protein, vitamins and minerals but low in fibre if young and fresh
   - Makes up the bulk of cattle diet
2. **Roughage** - examples are mature grass, sugarcane leaves, crop residues, grain hulls
   - high in fibre (cellulose and hemicellulose) and usually low to intermediate in energy
   - protein content varies widely, depending on the plant species and stage of maturity
3. **Grains** - examples are corn, barley and oats.
   - high in energy and relatively low in fibre
   - most have a moderate protein content
4. **Oilseeds** - examples are soybeans, canola meal, coconut meal and cake
   - high in protein, usually high in energy
   - variable fibre content
5. **Byproducts** -examples are distillers grains, pollards and brans
   - variable nutrient content
   - may contain a high level of moisture
   -

Para grass *Urochloa mutica*

http://weeds.brisbane.qld.gov.au

Coconut meal

http://img.21food.com

Copra cake

http://www.coconut-oil.net

Summarise the nutrient requirements of cattle.

Cattle need water, energy, protein, vitamins, minerals and fibre in their daily diet. The requirements of the different classes of animals differ due to their growth and physiological stage

Explain the importance of a bull's rumen in relation to his nutrition.

LESSON 3: REPLACEMENT BREEDERS

LESSON OUTCOME

At the end of this lesson, the student will discuss the criteria used for the selection of replacement stock.

Heifer - a young cow before she has had her first calf
Cow - the mature female of cattle
Calve - give birth to a calf

Breeders are the animals raised on livestock farms to produce young.
The farmer will have animals of different ages on the farm and will replace breeders which are:

1. bulls related by blood to the heifers
2. uncontrollable/ aggressive
3. under preforming
4. wrong breed
5. old
6. injured
7. infertile
8. diseased

When choosing calves for breeding stock, the dam and sire must also be examined and their records cited. The parents [sire and dam] of replacement calves should:

- ✓ share the same gender-specific physical characteristics
- ✓ calve unassisted (if a calf required assistance during birth, it should automatically be excluded from your cattle breeding program).
- ✓ perform well in a production strategy similar to your own (i.e. grass-based pasture rotation)
- ✓ have a history of producing calves that perform well in similar production conditions to your own.

Bull, calf and cow

http://tcpermaculture.com

All replacement animals should:

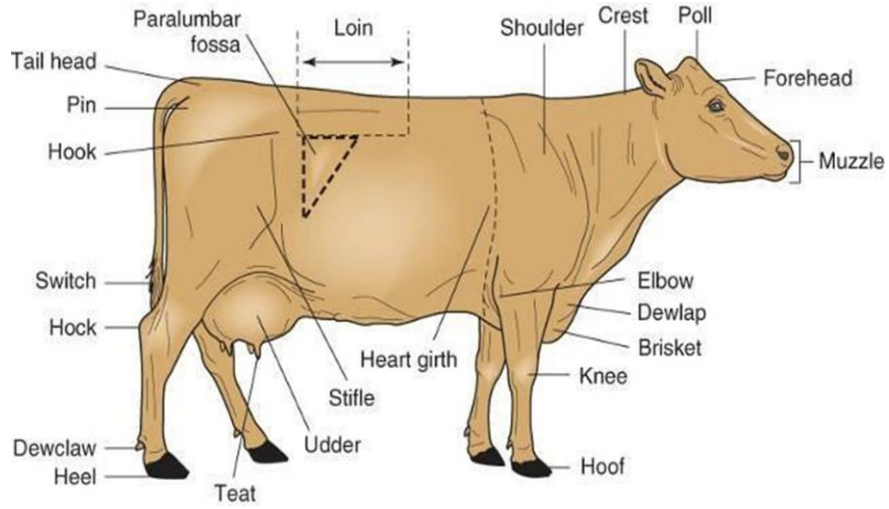
- ✓ Have functioning body parts – e.g. eyes, ears, legs, tail, mouth
- ✓ Big gut for foraging capacity
- ✓ Big mouth for maximum grazing intake per mouthful and maximum competitiveness within the grazing herd.
- ✓ Big nostrils and wide muzzle for easy breathing
- ✓ Proportioned, balanced build
- ✓ Calm temperament - not wild-eyed, skittish, or flighty
- ✓ Shiny hair which indicates healthy secretion of oils that help resist parasites and good health
- ✓ Inquisitive
- ✓ Be disease and injury free.

Always keep your cow's role in mind when picking cows and heifers for your cattle breeding herd.

Cows and Heifers appearance:

- ✓ Wide, calf-bearing hips
- ✓ Well-formed udder and teats for good milk production
- ✓ Feminine appearance as this shows the production of oestrogen

PARTS OF A COW



http://tcpermaculture.com

Bulls and bull calves: Always keep your bull's role in the herd in mind when picking bulls and bull calves for your cattle breeding herd.

Bull and bull calf appearance:

- ✓ Wide, strong shoulders, heavy, short neck, coarse head, and a muscular rump to provide power during competitive battles with other rivals during the cattle breeding season
- ✓ Be slightly front-heavy (within reason) for battle with other bulls
- ✓ Masculine appearance.
- ✓ Scrotum that is well-formed, equally-sized and balanced
- ✓ No enlarged teats - enlarged teats on a bull are a sign of a hormone imbalance
- ✓ Good, obvious muscle definition - lack of muscle definition is a sign of low testosterone and consequently lower beef cattle fertility.
- ✓ Coarser, curlier, darker hair around the head, neck and lower part of his body

Discuss what you would look for when selecting a replacement heifer for a dairy farm

Bulls are important members of cattle farms because they contribute 50% of the genetic material of offspring. Replacement bulls are often bought.
Cows produce young and milk. Farmers often choose replacement heifers from young born on the farm. Selection criteria are important for the informed choice of future replacement stock

You are tasked to buy a bull calf for a beef farm.
Discuss what you would look for when selecting the animal.

LESSON 4: PRODUCTION OF CALVES

LESSON OUTCOME:

At the end of this lesson, the student will discuss the production of calves on cattle farms.

Calving - act of giving birth to a calf
Dystocia - delayed or difficult parturition.

The calves produced on cattle farms ensure that there is milk and stock to either grow out or sell. The average reproduction cycle of a cow is:

Age of sexual maturity	Age for 1st Breeding	Length Of Oestrus Cycle	Length Of Oestrus [standing heat]	Ovulation occurs	Gestation
9 months	18 months	21 days	12 to 18 hours	12 to 18 hours after end of standing heat	283 days

Once heat is detected in the female breeder, she is taken for mating.

