

# **Applied Natural Resource Management Subjects**

**Agriculture  
Forestry  
Fisheries**

**Integrated Natural Resource Management**

**Upper Secondary  
Syllabuses**



Papua New Guinea  
Department of Education

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## Secretary's message

This syllabus document is to be used by teachers to teach Upper Secondary students (Grades 11 and 12) the subjects contained in this Applied Natural Resource Management syllabus framework document. This syllabus document includes the subjects Agriculture, Forestry, Fisheries and Integrated Natural Resource Management. The syllabuses build upon the concepts, skills and attitudes learnt in Lower Secondary and provide a sound foundation for further learning.

The Upper Secondary Applied Natural Resource Management syllabuses contribute to integral human development as they are based on the students' physical environments, societies and cultures. They link to the National Education Plan's vision, which is that secondary education enables students to achieve their individual potential to lead productive lives as members of the local, national and international community.

The syllabuses also help students to develop knowledge and understanding of a wide range of concepts and principles underlying natural resource management, together with practices that promote self-reliance and skills development. Students understand the importance of the subject and become sensitive to the sustainability of natural resources. They learn to use innovative scientific strategies to promote food security policy and effectively communicate these to their community members and other stakeholders.

I encourage other stakeholders—such as government line agencies, non-government organisations, tertiary institutions, aid agencies and farming communities—to actively participate in and support the implementation of the syllabuses in the Upper Secondary schools. Schools are also expected to take the lead in consultation with the line service providers and other stakeholders. Memorandums of understanding or memorandums of agreement are encouraged as they provide strategies conducive to the sharing of scarce resources throughout the implementation stages. The success of the syllabuses lies in the evidence of the knowledge and skills students develop through undertaking sustainable practical projects in schools and local communities.

I commend and approve this syllabus document as the official curriculum for Applied Natural Resource Management to be used in all schools with Grades 11 and 12 students throughout Papua New Guinea.



**DR JOSEPH PAGELIO**

Secretary for Education

# **Applied Natural Resource Management framework**

## Introduction

Applied Natural Resource Management subjects are organised in a framework that gives students the opportunity to specialise in an area of interest, such as forestry, or to take a more general course by studying units from the three resource areas: agriculture, fisheries and forestry. Using the framework makes it easy for teachers to replace any unit with their own school-developed units.

This Applied Natural Resource Management framework is based on the curriculum principles from the National Curriculum Statement. It has been designed using learning outcomes that identify the knowledge, skills, attitudes and values that all students achieve or demonstrate by the end of Grade 12. It is linked to the national curriculum learning area Culture and Community and builds on the knowledge and skills students have learnt since elementary grades and particularly in the Grades 9 and 10 Agriculture course.

Lower Secondary Agriculture Strands	Lower Secondary Agriculture Units	Upper Secondary Applied Natural Resource Management Strands	Upper Secondary Applied Natural Resource Management Subjects
Sustainability Agricultural technology Agricultural enterprise	<p><b>Core</b></p> <p>Agriculture in Papua New Guinea 1 and 2</p> <p>Agriculture Production Systems in Papua New Guinea 1 and 2</p> <p><b>Options</b></p> <p>Practical projects: growing crops, raising livestock, enterprise projects</p>	Effective communication Sustainability Entrepreneurship Technology	Agriculture Forestry Fisheries Integrated Natural Resource Management

Applied Natural Resource Management subjects require a good level of English competency. Students need to be fluent in reading, writing and speaking English for research, record keeping and communication purposes.

Assessment is an important component of teaching for learning and is integrated into the learning and teaching activities of Applied Natural Resource Management. Continuous assessment in Applied Natural Resource Management provides feedback to students and the teacher on students' progress towards achievement of the learning outcomes. It helps students improve their standards of achievement by knowing what they need to do well and where they need to improve. In Applied Natural Resource Management teachers will gather evidence from students' work during the course of each term and use those continuous assessments to improve their teaching and students' learning.

Learning in Applied Natural Resource Management is more meaningful and interesting when students are given opportunities to explore their own learning through undertaking projects, conducting experiments and engaging in meaningful discussions. Students conduct research using conventionally simple methods to plan, organise and set up investigative, sustainable practical projects in a diverse range of field-based learning activities. These

include laboratory and field investigations on crops, soils and animals. Skills to be developed include observation, measurement, data collection, analysing and reporting. There should also be opportunities in the course for interactions with industries through field excursions.

A critical task facing teachers is the selection of teaching resources for these subjects. This is particularly important for agriculture, forestry and fisheries, due to wide variations in environments throughout Papua New Guinea. The teacher is advised to closely investigate the available local resources and choose those that are most relevant and accessible in that area.

This syllabus document outlines the strands and units for all students in Grade 11 and Grade 12. Applied Natural Resource Management is to be timetabled for 240–250 minutes per week in Grades 11 and 12.

## Rationale

Papua New Guinea is rich in natural resources (land, water, mangroves, coral reefs, rivers, lakes, mountains, grassland, forests and swamps) that support the livelihoods of more than 85 per cent of the people living in rural areas. Agriculture is our way of life, sustaining culture, utilising natural resources and increasing wealth. It has been an integral part of development through providing employment, income, food and raw materials for exports such as cocoa, coffee, oil palm, copra, rubber and tea.

Management of our natural resources offers opportunities for producing and exporting food and cash crops, marine resources and forest products. Agriculture, fishing and forestry are important composites of rural and urban industries. They are structured to produce both raw and value-added materials and also those required for downstream processing to meet identified consumer needs, both nationally and internationally.

Applied Natural Resource Management enables students to appreciate and explore ways to use traditional and improved knowledge and skills, values and attitudes in agriculture, fishing or forestry processes. It involves the study and practical application of sustainable management practices, applied farm management skills and agricultural technologies and tools. Students become innovative and creative, and motivated to become entrepreneurial, self-reliant and contributing meaningfully to the community and nation building.

The study of Applied Natural Resource Management also addresses issues such as lack of employment opportunities, food security, poverty alleviation, HIV and AIDS, urban drift, law and order and climate change.

This subject provides a firm foundation for a range of career pathways and opportunities for students. It prepares students to be employed or self-employed in agriculture, forestry and fisheries industries upon leaving school, while others may continue further studies into tertiary institutions.



## Aims

Applied Natural Resource Management aims to enable students to:

- develop concepts and skills to manage natural resources for maximum benefits
- use natural resources in agriculture, fisheries and forestry in a sustainable way
- apply safety rules and regulations applicable within the agricultural environment consistent with the Occupational Health and Safety policy
- use tools, equipment and machinery correctly in the production and processing of agriculture, forestry and marine products
- apply appropriate technology to improve production
- develop and implement a business plan to generate a profitable income
- develop the ability to think critically and make informed decisions
- investigate and apply knowledge and skills that sustain resource production in Papua New Guinea
- provide skills, knowledge and experience in managing resources and making decisions in resources allocation
- communicate effectively and competently with other stakeholders to improve resource production practices in Papua New Guinea
- develop a favourable attitude towards agriculture, fisheries and forestry.

## Strands

Units in the Applied Natural Resource Management syllabus framework are developed from four strands. The strands describe the dimensions of the subject and define ways of approaching learning in Applied Natural Resource Management. They incorporate cross-curriculum contents and skills, which are all interwoven.

The strands for Applied Natural Resource Management are:

- 'Effective communication'
- 'Sustainability'
- 'Entrepreneurship'
- 'Technology'

### **Effective communication**

Students acquire relevant knowledge and skills in Applied Natural Resource Management that will enable them to communicate effectively and confidently in practical situations. It is critically important to address the prevailing food production constraints faced by societies. Through effective communication, students disseminate information and technology relevant for agriculture production.

### **Sustainability**

Applied Natural Resource Management focuses on the sustainable resource practices contributing to sustaining the socioeconomic benefits and environment in Papua New Guinea. Students are given opportunities to examine real-life situations and make decisions to protect and conserve available resources for future generations.

### **Entrepreneurship**

Applied Natural Resource Management emphasises the development of entrepreneurial farming, fishing and forestry skills. It develops the students' ability to analyse resources enterprises and opportunities for generating income. It also promotes, fosters and encourages students to participate meaningfully in any agribusiness.

### **Technology**

Applied Natural Resource Management focuses on resource management skills and technology to maximise crops and livestock production. Students are exposed to practical field experiences that enable them to be innovative and creative about the use of resources in their local environment. It also enables students to participate in decision-making processes involving resource management.

## Learning outcomes

The learning outcomes for the field of Applied Natural Resource Management identify the knowledge, skills, attitudes and values all students achieve or demonstrate at the end of Grade 12. These learning outcomes, listed below, apply to Agriculture, Forestry, Fisheries and Integrated Natural Resource Management.

Within the Applied Natural Resource Management context, students can:

1. demonstrate an understanding of the socioeconomic benefit and values of natural resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to improve and sustain production
4. identify and analyse issues affecting natural resource management and make recommendations for improvement
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support resource production at national and international levels.

## Content overview

### Subjects

Students may choose up to two subjects to study within the Applied Natural Resource Management subject field. If students study two subjects, each subject must be studied for 240–250 minutes per week.

The subjects are:

- Agriculture
- Forestry
- Fisheries
- Integrated Natural Resource Management

If students study two subjects from the Applied Natural Resource Management syllabus framework, teachers must make sure that students do not study the same unit twice.

## **Agriculture**

## Learning outcomes: Agriculture

The content of this syllabus is organised into units. Each unit has specific learning outcomes, which are taken from the learning outcomes of the subject. The Agriculture learning outcomes identify the knowledge, skills, attitudes and values all students achieve or demonstrate at the end of Grade 12. These learning outcomes are listed below.

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of crops and animals
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting farm management and make recommendations for improvement
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels.

