Applied Natural Resource Management

Agriculture
Forestry
Fisheries
Integrated Natural Resource Management

Upper Secondary

Teacher Guide

Papua New Guinea
Department of Education

Acknowledgements

Contents

Secretary's message

This teacher guide is to be used by Applied Natural Resource Management teachers when implementing the Upper Secondary Applied Natural Resource Management syllabuses throughout Papua New Guinea.

Three new subjects—Forestry, Fisheries and Integrated Natural Resource Management—have been introduced in addition to Agriculture. For consistency and validity, this syllabus framework needs to be consulted regularly when undertaking teaching programs and designing assessment tasks.

The teacher guide directly complements the Applied Natural Resource Management syllabuses. It builds on and promotes the concepts and principles required for a better future for young Papua New Guineans. The concepts emphasise the National Education Plan's vision and aspirations for integral human development. It enables students to develop and acquire relevant knowledge and skills to manage available and limited natural resources sustainably.

Teachers are equally encouraged to collaborate with relevant stakeholders, particularly research institutions, corporate bodies, government departments, tertiary institutions and non-government organisations to solicit relevant and up-to-date information. This will enable the key stakeholders to take ownership of the suggested programs and activities relating to Applied Natural Resource Management.

I commend and approve the Upper Secondary Applied Natural Resource Management Teacher Guide for use in all schools with Grades 11 and 12 students throughout Papua New Guinea.

DR JOSEPH PAGELIO

Secretary for Education

Introduction

The purpose of this teacher guide is to help teachers implement the Applied Natural Resource Management subjects. It is designed to provide further guidance on suggested learning and teaching activities.

The teacher guide supports the syllabus framework. The syllabus framework states the learning outcomes for the subject and units, and outlines the content and skills that students will learn, and the assessment requirements.

The teacher guide provides direction for teachers using the outcomes approach in the learning environment. The outcomes approach requires teachers to consider the assessment component for each unit in the planning stages as reflected in the teacher guide.

This teacher guide also provides examples of learning and teaching strategies. It provides detailed information on criterion-referenced assessment and the resources needed to teach Applied Natural Resource Management. The section on recording and reporting shows teachers how to process students' marks and report against the learning outcomes.

The outcomes approach

In Papua New Guinea, the Lower Secondary and Upper Secondary syllabuses use an outcomes approach. The major change in the curriculum is the shift to what students know and can do at the end of a learning period, rather than a focus on what the teacher intends to teach.

An outcomes approach identifies the knowledge, skills, attitudes and values that all students should achieve or demonstrate at a particular grade in a particular subject (the learning outcomes). The teacher is responsible for identifying, selecting and using the most appropriate teaching methods and resources to achieve these learning outcomes.

Imagine the student is on a learning journey, heading to a destination. The destination is the learning outcome that is described in the syllabus document. The learning experiences leading to the learning outcome are to be determined by the teacher. The teacher uses curriculum materials, such as syllabus documents and teacher guides, as well as textbooks or electronic media and assessment guidelines, to plan activities that will assist students achieve the learning outcomes.

The outcomes approach has two purposes. They are:

- to equip all students with knowledge, understandings, skills, attitudes and values needed for future success
- to implement programs and opportunities that maximise learning.

Three assumptions of outcomes-based education are:

- all students can learn and succeed (but not on the same day or in the same way)
- success breeds further success
- schools can make a difference.

The four principles of the Papua New Guinean outcomes approach are:

1 *Clarity of focus through learning outcomes*
   This means that everything teachers do must be clearly focused on what they want students to be able to do successfully. For this to happen, the learning outcomes should be clearly expressed. If students are expected to learn something, teachers must tell them what it is, and create appropriate opportunities for them to learn it and to demonstrate their learning.

2 *High expectations of all students*
   This means that teachers reject comparative forms of assessment and embrace criterion-referenced approaches. The 'principle of high expectations' is about insisting that work be at a very high standard before it is accepted as completed, while giving students the time and support they need to reach this standard. At the same time, students begin to realise that they are capable of far more than before and this challenges them to aim even higher.

3 *Expanded opportunities to learn*
   This is based on the idea that not all students can learn the same thing in the same way in the same time. Some achieve the learning outcomes sooner and others later. However, most students can achieve high standards if they are given appropriate opportunities. Traditional ways of

organising schools do not make it easy for teachers to provide expanded opportunities for all students.

4   *Planning and programming by 'designing down'*
This means that the starting point for planning, programming and assessing must be the learning outcomes—the desired end results. All decisions on inputs and outputs are then traced back from the learning outcomes. The achievement of the outcome is demonstrated by the skills, knowledge and attitudes gained by the student. The syllabuses and/or teacher guides describe some ways in which students can demonstrate the achievement of learning outcomes.

Outcomes-based approach
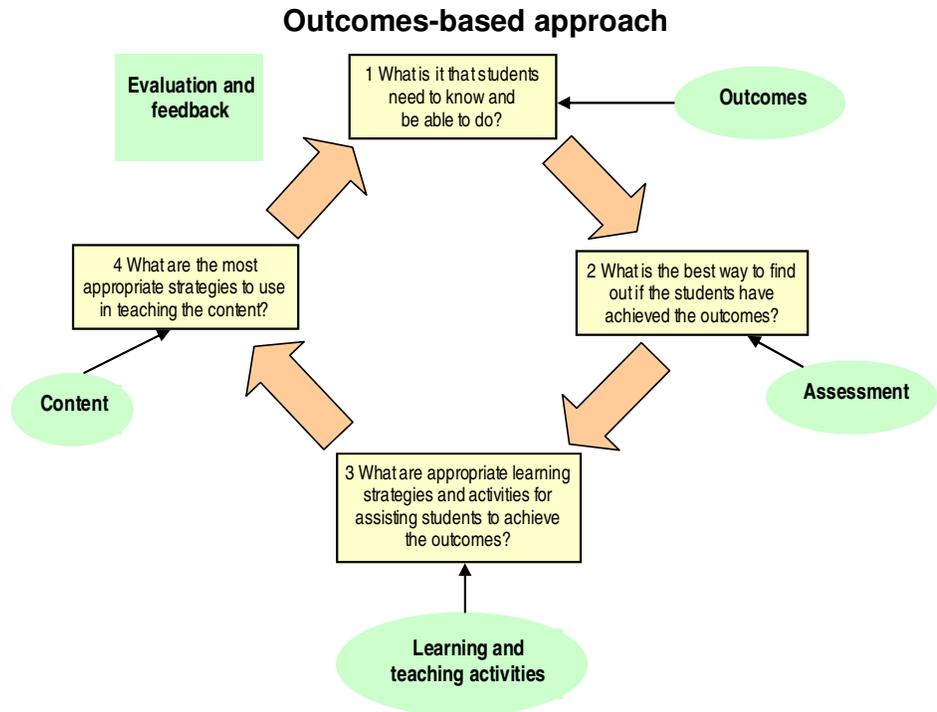
Learning outcomes provide teachers with a much clearer focus on what students should learn. They also give teachers greater flexibility to decide what is the most appropriate way of achieving the learning outcomes and meeting the needs of their students by developing programs to suit local content and involve the community.

The outcomes approach promotes greater accountability in terms of student achievement because the learning outcomes for each grade are public knowledge; that is, they are available to teachers, students, parents and the community. It is not the hours of instruction, the buildings, the equipment or support services that are the most important aspect of the education process but rather, what students know and can do, as they progress through each grade. The outcomes approach means that learning

- has a clearer purpose
- is more interactive—between teacher and students, between students
- has a greater local context than before
- is more closely monitored and acted upon by the teacher
- uses the teacher as a facilitator of learning as well as an imparter of knowledge.

Learning outcomes

The syllabus learning outcomes describe what students know and can do at the end of Grade 12. The level of achievement of the learning outcomes should improve during the two years of Upper Secondary study, and it is at the end of the study that students are given a summative assessment on the level of achievement of the learning outcomes. The learning outcomes for Applied Natural Resource Management are listed below. These learning outcomes 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.

Learning and teaching

You, as a teacher, must teach the knowledge that is included in the syllabus documents. You have to be able not only to teach what students should know, but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support learning and teaching. You also need to give students some opportunities to apply their knowledge, to be creative and to solve problems.

Learning and teaching strategies

Students who participate in guided instruction learn more than students who are left to construct their own knowledge (Mayer 2004). You need to employ a variety of learning and teaching approaches because all students do not learn in the same way. The 'auditory learner' prefers to use listening as the main way of learning new material whereas a 'visual learner' prefers to see things written down. Students should be actively involved in their learning and therefore you need to design appropriate practical activities or experiments, using resources that can be found in your location.

In Grades 11 and 12, students will already have had a wide variety of experiences. You need to make use of your students' experiences when designing and conducting learning in class, so that learning is connected to your students' world. There are many learning and teaching strategies described in the Lower Secondary teacher guides.

Teaching approaches

Before focusing on specific teaching activities and approaches for the units some general points need to be made. Teachers should keep these in mind when they are planning their teaching program and should continually evaluate their own performance.

1. Most educationists today stress that how we learn is even more important than what we learn. Too often in the past examiners have concentrated on the learning of facts, which meant that many of the past syllabuses were focused on content. Yet today much of the factual information becomes obsolete soon after leaving school and is not used again. Teachers need to place more focus on how to learn, as once students acquire these skills, they will continue to pursue learning for its own sake rather than for passing examinations.

2. Much of the emphasis in teaching Applied Natural Resource Management is placed on the students being actively involved in their own learning. Teachers need to design appropriate experiments and practical activities using resources that can be found in their location. Teachers will need to consult with their local community to determine the most suitable agricultural resources that can be used in the course. In this way, teachers will be able to select the most suitable farms to visit and suitable guest speakers.

3. Teachers also need to employ a variety of learning and teaching approaches. This is because not all students learn in the same way. For

instance one common classification is between auditory, visual, active and reflective learners. Thus an auditory learner prefers to use listening as the main way to learn new material, whereas a visual learner prefers to see things written down. Some teachers rely solely on talking, which means that about 70% of their students are not being exposed to their preferred way of learning.

4. Students studying this subject would already have had a wide variety of experiences, so teachers need to make use of these experiences when designing and conducting learning in the class. One of the most important pedagogical principles to employ is to ensure connectedness to the students' world. Ideally teachers will start each unit asking students what they already know about that topic and then building on that knowledge to help them learn what they need to know.

5. Too often learning is focused on the lower levels of the cognitive domain such as remembering and understanding. The most efficient and long-lasting learning occurs when teachers encourage the development of higher-order thinking and critical analysis skills, which include applying, analysing, evaluating and creating. Attention should also be paid to developing students' affective and psychomotor skills. To make sure that this happens, you should encourage deep or rich—rather than shallow—coverage of knowledge and understandings.

Developing Applied Natural Resource Management skills

Students need to develop the skills and techniques for applied natural resource management. Skills development should happen as a part of students' learning experiences and the learning and practising of skills needs to take place in the context of the Applied Natural Resource Management subject areas. Skills learning tends to be most effective when:

• students go from the known to the unknown

• students understand why it is necessary to master specific skills

• skills are developed sequentially at increasing levels of difficulty

• students identify the components of the skill

• the whole skill and the components of the skills are demonstrated

• there are frequent opportunities for practice and immediate feedback

• the skills being taught are varied in terms of amount and type, according to the needs of students

• the skill is used in a range of contexts.

What do students do in Agriculture, Forestry, Fisheries and Integrated Natural Resources Management?

Applied Natural Resource Management students:

• have a holistic view of the environment and its physical, biological, social, economic and political components in time and space

• understand and interpret patterns and processes

• have the skill to acquire (gather), organise, analyse and synthesise data and information in order to understand, manage and solve resource management problems

- design and conduct interviews and questionnaires, classify and summarise the resultant data and analyse and make deductions from the results
- have knowledge of key resource management theories and concepts and be able to apply such understanding to practical problems in the real world
- conduct basic field observations and measurements, represent these in the form of notes, sketching, interpreting and analysing the results
- exhibit proficiency in self-management, interpersonal skills, and written and oral communication.

Practical work

Practical work is an essential part of the study of Applied Natural Resource Management. It is the tool that facilitates the understanding of natural resource management processes. Practical work in the field can enhance learning opportunities for a wide range of students because it caters for a variety of learning and teaching styles. Practical work enables students to:

- acquire knowledge and skills by actively participating in integrated agriculture, forestry and fisheries activities
- effectively learn abstract concepts that may be difficult to understand in theory
- safely use different kinds of tools, materials, equipment and machinery appropriate for agriculture, forestry and fisheries production
- appreciate and directly benefit the value of natural resources production
- comprehend the contribution of natural resource management to the country's economy
- positively contribute towards poverty alleviation and improve standard of living.

What do teachers of Applied Natural Resource Management do?