There are four main systems of mating:

Pasture Mating	**Hand Mating**	**Pen Mating**	**Artificial Insemination**
Bulls run with cows and heifers	Bulls are kept in special enclosures away from the cows and heifers. A female on heat is introduced to bull's enclosure.	Bulls are kept separately. Bulls are introduced to the females which are on heat.	Teaser bulls used to identify females on heat Females are inseminated.
Heifers mate when not fully developed.	Heifers mate when fully developed.	Heifers mate when fully developed.	Heifers mate when fully developed.
No control over sires of calves	Matching of breeding pairs possible	Matching of breeding pairs possible	Matching of breeding pairs possible
Bulls waste time establishing right to mate. Many females may be mated but some unsuccessfully.	Female breeders on heat are introduced to the bull's enclosure one at a time. Limited number of females may be mated in one day.	Bulls introduced to batches of females on heat overnight then separated in the morning.	Female breeders on heat identified and inseminated with semen from reliable source.
Mating ratio: 1 male to 10 females	Mating ratio: 1 male to 100 or more females.	Mating ratio: 1 male to 20 females	Mating ratio: 1 male to thousands of females
Some female breeders not mated if heat is synchronised. Successful mating ratio lower.	All female breeders mated if heat detected. Higher successful mating ratio.	Some females not mated if heat is synchronised. Successful mating ratio may be lower.	All female breeders are mated if heat detected. Higher successful mating ratio
Calving all year round	Calving can be predicted or synchronised.	Calving can be predicted or synchronised.	Planned calving possible.
Difficult to take care of young stock of different ages.	Management of dams and young easier.	Management of dams and young easier	Management of dams and young easier

Parturition

Calving is divided into three stages:

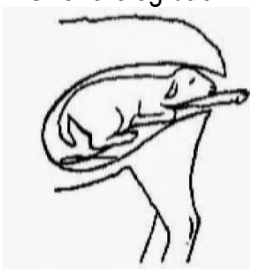
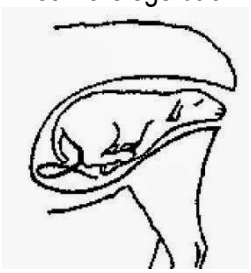
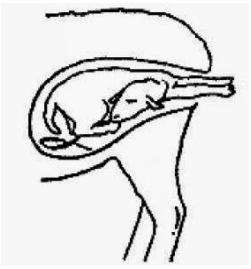
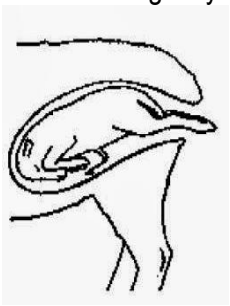
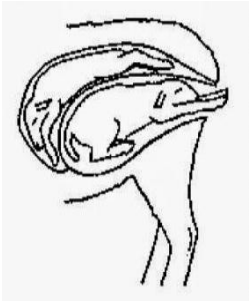
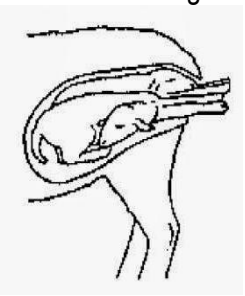
1. **Stage one: dilation of the cervix** – often takes 2 to 6 hours but may take longer.
   The cervix softens and the pelvic ligaments relax in preparation for the delivery of the calf.
   The teats will distends and fill with colostrum. There is a mucus discharge from the vulva.
   The animal may isolate itself, paw the ground and have poor appetite.

2. **Stage 2: Delivery -** the calf passes out the birth canal and usually takes from less than two hours to 4 hours. The calf should present right side up, the front feet first, with legs extended and the head lying between the knees and pasterns in a "diving" position. When the cervix is fully dilated, the calf's front hooves start moving through. This action stimulates the release of a hormone, Oxytocin, by the brain that further stimulates contraction of the uterus. A cycle of dilation and contraction develops that helps the calf on its way out, while the cow contributes by bearing down with her strong abdominal muscles.

Normal posture of calf during calving

http://www.nwvetvt.com

3. **Stage 3: Expulsion of the placenta**; the placenta, which is often referred to as the afterbirth, is expelled from the uterus up to 6 hours after the last calf is delivered.
Dystocia may occur where a vet is needed to assist the calf.
The diagrams below illustrate causes of calf dystocia.

Elbow lock 	One foreleg back 	Both forelegs back 	Head back 
Breech position 	One hind leg only 	Twins front and back 	Twins: four legs 
Adapted from: *http://arlingtonfarm.blogspot.com*			

If the dam is distracted or weak, clean the mucus away from the nose, mouth, and throat of the first issue. Weigh the calf, tag one ear, and dip the navel cord in 7-percent iodine solution to prevent joint ill. Make sure each issue receives its mother's first milk (colostrum) within one to four hours of parturition and that the issue is suckling well within 24 hours.

Single	Twins	Triplets	Quadruples
 http://www.motherearthnews.com	 https://itsallaboutthelifestyle.files.wordpress.com	 http://i.dailymail.co.uk/	 http://www.2.cdn.turner.com

Discuss the production of calves on a the following farms:
1. Farm with two tethered cows,
2. Extensive farm with 10 cows and 1 bull.
3. Semi-intensive farm with 20 cows and 2 bulls.
4. Intensive farm with 100 cows and 1 teaser bull.

Calves are the young of cattle. With calving come animals to sell, milk, replacement calves and beef animals. The farmer will provide facilities and services to ensure optimal conditions for the production of calves on the farm.

Explain why a vet is needed to assist with calf dystocia.

LESSON 5: FEEDING CALVES

LESSON OUTCOME: At the end of this lesson, the student will discuss the feeding of calves.

Colostrum - the first milk produced by dam after each parturition.

Calves born on livestock farms can be used for:

1. replacement animals – farmers may keep calves for breeders.
   These calves are allowed to suckle from the dam or from the foster cow so as to develop strong immune systems and bones and to learn to respond to humans.
2. meat – calves are often slaughtered for veal and sausage meat.
3. sale – many farms sell their excess calves.

Calves reared on the farm are provided with the following:

1. **milk** – calves are born with a limited defence mechanism against disease so are allowed to suckle from the dam until they are at least 3 days old, to obtain colostrum. Beef calves are allowed to suckle from the dam.
   Dairy calves earmarked for replacement stock are run with their dam or a foster cow for regular sucking of milk.
   They are also fed cow's milk or milk substitutes [skim or powdered full cream milk] until they are ready for weaning.
   In cases where the cow is to be milked, the calf is weaned from the dam onto milk replacer at 3 days of age.

Calf sucking from dam	Hand raised calf
	
http://www.farmfile.ie/	http://www.sarpysam.net/

2. **creep feed** - calves begin nibbling at solid feeds soon after birth as creep feed encourages the development of the digestive system. Fresh grass and grain are made available to 1 to 2 week old calves to develop the rumen.
   Prepared feeds in crumble form are also provided for calves to supplement their nutrition. The creep feed should be kept fresh and clean.

3. **water** –calves must be provided access to clean, fresh water which does not dampen the whole living area.

Calf eating pasture	Calf drinking water
	
http://www.jeffcountynews.com	http://s113.photobucket.com

Compare the feeding of calves on a dairy and a beef farm.
Why should calves suckle colostrum from their dam?

The calves born on cattle farms are used for replacement stock, slaughtered for meat or sold. The animals chosen for rearing are provided with milk, creep feed and water before being weaned. Other husbandry techniques are employed depending on the planned use of the animal.

Discuss what farmers use excess dairy calves for.

LESSON 6: IMPROVEMENTS

LESSON OUTCOME: At the end of this lesson, the student will discuss methods used by cattle farmers to assist with the management of their herds.