Learning outcomes mapped against Agriculture units										
Learning outcomes	Units									
	11.1	11.2	11.3	11.4	11.5	11.6	12.1	12.2	12.3	12.4
1. Demonstrate an understanding of the socioeconomic benefit and values of crops and animals	✓									
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation	✓	✓		✓	✓	✓				✓
3. Apply knowledge, skills and appropriate technology to undertake sustainable practical projects		✓	✓	✓	✓		✓		✓	✓
4. Identify and analyse issues affecting farm management and make recommendations for improvement	✓	✓	✓	✓				✓	✓	✓
5. Apply entrepreneurial skills in projects			✓				✓			
6. Communicate ideas and information in a variety of ways								✓		
7. Demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels	✓					✓		✓	✓	

## Unit sequence and content: Agriculture

Grade 11 units	Grade 12 units
<p><b>11.1 Introduction to Agriculture</b></p> <ul style="list-style-type: none"> <li>• Role and importance of agriculture</li> <li>• Agricultural resources in Papua New Guinea</li> <li>• Activities that affect agricultural resources</li> <li>• Government policies</li> <li>• Agriculture export and import data</li> <li>• Training and careers in agriculture</li> </ul> <p><b>11.2 Soil Management</b></p> <ul style="list-style-type: none"> <li>• Introduction to soils</li> <li>• Physical properties of soils</li> <li>• Chemical properties of soils</li> <li>• Soil fertility and fertilisers</li> <li>• Organic farming</li> <li>• Soil–plant relationship</li> <li>• Simple farmland survey</li> <li>• Soil water management</li> <li>• Soil conservation methods</li> </ul> <p><b>11.3 Annual Crop Production</b></p> <ul style="list-style-type: none"> <li>• Importance and roles of annual crops</li> <li>• Site selection</li> <li>• Land preparation</li> <li>• Crop selection</li> <li>• Nursery establishment</li> <li>• Field transplanting</li> <li>• Soil improvement methods</li> <li>• Field management practices</li> <li>• Harvesting and post-harvest for quality control</li> </ul> <p><b>11.4 Animal Production (Monogastrics)</b></p> <ul style="list-style-type: none"> <li>• Importance and uses of monogastric animals</li> <li>• Types of breeds</li> <li>• Livestock improvements</li> <li>• Animal nutrition</li> <li>• Planning and establishing a monogastric project</li> <li>• Housing and fencing</li> <li>• Animal husbandry</li> <li>• Processing and post-processing activities</li> </ul> <p><b>11.5 Farm Technology</b></p> <ul style="list-style-type: none"> <li>• Basic tools, equipment and machines</li> <li>• Tractors and implements</li> <li>• Draught animals</li> <li>• Planning and designing</li> <li>• Construction of farm tools and structures</li> </ul> <p><b>11.6 Agribusiness</b></p> <ul style="list-style-type: none"> <li>• Agricultural economics</li> <li>• Agricultural marketing</li> </ul>	<p><b>12.1 Applied Farm Management</b></p> <ul style="list-style-type: none"> <li>• Planning and organisation of farm groups</li> <li>• Choosing alternative farm enterprises</li> <li>• Farm operations</li> <li>• Farm banking</li> <li>• Farm sales and records</li> <li>• Farm accounting processes</li> <li>• Farm evaluation and reporting</li> </ul> <p><b>12.2 Introduction to Applied Research</b></p> <ul style="list-style-type: none"> <li>• Rationale</li> <li>• Principles of research</li> <li>• Methods and designs</li> <li>• Research project areas</li> <li>• Implementing research</li> <li>• Report writing and presentation</li> </ul> <p><b>12.3 Perennial and Biannual Crop Production</b></p> <ul style="list-style-type: none"> <li>• Importance and roles of perennial and biannual crops</li> <li>• Environmental requirements</li> <li>• Farming and cropping systems</li> <li>• Nursery construction and management</li> <li>• Field preparation</li> <li>• Crop management practices</li> <li>• Harvesting and post-harvest for quality control</li> </ul> <p><b>12.4 Animal Production (Polygastrics)</b></p> <ul style="list-style-type: none"> <li>• Importance and uses of polygastric animals</li> <li>• Types of breeds</li> <li>• Animal nutrition</li> <li>• Livestock improvements</li> <li>• Pasture establishment and management</li> <li>• Planning and establishing a polygastric project</li> <li>• Divisional fencing and stockyard designs</li> <li>• Animal husbandry</li> <li>• Processing and post-processing activities</li> </ul>

## TVET modules

Modules from TVET National Certificate 1 courses can be offered in place of three units only over Grades 11 and 12, provided that the modules are delivered by registered training providers.

Schools must be registered as, or in partnership with, registered TVET providers and comply with the requirements of the Quality Training Framework.

### TVET Training Packages

Students can study modules from the following courses at National Certificate 1 in place of two Agriculture units:

- Commodity Crop Production
- Livestock Production



## Grade 11 Agriculture units

### 11.1 Introduction to Agriculture

2 weeks

In this unit students are introduced to the study of Agriculture through understanding the farming principles and systems practised in Papua New Guinea. It also highlights the important role that agriculture plays in Papua New Guinea's economy and its international relationships. The unit motivates students to develop their interest in career pathways in agriculture.

Students appreciate the socioeconomic benefits of agriculture and how to manage these as stipulated in the National Agricultural Development Plan, which emphasises food security, export-driven, downstream processing, poverty alleviation and self-reliance. Contemporary issues of global warming, HIV and AIDS, population pressure, and so on, and their influences in the agriculture production, are included.

#### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of crops and animals
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
4. identify and analyse issues affecting farm management and make recommendations for improvement
7. demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels.

#### To achieve the learning outcomes, students:

- identify important agricultural resources in Papua New Guinea that could be used to produce food, generate income and provide employment
- evaluate the consequences of mismanagement of agricultural resources
- conduct research on issues affecting farming and make recommendations for improvement.

#### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Role and importance of agriculture

- food security
- cash economy
- employment

- self-reliance
- providing raw materials for downstream processing

### **Agricultural resources in Papua New Guinea**

- land
- vegetation
- crops such as food and cash crops
- animals: indigenous and exotic breeds
- human labour
- forestry products
- natural environment: lakes, rivers, mountains, mangroves, air
- industrial products; for example, coffee husks, fish meal, copra mills

### **Activities that affect agricultural resources**

- deforestation
- use of arable land for industrial purposes
- overuse of inorganic chemicals
- mining and petroleum activities
- inadequate implementation of government strategic plans

### **Government policies**

- understanding and interpreting existing government policies:
  - Medium Term Development Strategy (MTDS)
  - National Agriculture Development Plan (NADP)

### **Agriculture export and import data**

- trading partners of agricultural products
- export and import quantities and values
- factors affecting market prices
  - level of consumption versus production level

### **Training and careers in agriculture**

- tertiary institutions in Papua New Guinea and abroad
- careers in government and private sectors; self-employment

## 11.2 Soil Management

10 weeks, integrated with projects

This unit covers concepts that are considered to be vital for soil management to sustain crop production. It builds on the concepts covered by the Lower Secondary Agriculture Syllabus. Topics include physical and chemical soil properties, fertilisers and their application, organic farming, land surveys and mapping, and relevant practical experiments.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting farm management and make recommendations for improvement.

#### To achieve the learning outcomes, students:

- investigate, analyse and explain physical and chemical properties of soils
- describe the effects of soil nutrients and fertilisers on plant growth and their importance to crop production
- state the theoretical aspects of soil surveys and mapping
- demonstrate knowledge and understanding of a range of concepts and fundamental principles that underpin crop and animal production, management and conservation
- apply agricultural knowledge, skills, techniques and appropriate tools to improve agricultural enterprises in sustainable ways.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake practical investigations and activities related to soils.

#### Introduction to soils

- review of soil formation
- soil components: organic and inorganic matter, air and water
- soil organisms

#### Physical properties of soils

- structure
- texture
- profiles

### **Chemical properties of soils**

- inorganic components
- nitrogen and carbon cycles
- soil chemical testing for macro and micronutrients and pH level
- liming

### **Soil fertility and fertilisers**

- soil fertilisers
- organic or inorganic
  - types
  - uses and applications
  - environmental impacts

### **Organic farming**

- principles
- cost; available resources; benefits to soils
- methods such as green manuring, animal manures and composting

### **Soil–plant relationship**

- air and water movement in soils
- water retention and field capacity

### **Simple farmland survey**

- boundary survey and mapping
- farm area calculation

### **Soil water management**

#### *Methods of irrigation*

- furrow
- flood
- overhead sprinkler
- bucket
- drip
- rope and washer

### **Soil conservation methods**

- zero tillage
- mixed cropping
- cover cropping
- fallow
- contour farming
- terracing
- agroforestry

## 11.3 Annual Crop Production

Ongoing; to be studied throughout the year

In this unit students undertake practical food crop project activities to demonstrate essential knowledge and improved techniques to increase crop production and improved quality. Students participate in crop production activities that involve nursery management, land preparation, field management and post-harvest handling of products. The unit may also involve appropriate food-processing techniques. Schools are required to select any annual crops depending on the locality, market demands and other available resources. Food crop projects may include leafy vegetables, root staples, cereals, grains or legumes.

### Learning outcomes

Students can:

3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting farm management and make recommendations for improvement
5. apply entrepreneurial skills in projects.

#### To achieve the learning outcomes, students:

- demonstrate nursery techniques such as seed boxes, poly bags and ground beds to raise seedlings
- prepare land and apply improved field management practices: plant density, pests and disease control, soil management practices and husbandry practices
- demonstrate post-harvest techniques such as packaging, handling, processing and storage conditions to maintain quality of food product
- apply appropriate cropping systems on selected crops.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project in crop production.

#### Importance and roles of annual crops

- food security
- nutrition
- export
- raw materials
- employment
- contribution to GDP
- income generation

### **Site selection**

- topography
- soil
- water
- location
- vegetation cover

### **Land preparation**

- clearing
- soil tillage methods
- primary ploughing
- secondary ploughing
- drainage preparation
- seed bed preparation
- mulching

### **Crop selection**

- introduction of varieties
- naming crop varieties
- agronomic requirements
- suitability and adaptability

### **Nursery establishment**

- nursery types, materials and tools
- soil preparation, including sterilisation
- nursery sowing techniques, such as thinning, hardening
- care and maintenance; for example, plant nutrition and water
- pest and disease control

### **Field transplanting**

- optimum requirements for field planting
- spacing and planting
- field transplanting
- mulching and manuring

### **Soil improvement methods**

#### *Applications*

- green manuring
- animal manure
- composting
- chemical fertiliser applications
  - types, uses and applications, environmental impacts
- organic farming

- materials for organic farming
- crop rotation (non-legume plus legume crops)

### **Field management practices**

#### *Types of management practices*

- weed control
  - safe application of herbicides
- pest and disease control
  - applications using plant-derived pesticides (PDPs) such as chilli, derris, neem
- integrated pest management (IPM) practices
- soil management
  - fertiliser application: organic and inorganic
- husbandry practices
  - pruning, staking, tying, earthing, vine lifting

### **Harvesting and post-harvest for quality control**

- timing and signs of maturity
- harvesting, such as picking, gathering; sorting, grading
- post-harvest handling, packaging and marketing
- food processing
  - drying, use of preservatives, cooling, grinding and bottling or packaging
- storage methods and conditions, such as temperature and humidity

## 11.4 Animal Production (Monogastrics)

Ongoing; to be studied throughout the year

This unit enable students to acquire basic scientific knowledge of animal physiology and be involved in practical aspects of raising monogastric and ruminant animals for meat, egg, milk and fibre production. Students perform the tasks necessary to improve livestock production, which include planning, housing, fencing, husbandry practices, feeding and nutrition, slaughtering and processing, egg collection and grading. Monogastric animals may include chicken, ducks, pigs, rabbits and native animals. Ruminants may include cattle, buffalo, sheep and goats.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting farm management and make recommendations for improvement.