The Applied Natural Resource Management teacher

- is interested in and concerned about sustainable utilisation of available natural resource
- actively seeks to keep informed while maintaining a critical stance towards sources of information
- informs him or herself about environmental issues as they impact upon his or her community and on communities and ecological systems globally
- engages in some form of social action to support her or his beliefs.

As a teacher, she or he will:

- model democratic values of fairness, justice and equal respect
- use a range of teaching styles that foster both individual development and group cooperation and enable learners to make the best use of their differing learning styles
- encourage her or his learners to adopt a reflecting and questioning position in relation to geographic knowledge

- teach the prescribed curriculum well with an emphasis on infusing issues dealing with human rights, relationships, self-esteem and respect for diversity
- be a critical and thoughtful teacher
- consult and collaborate with relevant stakeholders and school authorities.

Developing a program

A teaching program outlines the nature and sequence of learning and teaching necessary for students to demonstrate the achievement of the learning outcomes. The content of the syllabus describes the learning context and the knowledge required for the demonstration of each outcome. The relevant learning outcomes for each unit or topic are stated at the beginning of the unit and the requirements of the outcomes are elaborated.

Teachers must develop programs that include appropriate learning activities to enable students to develop the knowledge and skills identified in the outcome statements.

The content prescribed in the units indicates the breadth and depth with which topics should be treated. The sequence of teaching is prescribed by the sequence of content. The learning outcomes and assessment, however, must be central to the planning of the teaching program.

Planning and programming units

The main purpose of planning and programming is to help you to arrange the presentation of the unit in an organised manner. This will help you to know what to teach and when to teach it. It is strongly recommended that you make plans with the other teachers who teach the same subject. By planning together, you will *all* have better lessons and make better use of your limited resources.

Points to consider when programming
- Which outcomes are students working towards?
- What is the purpose of this unit or topic or learning experience?
- Which learning experiences will assist students to develop their knowledge and understandings, skills, values and attitudes, in Applied Natural Resource Management?
- What are the indicators of student learning that you would expect to observe?
- How can the learning experiences be sequenced?
- How do the learning experiences in the unit relate to students' existing knowledge and skills?
- How are individual learning needs to be catered for?
- What are the literacy demands of this unit or learning experience?
- What authentic links can be made with the content of other subjects?
- How can school events and practices be incorporated into the program?

- Do the assessment methods address the outcomes and enhance the learning?
- How can the assessment be part of the learning and teaching program?

The planning process

In this teacher guide, ideas for programming and organising have been provided. These have been arranged in steps to help you teach the unit. The steps follow the thinking processes involved in the outcomes approach.

Step 1: Interpreting the learning outcomes

The first step is to read the description in the syllabus. Then study the learning outcomes and what students do to achieve the learning outcomes, in order to determine what students will know and be able to do by the end of the unit. You need to look at the action verb, concept and context of each learning outcome. This will help you to see what skills and knowledge are embedded in the outcome.

Step 2: Planning for assessment

It is necessary to plan for assessment early to ensure that you teach the content and skills students need to achieve the learning outcomes. You will have to decide when to schedule assessment tasks to allow yourself time to teach the required content and time for students to develop the necessary skills. You will also need time to mark the task and provide feedback. Practical tasks may, for example, be broken into a series of stages that are marked over several weeks as students progress with making their product. It is not appropriate to leave all the assessment until the end of the unit.

This teacher guide provides performance standards and examples of a marking guide. You should develop marking guides when you are marking tasks to ensure consistency in your assessment. You must also develop clear and detailed instructions for completing the task and make sure all students know exactly what they have to do.

Step 3: Programming a learning sequence

This step requires you to develop a program outlining a sequence of topics and the amount of time spent on each topic. If the unit involves a project, for example, you may plan to teach some theory at appropriate stages during the project, rather than teaching all the theory before the students start the project. To develop your program you need to study the topics listed in the syllabus and to think about which learning activities will best provide students with the opportunity to learn the content and practise the appropriate skills, and how long the activities will take. You will have to think about some major activities that last several weeks and smaller activities that may be completed in a single lesson.

Step 4: Elaboration of activities and content

Once you have mapped out your program for the term, you must then develop more detailed plans for each topic in the unit. All units require students to be actively engaged in learning, not just copying from the board. Make sure you develop a range of activities that suit all learning needs— some reading and writing, some speaking and listening, some observing and doing.

Browse through the textbooks and teaching resources you have access to and list the chapters, pages or items that you will use for each topic in your program. The textbooks should also provide you with ideas for activities

related to the topic. You may have to collect or develop some resources for yourself. Once you have sorted out your ideas and information, you can then develop your more detailed weekly program and daily lesson plans.

This teacher guide gives some suggested learning and teaching activities for each unit and some suggested assessment tasks that you might like to use to ensure active learning. It also gives background information on some of the content.

Using the internet for classroom activities

Planning
• Where appropriate, incorporate computer sessions as part of planned learning experiences.
• Be aware that computers can be time-consuming and may require extra teacher support at unexpected times.
• Consider methods of troubleshooting, such as having students with computer expertise designated as computer assistants.
• Design activities that provide the opportunity for students to access, compare and evaluate information from different sources.
• Check protocols, procedures and policies of your school and system regarding the use of the internet.

Managing
• Ensure that all students have the opportunity to explore and familiarise themselves with the technologies, navigation tools, e-mail facilities and texts on the internet. It is likely that students will have varying degrees of expertise in searching for information and navigating the internet. Students will also have varying experiences of, and be more or less familiar with, the way texts are presented on the World Wide Web.
• Ensure that all students understand how to access the internet and how to perform basic functions, such as searching, sending and receiving e-mail.
• Students with more experience in using the internet may have information that will benefit the whole class. Provide opportunities for students to share their experiences, interests, information and understandings. As well as planning lessons to instruct students in these skills, pairing students and peer tutoring on the computer can enable more experienced students to assist other students.
• Ensure that students critically analyse natural resource management information gathered on the internet, just as they would for any other text. They should be aware that material posted on the Web is not necessarily subject to the conventional editorial checks and processes generally applied to print-based publications. When evaluating information, students might consider:
  – the intended audience of the site
  – bias in the presentation of information, or in the information itself, including commercial or political motives
  – accuracy of information
  – balanced points of view
  – currency of information, including publishing dates
  – authority of source or author (institution, private individual)

- ownership of the website (such as corporate, small business, government authority, academic)
- cultural or gender stereotyping.
- Ensure that software and hardware (computer, modem) are maintained in good working order.
- Ensure that all students are given equal opportunities to use the computer.

Assessing student work containing material from the internet

- Students can download large quantities of information from the internet. In itself, such information provides very little evidence of student effort or student achievement. Students must make judgements about the validity and safety of information when working from the Web. They must consider the purpose of the text, identify bias, and consider the validity of arguments presented and the nature and quality of the evidence provided.
- When assessing student work that includes material drawn from the internet, it is therefore important to recognise how students have accessed the information, what value they place on it and how they have used it for the topic being studied in class. It is useful to look for evidence of critical evaluation, and the development of students' capacities to access, manipulate, create, restore and retrieve information.

Applied Natural Resource Management requirements

Agriculture requirements

There are six units in Grade 11 and four in Grade 12, which all students must complete. There is one optional unit in Grade 12. There is one example of an assessment task for each grade. For the rest of the units, teachers are expected to develop assessment tasks.

Agriculture requirements

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11	10	1	11.1 (1 week)	Commodity export data (PNG Bank Quarterly Bulletin), resource personnel, brochures from various Institutions. Chart papers, posters
			11.2 (9 weeks)	Farmland, tools, planting materials, nursery materials, agricultural chemicals, animal manures and so on
11	11	2	11.2 (1 week)	As above
			11.3 (10 weeks)	Day-old chicks, buildings, feed, feeders , water doughs, equipment, feed chart, farm land paddocks, resource personnel
11	10	3	11.4 (10 weeks)	Basic tools, equipment and machinery, draught animals, implements, buildings

11	10	4	11.5 (6 weeks)	Land, tools, equipment, water, market outlets, sample records, blank forms, case study reports, farm map, infrastructure plans
			11.6 (4 weeks)	Blank forms, markets, samples of agriculture products, resource personnel, existing cooperate bodies
12	10	1	12.1 (10 weeks)	Land, sample records, case study reports, resource personnel, nursery materials, livestock, planting materials, labour, tools and equipment, farm buildings
12	11	2	12.2 (2 weeks)	Worksheets, sample research reports, resource personnel, research materials
			12.3 (8 weeks)	Land, water source, labour, nursery materials, existing plantations, chemicals, tools and equipment, farm buildings, storage facilities
12	10	3	12.4 (5 weeks)	Soil testing kit, land, measuring equipment, chemicals, fertilizers, soil scientists, standard survey equipment, irrigation equipment and materials
			12.5 (3 weeks)	Posters, pamphlets, farm visitations, transport, sound system equipment
12	4	4	12.6 (2 weeks)	Land, bee hives, brooding stock, breeding equipment, tools and equipment, proactive gears, processing equipment and facilities, packaging materials, storage facilities, labour, markets, technical officer, chemicals

Forestry requirements

There are four units in Grade 11, which all students must complete. There are five units in Grade 12, which all students must complete. There are also two assessment tasks which must be completed by students.

Forestry requirements

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11	10	1	11.1 Introduction to Forestry	Papua New Guinea Forest Quarterly Report, chart papers, planting materials, land and nursery area
11	6	2	11.2 Introduction to Tree Science	Chart papers, tree species specimen, pictures of important tree species, herbarium if possible, and local Forestry officer
11	25	2,3,4	11.3 Plantation Silviculture	Poly-bag, soil mixture, seed trays and boxes, watering can, pruning saws, secateurs, budding knives, biochemicals
11	3	4	11.4 Forest Conservation	A natural forest area, publication materials on Papua New Guinea forest conservation sites, botanical garden sites
12	9	1	12.1 Measurements	Tape measure, survey and mapping equipment, compass

12	12	2	12.2 Harvesting Processing and Marketing.	Chainsaw, tree-harvesting procedure flow chart, timber milling flow chart, information on forest trading in Papua New Guinea and overseas, timber treatment chemicals and storage facilities
12	2	3	12.3 Forestry Economics and Marketing	Samples of forest tree products, information on Papua New Guinea Forestry government policies, imports and exports data
12	6	3	12.4 Agroforestry	Cartridge paper, coloured marker pens, rulers and equipment for drawing circles and half circles for writing agrisilviculture and silvipastoral posters. Tree seeds or seedlings
12	3	4	12.5 Introduction to Applied Research	Handouts on quantitative and qualitative research, calculators, simple survey equipment

Fisheries requirements

There are eight units in Grade 11 which all students must complete. There are five units in Grade 12 which all students must complete. There are also two assessment tasks which must be completed by students.

Fisheries requirements

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11	10	1		Fishery profiles of Papua New Guinea fisheries (electronic copies available from NFA). Papua New Guinea EEZ map, map of GOP fishery, map of barramundi fishery, NFA corporate plan Fisheries export data (BPNG quarterly bulletin, NFA export data summary by species),
11		2		Aquatic environment with abundance of wildlife for students to research basic stock, and behaviour of fish stocks as a result of fishing pressure River or sea environments with plants and animals Fishing equipment Boats, rope, small outboard or inboard engines Materials to construct fish ponds, dams or cages
11		3		Fish farming manuals (for example, trout, tilapia, carp, barramundi); seaweed and carp Materials for ponds and cage construction (spades, pipes, nets, floats, sinkers) Digestive system of different fish; for example, carnivore, herbivore and omnivore) Aquaculture seed; fingerlings of carp, tilapia, trout, barramundi and prawn post larvae Aquaculture feed: commercial fish feeds or chicken pellets, feed making ingredients (fish meal, rice bran, wheat bran, copra meal), (small grinder and mincer for pelleting feed) Organic and inorganic fertilisers for natural food production; for example, poultry and livestock manure, composting wastes and commercial fertilisers Fisheries Management Act and Fisheries Management Regulations, National Aquaculture Development Policy,

				Translocation policy and Quarantine policy
				Fisheries Management Plans (tuna, bêche de mer, life reef fish, aquarium, saratoga, barramundi, Gulf of Papua prawn fishery, lobster, trial fishing policy and pump boat fishery)
				Brochures on responsible fishing (no dynamite), use of gill nets, seasonal closures and bans
11		4		Guidelines on good hygiene and sanitary practices in food handling and processing
				EU HACCAP standards available from NFA, 'General cleanliness guidelines' for seafood handlers, information on seafood handling and spoilage
12		1		Marine ecosystems
				Sample of seawater
				Microscopes
				Sample of common marine organisms
				Samples of major mangrove species
				Access to estuaries, seagrass beds, coral reefs and open oceans

Integrated Natural Resource Management requirements

There is only one unit in Grade 11, which all students must complete. There are two units in Grade 12, which all students must complete. There are also two assessment tasks which must be completed by students.