Freeze branding	-	the process of using a branding iron to freeze a mark on the hide of an animal.
Hot branding	-	the process of using a branding iron to burn a mark on the hide of an animal.
Calfscale	-	a tape used to estimate the weight of a calf.

The following husbandry techniques are used by farmers to improve the production of cattle herds.

A] Identification

The cattle of one breed are often difficult to tell apart. Farmers brand calves so that they can identify the cattle which belong to their farms.

These brands are:

i) registered so that they are legal
ii) unique to each farm
iii) applied to calves

There are two major methods of branding;

i) **Hot branding** - a branding iron is heated by fire or electricity to a light ash colour [not red] and pressed to the skin of the animal. A permanent scar will result.

ii) **Freeze branding** – a branding iron is cooled to between minus 160 to minus 250 degrees Celsius [-160 to – 250^{O}C] using liquid Nitrogen or dry ice and alcohol.
The branding iron, which is made of copper, is then pressed against the skin of a calf where it burns the hair follicles.
The hair either regrows white or does not regrow, leaving a bold spot, both in the shape of the brand.

	Branding iron	Branding	Branded animal hide
Hot branding	 *http://www.bbqfans.com*	 *http://beefambassador.com*	 *http://brandingirons.com*
Freeze branding	 *https://www.enasco.com*	 *http://msucares.com*	 *https://netposse.com/*

Identification methods used for individual animals within a herd also apply to pigs, sheep and goats.

1. List two reasons why farmers need to apply identification methods to each animal within a herd.
2. Differentiate among three identification methods suitable for cattle in Fiji.
3. Discuss the advantages and disadvantages of each method

B] Disbudding and dehorning.

Most cattle naturally have two horns of various shapes and sizes depending on the breed, unless they are polled or the horns have been removed, typically soon after birth.

1. List six functions of horns on an animal.
2. Explain two disadvantages of having horned cattle on a farm.
3. Differentiate between horned and polled cattle.
4. Discuss the difference of disbudding and dehorning:
    a) age of animal
    b) instrument/equipment used
    c) effect on animals

The practice of either disbudding or dehorning is a subject of controversy because some people prefer to leave the animal in its natural state while others have found that leaving the horns on an animal can cause certain problems.

C] Castration – the process by which the testes, epidermis and a portion of each spermatic cord are removed from a male animal.

1. List 4 reasons why farmers castrate cattle.
2. State two reasons why cattle are castrated at a young age
3. Why should only healthy animals be castrated?
4. Why is tetanus antitoxin injected into calves after castration?
5. Discuss castration under the following headings:
    i) description
    ii) age of animal
    iii) instruments used
    iv) advantages and disadvantages

D] Hoof trimming: the nails on the hooves of cattle keep growing. In nature, the nails would get worn and trimmed naturally by the rocks the animals would be walking and climbing on or scratching.

Cattle reared indoors are kept in sheds and graze on pasture grown on soil so the animals' hoof nails are not worn down like in nature.

1. State why farmers trim the nails on the hooves of cattle.
2. Discuss the main condition which results from overgrown hoof nails.
3. Name the tools which are used to trim cattle hoof nails.
4. State two reasons from applying copper sulphate solution to trimmed hooves of cattle.

E] Weaning: calves are taken away from the dam so that they can no longer suckle. This allows the cow to re-join the milking herd. The time of weaning depends on what the animal is being reared for and the decision to re-breed the dam.

Calves of milking dairy cows are weaned off their dams and fed with milk replacer once they are at least 3 weeks old.

Calves of beef cattle are usually allowed to run with the dam and are weaned naturally or when they are 8 months old.

F] Weighing: Weight gain indicates that an animal is growing. If young animals do not increase in weight then the farmer knows that there is a problem, usually related to management.

Farmers weigh the calves at regular intervals. The weights are recorded and growth rates can be calculated.

Sling and spring scale	Cattle scales	Calfscale
 The calf is placed in the sling and hung from the scale.	 The calf stands on the platform which has a scale attached.	 The calftape is tightly wrapped around the coronary band of either front hoof and the birth weight is read off the tape in kilograms.
http://images.prod.meredith.com		http://rublecattleservices.com

Visit a cattle farm near the school and observe the improvement methods practised on the farm. Discuss the advantages and disadvantages of identification, disbudding, hoof trimming, castration, weaning and weighing practised on the farm.

Despite the system used, cattle farmers practise various improvement methods to safeguard their animals, farm structures and workers. Farmers are to carefully weigh the advantages and disadvantages of identification methods, disbudding, castration, hoof trimming, weaning and weighing before performing these operations on the animals of their flock

Differentiate between hot and freeze branding.

d) Students will identify and discuss the major diseases affecting cattle in Fiji

LESSON 1: DISEASES OF CATTLE

LESSON OUTCOME At the end of this lesson, the student will discuss diseases of livestock.

Septicemia	-	invasion of the bloodstream by microorganisms (bacteria, viruses, or fungi) from infection, that is accompanied by acute systemic illness - [**blood poisoning]**
Emaciation	-	the state of being abnormally thin or weak
Anorexia	-	a lack or loss of appetite for food
Intradermal	-	within or between the layers of the skin
Urogenital	-	of or relating to the urinary and genital organs and their functions
Bloat	-	an over distention of the rumen/reticulum with the gases of fermentation
Rumenotomy	-	surgical opening of the rumen through the left upper flank for the purpose of examining the reticulum, rumen or esophageal groove or for emptying the rumen

Being a mammal, cattle share many of the same diseases as sheep, goats and pigs. The following diseases will be discussed due to their prevalence on cattle farms in Fiji.

DISEASES OF CALVES:

Calves suffer from diseases if exposed to predisposing factors which include

i) presence of infectious agents in dam or surroundings;

ii) habitat is cold, wet, drafty, dirty and overcrowded;

iii) calves have not developed immunity due to lack of colostrum.

Healthy calf	Diseased calf
	
http:// www.lifestyleblock.co.nz	http://vetbook.org/wiki

Calf diseases can be prevented and controlled if the predisposing factors are addressed.

1. **Septicemia** – blood poisoning caused by the presence of disease producing organisms or their toxins present in the calf's blood which disseminate and damage the animal's different organs. Infections may occur while the calf is in the uterus or during, at or immediately after birth. The route of infection can be the blood of a sick dam, an infected placenta, the calf's umbilical stump, mouth, nose (inhalation) or wound.

Causal agents: bacteria including *Escherichia coli* and *Salmonella* mainly but viruses and fungi may also cause septicemia.

Symptoms: early signs of septicemia may be subtle but affected calves are usually depressed, weak, and reluctant to stand, and suckles poorly within 5 days of birth. Swollen joints, diarrhea, pneumonia, meningitis, cloudy eyes and/or a large, tender navel may develop.

Treatment: once the causal agent is identified, the vet may prescribe medication but it is usually cheaper to cull infected animals as this disease is contagious and expensive to treat.

Prevention: calves are allowed to suckle colostrum from their dams for at least the first 3 days of life. Housing calves in hygienic individual pens. Feed the calves a balanced diet which includes milk or milk replacer and water.