#### **To achieve the learning outcomes, students:**

- apply improved animal husbandry practices to increase production
- identify health problems and disorders and apply measures to maintain a healthy stock
- demonstrate post-processing operations according to hygiene standards.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project in animal production.

#### **Importance and uses of monogastric animals**

- food
  - meat
  - milk
  - eggs
- lard, medicine
- cash income
- social obligation
- fibres
- transportation; for example, horses
- decorations
  - types



- tusks
- feathers

### **Types of breeds**

- chickens
  - types
  - meat (broilers: hybrids)
  - eggs (White Leghorn, Rhode Island Red)
  - dual purpose (Australorp)
- duck
  - types
  - meat
  - eggs
- turkey
  - types
  - meat
- pigs
  - meat (Large White, Landrace)
- horses

### **Livestock improvements**

- breed selection
  - growth rate
  - product quality and quantity
- breeding systems
  - inbreeding and outbreeding

### **Animal nutrition**

- nutrient requirements for growth, meat, milk, egg and fibre production
- classes of feed and nutritional values
  - commercial feeds
  - local feeds
- local feed formulations

### **Planning and establishing a monogastric project**

- observation and site selection
- budget estimates
- materials and equipment requirements
- sourcing stock

### **Housing and fencing**

- stocking rate requirements and spacing calculations
- appropriate designs
- maintenance of housing, fencing, other farm structures

**Animal husbandry**

- breeding management
  - animal behaviour
  - mating, weaning, culling, castration
- stock management
  - ear tagging, branding, drenching
- health and hygiene practices
  - diseases and parasites
  - signs of healthy and sick animals
  - causes, prevention, control and treatment
- stockmanship and routine requirements

**Processing and post-processing activities**

- slaughtering
  - time, techniques, tools and equipment
- butchering techniques
- grading, packaging, storage, handling of products and transport

## 11.5 Farm Technology

Ongoing; to be studied throughout the year

This unit involves designing and constructing farm buildings and structures required for animals and crop production. It also involves safety handling and operation of simple tools and machines. Students develop innovative skills in designing and constructing appropriate farm tools and equipment to improve agriculture production.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects.

#### To achieve the learning outcomes, students:

- plan, design and construct buildings and structures
- plan, design and construct a farming tool or a piece of equipment
- operate a farming tool and equipment to improve farming techniques
- evaluate the efficiency of a tool or equipment and make recommendations for improvement
- plan and reconstruct or renovate existing farm facilities.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project using farm technology.

#### Basic tools, equipment and machines

- simple machines, such as chainsaw, lawnmower, knapsack sprayer
- farming tools; for example, hoes and spades
- machine operating skills
- safe use of tools and machines
- care and maintenance of machines

#### Tractors and implements

- implements such as disc plough, harrow, rotorvator, mouldboard plough
- safety checks, uses and operation

#### Draught animals

- techniques of handling and breaking animals
- tools and equipment

- field operations
- care and management

**Planning and designing**

- plan, design, cost and construct simple appropriate farm tools or equipment
- evaluation and recommendations

**Construction of farm tools and structures**

- tools and equipment
- animal buildings, fence, drainage, nursery house, copra drier, coffee drier, cocoa fermentry, and so on
- materials and supply
- applied construction of tools, buildings and equipment using techniques such as welding, soldering, nailing
- care and maintenance of equipment

## 11.6 Agribusiness

Integrated with projects

This unit enables students to explain the basic principles of agricultural economics in relation to the agriculture industry and to make economic decisions based on consumer behaviour being influenced by choice or preference. Students learn the marketing principles needed in agricultural business.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
7. demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels.

#### To achieve the learning outcomes, students:

- state the business and economic principles and factors of agricultural production
- apply economic and marketing principles when planning a viable agriculture business
- develop a workable agricultural business plan for a selected crop or livestock.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Agricultural economics

- introduction: the meaning of 'economic'
- Papua New Guinea's national agriculture policy
- types of agriculture business and competition affecting agricultural enterprises
  - monopoly
  - oligopoly
  - monopsony
  - pure competition
- principles of supply, demand and price
- consumer behaviour
  - choice or preference
  - income level
- comparative advantage

**Agricultural marketing**

- definition of markets
- types of markets: place, product name, seasonal event
- marketing channels for selling agriculture products in local area
- quality standards for marketing products locally and internationally
- advertising and selling of agriculture products
- problems of marketing agriculture products
  - infrastructure
  - transport
- hedging: market contracts
- the role of farmer associations and cooperatives in marketing

## Grade 12 Agriculture units

### 12.1 Applied Farm Management

Integrated with projects

Applied Farm Management is one of the main units of Applied Natural Resource Management since it integrates all the skills and knowledge of crops, livestock, farm buildings and extension into an agribusiness approach. It involves applying farm management principles in different farm enterprises to generate income. This unit requires farmland, financial resources and administrative support from the school. With assistance from the teacher, students are expected to form farm groups to operate an enterprise. It is also expected that the school lends working capital to the farm groups.

#### Learning outcomes

Students can:

3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
5. apply entrepreneurial skills in projects.

#### To achieve the learning outcomes, students:

- develop a farm plan
  - plan, organise and allocate farm resources
- operate and manage a profitable agricultural farm
- keep farm records and accounts
- analyse income and expenditure of the farm accounts
- apply management techniques to selected enterprises
- participate in making farm decisions on allocating resources

#### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project using farm management skills.

#### Planning and organisation of farm groups

- farm groups
- farm manager, secretary and treasurer
- roles and responsibilities of farm members
- school-based loan application or proposal

#### Choosing alternative farming enterprises

- conduct market survey

- crops: vegetables, staples, cereals
- livestock: sheep and goats, poultry
- gross margin analysis and deciding on alternative farm enterprise
- cash flow for enterprises
- calculating projected income for each enterprise

**Farm operations**

- resource allocation and/or purchasing
- establishing farm structure, such as a building or nursery
- farm production and management

**Farm banking**

- opening accounts
- deposits and withdrawals
- bank reconciliations
- bank statements

**Farm sales and records**

- farm meetings to report on sales
- cash book entries; income and expenditure
- farm diary and journals

**Farm accounting processes**

- costs
  - operating cost (fixed and variable costs)
  - non-operating costs (personal costs, tax)
- gross income
  - cash sales
  - inventory change
  - investments
  - home consumption
- profit and loss statement
- cash statement

**Farm evaluation and reporting**

- farm operation report
- profit and loss statement
- farm evaluation: 'strengths, weaknesses, opportunities and threats' (SWOT)
- recommendations for improvement



## 12.2 Introduction to Applied Research

5 weeks

In Grade 13, students carry out a basic scientific and/or social research project over an assessment period, closely supervised by the teacher. They apply relevant knowledge, techniques, skills and tools to systematically plan and conduct research, and collect and analyse data, to suggest solutions to certain agricultural issues and problems. They also learn how to disseminate information.

### Learning outcomes

Students can:

4. identify and analyse issues affecting farm management and make recommendations for improvement
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels.

#### To achieve the learning outcomes, students:

- describe the importance of research in agriculture
- explain the principles of research
- undertake a research project on a selected agricultural issues
- write and present the project report.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Rationale

- importance of research
- purpose of research

#### Principles of research

- quantitative: definition and example of quantitative research
- qualitative: definition and example of qualitative research
- social and biological

#### Methods and designs

- agricultural field experiments on crops, soils and livestock
- social inquiry
  - surveys
  - questionnaires
  - personal interviews

- observations
- research material preparation

### **Research project areas**

- livestock
- crops
- agricultural economics and marketing
- extension
- soils
- socioeconomic issues

### **Implementing research**

- agricultural inquiry
  - laying out experiment: preparing land and/or housing
  - preparing experimental treatments
  - data collection and sampling
  - analysing data: statistics software
- social inquiry
  - designing research instruments
  - collecting sample data
  - analysing data
  - reporting

### **Report writing and presentation**

- report format
  - title of the research
  - introduction
  - aims and objectives
  - materials and methods
  - results
  - discussion
  - conclusion
  - recommendations
  - references and/or bibliography
- report presentation
  - using a variety of media to present the report
  - acknowledgements

## 12.3 Perennial and Biannual Crop Production

Ongoing; to be studied throughout the year

This unit emphasises field applications. Students acquire basic skills in the agronomic systems of economically important plantation crops grown in Papua New Guinea. They apply improved farming and cropping techniques to increase production.

Biannual or perennial crops covered in this unit include cocoa, coffee, oil palm, rubber, coconut, tea fruit and nut trees. Biannual crops are crops such as cassava, sugarcane, banana, pineapple and so on.

It is a requirement for schools to establish minifarms where students demonstrate field management activities of these crops. Students learn to appreciate the important contribution of crop production to the economy.

### Learning outcomes

Students can:

3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting farm management and make recommendations for improvement
7. demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels.

#### To achieve the learning outcomes, students:

- identify and describe the basic skills involved in land selection, nursery establishment
- explain the activities involved in land preparation
- state and describe the crop management practices followed in plantations
- demonstrate site selection, field preparation and crop management skills to sustain crop yield.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project on perennial or biannual crop production.

#### Importance and roles of perennial and biannual crops

- food security
- nutrition
- export
- raw materials
- employment
- contribution to GDP

- income generation

### **Environmental requirements**

- soil type and preparation
- water requirements
- climate
- topography

### **Cropping systems**

- monocropping
- intercropping under field crops
- relay cropping

### **Nursery construction and management**

- site selection
- soil preparation
  - soil sterilisation
- types of nurseries
  - temporary
  - semi-permanent
  - permanent
- poly bag nursery or ground nursery
- factors affecting site selection
  - water
  - distance
  - slope
  - soil
  - security
- nursery management practices
  - watering
  - fertilising
  - pest and disease control
- plant propagation
  - seeds and cuttings

### **Field preparation**

- clearing vegetation
- burning
- drainage
- cover crop establishment
- shade tree lining
- lining and holing
- planting

### **Crop management practices**

- weed control
- chemical mixing and calibrations
- pest and disease control
- fertiliser application
- pruning

### **Harvesting and post-harvest for quality control**

- timing and signs of maturity
- harvesting; for example, picking, gathering, sorting, grading, bagging
- post-harvest processing: fermentation, drying, use of preservatives, cooling, grinding and bottling or packaging
- storage methods and conditions, such as temperature and humidity
- storage and marketing

## 12.4 Animal Production (Polygastrics)

Ongoing; to be studied throughout the year

In this unit, students acquire basic scientific knowledge of animal physiology and are involved in practical aspects of raising polygastric animals for meat, milk and fibre production. Students perform tasks necessary to improve livestock production, including planning, housing, fencing, husbandry practices, feeding and nutrition, slaughtering and processing. Polygastric animals may include cattle, buffalo, sheep, deer and goats.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation
3. apply knowledge, skills and appropriate technology to improve and sustain production
4. identify and analyse issues affecting farm management and make recommendations for improvement.