Integrated Natural Resource Management requirements

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11	20	1 and 2	11.1 Integrated Farming 1 Enterprise 1: For example: broiler chickens, tilapia fish and rice project	Fish pond, poultry house built over the fish pond, tilapia fingerlings, day old broiler chicks, rice seeds or seedlings, feed
11	20	3 and 4	Enterprise 2: For example: vanilla, coffee trees and honey bees project	Vanilla cuttings, nursery house, well mixed organic soil, coffee seeds or seedlings, all the materials or equipment needed for honey bees farming, a piece of arable coffee garden land
12	20	1 and 2	12.1 Integrated Farming 2 Enterprise 3: For example: coconuts, bananas and vegetables project	A piece of arable land, high yielding coconut variety seeds or seedlings,, banana suckers, vegetable seeds or seedlings
12	15	3 and 4	Enterprise 4: For example: fish, turtles and pearl farming project	A reef, different species of marine fish, young turtles, equipment or materials for growing pearls

Assessing Applied Natural Resource Management subjects

Assessment is an important part of learning and teaching. It is used to:

- evaluate and improve learning and teaching
- report achievement
- provide feedback to students on their progress
- provide feedback to stakeholders.

Criterion-referenced assessment

Assessment in Applied Natural Resource Management is criterion-referenced and measures students' achievement of the learning outcomes described in the syllabus. In criterion-referenced assessment, particular knowledge, skills or abilities are specified as criteria that must be achieved. The extent to which they are achieved is assessed and facilitated by the teacher.

Criterion-referenced assessment often takes on a problem-centred orientation, rather than a knowledge-based orientation. To achieve an outcome means having to demonstrate the attainment of skills and attitudes, not just write about them. Assessment then becomes more than just a means of judging knowledge and performance—it becomes an integral part of the learning process itself.

Criterion-referenced assessment is:

- standards or criterion-referenced; that is, outcomes are judged against pre-defined standards (see below)
- direct and authentic, related directly to the learning situation. This has the potential for motivating learning, since students can see a direct relevance between what is learnt and what is assessed.

Norm-referenced assessment

'Norm-referenced assessment' makes judgements on how well the student did in relation to others who took the test. It is often used in conjunction with a curve of 'normal distribution', which assumes that a few will do exceptionally well and a few will do badly and the majority will peak in the middle, normally judged as average.

Example of a criterion-referenced test

The driving test is the classic example of a criterion-referenced test. The examiner has a list of criteria, each of which must be satisfactorily demonstrated in order to pass; for example, completing a three-point turn without hitting either kerb. The important thing is that failure in one criterion cannot be compensated for by above-average performance in others; nor can a student fail in spite of meeting every criterion (as they can in norm-referenced assessment) simply because everybody else that day surpassed the criteria and was better than him or her. Criterion-referenced assessment has the following characteristics:

- a syllabus that describes what students are expected to learn in terms of aims, outcomes and content
- a syllabus that provides a clear sense of the syllabus standards through its aims, outcomes and content
- tasks designed to produce an image of what students have achieved at that point in the learning and teaching process relative to the outcomes
- standards of performance at different levels: the 'performance standards'
- a report that gives marks referenced to predetermined standards
- assessment tasks that refer to syllabus outcomes, content, assessment components and component weightings
- assessment that is better-integrated with learning and teaching.

Assessment *for* learning

Assessment *for* learning is often called 'formative assessment' and is assessment that gathers data and evidence about student learning during the learning process. It enables you to see where students are having problems and to give immediate feedback, which will help your students learn better. It also helps you plan your program to make student learning, and your teaching, more effective. Often it is informal—students can mark their own work or their friend's. An example is a quick class quiz to see if students remember the important points of the previous lesson.

Assessment *of* learning

Assessment *of* learning is often called 'summative assessment'. Summative assessment is used to obtain evidence and data that shows how much learning has occurred, usually at the end of the term or unit. End-of-year examinations are examples of summative assessment. It is usually done for formal recording and reporting purposes.

Assessing Applied Natural Resource Management units

In Applied Natural Resource Management, the learning outcomes are assessed using the range of assessment methods specified in the syllabus. In deciding what to assess, the starting point is: 'what do you want students to do and/or learn?' and following from this: 'how will the students engage with the material?', which in turn leads to the design and development of learning tasks and activities. It is crucial that at this point the assessment tasks clearly link back to the learning outcomes and are appropriate for the learning activities.

The assessment can be used for formative and summative purposes. Assessment can be represented as follows:

Assessment process

What do you want students to learn?

Learning outcomes

Assessment activities

Learning activities

How will you, or they, know the learning and teaching interaction has been effective?

How will students achieve this?
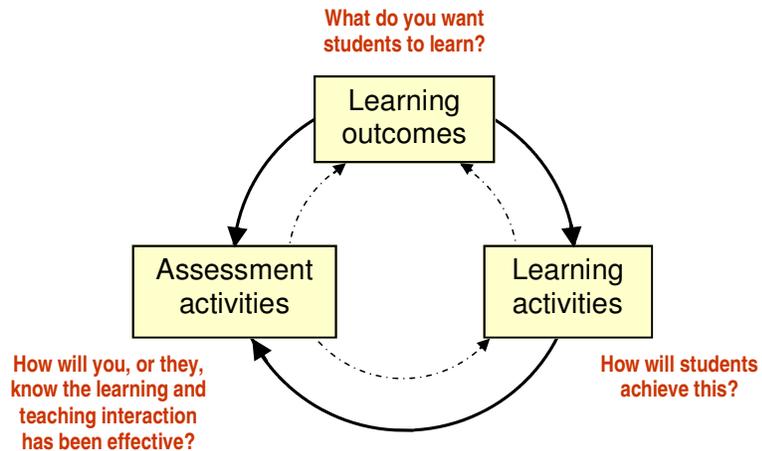
Once it is clear what needs to be assessed and why, then the form the assessment will take needs to be determined. There are many types of assessment tasks that can be implemented; the factors that will determine choices include:

- the students—how many are there, what is expected of them, how long will the assessment task take?
- the learning outcomes of the subject and how they might be best achieved.

During the year you must set assessment tasks that ensure that all the learning outcomes of the subject have been assessed internally. Each task you set must include assessment criteria that provide clear guidelines to students as to how, and to what extent, the achievement of the learning outcomes may be demonstrated.

Marking guides and assessment criteria help you with the marking process and ensure that your assessment is consistent across classes. It is important that marking guides and assessment criteria are collectively developed.

Students must complete the assessment tasks set. Each task must provide clear guidelines to students for how the task will be completed and how the criteria will be applied. When you set a task, make sure that:

- the requirements of the task are made as clear as possible to the student
- the assessment criteria and performance standards or marking guides are provided to the student so that they know what they have to do
- sources or stimulus material used are clear and appropriate to the task
- instructions are clear and concise
- the language level is appropriate for the grade
- it does not contain gender, cultural or any other bias
- materials and equipment needed are available to students
- adequate time is allowed for completion of the task.

Assessment methods

Although assessment components and weightings are stipulated in the syllabus, you decide which assessment method to use when assessing the

learning outcomes. You should use a variety of assessment methods to suit the purpose of the assessment. Assessment can be classified into four categories:

- tests
- product or project assessments
- performance assessments
- process skills assessments

Because each has limitations, maintaining a balance of assessment methods is very important.

Tests

A 'test' is a formal and structured assessment of student achievement and progress, which the teacher administers to the class. Tests are an important aspect of the learning and teaching process if they are integrated into the regular class routine and not treated merely as a summative strategy. Tests allow students to monitor their progress and provide valuable information for you in planning further learning and teaching activities.

Tests will assist student learning if they are clearly linked to the outcomes. Evidence has shown that several short tests are more effective for student progress than one long test. It is extremely important that tests are marked and that students are given feedback on their performance.

There are many different types of tests. Tests should be designed to find out what students know, and also to find out about the development of their thinking processes and skills. Open questions provide more detailed information about achievement than a question to which there is only one answer.

Principles of designing classroom tests

Tests allow a wide variety of ways for students to demonstrate what they know and can do. Therefore:

- students need to understand the purpose and value of the test
- the test must assess intended outcomes
- clear directions must be given for each section of the test
- the questions should vary from simple to complex
- marks should be awarded for each section
- the question types (true or false, fill-in-the-blank, multiple-choice, extended response, short answer, matching) should be varied.

Tests should:

- be easy to read (and have space between questions to facilitate reading and writing)
- reflect an appropriate reading level
- involve a variety of tasks
- make allowance for students with special needs
- give students some choice in the questions they select
- vary the levels of questions to include gathering, processing and applying information
- provide enough time for all students to finish.

Product or project assessments

A 'project' can be an assessment task given to an individual student or a group of students on a topic related to the subject. The project results in a 'product' that is assessed. The project may involve both in-class and out-of-class research and development. The project should be primarily a learning experience, not solely an assessment task. Because a great deal of time and effort goes into producing a quality product from a project assignment task, you should allow class time to work on the project. A product or project:

• allows the students to formulate their own questions and then try to find answers to them
• provides students with opportunities to use their multiple intelligences to create a product
• allows teachers to assign projects at different levels of difficulty to account for individual learning styles and ability levels
• can be motivating to students
• provides an opportunity for positive interaction and collaboration among peers
• provides an alternative for students who have problems reading and writing
• increases the self-esteem of students who would not get recognition on tests or traditional writing assignments
• allows for students to share their learning and accomplishments with other students, classes, parents, or community members
• can achieve essential learning outcomes through application and transfer.

Assignments

'Assignments' are unsupervised pieces of work that often combine formative and summative assessment tasks. They form a major component of continuous assessment in which more than one assessment item is completed within the term. Any of the methods of assessment can be set as assignments, although restrictions in format, such as word limits and due dates, are often put on the assessment task to make them more practical.

Investigations

An 'investigation' involves students in a study of an issue or a problem. Teachers may guide students through their study of the issue; or individual students, or groups of students, may choose and develop an issue in consultation with the teacher. This assessment component emphasises the student's investigation of the issue in its context, by collecting, analysing, and commenting on secondary data and information. Students should be encouraged to consider and explore a variety of perspectives as they develop and state their position on the issue. Students may present the investigation for assessment in a variety of forms, including one or a combination of the following: a written report, an oral presentation, a website, linked documents, multimedia, a video or audio recording.

Criteria for judging performance

The student's performance in the investigation will be judged by the extent to which the student:

- identifies and describes the issue or problem
- describes and explains the causes and effects
- critically analyses information and outlines possible steps leading to a solution or recommendation.

Computer-based tasks

Using computers to administer student assessment can provide flexibility in the time, location or even the questions being asked of students. The most common type of computer-based assessment is based on multiple-choice questions, which can assist teachers to manage large volumes of marking and feedback.

Performance or presentation assessments

The 'presentation' provides opportunities for students to develop skills and confidence when presenting to an audience. When presentations are used for assessment purposes, *how* the students present is as important as *what* they present.

Presentations can be formal or informal. Group or individual oral presentations can be very time-consuming, both in their use of valuable lesson time and in marking. The best approach is to allocate topics or allow students to choose from a variety of topics, to develop clear criteria for presentations, and to require the rest of the class (audience) to take notes, identify key points or write an evaluation to enhance their learning.

'Spotlighting' uses individual student checklists. This method can be used to focus on a few selected aspects of student presentations or outcomes. It is best to focus on five to six students at a time, systematically working through the class over time.

'Focused questioning' is a technique often used together with spotlighting. With focused questioning, teachers can be more aware of whether or not students understand the concepts or skills being taught.

Process skills assessments

This method of the assessment component, the 'process skills assessment', involves assessing students' understanding of concepts based on the practical skills that can be used, the evaluation of work done, and/or the reporting of information. These skills include, for example:

- interpretation skills
- evaluation skills
- reflection skills
- communication skills (such as writing, speaking and listening).

Using different assessment tasks is the way to make sure that students are able to demonstrate the range of their abilities in different contexts. Each category has advantages in assessing different learning outcomes. For example, a selected response assessment task, such as a series of multiple-choice questions, is able to assess all areas of mastery of knowledge, but only some kinds of reasoning.

Assessment ideas for individual students or groups

Tests	Products or projects	Performances	Process skills
Essay Multiple-choice Matching Short answer True or false	Assignments Nurseries Livestock herds Forestry products Portfolios Reports	Field or classroom activities Cooperative learning group activities Debates Discussions Explanations Field trips Interviews News reports Presentations Reports Speeches Management surveys Guest speakers Weather reports Radio broadcasts	Anecdotal records Checklist observations for processes Concept mapping Conferences: teacher and peer Interviews Journal entries regarding processes Learning logs Observations Process-folios Telling how they did something and justifying the approach

What tasks best assess learning outcomes?