2. **Diarrhoea-** frequent wet and smelly stools caused by the presence of disease causing pathogens in the animal's digestive tract.

Causal Agents: bacteria, viruses and parasites or a combination of these pathogens cause diarrhoea.

Symptoms: dehydration, listless calves with dirty tail area; weak and isolating itself from other herd members.

Treatment: once the causal agent is identified, the vet may prescribe medication but it is usually cheaper to cull infected animals as this disease is contagious and expensive to treat.

Prevention: calves allowed to suckle colostrum from dam for at least the first 3 days of life. Housing calves in hygienic individual pens. Feed the calves a balanced diet which includes milk or milk replacer and water.

3. **Pneumonia** and other respiratory diseases- infection that inflames the air sacs in one or both lungs
Causal agent: bacterium including *Mannheimia haemolytica* and *Haemophilus somnus* and viruses – including *Infectious Bovine Rhinotracheitis* (IBR), *Bovine Respiratory Syncytial Virus* (RSV) and *Parainfluenza III Virus* (PI3), along with many other bacteria and mycoplasma species and viruses.

Symptoms: calves are dull and depressed with high temperature and raised breathing rate due to lung damage, nasal discharge, coughing and reduced food intake.

Treatment: separation of calves, hygienic sheds, balanced diet, antibiotics, anti-inflammatories or anthelmintics can be prescribed for treatment.

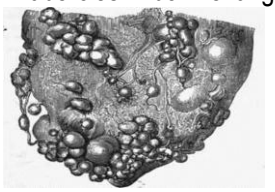
DISEASES OF ADULT CATTLE:

The following diseases pose a threat to cattle farms in Fiji and the human population too.

Healthy cow	Unhealthy cow
	
http://www.thumbs.dreamstime.com	*http://www.nadis.org.uk*

1. **BOVINE TUBERCULOSIS [TB]**
   - a contagious, chronic bacterial disease usually affecting the lungs, but it may spread to other organs. Animals often don't show signs until the infection has reached an advanced stage.

Tubercles in bovine lung



http://chestofbooks.com

Causal agent: a bacterium *Mycobacterium bovis*.

Predisposing factors: presence of the causal agent, the bacterium that causes bovine TB is found in the bodily fluids of infected animals and spreads through airborne particles from the respiratory tract. The bacteria can also spread through feed or watering sites contaminated with saliva and other bodily discharges (urine, manure) or by drinking raw, unpasteurized milk and eating the meat from infected animals. The risk of exposure is greatest in enclosed areas, such as barns with poor ventilation.

Symptoms: In the early stages of TB, clinical signs are not visible. In later stages, clinical signs may include: emaciation, lethargy, weakness, anorexia, low-grade fever, and pneumonia with a chronic, moist cough. Lymph nodes may also be enlarged.

Detection: In live cattle, tuberculosis is usually diagnosed in the field with the tuberculin skin test. In this test, tuberculin is injected intradermally in the caudal fold. A positive test is indicated by a delayed hypersensitivity reaction (swelling). Positive reactors are segregated from the herd, slaughtered and burnt.

On a carcass, Tubercles are found in the lymph nodes, particularly those of the head and thorax. They are also common in the lung, spleen, liver and the surface of body cavities. In disseminated cases, multiple small granulomas may be found in numerous organs.

Treatment: treating the bacterium is expensive and seldom successful so is not feasible in a herd.

Prevention: test and-segregation programs during the early stages of eradication and switch to test-and-slaughter methods in the final stage. Limit visits from other mammals including rats and humans

2. **LEPTOSPIROSIS**- a bacterial disease usually affecting the urogenital tract and kidneys of mammals including cattle, pigs, dogs, rats and humans.

Causal agent: the bacteria *Leptospira hardjo* and Leptospira *pomona* which have an incubation period of 4 to 20 days then circulate in the blood for 7 days, replicating in the liver, kidney, lungs, genital tract and central nervous system. Animals may remain carriers for many months after the initial infection has been treated.

Predisposing factors: presence of the causal agent in moist environments, stagnant water and in the urine, faeces, blood, milk, meat and aborted foetus of infected animals
The bacteria enter the body through the exposed mucus membranes in the mouth, eyes, skin abrasions and gastrointestinal tract.

Symptoms: A sudden drop in milk yield occurs two to seven days after infection of susceptible cows. The udder becomes soft and flabby with colostrum-like secretions or blood-tinged milk in all quarters. Signs may be mild and go undetected but some cows become lethargic and stiff with a fever and reduced appetite. Abortion may occur 3 to 12 weeks following infection with most abortions occurring during the last three months of pregnancy. Infection may also produce premature and weak calves.

Detection: Blood samples are collected from all members of the herd and taken for testing

Treatment: Antibiotic treatment of milk-drop cases is recommended to reduce excretion of leptospires and zoonotic risk. A single intramuscular injection of streptomycin/ dihydrostrepomycin at 25mg/kg will eliminate infection from most cattle.

Prevention – annual testing for reactors which are treated or culled. Isolate new stock in case they are carriers of the pathogen. Prevent visitors and potential carriers from visiting the farm. Protective clothing should be worn when working with cattle.

NB: Leptospirosis also affects humans.

- **Mild Leptospirosis - the patient experiences muscle pains, chills and possibly a headache.**
  90% of cases are of this type.
- **Severe Leptospirosis - can be life-threatening. Organ failure and internal hemorrhaging occurs when the bacterium infects the kidneys, liver and other major organs. Experts are not sure why some patients develop the severe form - people who are already very ill, such as those with pneumonia, children under five and elderly individuals are more likely to suffer from severe Leptospirosis.**

3. **BRUCELLOSIS** - a bacterial disease which infects the whole body, particularly the reticuloendothelial system which include the cells which remove impurities.
   This disease chiefly affects domestic animals, such as cattle, sheep, goats, and dogs and people too.
   Causal agent: This disease is caused by bacteria:

   i) cattle – *Brucella abortus* ii) pigs – *B. suis*. iii) dogs - *B. canis*
   iv) goats and sheep – *B. melitensis* v) reindeer and caribou - *B. rangiferi*

   It is transmitted to humans from domestic animals through contact with infected animals and their products.

   Predisposing factors: presence of the causal agent in the urine, faeces, blood, milk, meat and aborted foetus of infected animals
   The bacteria enter the body through the exposed mucus membranes in the mouth, eyes, nostrils, skin abrasions and gastrointestinal tract as well as from dam to calf and during mating.

   Symptoms: abortion; stillborn calves, weak calf born, retention of foetal membranes; signs of infection in the membranes; swollen and infected testicles in bulls.

   Detection – blood is collected from animals and tested for the presence of the bacterium.

   Treatment – no treatment is available
   Prevention - annual testing for reactors which are culled. Isolate new stock in case they are carriers of the pathogen. Prevent visitors and potential carriers from visiting the farm. Protective clothing should be worn when working with cattle.