#### To achieve the learning outcomes, students:

- apply improved animal husbandry practices to increase polygastric animal production
- grow and manage pastures
- identify health problems and disorders and apply measures to maintain a healthy stock
- demonstrate post-processing operations according to hygiene standards.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project in animal production.

#### Importance and uses of polygastric animals

- food, such as meat, milk
- lard, medicine
- cash income
- social obligation
- fibres
- tillage or transportation; for example, buffalo
- by-products, such as offal, manure, blood, hoofs and horns, hind

#### Types of breeds

- cattle

- meat (beef: Jersey, Brahman breeds)
- milk (dairy: Jersey, Friesian breeds)
- goats
  - meat
  - milk (Saanen, Toggenurg)
- sheep
  - meat (Corriedale, Merino)
  - wool (Corriedale)
- deer
  - meat
- buffalo

#### **Livestock improvements**

- breed selection: growth rate, product quality and quantity
- breeding systems: inbreeding and outbreeding

#### **Animal nutrition**

- nutrient requirement for growth, meat, milk, egg and fibre production
- classes of feed and nutritional values
  - commercial feeds
  - local feeds
- local feed formulations

#### **Pasture establishment and management**

- pasture grasses and legumes
- pasture management and improvement
- grazing systems (rotational, strip, open, tethering, integration)

#### **Planning and establishing a polygastric project**

- site selection and mapping
- stocking rate, determining animal unit per hectare of grazing land
- fencing calculations, materials required
- budget estimates
- sourcing stock

#### **Divisional fencing and stockyard designs**

- appropriate designs
- maintenance of fencing and stockyards

#### **Animal husbandry**

- breeding management
  - animal behaviour
  - mating, weaning, culling, castration
- stock management

- ear tagging, branding, drenching, hoof trimming, handling
- health and hygiene practices
  - diseases and parasites
  - signs of healthy and sick animals
  - causes, prevention, control and treatment
  - stockmanship and routine requirements

**Processing and post-processing activities**

- slaughtering
  - time, techniques, tools and equipment
- butchering techniques
- grading, packaging, storage, handling of products and transport



**Forestry**

## Learning outcomes: Forestry

The Forestry learning outcomes identify the knowledge, skills, attitudes and values all students achieve or demonstrate at the end of Grade 12.

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting forestry management and make recommendations for improvement
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support forest production at the community, national and international levels.

Learning outcomes mapped against Forestry units								
Learning outcomes	Units							
	11.1	11.2	11.3	11.4	12.1	12.2	12.3	12.4
1. Demonstrate an understanding of the socioeconomic benefit and values of forestry resources	✓	✓		✓		✓	✓	
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation		✓	✓	✓			✓	✓
3. Apply knowledge, skills and appropriate technology to undertake sustainable practical projects			✓		✓	✓	✓	✓
4. Identify and analyse issues affecting forestry management and make recommendations for improvement			✓	✓	✓		✓	
5. Apply entrepreneurial skills in projects			✓			✓		
6. Communicate ideas and information in a variety of ways		✓			✓	✓		
7. Demonstrate an understanding of the policies and organisations that support forest production at the community, national and international levels	✓			✓		✓	✓	

## Unit sequence and content: Forestry

Grade 11 units	Grade 12 units
<p><b>11.1 Introduction to Forestry</b></p> <ul style="list-style-type: none"> <li>• Role and importance of forests</li> <li>• Forest resources of Papua New Guinea</li> <li>• Forest policies</li> <li>• Training and careers in forestry</li> </ul> <p><b>11.2 Introduction to Tree Science</b></p> <ul style="list-style-type: none"> <li>• Plant classification levels</li> <li>• Naming of tree plants</li> <li>• Diversity in plants</li> <li>• Documentation</li> </ul> <p><b>11.3 Plantation Silviculture</b></p> <ul style="list-style-type: none"> <li>• Plantation terminology</li> <li>• Nursery management</li> <li>• Plantation establishment</li> <li>• Maintenance and protection</li> </ul> <p><b>11.4 Forest Conservation</b></p> <ul style="list-style-type: none"> <li>• What to conserve</li> <li>• How to conserve</li> <li>• Benefits</li> <li>• Constraints of conservation in Papua New Guinea</li> </ul>	<p><b>12.1 Measurements</b></p> <ul style="list-style-type: none"> <li>• Height and diameter measurements</li> <li>• Log measurements and volume calculations</li> <li>• Basic map reading</li> <li>• Transverse survey</li> <li>• Sampling techniques</li> </ul> <p><b>12.2 Harvesting, Processing and Marketing</b></p> <ul style="list-style-type: none"> <li>• Harvesting methods</li> <li>• Harvesting procedures</li> <li>• Advantages and disadvantages of forest harvesting</li> <li>• Processing of sawn timbers</li> <li>• Occupational health and safety</li> <li>• Marketing of forest products</li> <li>• Types of marketing</li> <li>• Sales of forest products</li> <li>• Other forest products</li> </ul> <p><b>12.3 Forestry Economics and Marketing</b></p> <ul style="list-style-type: none"> <li>• Forest resources and forest products</li> <li>• Demand for and supply of forest products</li> <li>• Trade of forest products</li> </ul> <p><b>12.4 Agroforestry</b></p> <ul style="list-style-type: none"> <li>• Definition</li> <li>• Common agroforestry systems</li> <li>• Patterns in agrisilviculture</li> <li>• Silvipastoral practice</li> <li>• Choice of tree species</li> <li>• Benefits</li> <li>• Constraints</li> </ul> <p><b>12.5 Introduction to Applied Research</b></p> <ul style="list-style-type: none"> <li>• Rationale</li> <li>• Principles of research</li> <li>• Methods and designs</li> <li>• Research project areas</li> <li>• Implementing research</li> <li>• Report writing and presentation</li> </ul>

## TVET modules

Modules from TVET National Certificate 1 courses can be offered in place of three units only over Grades 11 and 12, provided that the modules are delivered by registered training providers.

Schools must be registered as, or in partnership with, registered TVET providers and comply with the requirements of the Quality Training Framework.

### TVET Training Packages

Students can study modules from the following courses at National Certificate 1 in place of three Forestry units:

- Commodity Crop Production

## Grade 11 Forestry units

### 11.1 Introduction to Forestry

4 weeks

In this unit, students are introduced to the study of forestry through gaining knowledge of the forestry principles and practices used in managing forest resources in Papua New Guinea. It highlights the role and importance of forestry to Papua New Guinea's economy. The unit motivates students to develop interest in forestry career pathways.

Students appreciate the socioeconomic benefits of forest resources and how to manage these as stipulated in the National Forest Policy, which emphasises wise use of forest resources.

#### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
7. demonstrate an understanding of the policies and organisations that support forest production at the community, national and international levels.

#### To achieve the learning outcomes, students:

- identify important forest resources in Papua New Guinea and which resources could be used to produce timber materials, generate income and provide employment
- evaluate the consequences of mismanagement of forest resources
- identify appropriate forestry practice and make projections according to the National Forest Plan and other related strategies.

#### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Role and importance of forests

- providing food and shelter
- aesthetic values
- cash economy
- employment
- balancing of ecological systems
- medicinal values
- clean water
- carbon sink

**Forest resources of Papua New Guinea**

- forest resource distribution by province
- forest types
- forestry statistics
  - export data
  - employment
  - income

**Forest policies**

- understanding and interpreting existing government policies
  - Medium Term Development Strategy (MTDS)
  - National Forest Plan (NFP)

**Training and careers in forestry**

- tertiary institutions in Papua New Guinea
- careers
  - government and private sectors
  - self-employment

## 11.2 Introduction to Tree Science

6 weeks

In this unit students demonstrate knowledge and skills of plant botany, including plant classification levels. Students develop skills in naming plants and in preparing, mounting and storing plant specimens.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
6. communicate ideas and information in a variety of ways.

### To achieve the learning outcomes, students:

- explain the importance of plant classification
- describe the features of the common plants
- collect, name and mount plant specimens
- develop the ability to think critically and make informed decisions.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Plant classification levels

- plant kingdom
- phylum
- class
- order
- family
- genus
- species

#### Naming of tree plants

- importance of naming plants
- scientific (botanical) names
- trade and common names
- identification of common trees

**Diversity in plants**

- non-vascular plants
- vascular plants
- naming and identification of medicinal plants

**Documentation**

- importance of documentation
- principles of collecting plant specimens
- procedures and materials for mounting plant specimens
- collecting, mounting and displaying tree plant species



## 11.3 Plantation Silviculture

25 weeks

In this unit, students undertake practical activities to demonstrate essential knowledge and techniques in plant propagation, land preparation, planting, tending and protection of tree crops. Students should be linked with nearby existing projects to gain practical exposure. As it is a practical unit, it should be taught throughout the year, alongside the other Grade 11 Forestry units.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting forestry management and make recommendations for improvement
5. apply entrepreneurial skills in projects.

#### **To achieve the learning outcomes, students:**

- apply a range of concepts and skills in planting forests
- demonstrate knowledge and skills in creating forests
- identify risks to tree crops
- explain techniques involved in maintaining tree crops
- demonstrate knowledge and skills involved in creating forests
- suggest ways to protect trees from destructive agents.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a project in silviculture.

#### **Plantation terminology**

- reforestation
- afforestation
- enrichment

#### **Nursery management**

- site selection
- types of nurseries
- seed collection and cuttings
- soil preparation
- germination

- sowing and transplanting
- caring for seedlings
- nursery records

**Plantation establishment**

- site preparation
- planting patterns and spacing
- planting

**Maintenance and protection**

- tending
- pruning
- thinning
- fire control
- pest and disease control

## 11.4 Forest Conservation

3 weeks

In this unit, students identify the importance of conserving the forest for the wellbeing of its inhabitants. The knowledge acquired enables students to appreciate the socioeconomic benefits derived from conserving the forests and regenerating forests that have been destroyed. The unit prepares students to apply conservation skills and knowledge in forest sustainability.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
4. identify and analyse issues affecting forestry management and make recommendations for improvement
7. demonstrate an understanding of the policies and organisations that support forest production at the community, national and international levels.

#### To achieve the learning outcomes, students:

- list benefits of conservation
- describe the features of each conservation method
- identify problems of conservation in Papua New Guinea
- suggest ways for improving problems that affect conservation in Papua New Guinea
- distinguish types of conservation areas.

### Content

#### What to conserve

- biodiversity
- carbon sinks
- watersheds and soils
- habitats

#### How to conserve

- national parks
- nature reserves
- wildlife management area (WMA)
- buffers and corridors
- botanical gardens

- zoos
- marine parks (mangroves)

**Benefits**

- aesthetic values
- ecotourism
- climate change reduction
- carbon trading

**Constraints of conservation in Papua New Guinea**

- land ownership
- agriculture development and other land uses
- views and preferences of people
- lack of awareness of conservation benefits
- lack of political support
- lack of funds

## Grade 12 Forestry units

### 12.1 Measurements

9 weeks

This unit enables students to gain the knowledge and skills to measure standing trees and logs. Students also use maps to identify common features on the maps and relate them to the field.