The primary goal is to choose a method or task that most effectively assesses the outcomes of the unit. Some suitable tasks are listed below for the following broad categories of Upper Secondary learning outcomes:

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

Feedback

When you assess the task, remember that feedback will help the student understand why he or she received the result and how to do better next time. Feedback should be:

- *constructive*, so students feel encouraged and motivated to improve

- *timely*, so students can use it for subsequent learning
- *prompt*, so students can remember what they did and thought at the time
- *focused on achievement*, not effort. The work, not the student, should be assessed
- *specific to the unit learning outcomes*, so that assessment is clearly linked to learning.

Types of feedback

Feedback can be:

- *informal* or *indirect*—such as verbal feedback in the classroom to the whole class, or person to person
- *formal* or *direct*—in writing, such as checklists or written commentary to individual students, in either written or verbal form
- *formative*—given during the topic with the purpose of helping the students know how to improve
- *summative*—given at the end of the topic with the purpose of letting the students know what they have achieved.

Who assesses?

Teacher assessment

Assessment is a continuous process. You should:

- always ask questions that are relevant to the outcomes and content
- use frequent formative tests or quizzes
- check understanding of the previous lesson at the beginning of the next lesson, through questions or a short quiz
- constantly mark or check the students' written exercises, class tests, homework activities and so on
- use appropriate assessment methods to assess the tasks.

Frequency of assessment

You should schedule the specified assessment tasks to fit in with the teaching of the content of the unit that is being assessed. Some assessment tasks might be programmed to be undertaken early in the unit, others at the end of the unit. You should take care not to overload classes with assessment tasks at the end of the term.

Judging student performance

Student achievement is recorded and reported against standards. You must use performance standards or marking guides, examples of which are provided in this teacher guide, when making a decision about the achievement of your students in relation to the learning outcomes. The performance standards describe the level at which the student has to be working to achieve a particular standard or mark.

Students should always have access to a copy of the assessment criteria and the performance standards, so that they know what it is they have to know and be able to do to get a good mark in a particular task. The performance standards will help you in your marking and will help your

students improve their performance in the future. They are useful when providing feedback to students, as they explain what it is the student needs to do to improve.

Moderation

To make sure that you are interpreting the performance standards correctly when assessing your students, it is important to undertake Applied Natural Resource Management moderation of student work within your school and with teachers of nearby schools.

To moderate student work, a common assessment task must be used and a marking scheme developed so that all students complete the same task under the same conditions, and all teachers use the same marking scheme. Teachers can then compare (moderate) the students' work and come to a common understanding of the performance standards and the requirements for a particular mark or level of achievement.

Moderation enables you to be sure that your understanding of the required standards for levels of achievement is similar to the understanding of other teachers and that you are assessing students at the appropriate level.

Self-assessment and peer assessment

Self-assessment and peer assessment help students to understand more about how to learn. Students should be provided with opportunities to assess their own learning (self-assessment) and the learning of others (peer assessment) according to set criteria. Self-assessment and peer assessment:

- continue the learning cycle by making assessment part of learning
- show students their strengths and areas where they need to improve
- engage students actively in the assessment process
- enable students to be responsible for the learning
- help to build self-esteem through a realistic view of their abilities
- help students understand the assessment criteria and performance standards.

Managing assessment tasks for Applied Natural Resource Management

Usually, the marking of assessment tasks is done by the teacher. To reduce the amount of work it is necessary to develop a strategic approach to assessment and develop efficiencies in marking.

In Applied Natural Resource Management there are some assessment tasks that may be new to teachers and students. Below are suggestions on how to manage some of these tasks to minimise marking or presentation time.

Develop efficiency in marking

Clarify assessment criteria

Plan the assessment task carefully, and make sure that all students are informed of the criteria before they begin. Discuss the task and its criteria in class, giving examples of what is required. Distribute a written copy of the

instructions and the criteria, or put them on the board. Making the assessment criteria explicit speeds marking and simplifies feedback.

Supply guidelines on what is required for the task

Supplying guidelines reduces the amount of time wasted evaluating student work that is irrelevant.

Use attachment sheets such as marking guides

An assignment attachment sheet, which is returned with the assessed work, rates aspects of the task with a brief comment. Such a system enables each student's work to be marked systematically and quickly. This strategy can be applied to posters, presentations and performances.

Assess in class

Use class time to carry out and to assess tasks. Presentations or projects that are marked by you or the students enable instant developmental evaluation and feedback. Brief assessments of projects, stages of the design process, or practical work take less time to mark and are useful because they give immediate feedback to students on their progress and allow you to mark the project in stages with minimum effort.

Feed back to the whole class

Giving feedback to the whole class can cut down on the amount of individual feedback required. On returning assessed work, emphasise the criteria for judging the work, discuss the characteristics of good and bad answers, and highlight common strengths and weaknesses.

Set group-work alternatives

Assess one performance per group. The student's mark is the group mark, but may include a component based on the contribution of the individual. A strategy for allocating an individual mark includes each member of the group using criteria to evaluate the relative contributions of individuals, with the marks averaged for the individual.

Set clear deadlines

Set aside a time for marking. Be careful about extending this period (by allowing students to hand in work late).

Shift the responsibility

Introduce self-assessment and peer assessment

Develop in students the skills to evaluate their own work and that of their peers. With the students, use the assessment criteria against which work is judged, highlighting strengths and weaknesses. Self-assessment increases the amount of feedback students get. It can supplement or replace teacher assessment.

Treat each task differently

Every piece of work need not be evaluated to the same degree; a mark need not be the outcome in every case; and every piece of student work need not contribute to the final grade. Assessment is designed to enhance the

learning and teaching experience for the teacher and the learner, not just to give marks.

Applied Natural Resource Management units
Sample assessment tasks

Sample assessment tasks for Agriculture

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment. What follows are the learning outcomes performance standards for Agriculture, examples of assessment tasks and a marking guide.

Criterion or standards-referenced assessment in Agriculture

Learning outcomes performance standards for Agriculture					
Learning outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
1.Demonstrate an understanding of the socioeconomic benefit and values of crops and animals	Demonstrates extensive knowledge and understanding of a wide range of socioeconomic benefits and values of crops and animals	Demonstrates sound knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates limited knowledge of socioeconomic benefits and values of crops and animals	Has failed to meet the minimum standard required
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin crop and animal production, management and conservation	Demonstrates extensive knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	Demonstrates sound knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	Demonstrates knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	Demonstrates limited knowledge of concepts and fundamental principles that underpin crop and animal production	Has failed to meet the minimum standard required
3. Apply knowledge, skills and appropriate technology to undertake sustainable practical projects	Selects appropriate technology and applies skills to undertake sustainable practical activities	Selects technology and applies skills to undertake sustainable practical activities	Applies skills to undertake sustainable practical activities	Applies minimal skills to undertake sustainable practical activities	Has failed to meet the minimum standard required
4. Identify and analyse issues affecting farm management and make recommendations for improvement	Independently identifies all issues affecting farm management, describes them in detail and make practical recommendations for improvement	Independently identifies some issues affecting farm management, describes them in detail and makes practical recommendations for improvement	Identifies some issues affecting farm management and describes them in detail, makes some recommendations for improvement	Identifies some issues affecting farm management and describes them in detail, makes no recommendations for improvement	Has failed to meet the minimum standard required.

5. Apply entrepreneurial skills in projects	Independently applies entrepreneurial skills effectively in project planning, implementation, reporting and evaluation	Applies entrepreneurial skills effectively in project planning, implementation, reporting	Applies entrepreneurial skills in project planning, implementation, reporting	Applies entrepreneurial skills in project planning, implementation	Has failed to meet the minimum standard required
6. Communicate ideas and information in a variety of ways	Clearly communicates well-researched concepts effectively to target groups using a range of appropriate mediums of communication	Communicates well-researched concepts effectively using several appropriate mediums of communication	Communicates using an appropriate medium of communication	Communicates well-researched concepts using one medium of communication	Has failed to meet the minimum standard required
7. Demonstrate an understanding of the policies and organisations that support agricultural production at national and international levels	7. Demonstrates extensive knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels	Demonstrates sound knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels	Demonstrates knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels	Demonstrates limited knowledge of agriculture policies and organisations that support agricultural production at national and international levels	Has failed to meet the minimum standard required

Grade 11

Sample task: Design and construct an agricultural tool or structure or equipment to improve agricultural production.

Students may choose any of the following items such as:

- a seed tray
- a nursery shed or greenhouse
- tools for digging, harvesting, cutting, fencing, planting
- equipment for processing, such as rice mill, feeders, drinkers.

Task specifications

- write an action plan
- budget or cost the item
- draw a design plan
- identify and collect appropriate materials
- source information from experts
- follow the recommended steps to construct the tool, structure or equipment

Assessment criteria

Students will be assessed on the extent to which they:

- demonstrate creativity and simplicity in the design
- devise a plan
- make a tool, structure or equipment that is durable
- use materials that are cost effective and locally available
- use safety procedures
- follow the design plan and construct the tool or equipment
- work in collaboration with others to source advice.

Example of a marking guide

Marking guides like the one below should be used to assess the tasks you set. You can tick the appropriate box, look at the performance standards and the students' overall achievement and give an on-balance assessment.

If, for example, the students gets two ticks in the Very High Achievement (VHA) column, most of their ticks in the High Achievement (HA) column, several ticks in the Satisfactory column and one tick in the Low Achievement column, then, on balance you would give the students a High Achievement and a mark between 70 and 89.

Sample marking guide

Marking guide: Design and construction		30 marks			
Criteria	**Descriptors**	**VHA**	**HA**	**SA**	**LA**
Tool design 5 marks	VHA-Design is detail including measurements, materials required, method including costs. HA: design is made, some materials included, some methods are mentioned and some costs are included SA: design is made, few materials included but difficult to work out cost LA-little attempt made to do a design, no methods, cost included.	5	4	2	1
Tool construction 12 marks	VHA-Construct the tool using the precise measurement according to the plan, use proper methods of constructing the tool HA-Construct the tool using measurement according to the plan, use proper methods of constructing the tool SA-Use proper method, plan partly followed LA: Little or no attempt at all	12	10	6	3
Material used 5 marks	VHA-Appropriate available materials are used to construct. Materials are durable and economical. Use materials that are cost effective and locally available HA: appropriate locally available materials used are used with some cost effective measures considered SA: locally available material used but does not consider cost LA: Little attempt is made	5	4	2	1
Safety and quality 4marks	VHA-Easy to handle the tool Not dangerous and use effectively HA-Easy to handle the tool, not dangerous SA: Easy to handle LA-difficult to and handle and dangerous	4	3	2	1

Attitude 4 marks	VHA-Tool construction fully completed on time	4	3	2	1
	Positive attitude towards task given-punctuality, participation, obey instructions				
	HA: Tool construction fully completed on time				
	Positive attitude towards task given-punctuality, participation, instructions are obeyed only sometimes				
	SA: Tool construction not completed on time				
	Positive attitude towards task given-punctuality, participation, obey instructions sometimes				
	LA-Show little interest in the task				

Grade 12

Sample task: Farm project

Students in groups plan and implement a viable and profitable farm enterprise.

Learning outcomes

This task assesses learning outcomes 3 and 5

Task specifications

- develop an action plan
- produce a budget
- perform operational activities for each enterprise
- keep physical and financial records
- apply field management techniques for maximum production
- evaluate the performance of the enterprise and make recommendations

Assessment criteria

Students will be assessed on the extent to which they:

- develop an action plan that is logical and simple
- draw a budget to show accurate costing and expected income
- use recommended field management practices specifically for each enterprise such as
  - crop protection: weed, pest and disease control
  - livestock: brooder management, feeding, housing
- use tools safely
- use resources wisely
- analyse physical and financial records and use the information for future decision making
- work collaboratively with others

●

Sample marking guide

Marking guide: Farm project					
Criteria	**Descriptors**	**VHA**	**HA**	**SA**	**LA**
Enterprise Plan	The enterprise plan is realistic based on available resources, plan easy to follow, feasible, logical and simple				
Budget	-the budget prepared based on current, accurate and realistic values include the expected income				
Field management practices	-appropriate Weed control, - Insect pest or disease control and Fertiliser • Application done accurately and safely? • Have they used the appropriate chemicals and methods? Have they performed other management practices eg. Pruning, watering, drainage etc.?				
Tools or Equipment used-	Have they use Appropriate tools, • correctly with care? • safely? • Have they maintained the tools?				
Resources - Students maximise use of available resources	Have students identified and selected the available resources to maximise production? Have students stated the reasons for selecting the appropriate resources?				
Record Keeping	Have students develop - accurate Physical and Financial records? • Are students able to analyse, explain and make decisions?				
Report presentation	confidently present farm or project report • Have students produce a farm operation report • - for presentation, discussion and evaluation of the report?				