NB- **Humans also contact this disease, which can be treated and is not usually fatal, but the intermittent fevers (a source of its nickname, "undulant fever") can be exhausting. Symptoms usually appear between five days and a month after exposure and begin with a si ngle bout of high fever accompanied by shivering, aching and drenching sweats that last for a few days. Other symptoms may include headache, poor appetite, backache and weakness. Mental depression can be so severe that the patient may become suicidal**.

4. **MASTITIS**- is the inflammation of the mammary gland and udder tissue, and is a major endemic disease of dairy cattle.
   There are two forms of mastitis in cattle
   i) non- infectious mastitis – is caused as a result of chemical, mechanical or thermal injury to the cow's udder.
   ii) infectious mastitis - occurs when causal agents enter the udder and infect tissue. This results from unhygienic milking processes and environments.

Infected udder

http://s1324.photobucket.com

Causal agent: Many bacteria cause mastitis in cattle but the two common bacteria are *Streptococcus agalactia* and *Staphylococcus.*

Predisposing factors: Presence of the causal agents, injury to the udder, dirty milking machines, unhygienic milking practices (improperly washed udders and teats before milking, damaged milking cups, sharing cloth used to wipe udders before cups are applied), flies carry the germ from one animal to the next, calves can also transfer the germ from one teat to the next.

Symptoms: Mastitis can be broken down into four categories depending upon the signs and symptoms,

i. **Pre-acute mastitis** – a udder quarter that is swollen, hot, and red and sensitive so the cow may flinch or kick when the udder is touched. Milk production is reduced. A general fever may be present, depression, shivering, rapid weight loss and appetite loss occurs in many cases. In very severe cases death may occur.
ii. **Acute mastitis** - severe inflammation and some signs of fever and mild depression.
iii. **Sub-acute mastitis**- symptoms on the udder are much less pronounced and there are no signs of fever or depression or any other systemic signs.
iv. **Subclinical mastitis** is the inflammation of the mammary gland without showing any signs or symptoms.

Detection

i. **Fore milk examination** – prior to milking, a little milk is extracted from each quarter onto a strip cup. The milk is examined for signs of infection.
ii. **Milk cell count** – where the milk is tested for the presence of bacteria.
iii. **Detecting symptoms** – hot, painful udder, listless animal, reluctance to be milked.

Treatment

i. Cows which keep contacting mastitis need to be culled.
ii. All the milk must be stripped from the infected udder an disposed of before penicillin is applied inside the udder via the teat. This treatment is repeated every 12 hours.
iii. All injuries are to be treated to avoid the buildup of pathogens

Prevention –

i. Hygienic environment – remove dirty bedding, clean and drain area, ensure good ventilation.
ii. Hygienic milking machines and practices
iii. Careful monitoring, detection and treatment of infected cows
iv. Culling of repeat suffers.

5. BLOAT: the accumulation of excess gas in the rumen can develop in less than one hour after introduction to a high-risk paddock, but more often after one day.

Causal agent: Bloat is not caused by any microorganism.

Mild bloat	Moderate bloat	Severe bloat
		
Adapted from: http://tractorsupply.com		

Predisposing factors: It occurs as a result of feeding on any forage that is low in fibre and high in protein.

Under normal conditions, gasses that build up in the rumen during fermentation of feed are belched out by the animal. However, feeds with low fibre and high protein content cause foam to form on top of the gasses. This foam prevents the belching of gasses. As the gasses build up they cause the rumen to swell. This creates a large bulge in the stomach. Pressure builds up behind the rib-cage. The cattle soon stop eating and continue to show their discomfort. As the gas builds up more pressure, the cattle sometimes produce a lot of saliva. The difficulty in breathing will lead to a bluish tinge to the skin inside the mouth. Convulsions may occur quickly and heart-failure is a possibility. In some cases, bloat affected cattle have died within 30 minutes after consuming high protein diets.

Symptoms:

1. Swelling of the left side of the animal
2. The affected cattle show their discomfort by stamping of feet and vocalising
3. Kicking or rubbing belly against a hard object
4. Breathing difficulty sometimes with bubbles being exhaled.
5. Frequent urination and defecation
6. In advanced cases, cattle have been known to collapse almost completely.

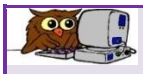
Detection: Since there is no microorganism responsible for this condition, the farmer must examine the feed that the animal has eaten. Fresh pasture and grain are the main causes in Fiji.

Treatment: The gas built up in the rumen or reticulum must be released. This can be done by

i) emergency rumenotomy – if the condition is life threatening, a trocar is inserted into the rumen to allow the escape of the gasses.

ii) bore tube– if the condition is not life threatening, a large bore tube is inserted into the rumen through the mouth so that anti frothing agents can be added to the rumen, allowing gas to be expelled.

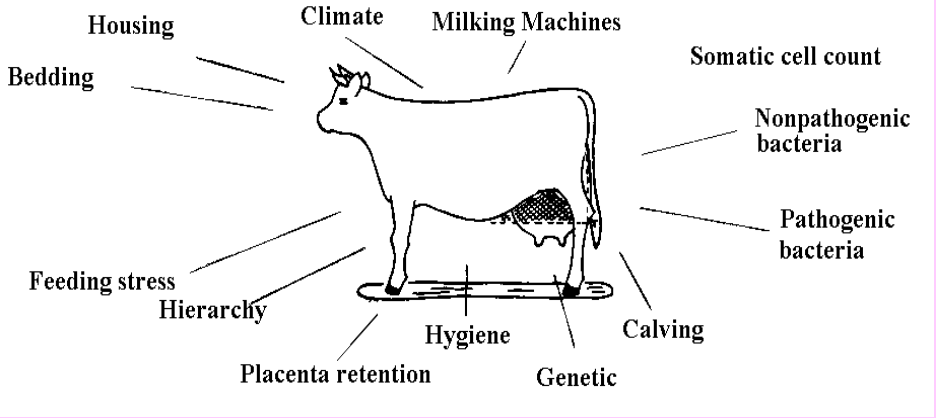
Once the swelling resides, the animal is fed a high fibre diet



Summarise the main diseases of cattle.
Discuss two ways in which farmers can prevent the introduction and spread of diseases in herds.

Cattle suffer the same diseases as other domestic mammals and the majority of these diseases can be passed on to humans who handle the animals and through infected meat and milk.

Discuss how the factors below influence diseases in cattle.



http://eap.mcgill.ca

AS12.4.1.4. Describe the harvesting, post-harvest treatment and use of cattle products and by-products.

a) Discuss the harvesting, post-harvest treatment and use of cattle products and by-products

LESSON 1: MOVING CATTLE

LESSON OUTCOME:

At the end of this lesson, the student will discuss the catching and moving of cattle.

Handling	- how agricultural animals are touched, moved and interacted with during husbandry procedures
Droving	- a flock or herd being driven on foot from one place to another.
Transport	- when agricultural animals are moved by vehicle or vessel from one place to another

Cattle, both dairy and beef, often have to be moved from one place to the next. Animals can be walked over short distances but transportation is often used to move animals over long distances or to the abattoir.

Transportation can be one of the most stressful situations an animal experiences and can cause a number of physiological and behavioural changes including fighting, stamping and running away.