#### Learning outcomes

Students can:

3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting forestry management and make recommendations for improvement
6. communicate ideas and information in a variety of ways.

#### To achieve the learning outcomes, students:

- measure height and diameter of standing trees; calculate volume of logs
- read and interpret the different features on a map
- undertake surveys and sampling using maps
- demonstrate the skills of using measuring instruments.

#### Content

Students acquire knowledge and skills through classroom teaching and field demonstration of this content. Students undertake practical activities in map reading and surveying; and in harvesting, processing and measuring logs.

#### Height and diameter measurements

- use of tools for height and diameter measurements
- procedures in height and diameter measurements

#### Log measurements and volume calculation

- use of different methods for determining volumes of logs
- use of tools for length and diameter measurements
- procedures in length and diameter measurements
- calculation of volume using Hiber's formula and Smilian's formulas

#### Basic map reading

- read a range of maps and identify features
  - topographic maps
  - vegetation maps

- identify map information in the field
- convert map scales into field measurements

**Transverse survey**

- basic chain compass survey
- plotting of sketch maps

**Sampling techniques**

- strip line
- circular
- square
- rectangular

## 12.2 Harvesting, Processing and Marketing

12 weeks

In this unit, students identify and practise common techniques in harvesting and use different equipment and machines. Students acquire knowledge of health and safety issues, particularly in regard to the use of machinery. Students learn how timber is processed and treated. This unit also gives students the opportunity to apply entrepreneurial skills in forestry.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support forest production at the community, national and international levels.

### To achieve the learning outcomes, students:

- use a range of equipment and apply techniques used in harvesting and processing of forest products
- list and describe the benefits of harvesting forest resources
- demonstrate knowledge of occupational health and safety rules in the use of equipment in forestry operations
- apply appropriate safety rules in the working environment.

### Content

Students acquire knowledge and skills through learning and teaching of this content. Students undertake practical activities related to harvesting and processing timber.

#### Harvesting methods

- selective logging
- clear-fell logging

#### Harvesting procedures

- tree marking
- direction of felling
- cutting of climbers and vines
- creating escape route for felling
- felling techniques

### **Advantages and disadvantages of forest harvesting**

- advantages
  - income generation
  - employment
  - development of infrastructure
  - food and shelter
  - fuel wood
- disadvantages
  - destruction of habitat
  - pollution of water
  - global warming
  - social effects in large-scale harvesting operation
  - soil erosion

### **Processing of sawn timbers**

- types of sawmills: large-scale sawmill, portable sawmill
- cutting timber into different sizes
- grading timbers and calculating timber volumes
- treatment of timbers: drying: dress all around (DAR): chemical treatment
- storage: timber yards

### **Occupational health and safety**

- safety equipment and rules

### **Marketing of forest products**

- sawn timbers: sold as roughsawn, DAR in cubic metres or lineal metres
- round logs
- firewood
- sawdust
- posts and poles

### **Types of markets**

- supply and demand of forest products
- domestic
- international

### **Sales of forest products**

- royalty payments for forest resource owners
- selling of sawn timber
- log exports

### **Other forest products**

- rattans, eaglewood, sandalwood, bamboo, palms, orchids, resins and gums, butterflies



## 12.3 Forestry Economics and Marketing

2 weeks

In this unit, students identify forestry resources and products produced by industries in Papua New Guinea, such as plywood, chipwood, round logs and sawn timber, which have important effects in the general economy of Papua New Guinea. Students identify markets available locally and internally and explain the economic factors that affect prices for these products, such as consumer demand or supply levels, both locally and internationally.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. apply entrepreneurial skills in projects
7. demonstrate an understanding of the policies and organisations that support forest production at national and international levels.

### To achieve the learning outcomes, students:

- state the business and economic principles and factors of forestry production
- discuss various products that are in demand nationally and internationally
- apply economic and marketing principles to planning a viable forestry business
- develop a workable forestry enterprise.

### Forest resources and forest products

- resources
- composition
- productivity
- forest products

### Demand for and supply of forest products

- tree species
  - common name
  - world distribution
  - wood density
  - product market

- demand for product: market locally and internationally
- supply: locally and internationally

**Trade of forest products**

- domestic trade
- foreign trade
- forest management techniques of forest products
- regeneration
- regulation of yield
- sale of timber

## 12.4 Agroforestry

6 weeks

In this unit, students learn knowledge and skills in integrated tree cropping and multiple land use to enhance socioeconomic benefits.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects.

#### To achieve the learning outcomes, students:

- plan and design integrated farming and land use systems
- demonstrate knowledge of the benefits of integrated projects
- appreciate the value of integrated land use.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a practical project integrating farm and land use systems.

#### Definition

- definition of agroforestry
- purpose of agroforestry

#### Common agroforestry systems

- agrisilviculture
- silvipastoral

#### Patterns in agrisilviculture

- border plantings
- rows
- strips
- random

#### Silvipastoral practice

- border planting and shade trees
- trees with grazing animals

**Choice of tree species**

- types of trees
- nitrogen fixation ability
- compatibility with agriculture systems

**Benefits**

- balancing ecosystems
- maximum land use
- maintaining soil fertility
- fuel wood
- erosion control
- providing shade
- multiple cycle production
- fodder

**Constraints**

- intensive management
- incompatible systems
- land limitations
- topography

## 12.5 Introduction to Applied Research

3 weeks

Students carry out a basic scientific and/or social forestry research project over a period in Grade 12. They apply relevant knowledge, techniques, skills and tools to systematically plan, research, collect and analyse data or suggest solutions to certain forestry problems. Students learn how to disseminate information.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of forestry resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation
4. identify and analyse issues affecting forestry management and make recommendations for improvement
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support forest production at national and international levels.

### To achieve the learning outcomes, students:

- describe the importance of research in forestry
- explain the principles of research
- undertake a research project on a selected forestry issue
- write and present the project report.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake a research project on a selected forestry issue.

#### Rationale

- importance of research
- purpose of research

#### Principles of research

- quantitative: definition and example of quantitative research
- qualitative: definition and example of qualitative research

#### Methods and designs

- field experiments: forestry crops and soils

- surveys
- questionnaires
- personal interviews
- observations
- preparing research materials

### **Research project areas**

- soils
- seed germination and testing
- impact of forestry development

### **Implementing research**

- experiment design
- data collection: sampling
- analysing data

### **Report writing and presentation**

- report format
  - title of the research
  - introduction
  - aims and objectives
  - materials and methods
  - results
  - discussion
  - conclusion
  - recommendations
  - references and/or bibliography

## **Fisheries**

## Learning outcomes: Fisheries

The Fisheries learning outcomes identify the knowledge, skills, attitudes and values all students achieve or demonstrate at the end of Grade 12.

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of fisheries resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to improve and sustain production
4. identify and analyse issues affecting fisheries management and make recommendations for improvement
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support fish production, management, conservation and development at national and international levels.

Learning outcomes mapped against Fisheries units														
Learning outcomes	Units													
	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	12.1	12.2	12.3	12.4	12.5	
1. Demonstrate an understanding of the socioeconomic benefit and values of fisheries resources	✓	✓			✓			✓						✓
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation		✓	✓	✓	✓		✓			✓	✓	✓		
3. Apply knowledge, skills and appropriate technology to improve and sustain production			✓	✓	✓		✓				✓	✓		
4. Identify and analyse issues affecting fisheries management and make recommendations for improvement	✓		✓			✓			✓					✓
5. Apply entrepreneurial skills in projects					✓		✓	✓				✓		
6. Communicate ideas and information in a variety of ways									✓	✓				✓
7. Demonstrate an understanding of the policies and organisations that support fish production, management, conservation and development at national and international levels	✓					✓			✓					✓



## Unit sequence and content: Fisheries

Grade 11 units	Grade 12 units
<p><b>11.1 Introduction to Fisheries</b></p> <ul style="list-style-type: none"> <li>Natural resources in Papua New Guinea</li> <li>Role and importance of fisheries</li> <li>Export and import data</li> <li>Government policies</li> <li>Training and careers in fisheries</li> </ul> <p><b>11.2 Marine Biology 1</b></p> <ul style="list-style-type: none"> <li>Introducing the science of marine biology</li> <li>Tropical seas</li> <li>Fundamentals of biology</li> </ul> <p><b>11.3 Fishing Technology 1</b></p> <ul style="list-style-type: none"> <li>Fish aggregating device (FAD)</li> <li>Line fishing</li> <li>Pots and traps</li> <li>Gear construction</li> </ul> <p><b>11.4 Basic Seamanship (option)</b></p> <ul style="list-style-type: none"> <li>Boat handling (open dinghy)</li> <li>Rope work</li> <li>Marine engineering (outboard)</li> <li>Small boat sea safety</li> </ul> <p><b>11.5 Aquaculture and Mariculture</b></p> <ul style="list-style-type: none"> <li>Introduction to aquaculture</li> <li>Species to culture</li> <li>Ponds, dams and cages</li> <li>Aquaculture and the environment</li> </ul> <p><b>11.6 Fisheries Management</b></p> <ul style="list-style-type: none"> <li>Marine environmental management</li> <li>Fresh and sea water management</li> <li>Papua New Guinea's fisheries laws and regulations</li> <li>Sustainable fishing practices</li> <li>Impacts of people on fisheries</li> </ul> <p><b>11.7 Handling, Processing and Storage</b></p> <ul style="list-style-type: none"> <li>Personal hygiene and conduct</li> <li>Fish handling and storage</li> <li>Clean work area</li> </ul> <p><b>11.8 Fisheries Business</b></p> <ul style="list-style-type: none"> <li>Record keeping</li> <li>Costs</li> <li>Gross income</li> <li>Fisheries and economics</li> <li>Fisheries marketing</li> </ul>	<p><b>12.1 Introduction to Applied Research</b></p> <ul style="list-style-type: none"> <li>Rationale</li> <li>Principles of research</li> <li>Methods and designs</li> <li>Research project areas</li> <li>Implementing research</li> <li>Report writing and presentation</li> </ul> <p><b>12.2 Marine Biology 2</b></p> <ul style="list-style-type: none"> <li>Biology of marine organisms</li> <li>Anatomy and physiology of marine organisms</li> <li>Structure and function of marine ecosystems</li> </ul> <p><b>12.3 Fishing Technology 2</b></p> <ul style="list-style-type: none"> <li>Net fishing</li> </ul> <p><b>12.4 Seamanship (option)</b></p> <ul style="list-style-type: none"> <li>Boat handling</li> <li>Piloting and navigation</li> <li>Marine engineering (inboard)</li> <li>Sea safety</li> </ul> <p><b>12.5 Fisheries Extension</b></p> <ul style="list-style-type: none"> <li>Roles and importance of fisheries extension</li> <li>Extension and communication methods</li> <li>Identifying fisheries problems</li> </ul>

## Grade 11 Fisheries units

### 11.1 Introduction to Fisheries

2 weeks

In this unit, students are introduced to the study of Fisheries and understanding the fishing and fish-farming principles and systems practised in Papua New Guinea. The unit also highlights the role and importance of fisheries for Papua New Guinea's economy. The unit motivates students to develop an interest in career pathways in fisheries.