Sample assessment tasks for Forestry

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment. What follows are the learning outcomes performance standards for Forestry, examples of assessment tasks and a marking guide.

Criterion or standards-referenced assessment in Forestry

Learning outcomes performance standards for Forestry					
Learning Outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
1. Demonstrate an understanding of the socioeconomic benefit and values of forestry resources	Demonstrates extensive knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates sound knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates limited knowledge of socioeconomic benefits and values of crops and animals	Has failed to meet the minimum standard required
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin forestry production, management and conservation	Demonstrates extensive knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	Demonstrates sound knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	Demonstrates knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	Demonstrates limited knowledge of concepts and fundamental principles that underpin crop and animal production	Has failed to meet the minimum standard required
3. Apply knowledge, skills and appropriate technology to undertake sustainable practical projects	Select appropriate technology and applies skills to undertake sustainable practical activities	Select technology and applies skills to undertake sustainable practical activities	Applies skills to undertake sustainable practical activities	Applies minimal skills to undertake sustainable practical activities	Has failed to meet the minimum standard required
4.identify and analyse issues affecting forestry management and make recommendations for improvement	Independently identifies all issues affecting forestry management and describes them in detail and makes practical recommendations for improvement	Independently identifies some issues affecting forestry management and describes them in detail and makes practical recommendations for improvement	Identifies some issues affecting forestry management and describes them in some detail, but makes only few recommendations for improvement	Identifies some issues affecting forestry management and but makes no recommendations for improvement	Has failed to meet the minimum standard required.

5. Apply entrepreneurial skills in projects	Independently applies entrepreneurial skills effectively in project planning, implementation, reporting and evaluation	Applies entrepreneurial skills effectively in project planning, implementation, reporting	Applies entrepreneurial skills in project planning, implementation, reporting	Applies entrepreneurial skills in project planning, implementation	Has failed to meet the minimum standard required
6. Communicate ideas and information in a variety of ways	Clearly communicate well -researched concepts effectively to target groups using a range of appropriate mediums of communication	Communicate well - researched concepts effectively using several appropriate mediums of communication	Communicates concepts using an appropriate medium of communication	Communicates well -researched concepts using one method of communication	Has failed to meet the minimum standard required
7. Demonstrate an understanding of the policies and organisations that support forest production at the community, national and international levels	7. Demonstrate an extensive knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels	Demonstrates sound knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels	Demonstrates knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels.	Demonstrates limited knowledge of agriculture policies and organisations that support agricultural production at national and international levels	Has failed to meet the minimum standard required

Grade 11

Sample task: Design and construct a forestry tool or structure or equipment for a specific purpose.

Students may choose items such as a

- seed tray
- nursery shed or green house
- tools for digging, harvesting, cutting, fencing, planting
- equipment - processing such as a rice milling, feeders, drinkers

Learning outcome

This task assesses learning outcome 3.

Task specifications

- write an action plan
- draw a design plan
- identify and collect appropriate materials
- source information from experts
- follow the recommended steps to construct the tool or structure or equipment

Assessment criteria

Students will be assessed on the extent to which they:

- demonstrate creativity and simplicity in the design
- devise a plan
- make a tool or equipment and structure that is durable
- use materials that are cost effective and locally available
- use safety procedures
- follow the design plan and construct the tool or structure or equipment
- work in collaboration with others to source advice.

Example of a marking guide

Marking guides like the one below should be used to assess the tasks you set. You can tick the appropriate box, look at the performance standards and the students' overall achievement and give an on-balance assessment.

If, for example, the students gets two ticks in the Very High Achievement (VHA) column, most of their ticks in the High Achievement (HA) column, several ticks in the Satisfactory column and one tick in the Low Achievement column, then, on balance you would give the students a High Achievement and a mark between 70 and 89.

Sample marking guide

Criteria	VHA	HA	SA	LA
Demonstrate creativity and simplicity in the design of a plan	Demonstrated high level of creativity and simplicity in the design of a detail plan of a forestry tool or structure or equipment chosen	Demonstrated high level of creativity and simplicity in the design but not detailed plan of a forestry tool or structure or equipment chosen	Demonstrated some level of creativity and simplicity in the design but not detailed plan of a forestry tool or structure or equipment chosen	Demonstrated evidence of poor planning of a forestry tool or structure or equipment chosen
Make a tool or equipment and structure that is durable	A forestry tool or structure or equipment produced is of high quality and is made of durable materials	A forestry tool or structure or equipment produced is of high quality and is made of mixture of durable and not durable materials	A forestry tool or structure or equipment produced is of satisfactory quality and is made of mixture of durable and not durable materials	A forestry tool or structure or equipment is made of poor quality
Use materials that are cost effective and locally available	A forestry tool or structure or equipment is made of materials that are cost effective and are locally available	A forestry tool or structure or equipment is made of expensive materials that are locally available	A forestry tool or structure or equipment is made of expensive materials that are not locally available	A forestry tool or structure or equipment is made of very expensive materials that are not locally available
Use safety procedures	Student used all the workplace safety procedures during the construction of a forestry tool or structure or equipment	Student used some workplace safety procedures during the construction of a forestry tool or structure or equipment	Students did not always follow the workplace safety procedures during the construction of a forestry tool or structure or equipment	Student did not follow the workplace safety procedures during the construction of a forestry tool or structure or equipment
Follow the design plan	Student carefully followed in detail the	Student followed the design plan in the	Student followed parts of the design	Student did not followed design plan

and construct the tool or equipment	design plan in the construction of a forestry tool or structure or equipment	construction of a forestry tool or structure or equipment	plan in the construction of a forestry tool or structure or equipment	in the construction of a forestry tool or structure or equipment
Work in collaboration with others to source advice	Student worked in collaboration with others to source advice	Student worked in collaboration with others but reluctant to source advice	Working in collaboration and sourcing advice was done satisfactorily	Student always worked with assistance from teacher

Grade 12

Sample task: Plan and implement a viable and profitable mini-forestry farm.

Learning outcomes

This task assesses learning outcomes 3 and 5.

Task specification
- develop an action plan
- produce a budget
- perform operational activities for each enterprise
- keep physical and financial records
- apply field management techniques for production
- evaluate the performance of the enterprise and make recommendations

Assessment criteria

Students will be assessed on the extent to which they:

- develop an action plan that is logical and simple
- draw a budget to show accurate costing and expected income
- use recommended field management practices specifically for each enterprise
    - such as crop protection: weed, pest and disease control
- use tools safely
- use resources wisely
- analyse physical and financial records and use the information for future decision making
- work collaboratively with others.

Sample marking guide

Criteria	VHA	HA	SA	LA
Develop an action plan that is logical and simple	Student developed detailed action plan that is logical and simple	Student developed an action plan that is logical but complex	Student developed an action plan that is simple but difficult to execute	Student developed an action plan that is confusing
Draw up a budget to show accurate costing and expected income	Student drew up a detailed budget showing accurate costing and expected income	Student drew up a budget showing accurate costing and expected income	Student drew up a budget that showed some costing and some expected income	Student drew up a budget that showed lots of errors
Use recommended field management practices specifically for each enterprise	Student used most of the recommended field management practices specifically for each enterprise	Student used some of the recommended field management practices specifically for each enterprise	Student used some recommended field management practices that are not specific for each enterprise	Did not use recommended field management practices specifically for each enterprise
Use tools safely	Student used all the workplace safety procedures during the construction of a mini forestry farm	Student used some workplace safety procedures during the construction of a mini forestry farm	Sometimes student did not follow the workplace safety procedures during the construction of a mini forestry farm	Student did not follow the workplace safety procedures during the construction of a mini forestry farm
Use resources wisely	Student used very wide range of resources by wisely employing innovative strategies	Student used some resources wisely by employing innovative strategies	Student used limited resources	Unwise use of limited number of resources
Analyse physical and financial records and use the information for future decision making	Student made detailed analysis of physical and financial records and systematically used the information for future decision making	Student analysed physical and financial records and used the information for future decision making	Student analysed some physical and financial records and used some information for future decision making	Student made poor analysis of physical and financial records; recommendations were made for future decision-making process
Work collaboratively with others	Student worked in collaboration with others to source advice	Student worked in collaboration with others but reluctant to source advice	Working in collaboration and sourcing advice was done satisfactorily	Student always worked with assistance from teacher

Sample assessment tasks for Fisheries

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment. What follows are the learning outcomes performance standards for Fisheries, examples of assessment tasks and a marking guide.

Criterion or standards-referenced assessment in Fisheries

Learning outcomes performance standards for Fisheries					
Learning outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
1. Demonstrate an understanding of the socioeconomic benefit and values of fisheries resources	Demonstrates extensive understanding of the socioeconomic benefits and values of fisheries resources	Demonstrates sound understanding of the socioeconomic benefits and values of fisheries resources	Demonstrates average understanding of the socioeconomic benefits and values of fisheries resources	Demonstrates limited knowledge of the socioeconomic benefits and values of fisheries resources	Has failed to meet the minimum standard required
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation	Demonstrates extensive knowledge of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation	Demonstrates sound understanding and knowledge of a range of concepts and fundamental principles that underpin fisheries production, management and conservation	Demonstrates average understanding and knowledge of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation	Demonstrate limited or below average knowledge of a range of basic concepts and fundamental principles that underpin fisheries production, management and conservation	Has failed to meet the minimum standard required
3. Apply knowledge, skills and appropriate technology to improve and sustain production	Applies appropriate technical knowledge and skills effectively in project planning implementation sustainable project management and makes constructive recommendations for improvements production	Applies sound technical knowledge, skills in project planning, implementation of sustainable practical projects	Applies technical knowledge, skills in project implementation of sustainable practical projects	Applies limited technical knowledge, skills in project planning and implementation of sustainable practical projects	Has failed to meet the minimum standard required

4. Identify and analyse issues affecting fisheries management and make recommendations for improvement	Clearly identifies and analyses issues affecting fisheries management and makes constructive recommendations for improvement	Identifies and analyses issues affecting fisheries management and makes constructive recommendations for improvement	Identifies issues affecting fisheries management but provides few constructive recommendations for improvements	Identifies issues affecting fisheries management but fails to completely understand issues, makes poor recommendations for improvement	Has failed to meet the minimum standard required
5. Apply entrepreneurial skills in projects	Applies entrepreneurial skills effectively in project planning, implementation, reporting and evaluation	Applies above average entrepreneurial skills in project planning, implementation, reporting and evaluation	Applies entrepreneurial skills in project planning, implementation, reporting and evaluations	Applies limited entrepreneurial skills in project planning, implementation, reporting and evaluation	Has failed to meet the minimum standard required
6. Communicate ideas and information in a variety of ways	Clearly ommunicates well researched concepts effectively to target groups using a range of appropriate means of communication	Communicates well researched concepts using several appropriate means of communication	Communicates concepts using an appropriate medium of communication	Limited communication of researched concepts to target groups	Has failed to meet the minimum standard required
7. Demonstrate an understanding of the policies and organisations that support fish production, management, conservation and development at national and international levels	Demonstrates an extensive knowledge and understanding of the policies and organisations that support fish production, management, conservation at national and international levels	Demonstrates a sound knowledge and understanding of the policies and organisations that support fish production, management, conservation at national and international levels	Demonstrates average understanding of the policies and organisations that support fish production and conservation at national and international levels	Demonstrates limited understanding of the policies and organisations that support fish production and conservation at national and international levels	Has failed to meet the minimum standard required

Grade 11

Sample task: Design and construct fishing gear

Students design and construct fishing gear or structure or equipment for a specific purpose. Students may choose items such as:

- fish-aggregating device (FAD) (group work)
- rope work (joining, tying or splicing a rope)
- construct a wooden hand reel or fish trap
- connecting a hook to a fishing line
- construct a fish pond (group work)

Learning outcome

This task assesses learning outcome 3.

Task specifications

- source information from experts

- write a plan for a gear, structure or equipment
- draw a design of the gear, structure or equipment and costing
- collect appropriate materials
- follow the recommended steps to construct the fishing gears or structure and equipment

Assessment criteria

Students will be assessed on the extent to which they:

- write a plan showing the objective of the task
- demonstrate creativity and simplicity in the design
- make gear or equipment and structure that is durable and sustainable
- use materials that are cost effective and locally available
- use safety procedures
- follow the design plan and construct the gear or equipment
- work in collaboration with others to source advice.

Grade 12

Sample tasks

Students can choose from any of the following tasks:

- Choose a aquatic animal of their choice and conduct research or study their ecosystem.
- Construct fish cages or ponds for mariculture or aquaculture purposes.
- Assist and train locals in their area to repair fishing nets.
- Use the skills of net mending be creative to make volley ball nets, hammocks or string baskets.
- Plan and implement a viable and profitable fishing project.
- Write up scientific report of their research.