Effects of transport and movement include:

a. stress - uncooperative animals.
b. bruising - meat is unsuitable for use.
c. trampling - occurs when animals go down due to slippery floors, overcrowding or stress
d. suffocation - usually follows on trampling or when smaller animals are transported with larger animals
e. heart failure - occurs if animals are too hot and stressed
f. sun burn - when animals transported in the heat of the day over long distances.
g. bloat - restraining ruminants or tying their feet without turning them
h. predation - unguarded animals moving on the hoof may be attacked
i. dehydration - animals subject to long distance travel without proper watering will suffer weight loss and may die
j. exhaustion - may occur for many reasons including heavily pregnant animals or weaklings
k. injuries - broken legs, horns
l. fighting - when animals are stressed and overcrowded.

Animals which are treated well and protected from stress arrive at their destination in far better physical and mental condition. This translates into significant benefits and economic advantages no matter what the reason for transport.

http://www.ckom.com

Droving cattle

-one person to lead and others to follow cattle
-move animals at their walking pace
- keep animals in groups with which they are comfortable e.g. same size, sex and horns; with a dominant animal leading
- herd cattle into yards following barriers like fence lines, roads, river banks etc.

https://www.google.com

Loading cattle:

Load different groups into separate compartments: place heavier cattle toward the front of the trailer; keep bulls and animals from different farms separated. This keeps animals from trying to establish a new social order on the trailer

Walk cattle along a chute and up a ramp of less than 25 degree elevation.

http://www.abc.net.au

Transporting cattle;

1. use a vehicle which has a non-slip floor, is well ventilated and can keep groups of livestock separated from each other.
2. ensure driving habits provide livestock with a safe ride.
3. travel when it is cool and traffic is lighter on the roads
4. travel for less than 4 hours or provide a stop where animals can be watered and fed.

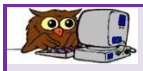
http://www.saleyards.info

Unloading cattle:

The transport should be backed up into a field or holding pen which has water and feed available.

Attach the chute then turn the engine off and open the doors

Animals are then gently encouraged to disembark.



You have been asked by your family to transport four steers to the abattoir for slaughter. Discuss the herding, loading, transport and unloading of the animals.

The herding, loading, transport and unloading of beef cattle impact the quality of beef produced.

Discuss the consequences which may result from the improper handling and transporting of cattle.

LESSON 2: MILKING DAIRY CATTLE

LESSON OUTCOME: At the end of this lesson the student will discuss the milking of cattle.

Cattle are milked twice a day, usually 12 hours apart.
Hygiene is important so cows and equipment must be cleaned and inspected daily.

1. **Cleaning**: hygiene keeps the milk clean and also reduces the spread of diseases in the milking herd.
   i) Udder: water is sprayed onto the udder as the animal enters the milking yard to soften dirt on the udder.
   Before each animal is milked, all dirt is thoroughly washed off the udder and the udder is inspected for injuries and pests like ticks. The udder is dried using a paper towel, which is then discarded.
   ii) Milking parlour: the walls and floors are hosed down after each milking to remove all dirt that the animals leave behind. Good drainage is essential.
   iii) Milking equipment: it is recommended that all equipment used for milking be made of stainless steel. This equipment is to be thoroughly washed after milking and sterilised before the next milking begins.
   iv) Milking hands: everyone involved in the milking process is to wash their hands with soap and water before using the proper techniques to clean the udder. They should also wear gum boots to protect their feet and clean coveralls to protect their clothing. This will reduce the spread of diseases between the workers and the cattle and among the cattle.

2. **Stripping** is the process which is used to determine if the milk in each quarter of the udder is suitable for consumption. A little milk is removed from each teat into a separate stripping cup. The milk is checked for signs of mastitis such as flakes, clumps of milk, discolored milk etc. If healthy, the cow can be milked.
   Stripping is also used to remove the last of the milk from the teat once milking is complete.
   Just as with sheep and goats, there are two methods of milking: hand milking and machine milking.

Discuss why hygiene is so important to the milking process.

Cattle kept for the production of milk are termed dairy cattle.
Cattle can be miked by hand or by machine.

Compare hand and machine milking.

LESSON 3: PRODUCTS OF DAIRY FARMS

LESSON OUTCOME: At the end of this lesson the student will discuss the products of dairy farms.

Yogurt	-	a semisolid food prepared from milk fermented by added bacteria, often sweetened and flavored.
Whey	-	the watery part of milk that remains after the formation of curds.
Cheese	-	a food made from the pressed curds of milk.
Cream	-	the yellowish fatty component of un-homogenized milk that tends to accumulate at the surface.
Buttermilk	-	the slightly sour liquid left after butter has been churned, used in baking or consumed as a drink.
Ghee	-	clarified butter made from the milk of a buffalo or cow, used in Indian cooking.

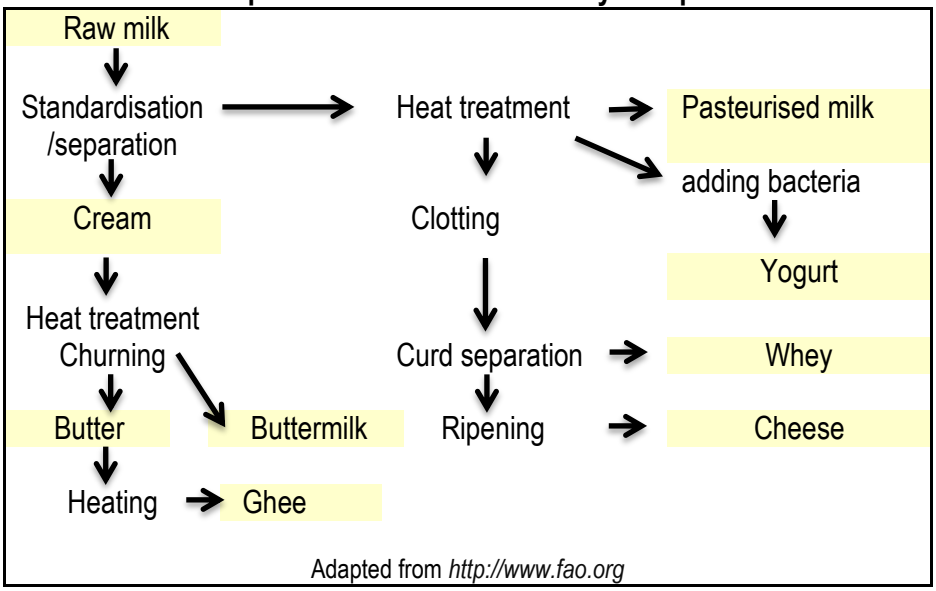
The main product from dairy farms is raw milk.
The average composition of cow's milk is:

- **87.2% water**
- **4.9% lactose (carbohydrates)**
- **3.7% milk fat**
- **3.5% protein**
- **0.7% ash (minerals)**