Students appreciate and describe the socioeconomic benefits of natural resources and how to manage these, as stipulated in the National Fisheries Development Plan, which emphasises food security, export, poverty alleviation and self-reliance. Students are introduced to the basic stock assessment skills used in assessing behaviour of fish stocks as a result of fishing pressure. The concept of sustainable levels of fisheries is introduced.

#### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of fisheries resources
4. identify and analyse issues affecting fisheries management and make recommendations for improvement
7. demonstrate an understanding of the policies and organisations that support fish production at national and international levels.

#### To achieve the learning outcomes, students:

- identify important natural resources in the country
- demonstrate a basic understanding of fish farming and inland fisheries
- explain the importance of fisheries resources to the economy of Papua New Guinea
- evaluate and describe the consequences of mismanagement of natural fisheries resources
- understand that fish and other aquatic organisms can be cultivated like agriculture crops and livestock
- become aware of appropriate strategies to operate a sustainable project consistent with the National Fisheries Development Plan and policies.

#### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Natural resources in Papua New Guinea

- marine resources

- aquatic resources
- freshwater resources
- natural environment: lakes, rivers, mountains, mangroves
- climate

### **Role and importance of fisheries**

- food security
- health benefits through provision of quality protein
- cash economy
- employment
- self-reliance
- providing training
- monitoring and managing fisheries resources for sustainable use

### **Export and import data**

- why and how to use data
- data collection
- export and imports: qualities and values
- factors affecting market prices
- fishery-dependent and fishery-independent data

### **Government policies**

- understanding and interpreting existing government policies
- Medium Term Development Plan strategies
- National Fisheries Development Plan
  - fisheries management policies
  - fisheries legislation and regulations
  - fisheries management plans

### **Training and careers in fisheries**

- diploma or degree program in fisheries (University of Vudal)
- National Fisheries College
- other tertiary institutions in Papua New Guinea
- careers
  - government and private sectors
  - self-employment

## 11.2 Marine Biology 1

8 weeks

This unit introduces students to the ecology, anatomy and physiology of marine and freshwater plants and animals. They have the opportunity to study a marine plant or animal of their choice. Students understand the complexity of fisheries and marine and freshwater organisms and their adaptations. Students apply practical skills in marine biology.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of fisheries resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production.

#### **To achieve the learning outcomes, students:**

- explain and apply a range of concepts and skills of marine biology to enhance sustainability of the marine environment
- demonstrate appropriate skills and practices to effectively manage the marine environment
- identify and explain the anatomy and physiology of marine life
- identify and explain the anatomy and physiology of freshwater organisms
- briefly describe and explain the fundamentals of biology
- describe the ocean and its features
- conduct research on issues affecting fishing and fish farming and make recommendations to improve productivity.
- describe the marine environment as a source of food security, employment, income and leisure.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### **Introducing the science of marine biology**

- definition of marine biology
- history; importance of marine biology today

#### **Tropical seas**

- geography of the tropical seas
- chemical and physical properties of the tropical seas
- seawater
  - salt composition and salinity

- quality tests and checks
- temperature and density
- tropical ocean circulation
  - surface and thermocline circulation
- waves and tides
  - types
  - what causes them

**Fundamentals of biology**

- building blocks
- cells and organelles
- challenges of life in the sea
- introduction to different marine habitats
- introduction to diversity of life in the different marine habitats

## 11.3 Fishing Technology 1

8 weeks

This unit enables students to be involved in the practical aspects of constructing, deploying, retrieving, caring for and maintaining fishing gear, as well as fishing activities. Students apply skills to improve catches, which include planning, identifying potential fishing grounds and applying appropriate fishing methods to catch the targeted species.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production
3. apply knowledge, skills and appropriate technology to improve and sustain production
4. identify and analyse issues affecting fisheries management and make recommendations for improvement.

#### **To achieve the learning outcomes, students:**

- explain and apply improved fishing practices to increase production
- apply and identify appropriate techniques to construct and maintain a range of fishing gear and equipment
- demonstrate and use appropriate fishing techniques.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake practical activities using fishing skills.

#### **Fish aggregating device (FAD)**

- definition of FAD
- types of FADs
- site selection, survey and awareness
- FAD construction and deployment
- care and maintenance of FADs

#### **Line fishing**

- hand lining and casting rod
- trolling and trolling rod
- horizontal and vertical long line
- pole and line
- target species
- baits
- care and maintenance

**Pots and traps**

- types of materials
- size and shape of pots and traps
- identifying target species
- selecting fishing sites
- types of baits
- care and maintenance of pots and traps

**Gear construction**

- FAD construction
- wooden reel construction
- mainline, snoods and branch lines
- trolling line
- pots and traps

## 11.4 Basic Seamanship (option)

5 weeks

This unit involves practical aspects of boat handling and outboard motor operation, maintenance and troubleshooting. It also involves applying occupational health and safety principles in fishing.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production
3. apply knowledge, skills and appropriate technology to improve and sustain production.

#### To achieve the learning outcomes, students:

- demonstrate skills of boat handling
- apply and demonstrate skills of rope work
- operate and maintain small marine outboard motors
- demonstrate the appropriate skills of safety on the water to minimise mishaps
- demonstrate first aid skills on the water.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. They undertake practical activities involving the safe use of boats and small engines.

#### Boat handling

- main parts of a small boat
- manoeuvring
- rough weather
- practical boat handling

#### Rope work

- ropes terminology
- knots, splices and uses
- care and maintenance of ropes
- practical tying and splicing of ropes

#### Marine engineering (outboard)

- main components
- basic operation



- starting and shutting down procedures
- maintenance and troubleshooting
- un-drowning an outboard
- practical use and maintenance of engines

**Small boat sea safety**

- first aid at sea
- emergencies; preventing accidents and actions
- safety equipment
- safety checklist

## 11.5 Aquaculture and Mariculture

10 weeks

In this unit, students acquire and demonstrate aquaculture and mariculture knowledge and skills to promote food security and income generation.

The unit promotes the importance and relevance of inland and coastal fishing, and emphasises that the present level of wildlife capture cannot be maintained. Students learn that habitat degradation in nursery areas is limiting the wildlife stock replacement rate, and understand that the increasing demand for seafood makes aquaculture and mariculture an alternate source of seafood.

This unit provides students with the opportunity to undertake practical activities; for example, in site selection, feed formulation, spawning fish, algae culture for larval feeding, making fish ponds, cage fishing, shell farming and seaweed farming.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of fisheries resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to improve and sustain production
5. apply entrepreneurial skills in projects.

#### **To achieve the learning outcomes, students:**

- identify and select suitable species to culture
- identify and select sites for establishing ponds, dams or cages
- construct suitable fish ponds, dams or cages
- apply aquaculture and mariculture technology to increase fish production
- demonstrate harvesting and processing methods and skills
- demonstrate an understanding of the reproductive biology and nutrition of aquaculture organisms
- demonstrate an understanding of environmentally sustainable aquaculture development
- demonstrate an understanding of the potential environmental impacts and risks in large-scale aquaculture development
- demonstrate an understanding of aquaculture quarantine and the risks involved in domestic and international translocation of aquaculture organisms
- demonstrate an understanding of the economics of aquaculture and mariculture and apply entrepreneurial skills in aquaculture.

## Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake practical aquaculture or mariculture projects to culture fish or other species.

### **Introduction to aquaculture**

- definition of aquaculture and mariculture
- history of aquaculture and current global trends in aquaculture
- history of aquaculture in Papua New Guinea; current trends
- types of fish to breed
- suitable types of seaweed to farm
- suitable shellfish to farm

### **Species to culture**

- types of fish to breed
- suitable types of seaweed to farm
- suitable shellfish to farm
- suitable crustaceans to farm, including
  - prawn species
  - crabs
  - freshwater crayfish
  - freshwater prawns
  - lobsters

### **Ponds, dams and cages**

#### *Site selection for ponds, dams or cages*

- type of soil structure
- geographical location
- weather patterns
- temperature and salinity level
- survey
- construction

#### *Types of aquaculture systems*

- extensive aquaculture
- semi-intensive aquaculture
- intensive aquaculture
- sea ranch and stock enhancement
- recirculating aquaculture systems
- polyculture
- integrated aquaculture systems (livestock, vegetables and aquaculture)

#### *Culture methods*

- ponds, cages, tanks

- long line and rafts (pearls, oysters and seaweeds)
- types and construction of ponds, dams and cages

*Fish reproduction*

- importance of genetic quality in breeding
- maintaining pure lines
- basic fish genetics
- broodstock selection and management
- broodstock care and maintenance
- sex determination and determination of spawning time
- types of spawning
  - natural spawning
  - artificial spawning; that is, providing natural cues for spawning or artificial injection of hormones

*Nursery and larval rearing*

- hatchery management
- larval rearing
- natural food organisms (green water culture)
- algae culture for larval feeding of fish and crustaceans

*Fish nutrition*

- digestive systems and nutritional requirements of aquatic organisms (aquaculture organisms)
- feeding (how much to feed)
- type of feed
  - larval feeds
  - growout feed
  - finisher feeds
  - broodstock nutrition and feeds
  - natural pond productivity
  - feed conversion ratio
  - fish feed formulation

*Fish farm management*

- feeding; how much to feed
- stocking density
- water quality management

*Fish health*

- pest and diseases
- disease management and use of antibiotics
- importance of quarantine
- risks involved in domestic and international translocation of species
- legislation in importing and quarantine

*Harvesting and processing.*

- sanitary and phytosanitary requirements
- food safety

**Aquaculture and the environment**

- environmental impacts of aquaculture
- waste discharge

## 11.6 Fisheries Management

2 weeks

This unit both expands on and integrates with the Lower Secondary Aquaculture Unit 9.7. It focuses on the sustainable management of commercial fishing and gives students the opportunity to appreciate the scope and value of resources found in their respective seas, rivers, lakes and ponds. Students learn about the impacts, issues and socioeconomic benefits of fisheries management.

Students develop the knowledge to be able to operate a viable small-scale or commercial fishing project, in line with fisheries policies and laws. Note: because different management techniques and approaches are required for different target species, this unit may only cover general aspects of fisheries such as tuna, lobster, trochus, eel, bêche-de-mer, tilapia and trout.

### Learning outcomes

Students can:

4. identify and analyse issues affecting fisheries management and make recommendations for improvement
7. demonstrate an understanding of the policies and organisations that support fish production at national and international levels.