Learning outcomes

This task assesses learning outcomes 3 and 5

Task specification

- develop an action plan, which relates to any of the above tasks
- produce a budget
- find where to source materials
- apply field management techniques for production
- perform operational activities for each enterprise
- keep physical and financial records
- evaluate the performance of the enterprise and make recommendations

Assessment criteria

Students will be assessed on the extent to which they:

- develop an action plan that is logical and simple
- draw a budget to show accurate costing and expected income
- use recommended field management practices specifically for each enterprise, that is:
  - open water fishing
  - aquaculture or mariculture
- use gear and equipment safely
- use resources wisely
- analyse physical and financial records and use the information for future decision making
- work collaboratively with others.

Example of a marking guide

Marking guides like the one below should be used to assess the tasks you set. You can look at the performance standards and the students' overall achievement and give an on-balance assessment.

Sample marking guide

Criteria	VHA	HA	SA	LA
Developing action Plan	Demonstrates high ability, drafts simple workable plan that is easily executed and can be repeated by others	Develops logical and workable plan but a little confusing to follow	Develops plan but difficult or expensive to implement	Develops poor plan that is difficult or impossible to implement
Project bBudget	Develops accurate and comprehensive budget that takes into account expected income, contingencies and possible shortfalls	Develops good budget that is quite comprehensive and takes into account expected income, contingencies and possible shortfalls	Develops good budget but fails to take into account contingencies and shortfalls. Some shortfall in understanding budgeting	Develops a poor budget that fails to capture the expenditure requirements and contingencies in project
Application of field management practices	Understands and shows exceptionally high ability in applying field management practices in fisheries especially in aquaculture or capture fisher	Understands and shows high ability in applying field management practices in aquaculture or capture fisheries	Shows some understanding of field management practices in aquaculture or capture fisheries and attempts to implement them	Shows poor understanding in fisheries management practices in aquaculture or capture fisheries and makes a poor attempt at implementing them

Safe use of equipments	Exceptionally high understanding of safety and uses gear and equipment cautiously and appropriately	Above average understanding of safety and uses equipment cautiously and in the appropriate manner	Good understanding of safety but takes a rushed or careless attitude in using the equipment	Poor understanding of safety and uses equipment in an inappropriate manner that is likely to be detrimental to themselves and others
Wise use of resources	Realises that resources are costly and makes a concrete effort to use limited resources wisely. Sometimes tries to improvise cheaper alternatives to expensive resources	Highly cost conscious and attempts to use the limited resources as wisely and resourceful as possible	Cost conscious and makes a satisfactory attempt to use the limited resource wisely	Not so cost conscious and makes no attempt to use limited resources wisely
Financial analysis and decision making	Highly capable of analysing financial records and using them to make informed decisions on subsequent projects	Capable of analysing financial records and using them for future or other project decisions	Capable of analysing financial information but a poor in correcting or using records in making future decisions. Cannot properly implement lessons learnt from records	Has below average capability in analysing financial records and is unable to utilise that experience in future decision making for other projects
Collaboration with others	Exceptionally capable of communicating with other students and collaborates with them to implement projects. Is a natural leader and can pull everyone together	Highly capable of communicating with others and can collaborate with others to implement projects	Can collaborate with others but is a little reserved or bossy and likely to cause division	Unable to collaborate with others; either causes divisions or keeps to him or herself

Sample assessment tasks for Integrated Natural Resources Management

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment. What follows are the learning outcomes performance standards for Integrated Natural Resources Management, examples of assessment tasks and a marking guide.

Criterion or standards-referenced assessment in Integrated Natural Resource Management

Learning outcomes performance standards for Integrated Natural Resources Management					
Learning outcomes	Very high achievement	High achievement	Satisfactory achievement	Low achievement	Below minimum standard
1. Demonstrate an understanding of the socioeconomic benefit and values of natural resources	Demonstrates extensive knowledge and understanding of a wide range of socioeconomic benefits and values of crops and animals	Demonstrates sound knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates knowledge and understanding of socioeconomic benefits and values of crops and animals	Demonstrates limited knowledge of socioeconomic benefits and values of crops and animals	Has failed to meet the minimum standard required
2. Demonstrate knowledge and understanding of a range of basic concepts and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation	Demonstrates extensive knowledge and understanding of a range of basic concept and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation	Demonstrates sound knowledge and understanding of a range of basic concept and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation	Demonstrates knowledge and understanding of a range of basic concept and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation	Demonstrates limited knowledge of a range of basic concepts and fundamental principles that underpin agriculture, forestry and fisheries production, management and conservation	Has failed to meet the minimum standard required
3. Apply knowledge, skills and appropriate technology to undertake sustainable practical projects	Applies appropriate technical knowledge and skills effectively in project planning and implementation of sustainable practical projects	Applies sound technical knowledge, skills in project planning and implementation of sustainable practical projects	Applies technical knowledge, skills in project planning and implementation of sustainable practical projects	Applies limited technical knowledge, skills effectively in project planning and implementation of sustainable practical projects	Has failed to meet the minimum standard required

4. Identify and analyse issues affecting natural resource management and make recommendations for improvement	Identifies and analyses issues affecting natural resource management and make constructive recommendations for improvement	Identifies and analyses issues affecting natural resource management and make constructive recommendations for improvement	Identifies and analyses issues affecting natural resource management and make constructive recommendations for improvement	Identifies and analyses issues affecting natural resource management and make constructive recommendations for improvement	Has failed to meet the minimum standard required
5. Apply entrepreneurial skills in projects	Applies entrepreneurial skills effectively in project planning, implementation, reporting and evaluation	Applies entrepreneurial skills effectively in project planning, implementation, reporting	Applies entrepreneurial skills in project planning, implementation, reporting	Applies entrepreneurial skills in project planning, implementation	Has failed to meet the minimum standard required
6. Communicate ideas and information in a variety of ways	Communicates well - researched concepts effectively to target groups using appropriate mediums of communication	Communicates well -researched concepts effectively using appropriate mediums of communication	Communicates well researched concepts using appropriate mediums of communication	Communicates well researched concepts using one of communication	Has failed to meet the minimum standard required
7. Demonstrate an understanding of the policies and organisations that support resource production at community, national and international levels	Demonstrates a clear understanding of policies and organisations that support resource production at community, national and international level	Demonstrates some understanding of policies and organisations that support resource production at community, national and international level	Demonstrates a sound understanding of policies and organisations that support resource production at community, national and international level	Demonstrates limited understanding of policies and organisations that support resource production at community, national and international level	Has failed to meet the minimum standard required

Grade 11

Sample task

Students determine densities for rice, fish, chicken to raise in a given area using standard rates and determines the materials, equipment and other cost items required for setting up each enterprise (rice, chicken, tilapia fish) to produce a cost budget.

Learning outcome

This task assesses learning outcome 3.

Task specifications

- measure the length and the width of the floor space of chicken house
- sketch a design of the house
- calculate floor space area and number of chickens to raise in the area
- measure the length and the width of the area for a fish pond for tilapia
- sketch a design of the fish pond
- calculate number of tilapia to raise in the area
- measure the length and the width of the area for a rice plot

- sketch a design of the rice plot
- calculate number of rice plants to raise in the area using appropriate spacing
- determine the materials, equipment required for raising chickens, tilapia and rice

Assessment criteria

Students will be assessed on the extent to which they:

- demonstrate an understanding of the processes required to determine densities for the raising of crops or animals in a given area
- select appropriate equipment
- demonstrate understanding of budget requirements.

Example of a marking guide

Marking guides like the one below should be used to assess the tasks you set. You can tick the appropriate box, look at the performance standards and the students' overall achievement and give an on-balance assessment.

If, for example, the students gets two ticks in the Very High Achievement (VHA) column, most of their ticks in the High Achievement (HA) column, several ticks in the Satisfactory column and one tick in the Low Achievement column, then, on balance you would give the students a High Achievement and a mark between 70 and 89.

Sample marking guide

Marking guide: Produce a cost budget					
Criteria	**Descriptors**	**VHA**	**HA**	**SA**	**LA**
Structure designing-	• Chicken house design with correct dimensions • Tilapia pond design with correct dimensions • Rice plot design with correct dimensions				
Density calculations	• Number of chickens to raise in given space is accurate • Number of tilapia to raise in a given space is accurate • Number of rice seeds required to raise in a given space is accurate				
Material and equipment calculations	• Number of materials, equipment required to raise chickens is accurate • Number of materials, equipment required to raise tilapia is accurate • Number of materials, equipment required to grow rice is accurate				

Grade 12

Sample assessment tasks: In groups plan and implement a viable and profitable integrated farming system.

Learning outcomes

This task assesses learning outcomes 2, 3 and 5.

Task specifications

• develop an action plan

• produce a budget

• perform operational activities for each enterprise

• keep physical and financial records

• apply field management techniques for maximum production

• evaluate the performance of the enterprise and make recommendations

Assessment criteria

The farm project will be assessed on the extent to which the student can:

• develop an action plan that is logical and simple

• draw up a budget to show accurate costing and expected income

• use recommended field management practices specifically for each enterprise

  – rice protection: weed, pest and disease control

  – chickens: brooder management, feeding, housing

  – tilapia: pond and fish management

• use tools safely

• use resources wisely

• analyse physical and financial records and use the information for future decision making

• work collaboratively with others.

Sample marking guide

Marking guide:					
Criteria	**Descriptors**	**VHA**	**HA**	**SA**	**LA**
Enterprise Plan	The enterprise plan is realistic and based on available resources, easy to follow, feasible, logical and simple				
Budget	Budget prepared based on current, accurate and realistic values; include the expected income				
Field management practices	Appropriate weed control Insect pest or disease control Fertiliser application done accurately and safely Have they used the appropriate chemicals and methods? Have they performed other management practices (pruning, watering, drainage and so on)?				

Tools or Equipment used	Have they used appropriate tools • correctly with care? • safely? Have they maintained the tools?				
Resources Students maximise use of available resources	Have students identified and selected the available resources to maximise production? Have students stated the reasons for selecting the appropriate resources?				
Record Keeping	Have students developed accurate physical and financial records? Are students able to analyse, explain and make decisions?				
Report presentation	Have students produced a farm operation report Confidently present farm or project report for presentation, discussion and evaluation of the report				

Example of a school-developed unit

Apiculture: Practical Bee Keeping

4 weeks

This Apiculture unit emphasises the management skills and economics involved in practical bee keeping. Students are guided to master the skills involved as a means of an alternative enterprise after leaving school. The major product in this industry is honey. There is a very high demand for honey in the international market, particularly Papua New Guinean honey, due to its purity and high quality because it is organically produced. In order to teach this unit, schools should have bee hives made available. Bee keeping requires less labour input and has high returns but students must master the skills to competently handle the bees as a profitable venture.

Learning outcomes

Students can:

1. demonstrate an understanding of the socioeconomic benefit and values of natural resources
3. apply knowledge, skills and appropriate technology to improve and sustain production
5. apply entrepreneurial skills in projects.

To achieve the learning outcomes, students:

- state, explain and demonstrate the steps involved in practical bee keeping
- describe importance of honey bees in agriculture and to humankind
- describe the different classes of bees, their functions and life cycle in a beehive
- identify and demonstrate the correct use of tools or equipment or materials in the apiary
- identify and describe pests, diseases and their control measures
- identify and describe the various useful products and their economic values.

Content

Students acquire knowledge and skills through classroom teaching and field demonstration of this content.

Constituents of honey

Types of bees (colonies or castes)
- biology (entomology)
- different castes of a bee colony

- the queen (Her Majesty)
- the drone
- worker bees
- different functions of the castes in a bee hive

Production techniques and management
- introduction
- tools for bee keeping
- setting up an apiary
  - parts of a bee hive
  - establishing a bee nucleus
  - queen breeding
  - commercial production
- handling methods
- common pests, diseases and control methods

Harvesting, processing and marketing
- hand method
- using an extractor
- honey and other products
- corporative marketing scheme
- how and where to sell.

Suggested activities

- Carry out literature review and describe how the honey bee was domesticated, when and why it was introduced into Papua New Guinea.
- List the major constituents found in honey.
- List and describe the uses of honey and other products harvested in a bee hive.
- Students research biology and roles of members of a bee colony (castes): the queen (her majesty), the drone, worker bees.
- Identify and demonstrate correct use of tools or equipment used in bee keeping.
- Set up an apiary.
- List parts of a hive and its functions.
- Describe the procedures involved in setting up a bee nucleus.
- Describe how queen bees are raised.
- Demonstrate bee-handling techniques.
- Identify and describe bee pests, diseases and their control methods.
- Describe and demonstrate apiary management practices.
- Describe and demonstrate harvesting and processing techniques.
- List and identify products of honey bees and their marketing potential.
- State the advantages and disadvantages of forming a cooperative marketing scheme for bee farmers (and its application in their locality).