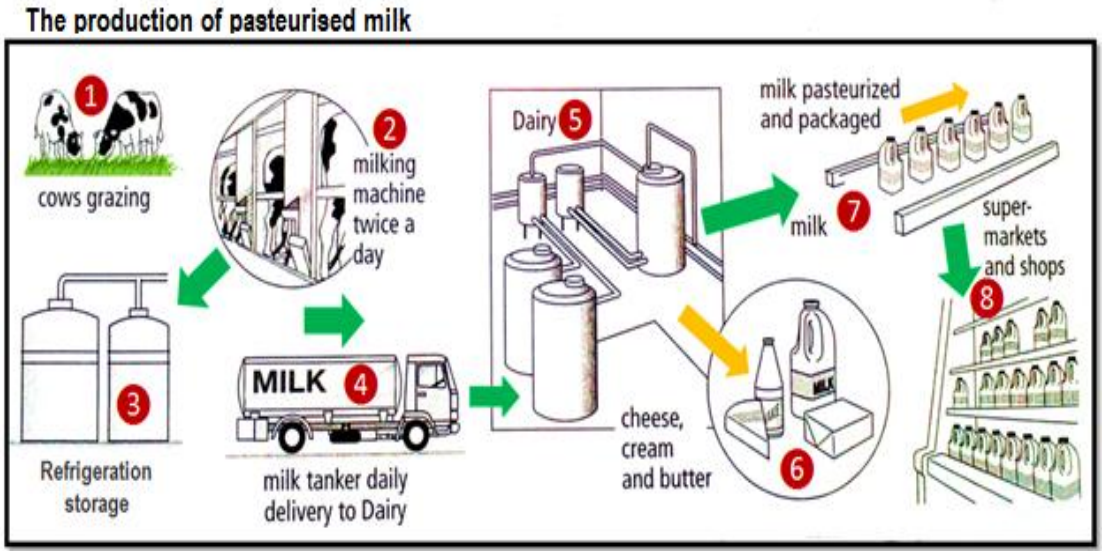
This milk may be used to produce pasteurised milk, yogurt, curd, whey, cheese, cream, butter, buttermilk and ghee.

Milk  *http://i.huffpost.com*	**Yogurt**  *http://www.prevention.com*	**Curds & Whey**  Curd (solid) Whey (liquid) *https://chicafinca.files.wordpress.com*	**Cheese**  *http://www.abcqualitymeats.co.uk*
Ghee  *http://www.themandozaline.com*	**Butter**  *https://a2ua.com*	**Buttermilk**  *https://bigoven-res.cloudinary.com*	**Cream**  *http://theprieriehomestead.com*

The relationship between raw milk and dairy milk products:



Adapted from *http://www.fao.org*



http://msdiepielts.com

Research and discuss how ghee is/was traditionally made in Fiji.

Raw milk is processed into many dairy milk products including pasturised mik, yogurt, whey, cheese, cream, butter, buttermik and ghee.

There is a major milk processing company in Fiji which buys raw milk from commercial dairy farmers.
Discuss the products that this company makes from raw milk.

LESSON 4: SLAUGHTERING & POST HARVEST TREATMENT OF CATTLE

LESSON OUTCOME: At the end of this lesson the student will discuss the slaughtering of cattle.

Lairage	-	a place where sheep or cattle may be rested during transit to a market or abattoir
Exsanguination	-	the action of draining an animal or organ of blood.

There are several criteria for a good slaughter method:

i. animals must not be treated cruelly,
ii. animals must not be unnecessarily stressed,
iii. exsanguination must be as rapid and as complete as possible,
iv. damage to the carcass must be minimal,
v. the method of slaughter must be hygienic, economical and safe for abattoir workers.

Preparing the animal for slaughter

http://article.wn.com

- Sometimes, animals are hosed down to remove excess dirt from their bodies.
- Animals are inspected before slaughter for injury and illness because an animal should be healthy and physiologically normal.
- Animals should be rested overnight, calm and have sufficient access to water.
- Animals should be fasted before slaughter to empty the stomach content and allow complete bleeding
-

Stunning

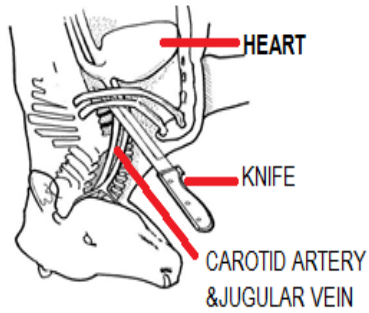
http://www.mps-group.nl

The animal is led into a stunning box and stunned by either:

- a penetrating captive bolt - a gun fires a metal bolt into the brain of the animal causing the animal to lose consciousness immediately.
- an electrical current - is passed through the animal's brain via a large pair of tongs, causing temporary loss of consciousness. Some systems also pass the current through the heart, so the animal is not just stunned but also killed.

This makes the slaughter painless, motionless and quick.

Sticking [bleeding]



http://www.veterinaryhandbook.com.au

- The unconscious animal is hung upside down from the ceiling
- The carotid artery and jugular vein at the base of the neck, not far from the heart are cut, causing exsanguination
- Blood is drained away for blood and bone meal.
- Incomplete exsanguination increases the amount of residual blood in the carcass. Lean meat may then appear dark and fat may become streaked with blood
- .

Skinning

http://www.abc.net.au

- The head is skinned and then cut away from the carcass. It is hung on a hook so that it can be identified later.
- The hide of the hanging animal is removed and sent to the tannery where it is used to make leather.
- To avoid contamination, the outer side of the hide must never touch the skinned surface and meat of the carcass.

Evisceration and viscera inspection

http://www.908x0.com

- The hanging carcass is cut open starting at the anus, allowing the internal organs to fall forward, out of the animal.
- This helps the meat inspector check for signs of disease and injury in the lymph nodes and also in the internal organs as he removes them.
- The edible organs like the kidney, liver and heart are separated from the other organs.

Splitting and washing carcass

http://g02.s.alicdn.com

The passed carcass is spit in half along the backbone. The carcass is then washed with clean water to remove all dirt

Refridgeration

http://cdn.c.photoshelter.com

The beef carcasses are stored in refrigerated conditions awaiting delivery to customers including butcher shops.

Compare the slaughter and post-harvest management of cattle at subsistence and commercial levels.

The slaughter and post-harvest treatment of cattle is important in the quality of veal and beef produced.

Where are the abattoirs in Fiji located?

LESSON 5: PRODUCTS OF BEEF FARMS

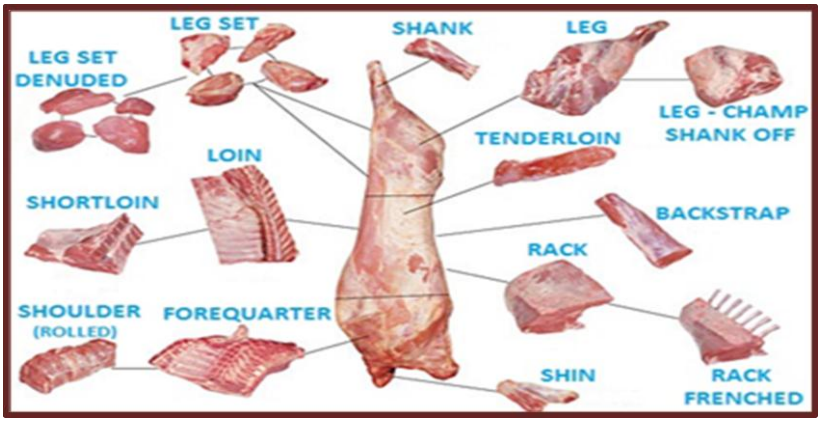
LESSON OUTCOME:

At the end of this lesson the student will discuss the products and by-products of beef farms.