#### To achieve the learning outcomes, students:

- demonstrate and explain sustainable practices in fisheries management
- apply and monitor fisheries management measures to raise juveniles to reach maturity
- apply fisheries management knowledge and skills for sustainable fishing
- explain the principles of marine resource management.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Marine environmental management

- traditional and historical management practices
- local resource owners and the sea
- contemporary management practices

#### Fresh and sea water management

- resource owners and the river
- closed sea and river systems: lakes
- importance of sea and river to livelihoods
- coastal and inland fish resources

- traditional and sustainable management

### **Papua New Guinea's fisheries laws and regulations**

#### *The government's role*

- to balance competing claims to ensure sustainable use and act as referee in managing the nation's territorial waters
  - the process for access or allocation
- to balance competing claims in managing the nation's territorial waters
  - fishing permit and licence
  - enforcement and monitoring
  - aquaculture licence
  - aquaculture policy
  - territorial waters: shore to 3 nautical miles
  - provincial waters: 3 to 12 nautical miles
  - exclusive economic zone or declared fishing zone: 12 to 200 nautical miles

### **Sustainable fishing practices**

- our role as fishers (or stakeholders)
- fisheries management tools and measures
  - closed areas or seasons
  - size limits and gear restrictions
  - marine reserves
- alternatives
  - fish aggregating device
  - aquaculture and mariculture enhancement

### **Impacts of people on fisheries**

#### *Direct impacts*

- fishing
- land reclamation
- mineral exploitation
- pollution; for example, tailings from industry
- rubbish and waste
- increase in the by-catch

#### *Indirect impacts*

- global warming

#### *Creating solutions to sustainable fisheries management*

- single species and multi-species fisheries

## 11.7 Handling, Processing and Storage

2 weeks

This unit provides the skills and knowledge required to apply important hygiene procedures in the fishing industry. Students learn about handling fish and seafood products and cleaning the work area, during and after production; and according to procedures that make sure occupational health and safety standards and food regulations are met. This knowledge and these skills are essential for all sectors of the seafood industry. They cover food safety procedures and practices and risk management.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to improve and sustain production
5. apply entrepreneurial skills in projects.

#### **To achieve the learning outcomes, students:**

- demonstrate understanding of occupational health and safety standards and food regulations in the fishing industry
- describe economic activities and their impacts on marine life and environment
- apply the principles and practices of managing marine and fresh water resources
- demonstrate the use of fisheries technology for producing and marketing a fisheries product
- apply and use astrological knowledge and techniques for open fishing to improve the catch.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### **Personal hygiene and conduct**

- types of hazards
- controlling hazards

#### **Fish handling and storage**

- good product handling
- avoiding cross-contamination
- minimising physical damage



- maintaining the cold chain
- requirements for different seafood products
- gilling and gutting

**Clean work area**

- cleaning the work area
- cleaning work areas and equipment
- storing chemicals
- pest control

## 11.8 Fisheries Business

2 weeks

In this unit, students learn to use available resources and make economic decisions when planning and operating a fisheries enterprise. Topics include resources, factors of production, fisheries planning, record keeping, accounting principles, and budgeting and gross margin analysis. Students also learn economic and marketing principles needed for fisheries business.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of fisheries resources
5. apply entrepreneurial skills in projects.

#### To achieve the learning outcomes, students:

- state the business and economic principles and factors of fisheries production
- explain the importance and functions of record keeping
- apply economic and marketing principles when planning fishing or fish farming business to improve profitability
- develop a fishing or fish-farming business plan to generate a profitable income.

### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Record keeping

- importance of record keeping
- types of records, such as journals, sales, payments, inventory
- fisheries accounting or aquaculture economics

#### Costs

- operating costs
  - fixed costs
  - variable costs
- non-operating costs
  - personal costs
  - tax

#### Gross income

- cash sales

- inventory changes
- investments
- profit and loss statement
- cash statements

### **Fisheries and economics**

- relationship between economics and fisheries business
- types of fisheries businesses
- competition affecting fisheries enterprises
  - monopoly
  - oligopoly
  - monopsony
- principles of supply and demand, and price
- consumer behaviour
  - preferences
  - income levels

### **Fisheries marketing**

- definition of markets
- types of markets
  - place, product name, seasonal event
- marketing channels for selling fisheries products
- quality standards for marketing fisheries products locally and internationally
- problems of marketing fisheries products
  - infrastructure, transport
- hedging
  - market contracts
- decision making
  - evaluation of fishing ground and fish farm performance
- gross margin analysis
  - deciding alternative fishing and fish farm enterprises

## Grade 12 Fisheries units

### 12.1 Introduction to Applied Research

2 weeks

Students carry out a basic scientific and or social research project over a period in Grade 12. They apply relevant knowledge, techniques, skills and tools to systematically plan, research, collect and analyse data to suggest solutions to certain fisheries problems. They also learn how to disseminate information.

#### Learning outcomes

Students can:

4. identify and analyse issues affecting fisheries management and make recommendations for improvement
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support fish production at national and international levels.

#### To achieve the learning outcomes, students:

- describe the importance of research in fisheries
- explain the principles of research
- undertake a research project on a selected fisheries issue.

#### Content

Students acquire knowledge and skills through the learning and teaching of this content.

#### Rationale

- importance of research
- purpose of research

#### Principles of research

- quantitative: definition and example of quantitative research
- qualitative: definition and example of qualitative research

#### Methods and designs

- field experiments
- surveys
- questionnaire
- personal interviews
- observations

- preparing research materials

### **Research project areas**

- fish
- seafood
- fisheries economics
- marketing
- extension
- fisheries issues

### **Implementing research**

- preparing experimental treatments
- data collection: sampling
- analysing data

### **Report writing and presentation**

#### *Report format*

- title of the research
- introduction
- aims and objectives
- materials and methods
- results
- discussion
- conclusion
- recommendations
- references and/or bibliography

## 12.2 Marine Biology 2

8 weeks

In this unit, students are introduced to the ecology, anatomy and physiology of marine plants and animals. Students have the opportunity to study a marine plant or animal of their choice. This unit aims to make students aware of the complexity of fisheries and marine organisms and their adaptations. It enables student to apply practical skills in marine biology.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation
6. communicate ideas and information in a variety of ways.

#### **To achieve the learning outcomes, students:**

- explain and demonstrate a range of concepts and skills of marine biology to enhance sustainability of the marine environment
- identify and explain the anatomy and physiology of marine life.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake field trips to marine ecosystems, collect samples where appropriate, analyse samples and present reports on their findings.

#### **Biology of marine organisms**

- different groups of organisms in marine ecosystems
- primary producers (microbes, seaweeds and other marine plants)
- marine invertebrates (animals with backbones)
- special subject (dangerous marine organisms)
- marine organisms and human interaction

#### **Anatomy and physiology of marine organisms**

- anatomical structures
  - functions of these structures
- energy production
- excretion
- muscular coordination
- respiration

### **Structure and function of marine ecosystems**

- mangrove forests
  - definition
  - species
  - distribution
  - common crustaceans and fish
- estuaries
  - main ecosystem (tidal, salinity, open river)
  - sources of food and nursery for fish and crustacean species
  - influence
  - salinity variations
- seagrass beds
  - biology
  - taxonomy
  - zonation
- coral reefs
  - coral anatomy
  - types of coral
  - feeding
- open oceans
  - pelagic
  - environment
  - ocean structure

## 12.3 Fishing Technology 2

8 weeks

In this unit, students are involved in practical aspects of constructing, maintaining, deploying and retrieving fishing nets. They learn skills in and knowledge of different net fishing techniques available in the fishing industry.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to improve and sustain production.

#### To achieve the learning outcomes, students:

- apply skills to construct and maintain fishing nets
- use a range of nets and techniques to catch fish
- identify problems encountered in deploying and retrieving nets
- apply safety skills in deploying and retrieving nets
- describe the different net fishing methods.

### Content

Students acquire knowledge and skills through the learning and teaching of this content. Students undertake practical activities using nets to harvest and process fish for marketing.

#### Net fishing

- types of nets
  - gill nets; beach seine and cast net; purse seine; prawn trawl
- deployment and retrieval of nets
  - gill nets; beach seine and cast net; purse seine; prawn trawl
- assembly and repair of damaged netting
  - netting terminology; cutting a hole; sewing a hole; putting up a patch
- harvesting fish
  - catching, cleaning, processing, packaging, marketing



## 12.4 Seamanship (option)

8 weeks

This unit enables students to acquire skills in and knowledge of safe boat handling, sea safety, basic navigation and vessel maintenance when fishing. Students also learn and explain the basic weather patterns for safe navigation to and from fishing grounds.

### Learning outcomes

Students can:

2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production
3. apply knowledge, skills and appropriate technology to improve and sustain production
5. apply entrepreneurial skills in projects.

#### To achieve the learning outcomes, students:

- demonstrate skills of planning and organising a fishing trip
- apply and demonstrate skills of boat handling and safe navigation
- identify and describe main components of an inboard engine
- demonstrate skills in troubleshooting and maintenance
- apply and demonstrate skills of sea safety and survival techniques.

### Content

#### Boat handling

- main parts of a small boat
- manoeuvring
- rough weather
- practical boat handling

#### Piloting and navigation

- navigation equipment
- marine charts
- rules of the sea
- weather

#### Marine engineering (inboard)

- main components
- basic operation
- starting and shutting down procedures
- maintenance and troubleshooting

**Sea safety**

- lifesaving equipment
- survival at sea
- dangers to survivors
- fire fighting

## 12.5 Fisheries Extension

3 weeks

This unit enable students to explain the importance and purposes of fisheries extension and the role it plays in fisheries development in Papua New Guinea. Students describe and participate in the process of communicating fisheries information and innovative technology to fisherpersons. Students collect relevant information from the NFA office, statutory bodies and other relevant offices and communicate it to fisherpersons in appropriate ways. It prepares students to be change agents for fisheries development in their communities. Students participate and collaborate in discussing issues affecting fisheries communities.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of fisheries resources
4. identify and analyse issues affecting fisheries management and make recommendations for improvement
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support fish production at national and international levels.

#### To achieve the learning outcomes, students:

- explain the roles and importance of fisheries extension in educating fishermen and women
- apply the methods and processes of fisheries extension
- identify and analyse fisheries problems and offer advice on possible solutions.

### Content

Students acquire knowledge and skills through learning and teaching of this content.

#### Roles and importance of fisheries extension

- change agents
  - extension officer roles: such as being the middle person disseminating knowledge and skills to the fisheries community and the other way around
- linkages
  - fishermen and women with service providers and agencies
- information
  - sourcing and transferring information

**Extension and communication methods**

- field days and awareness meetings
- publications: media, charts
- training and visits (televised)
- radio and television
- training attachments
- extension patrols

**Identifying fisheries problems**

- production factors: waste disposal and destructive practices
- over-fishing
- lack of fisheries information
- law and order
- HIV and AIDS
- road infrastructure
  - roads and bridges

# **Integrated Natural Resource Management**

## Learning outcomes: Integrated Natural Resource Management

The Integrated Natural Resource Management learning outcomes identify the knowledge, skills, attitudes and values all students achieve or demonstrate at the end of Grade 12. The learning outcomes listed below apply to the integration of natural resources.