Suggested assessment tasks

- Demonstrate the correct steps involved in bee keeping.
- List reasons for the importance of the industry.
- Identify different classes or castes of bees and their functions.
- List and demonstrate the correct use of tools or equipment or materials used in the bee keeping industry.

Applied Natural Resource Management units
Learning activities
and assessment tasks

Learning activities and assessment tasks: Agriculture

Examples of learning activities and assessment tasks for each of the Agriculture units are provided in the following sections. Some examples are explained in detail.

Grade 11 units

11.1 Introduction to Agriculture

Suggested activities

- Ask students what they understand by the term Agriculture and then define agriculture with emphasis on applications as well as management. Then ask them to give you examples of different agricultural projects and industries of crops or livestock origin in the country; for example, Ramu Agribusiness, Trukai Industries in their locality. Ask students to explain and differentiate between science and the agricultural practice. Now try to expand that to provide examples of different agricultural practices that are adopted by farmers in Papua New Guinea.

- Work in small groups and are asked to research one of the following: food security, cash economy, employment and so on; and answer certain questions relating to its role and importance in Papua New Guinea such as: numbers employed in this role; contribution to national income; and contribution to lifestyles.

- Work in small groups and assign to list on the charts the economically important natural resources in Papua New Guinea, and specifically describe major agriculture industries currently in operation.

- Research the recent agriculture export figures for the past 1-5 years of important cash crops such as coffee, cocoa, palm oil, copra, rubber, tea, and the value of export and foreign income received (see Bank of Papua New Guinea monthly bulletins.

- Invite a resource person from the Department of Agriculture to present a talk on the National Agriculture Development Plan and relevant policy matters. Allow students to take notes and briefly explain the purpose and importance.

- Invite a guest speaker to talk to the class about employment, career and training opportunities for students after leaving school. Students are encouraged to ask questions and then asked to consider their future career path. Next ask the students what they know about the different branches of agriculture, such as crop science or agronomy, plant or animal breeding, animal nutrition, agriculture economics, entomology, plant pathology, extension, animal health and hygiene and discuss this with others in the class.

- Work in small groups and are asked to identify training institutions that offer agriculture and the entry level of courses. Students also list the government and private employers employing agricultural officers and graduates of agricultural institutions. The teacher and guidance officer

may distribute course brochures from relevant institutions offering agriculture courses.

Suggested assessment tasks

- Draw up a chart showing all the different branches of agriculture.
- Make a summary of possible career paths and entry level for future training opportunities.

11.2 Soil Management

Suggested activities

- Collect soil samples from the field and describe the components of the soil including type of inorganic, organic, water, air and living matter. This is a review of what was covered in Lower Secondary.
- Apply organic farming activities such as adding manure, composting to improve soil fertility.
- Organise a field trip or visit to a nearby area, identify three soil types (sandy, loam and clay) and describe the physical properties of the soil: structure, texture and profiles. Another review activity as covered in Lower Secondary.
- Carry out library or textbook research in groups of 4-5 students and:
    - list in order the chemical processes involved in nitrification, denitrification and ammonification as they relate to providing soil nutrients
    - list in order the chemical processes involved in the carbon cycle
    - identify the macro and micronutrients and describe their importance and significance to crop growth and yield

Note that any cropping program should include careful consideration and study of the soil type, crop rotation, fertilisers, irrigation and drainage practices to be used.

- Explain the importance of soil texture and structure as they relate to the rate of infiltration of water
- Describe the relationship of soil texture and structure to the water holding capacity of a soil
- Use a pH meter or other alternatives to test soil pH
- Students use their indigenous knowledge to give some examples of organic fertilisers used in their local community and explain their understanding of the importance of organic farming and identify what nutrients are supplied. Teachers expand on this information by providing necessary reference material. A similar activity could involve inorganic fertilisers.
- State some reasons for how soils and plants depend on each other for survival and how they interact.
- Describe the methods employed in their local environment to retain soil water for crop cultivation and usage. With this knowledge base, they will

identify and describe the modern methods of soil water conservation and management practices in place.

- List and explain some local or traditional methods of soil-water conservation practices.
- List and explain modern or improved methods of soil-water conservation.
- Discuss the advantages and disadvantages of both improved or modern and traditional methods of soil-water conservation.
- State and explain the soil erosion control measures to sustain soil-water for crop production.
- List the various ways of applying irrigation water to their farm or garden.
- Describe each method of irrigation system as listed above and determine the most affordable system of irrigation for the average farmer.
- State some of the important factors to consider when the farmer is planning an irrigation system in regard to soil-water and crop-water management and conservation.

Suggested assessment tasks

- Establish fertiliser trial plots to determine impact of plant nutrient factors.
- Perform simple land (soil) survey using appropriate tools or devise and produce a map.
- Demonstrate crop rotation system to maintain soil fertility.
- Calculate the soil bulk density and pore space of the soil.

11.3 Annual Crop Production

Suggested activities

- With assistance of the teacher, students select farming land within the school considering the factors in land selection. Students mark out an area of 20m x 10m (200m^2) to be allocated for each student.
- Students given farming tools and prepare the land (slashing, burning, tilling, digging, drainage and prepare seed beds).
- Construct seed beds for a selected crop according to their agronomic requirement ready for planting.
- List some of the common staple crops and other vegetable crop varieties and state common or scientific names, and grow the crops on their plots during the year.
- Construct a field vegetable nursery to nurse the selected crop seedlings.
- Students perform practical aspects of the following agronomic systems
  - collecting, preparing and sterilising soil
  - filling seed boxes or pot or beds with soils
  - sowing, watering, thinning, hardening
  - transplanting
  - pest and disease management

- Apply crop management practices including, weeding, fertiliser application, pest and disease control, mulching and pruning of the crops grown
- Apply soil fertility improvement techniques involving composting, mulching, application of animal manure, green manure, crop rotation and fallow and so on.
- Students demonstrate the recommended harvesting procedures of selected crops to maintain crop quality.
- Present on charts the post-harvest storage methods of selected crops grown from their plots.

Suggested assessment tasks

- List the factors to consider when selecting land for farming.
- Practical activities example: constructing a field nursery.
- Select a crop, establish and perform its management practices such as soil preparation, spacing, planting, watering, weed and pest control activities.

11.4 Animal Production (Monogastrics)

Suggested activities

- Discuss the importance and uses of raising an animal such as meat, eggs, social obligations, clothing.
- Visit a site for a livestock establishment and factors considered in the selection of the site. Suggest possible site and list materials required to establish the project.
- List materials required to establish a livestock animal and describe uses.
- Discuss features and qualities to look for when selecting a breed of animal for farming; breeds of animals and purposes such as wool, meat, milk, eggs, skin, medicine.
- Display actual animal organs: digestive system, lungs, reproductive, of an animal and bird and discuss their functions. Differentiate between the important functions of ruminants, birds and monogastric.
- Visit an animal farm and observe types of behaviour such as courting, stress, panting, cannibalism and explain reasons for behaviour. Stress importance of preventing undesirable behaviours that affect production
- Oven drying of feed samples to determine percentage of water, dry matter and ash content of at least 5 locally available feedstuffs (pastures, feed ingredients) usually fed to farm animals using the following methods:
  - use standard dietary data and discuss nutrients requirements for an animal or a bird at different growth and reproduction stages. Energy, protein, vitamins and mineral levels for growth, reproduction and maintenance are emphasised.

- differentiate types of animal or poultry feed concentrates and non-concentrates and the importance of local feed ingredients.
- determine dry matter and water content of a local feed sample using oven drying method. Sample cross check results with literature and further examine the percentage of the major nutrients: protein, carbohydrates, fat and fibre

- Burn a feed sample in a furnace to determine the ash content which indicate the percentage of mineral content in a feed sample. Cross check results with literature and further examine the percentage of the major nutrients: protein, carbohydrates, fat and fibre.

- Collect samples of pasture grasses and legumes; identify their names, and discuss the conditions which they grow well.

- Measure dimensions of the floor space for a livestock house or fencing paddock space and sketch a design of the dimensions. Calculate its area to determine an appropriate stocking rate using appropriate space requirements per class of poultry or livestock. Space requirement - 0.4 square metres per adult chicken to raise 100 chickens:
0.4 x 100 = 40 square metres.

- House dimensions: length 8 metres, width 5 metres

- Observe and describe features of a poultry or livestock breeds important for meat egg, milk or fibre production in local area; discuss factors to consider when selecting a breeding stock, such as growth rate, litter size, egg laying capacity, leanness of meat.

- There are a number of breeding systems, including random, inbreeding, line breeding and cross breeding:
  - draw diagrams to illustrate each breeding system and explain the purpose of the system
  - discuss the advantages and disadvantages of each breeding system
  - discuss the application of these different breeding systems with reference to improving one type of farm animal in your locality; for example, improve milk or egg production, meat, litter size.

- Work out the genotype and phenotype of:
  - a carrier bull (Mm) and a normal cow (MM)
  - a carrier bull (Mm) and a carrier cow (Mm).

- Teacher selects an operation task such as castration and demonstrates step by step process. The appropriate handling of poultry or livestock, tools, materials and key points must be emphasised to ensure the operation is carried out successfully. Other operations may involve ear tagging, dehorning, drenching, and so on.

- Investigate a disease of a farm animal. Discuss its symptoms and causes. State the control measures you would take in each case.

- Arrange a field trip for students to an abattoir and ask the butcher to discuss the slaughtering and butchering processes of an animal and procedures used to maintain product quality for market: meat, hide, fibre Students write a report on the talk.

- Arrange a field trip for students to a layer farm and ask the manager to explain processes followed from when eggs are collected to when they are sold to buyers. Emphasise how quality of eggs is maintained in each process.

- Students to use appropriate materials to practise packaging marketable poultry or livestock products to prolong storage life and maintain quality

Suggested assessment tasks

- Students given actual digestive organs or library research and differentiate between monogastric and ruminants:
  - name the parts and describe their functions correctly
  - discuss how these differences affect dietary requirements and feed-conversion rates.
- Measure dimensions of floor space for a livestock house or fencing paddock space and sketch a design of the dimensions. Calculate its area to determine an appropriate stocking rate using appropriate space requirements per class of poultry or livestock.
  - space requirement: 0.4 square metres per adult chicken to raise 100 chickens: 0.4 x 100 = 40 square metres
  - house dimensions: length 8 metres, width 5 metres

11.5 Farm Technology

Suggested activities

- Students organised in groups to research and accurately identify and list basic tools by correct names and their uses, safety and functions by drawing, pictures or photos, or illustrating on flip charts or posters.
- Collect damaged tools from the school farm or school general toolshed and repair or maintain for maximum use as an assignment or project.
- Visit school farm or a nearby farm or agriculture project and identify the types of farm tools, equipment and farm machineries used.
- Either visit school workshop (garage) or invite the mechanic to display common basic mechanical tools used for tractor maintenance and other automotive servicing and repairs.
- Identify tractor and implement parts by correct names and describe the main functions.
- In groups carry out poster or flipchart activities on different principal parts of a farm implement, equipment, tractor, machinery.
- In groups perform project planning (physical and financial) for constructing a single item of farm equipment, tool or machinery.
- In groups produce posters, postcards, charts or flipcharts on importance of safety and care of tools, equipment, implements and machinery in farming process.

Suggested assessment tasks

- Identify a farm tool or equipment, name the parts, draw a diagram and describe its use.

- Identify different farm implements and describe their correct uses.
- Design and construct a simple farm structure, tool or equipment.

11. 6 Agribusiness

Suggested activities

- Explain the meaning of agricultural economics as a discipline that deals with government policies and decisions on how resources are allocated. Relate how agricultural policy affects farmers' production output.
- Students are given a copy of the National Agriculture policies in Papua New Guinea and discuss the details in the policy.
- Discuss the fact that all businesses are categorised into three types according to type of market competition. Understanding this would help students to take appropriate actions when producing and market products in the type of business they wish to operate in their area.
- Investigate and give examples of businesses that operate in their local environment. Categorise each of the following businesses according to market competition:
  - *monopoly*: example Milne Bay Water Board
  - *pure competition*: example is agriculture farmers in public markets
  - *monopsony*: example is Coffee Marketing Board
  - *oligopoly*: example is chemical suppliers
- Illustrate with a graph to discuss price movements in a pure market competition system by the forces of demand and supply.
- Explain the factors that influence consumer behaviour by discussing the following conditions in the market system:
  - how does a consumer behave when his income level changes?
  - how does a consumer behave in response to media advertisements for a particular product?
- Students define *market* and give examples of different types. Market types include
  - *product:* fish market, pig market
  - *place:* Hohola market
  - *seasonal*: Christmas market
  - *regional or international: e*xport and local
- Marketing survey of two common agricultural food or fibre products. The survey data should include:
  - agriculture products on demand
  - prices per product locally and overseas
  - quality standards required by buyers for agriculture products
  - means of transport and channels established to market products
  - storage facilities and conditions
  - infrastructure, such as roads.