Veal - the flesh of a calf, used as food
Beef - the flesh of a slaughtered full-grown steer, bull, ox, or cow

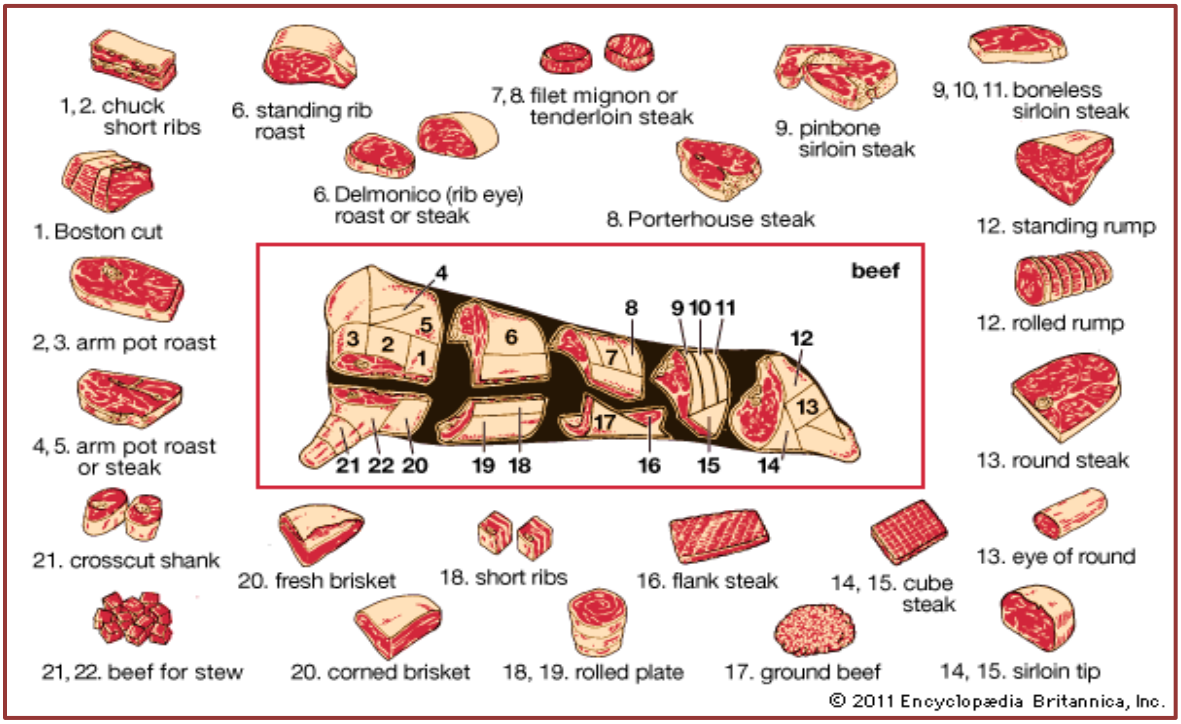
Beef cattle are raised mainly for meat;
i) veal from calves ii) beef from adult animals

CUTS OF VEAL



http;//www.coast2coastservices.com/services/provisions.htm

CUTS OF BEEF



http://media.web.britannica.com

Differentiate between veal and beef.

The different portions of a calf and cattle carcas produce meat of differing quality and value.

Compare the nutritional value of veal and beef.

LESSON 6: BY-PRODUCTS OF CATTLE FARMS

LESSON OUTCOME: At the end of this lesson the student will discuss the by-products of cattle farms.

Tripe	-	the lining of the first and second divisions of the stomach of a ruminant, especially oxen, sheep, or goats which is used as food.
Sweetbreads	-	the thymus gland (from the throat) and the pancreas gland that are taken from **calves** or lambs.
Tripe		muscle wall of rumen, reticulum and omasum

The by-products of the cattle farming include:

Edible by-products:

i) **Variety meats** including liver, kidneys, brain, tripe, sweetbreads, and tongue.

Liver	Kidney	Brain
 *http://www.highlandsfamilyfarm.com*	 *http://img.21food.com*	 *http://www.foodsubs.com*
Sweetbreads	**Tripe**	**Tongue**
 *https://dorastable.files.wordpress.com*	 *http://images.wisegeek.com*	 *http://www.foodsubs.com*

ii) **Fats** yield oleo stock and oleo oil for margarine and shortening. Oleo stearin is used in making chewing gum and certain candies.

iii) **Gelatin** produced from bones and skin is used in marshmallows, ice cream, canned meats, and gelatin desserts.

iv) **Intestines** may provide natural sausage casings.

Inedible By-products

i) **Hide** makes leather, felt, nubuck and suede.
It also provides a base for many ointments, binders for plaster and asphalt and a base for the insulation material used to cool and heat houses. Footballs are also generally produced from cattle hide.

ii) "**Camel hair**" artists' brushes are not really camel hair at all, but are made from the fine hair found in the ears of beef cattle.

iii) The **inedible fats** from beef are used to produce industrial oils and lubricants as well as tallow for tanning, soaps, lipsticks, face and hand creams, some medicines, and ingredients for explosives.

iv) **Fatty acids** are used in the production of chemicals, biodegradable detergents, pesticides, and flotation agents. One fatty acid is used to make automobile tires run cooler and, therefore last longer.

v) **Bones, horns, and hooves** also supply important by-products including buttons, bone china, piano keys, glues, fertilizer, and neat's - foot oil, gelatin for photographic film, paper, wallpaper, sandpaper, combs, toothbrushes, and violin string. Bone charcoal is vital in the production of high grade steel ball bearings.

vi) **Meals** made of beef fat, protein, and bones are used in feeding poultry, pigs, dairy cattle, and domesticated fish.

vii) **Faeces and urine** are used for fertilizing materials and digested to produce biogas.

Medical By-products

More than 100 individual drugs are made of ingredients sourced from cattle. They perform such important and varied functions as helping to make childbirth safer, settling an upset stomach, preventing blood clots in the circulatory system, "pepping up" a sluggish thyroid, controlling anaemia, relieving some symptoms of hay fever and asthma and helping babies digest milk.

Insulin is perhaps the best-known pharmaceutical derived from cattle. It takes the pancreases from 26 cattle to provide enough insulin to keep one diabetic person alive for a year.

Through genetic engineering techniques and other research developments, many of the drugs produced from cattle are now being chemically produced in the laboratory. These procedures are often less expensive than recovery from animal organs. However, synthesis has been only partial, and the animal sources remain extremely important in many situations.

Adapted from https://factsaboutbeef.files.wordpress.com

Discuss the many uses that is made for the by-products from cattle farms

Almost every part of a cattle's carcass has a use; from the horns to the tail.

Visit an abattoir and observe the tanning of leather and the production of blood and bone meal.

REFERENCE

For Agricultural Concepts

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