Within the Integrated Resource Management context, students can:

1. demonstrate an understanding of the socioeconomic benefit and values of natural resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting natural resource management and make recommendations for improvement
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support resource production at community, national and international levels.

<b>Learning outcomes mapped against Integrated Natural Resource Management units</b>			
<b>Learning outcomes</b>	<b>Units</b>		
	<b>11.1</b>	<b>12.1</b>	<b>12.2</b>
1. Demonstrate an understanding of the socioeconomic benefit and values of natural resources	✓	✓	✓
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation	✓	✓	
3. Apply knowledge, skills and appropriate technology to undertake sustainable practical projects	✓	✓	
4. Identify and analyse issues affecting natural resource management and make recommendations for improvement	✓	✓	
5. Apply entrepreneurial skills in projects	✓	✓	
6. Communicate ideas and information in a variety of ways	✓	✓	✓
7. Demonstrate an understanding of the policies and organisations that support resource production at community, national and international levels	✓	✓	✓

## Unit sequence and content: Integrated Natural Resource Management

Grade 11 units	Grade 12 units
<p><b>11.1 Integrated Farming Systems 1</b></p> <ul style="list-style-type: none"> <li>• Definitions and examples</li> <li>• Benefits of integrated farming systems</li> <li>• Requirements of various farming enterprises</li> <li>• Integrated farm projects operations</li> </ul>	<p><b>12.1 Integrated Farming Systems 2</b></p> <ul style="list-style-type: none"> <li>• Definitions and examples</li> <li>• Benefits of integrated farming systems</li> <li>• Requirements of various farming enterprises</li> <li>• Integrated farm projects operations</li> </ul> <p><b>12.2 Extension</b></p> <ul style="list-style-type: none"> <li>• Roles and importance of extension</li> <li>• Extension and communication methods</li> <li>• Identifying farming problems and applications</li> </ul>

### TVET modules

Modules from TVET National Certificate 1 courses can be offered in place of three units only over Grades 11 and 12, provided that the modules are delivered by registered training providers.

Schools must be registered as, or in partnership with, registered TVET providers and comply with the requirements of the Quality Training Framework.

TVET Training Packages
<p>Students can study modules from the following courses at National Certificate 1, in place of two Integrated Management units:</p> <ul style="list-style-type: none"> <li>• Commodity Crop Production</li> <li>• Livestock Production</li> </ul>

## Grades 11 and 12: Integrated Natural Resource Management units

### Integrated Farming Systems 1 and 2

40 weeks

This year-long unit introduces students to the concept of integrating several enterprises on the same farm area, which is successful in many countries, including Papua New Guinea. Concepts covered include examples of farms adopting integrated farming systems; how they are managed; and social, environmental and economic benefits.

Examples of integrated farming can include mixes of two or more animals; plants with animals; crops with crops; and crops with animals and fish, such as growing rice, raising pigs, keeping a fish pond and keeping bees (apiculture) on the same area of land—in other words, integrated livestock management; integrated fish and livestock management; integrated agroforestry management; integrated pest and disease management.

Small specialised projects should be undertaken at the same time as larger projects. For example, coffee would be a larger project, which would take two years; and vegetable growing, poultry and bees could be smaller projects. All projects would run at the same time.

Students are required to work on a practical model farm where the concepts discussed can be applied to enhance learning. Schools can choose combinations that are suitable for their local environment and operate over a period of one year.

There will be collaborations with other line agencies, such as the Department of Agriculture and Livestock, the National Forest Authority, the National Fisheries Authority, the National Agriculture Research Institute, the Coffee Industry Corporation, the National Agriculture Quarantine and Inspections Authority, the Fresh Produce Development Agency, Highlands Honey Ltd and Cocoa-Coconut Research Institute.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of natural resources
2. demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation
3. apply knowledge, skills and appropriate technology to undertake sustainable practical projects
4. identify and analyse issues affecting natural resource management and make recommendations for improvement
5. apply entrepreneurial skills in projects
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations the support resource production at community, national and international levels.



**To achieve the learning outcomes, students:**

- give some examples of integrated farming systems practices in Papua New Guinea and other countries
- explain the benefits of integrated farming systems
- sketch a design of an integrated farming system that can be adopted in the local area
- apply practical activities related to integrated farming systems on a model farm
- raise crops, animals and/or trees as part of an integrated project.

**Content**

Students acquire knowledge and skills through the learning and teaching of this content.

**Definitions and examples**

- defining integrated farming systems
- examples of integrated farming systems
  - animal and animal mix, such as cattle and goats
  - plant and plant mix, such as cocoa and coconut
  - plant, animal and fish mix, such as poultry, fish, vegetables
  - plant and animal mix, such as coffee, poultry and honeybees; oil palm and cattle

**Benefits of integrated farming systems**

- benefits of integrated farming systems
- biological processes
  - pollination
  - biogas
- economic
  - higher return per land unit or hectare
- self-sufficiency
- environmental benefits
  - wastes are recycled

**Requirements of various farm enterprises**

- site selection
- soil
- climate
- environmental
- biological relationship
- husbandry practices
- socioeconomic values and benefits

**Integrated farm projects operations**

- planning and designing an integrated farm project
- economics of the business
  - budgeting
  - record keeping
  - marketing of the business products
- project implementation
- evaluation

## 12.2 Extension

3 weeks

This unit is teacher-guided to help students explain the importance and purposes of agricultural extension and the role it plays in agricultural development in Papua New Guinea. Students describe and participate in the process of communicating agriculture information and innovative technology and skills to their local communities. They may go beyond the allocated time.

Many activities involve students in collecting relevant information from the Provincial Division of Primary Industry, the National Department of Agriculture and Livestock offices, national agricultural research institutions, statutory bodies and other relevant sister agencies, and communicating effectively to the community members. The 'public-private partnership' concept is to be adopted for ownership and sustainability of the subject.

The unit also prepares students to be change agents for agricultural development in their communities, where they participate and collaborate in discussing common issues affecting farming communities and offer possible solutions.

### Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of natural resources
6. communicate ideas and information in a variety of ways
7. demonstrate an understanding of the policies and organisations that support resource production at national and international levels.

#### **To achieve the learning outcomes, students:**

- explain the roles and importance of agricultural extension in educating rural families and farmers
- apply methods and processes of agriculture extension in a simplified manner
- identify and analyse farming problems and offer advice on possible solutions

### Content

Students acquire knowledge and skills through learning and teaching of this content and participating in extension activities.

#### **Roles and importance of extension**

- change agents
  - extension officer roles: such as being the middle person disseminating knowledge and skills to the farming communities (as well as the other way around)

- linkages through farmers, service providers and agencies
- information: sourcing and transferring information to target groups

**Extension and communication methods**

- field days, agricultural shows: (posters)
- publications (media, charts)
- training and visiting (televised)
- radio and television
- training attachments
- extension patrols
- practical field demonstrations or model farms

**Identifying farming problems and applications**

- production factors such as
  - land
  - labour
  - time
  - capital
  - pests or diseases
- unavailability of improved crop variety or livestock breeds
- lack of technical information
- law and order
- HIV and AIDS
- infrastructure
  - roads and bridges
  - market outlets

## **Assessment**

## Assessment components, weightings and tasks

The internal assessment mark for Applied Natural Resource Management is to be based on the Grade 11–12 syllabus only. Final assessment should be based on a range and balance of assessment instruments.

The components, weightings and tasks for Grade 11 and 12 units are detailed below.

### Components, weightings and tasks for Grades 11 and 12

Component	Weightings	Marks Grade 11	Marks Grade 12	Tasks
Tests and examinations	20%	60	60	These will include multiple-choice items, short answers and extended responses
Sustainable practical projects	55%	165	165	Growing crops, raising animals, analysing soils and producing farm tools
Investigations and problem-solving or research activities	20%	60	60	Students are expected to collect, analyse, interpret and evaluate information from a range of sources, which could be used to solve agricultural problems
Work attitudes	5%	15	15	Students to demonstrate their commitment, confidence, independence and teamwork in carrying out their learning
<b>Total</b>	<b>100%</b>	<b>300</b>	<b>300</b>	

## Assessment and certification

The assessment and reporting practices described here are detailed further in the *National Assessment and Reporting Policy for Papua New Guinea* (2003) and in other support materials produced by the Department of Education

### Assessment

The main purpose of assessment is to improve student learning.

Assessment needs to be *for* learning as well as *of* learning. It is used to evaluate and improve learning and teaching, report achievement and provide feedback to students on their progress.

Assessment measures students' achievement of learning outcomes as described in the syllabuses. It is the ongoing process of identifying, gathering and interpreting information about students' achievement of the learning outcomes.

Learning and teaching using an outcomes approach requires teachers to plan their teaching and assess learner performance in relation to outcomes using criteria derived from those outcomes. Assessment involves focusing less on whether a learner has 'passed' or 'failed' and more on what outcomes a learner has achieved and in which areas further support is required.

### Assessment in Applied Natural Resource Management

A student's achievement in Applied Natural Resource Management at the end of Grade 12 will be assessed against the learning outcomes. Assessment of student progress towards achieving these learning outcomes is cumulative throughout Grades 11 and 12.

It is important that teachers plan the learning and teaching sequence so that there is a balanced spread of assessment during the year. Some tasks, such as investigations or research projects, can be designed so that they are completed over a period of time rather than at the end of the unit. Other tasks can be done immediately after the relevant section of the unit or topic has been covered.

### Assessment for certification

A student's overall achievement in Applied Natural Resource Management will be internally assessed. Successful completion of the subject will be recorded on the national certificate.

#### Internal assessment

Internal assessment provides a measure of a student's achievement based on a wide range of syllabus content and outcomes. For Applied Natural Resource Management, the internal assessment marks will provide a summation of each student's achievements in Grades 11 and 12. The

assessment tasks used to determine the internal assessment mark must comply with the components, weightings and types of tasks specified in the table on page 98. A variety of tasks gives students the opportunity to demonstrate all the learning outcomes in different ways to improve the validity and reliability of the assessment.

All schools must meet the requirements for internal assessment as specified in the *Grade 12 Assessment, Examination and Certification Handbook*.

## **Recording**

All schools must meet the requirements for maintaining and submitting student records as specified in the *Grade 12 Assessment, Examination and Certification Handbook*.

## **Certification**

Candidates will be awarded the national certificate only if they meet all requirements for internal assessment. Eligibility rules for the award of certificates are specified in the *Grade 12 Assessment, Examination and Certification Handbook*.

## **TVET qualification**

Students who successfully complete TVET modules will be issued with a TVET National Qualification by the registered provider of the training.