- Students write survey report and discuss some constraints of marketing of agricultural produce in their home province and Papua New Guinea and suggest solutions. To include: lack of infrastructure, transport difficulties, quality standards of produce and explain market contracts (hedging) as a way securing markets.
- Students encouraged to sell agriculture products and apply selling skills.
- Discuss the role of farmers' associations and benefits in marketing.

Suggested assessment tasks

- Students conduct a survey to identify available local markets and types of agriculture products produced and sold by farmers.
- Students conduct a survey to identify factors affecting commodity price fluctuation in a market.
- Students prepare a product and present it for sale at a market place.

Grade 12 units

12.1 Applied Farm Management

Suggested activities

- Students put into groups, elect their farm manager, secretary, treasurer.
- Teacher discusses roles and responsibilities of each member of group.
- Select a farm enterprise from alternatives of farm enterprises (such as poultry, vegetable or mix) and identify resources required for selected enterprise: land, buildings, tools and equipment, human, finance and so on. Discuss concept of gross margin while students are choosing.
  - Gross Margin = Gross Income - Variable Costs
  - comparison of gross margins for different enterprises
- Draw up a cash flow to forecast income for the enterprise.
- Each group to produce an operational plan for implementation.
- Apply management skills required in a farm (due to many factors that affect farm production and profit, such as weeds, insects, diseases, soil improvement, environment conditions, housing improvements).
- Groups open an account with school bursar and make deposits and withdrawals, bank reconciliations, bank statements and make entries in an appropriate record.
- Display samples of business farm records (for example, of Ramu Agribusiness); and maps, livestock, crop and financial records for students to view. Discuss uses and importance; and concepts such as costs, returns, variable costs, profit and loss statement.
- Students keep records of their daily enterprise activities in a dairy.
- Describe two main cost categories as: operational costs (fixed items, variable items) and non-operational costs(tax, personal items).

- Give example of how to calculate depreciation cost of an asset over a period of 5 years.
- Give examples of fixed cost items like machinery or buildings and examples of variable cost items as fertiliser, seeds and hired labour.
- Calculate the total value for farm costs.
- Define gross income as total value of farm production.
- Explain components of gross income to include sales of crops and animals, inventory change, dividend from investments, sales of capital items.
- Profit and loss statement
    - calculate operating profit using the formula
      total farm returns - total cost = operating profit
    - calculate net profit using formula
      operating profit - (personal + GST) = net profit
- Produce a project report and discuss project performance, highlight SWOT and make recommendation for improvement.

Suggested assessment tasks

- Develop a farm plan including all possible enterprises.
- Students develop a cash flow budget for an enterprise.
- Interpret an annual report from a selected agricultural company such as Ramu Sugar Ltd, New Britain Palm Oil.
- Discuss the functions performed by bookkeepers in an enterprise.
- Conduct an inventory of the assets—tools, crops, and livestock—in the school or on a local farm and assess the value of those assets.

12.2 Introduction to Applied Research

Suggested activities

- Discuss the importance of research and explain the reasons of doing research; such as to investigate and solve agricultural problems and social issues.
- Differentiate between qualitative and quantitative research and give examples: qualitative research involves a survey using questionnaire on opinions while quantitative research involves field trial where data is quantified.
- Conduct a survey using questionnaire and interviews on selected topic.
- Demonstrate a field layout on a selected experimental design.
- Students are given samples of a research report and discuss ways the research is carried out.
- Write a research report using the format that includes:
    - Title and researcher's name
    - Abstract: brief and concise summary of the whole report

- Introduction
- Rationale and scope of the research; sometimes written as 'Aims and objectives'
- Materials and methods
- Results (for example, diagrams, graphs, tables)
- Discussion and Conclusion
- Recommendations for further research
- Bibliography.

Suggested assessment tasks

- In groups or as individuals select a topic, prepare materials and conduct research.
- Collect and analyse data and write a report.
- Oral presentation of the report.

12.3 Perennial and Biannual Crop Production

Suggested activities

- In groups and discuss the important roles of perennial or biannual crop production in the Papua New Guinean economy:
  - food security: fruits supply, nuts, starch
  - nutrition: vitamins and minerals
  - export of raw materials: copra, coffee, palm oil, latex
  - employment: self-employment, agronomist, soil scientist in industries
  - contribution to GDP: export income, improvement of living standards
- Visit a selected site and do a critical assessment on the environmental conditions required to establish a selected perennial or biannual crops:
  - soil type, soil pH, nutrient content, organic matter content, water accessibility and so on
  - climate: sunlight, humidity, temperature, rainfall, wind
  - topography: sloppiness, vegetation cover
- Students are given a flip chart and illustrate with diagrams different cropping systems (mono-cropping, mixed cropping, relay cropping) for perennial or biannual crops grown in Papua New Guinea and describe their advantages and disadvantages. Present their activity to the class.
- Students, with assistance from the teacher, build a crop nursery for a selected crop and demonstrate nursery management techniques: soil preparation and sterilisation, seed or vegetative propagation and care.
- In groups, students:
  - select a crop and demonstrate the skills of crop establishment practices: marking and lining, shade establishment, holing, planting, cover cropping and infilling.

- demonstrate field management and agronomic practices like: weed control, fertiliser application, pest and disease control, chemical mixing and calibration, pruning, marcotting, layering, budding, grafting.
- perform the harvesting and processing procedures using the appropriate tools and equipments.
- apply processing techniques: picking, gathering, sorting, grading, bagging, post-harvest processing, fermentation, drying, use of preservatives, cooling, grinding and bottling or packaging
- package a product and store in an appropriate storage conditions (considering factors such as temperature, humidity)
- sell the product.

Suggested assessment tasks

- Students demonstrate basic agronomy practices; for example nursery establishment for a selected field crop such as cocoa, coffee.
- Students demonstrate harvesting and processing techniques of a selected field crop.

12.4 Animal Production (Polygastrics)

Suggested activities

- Discuss importance and uses of raising an animal for purposes such as food, social obligations like feasting, fibres for clothing, cash income, draught uses.
- Visit a site for a livestock establishment and consider factors in selection of the site. Suggest a possible site and list materials required to establish the project and to establish a livestock animal.
- Use by-products from polygastric animals for various purposes; for example, offal made into feed meals, manures for gardening, blood for blood meals, hinds for belts.
- Students collect pictures of various breeds of polygastric animals and paste onto a chart, name and describe their features and adaptability.
- Discuss features and qualities to look for when selecting a breed for farming; purposes such as wool, meat, milk, skin, medicine.
- Illustrate breeding systems aimed at improving animal production; for example:
  - line breeding such as a bull x cow = offspring. Offspring to be crossed with the parent bull
  - out-breeding system: two different breeds are crossed to produce a crossbreed offspring; for example, Brahman x Hereford
- There are a number of breeding systems including-random, inbreeding, line breeding and cross breeding.
  - draw diagrams to illustrate each system and explain purpose of it
  - discuss advantages and disadvantages of each breeding system

- discuss application of these different breeding systems for improvement of one type of farm animal in your locality; for example, improve milk production, meat, calf size
- Work out the genotype and phenotype of:
  - a carrier bull (Mm) and a normal cow (MM)
  - a carrier bull (Mm) and a carrier cow (Mm).
- Oven-drying of feed samples: to determine percentage of water, dry matter and ash content of at least 5 locally available feed stuffs (pastures and feed ingredients) usually fed to farm animals using the following methods:
  - use standard dietary data and discuss nutrients requirements for an animal at different growth and reproduction stages. Energy, protein, vitamins and mineral levels for growth, reproduction and maintenance are emphasised
  - differentiate types of feeds for polygastric animals: concentrates and non-concentrates and the importance of local feed ingredients
  - determine dry matter and water content of local feed sample using oven-drying method. Cross check results with literature and examine percentage of major nutrients (protein, carbohydrates, fat and fibre).
- Burn a feed sample in a furnace to determine ash content, which indicates the percentage of mineral content in a feed sample. Cross check results with literature and further examine the percentage of major nutrients (protein, carbohydrates, fat and fibre).
- Collect samples of pasture grasses and legumes; identify their names, and discuss the conditions which they grow well.
- Students establish and manage a pasture area
  - grow improved pasture grasses and legumes and maintain them
  - clear weeds from existing grazing land area
  - carry out selective grazing techniques such as rotational, strip, open, tethering, integration; for example, cattle under coconut trees
- Students measure dimensions of grazing area for a livestock type and sketch a design of dimensions. Calculate area to determine appropriate stocking rate using appropriate space requirements per animal unit. For instance, space requirement for cattle – x animal unit per hectare
- Students map out project area and calculate fencing materials and costs.
- Design and construct sub-divisional fences and stockyards.
- Teacher selects an operation task like castration and demonstrates step by step process. The appropriate handling of poultry or livestock, tools, materials and key points must be emphasised to ensure the operation is carried out successfully. Other operations may involve ear tagging, dehorning, drenching, branding, hoof trimming, handling
- Carry out stockman and routine duties.
- Investigate a disease of a farm animal. Discuss its symptoms, causes, prevention, control and treatment.
- Arrange a field trip for students to an abattoir and ask the butcher to discuss the slaughtering and butchering processes of an animal and procedures used to maintain product quality for market (meat, hide, fibre)
- Students write a report on the talk.

- Arrange a field trip to a layer farm and ask the manager to explain the processes followed, from when eggs are collected to when they are sold to buyers. Emphasise how quality of eggs is maintained in each process. (Quality standards such as colour, freshness, taste.)
- Students use appropriate materials to practise packaging marketable poultry or livestock products to prolong storage life and maintain quality.

Suggested assessment tasks

- Discuss importance and uses of raising an animal; for example, for food, social obligations such as feasting, fibres for clothing, cash income, draught uses.
- Students visit a site for a livestock establishment and consider factors in selection of site. Suggest possible site and list materials required to establish the project and establish a livestock animal.
- Students use by-products from polygastric animals for various purposes; for example, offal made into feed meals, manures for gardening, blood for blood meals, hinds for belts.
- Students collect pictures of various breeds of polygastric animals and paste them onto a chart, name and describe their features and their adaptability.
- Discuss features and qualities to look for when selecting a breed for farming and purposes like wool, meat, milk, skin, medicine.

Learning activities and assessment tasks: Forestry

Examples of learning activities and assessment tasks for each of the Forestry units are provided in the following sections. Some examples are explained in detail.

Grade 11 units

11.1 Introduction to Forestry

Suggested activities

- Describe forest and forestry.
- Describe role and importance of forestry.
- List and explain different uses of forests.
- Discuss mission statement (goal) and objectives of managing forest resources in Papua New Guinea.
- Discuss ownership of forest resources in Papua New Guinea.
- Explain different forest types in Papua New Guinea and distribution.
- Illustrate on graphs the yield and financial statistics of forestry.
- Explain forestry training in Papua New Guinea.
- Explain various organisations in which forestry graduates are employed.

Suggested assessment tasks

- Oral Presentation: land ownership in their respective areas.
- Essay: discuss the contribution of forestry in national economy.
- Report: Field trip to the local village for elders to explain land ownership and use of the land and forest products.

11.2 Introduction to Tree Science

Suggested activities

- Explain classification levels of plants.
- Describe and give examples of vascular and non-vascular plants; provide sample or specimens of theses plants.
- Explain importance of naming biological organisms including plants.
- Explain procedures used in documentation of plant specimens.
- Describe functions of herbarium.
- Name all the trees in school area: their origin, indigenous or exotics.

Suggested assessment tasks

- Collect, name and mount plant specimen.
- Identify trees in the school ground or nearby forest.

11.3 Plantation Silviculture

Suggested activities

- Describe different planting terminology: reforestation, afforestation and enrichment.
- Give localities where above plantings exist.
- Visit nearby planted forest: plantation or woodlot.
- Explain functions of nursery and types of nursery.
- Give facilities of nursery.
- Discuss seed collection and use of cutting.
- Explain procedures in soil preparation.
- Explain functions of standout beds and seed beds.
- Explain care given to the seedlings.
- Explain activities in site preparation.
- Calculate plants or seedling needed using different spacing.
- Discuss relevance of maintenance activities like tending, pruning and thinning.
- Name all factors that pose risks to trees.

Suggested assessment tasks

- Construction of seedbed, seedling containers.
- Prepare soil for tubing.
- Germination of seeds in seed trays or wooden boxes and transplanting seedlings into containers or for large seeds direct sowing into containers.

11.4 Forest Conservation

Suggested activities

- Define the concept of conservation.
- Discuss relevance of conservation in relation to global issues like global warming and climate change.
- Name resources to be conserved.

- Place more emphasis on conservation of endemism, endangered species and genetic resources.
- Discuss the impact of mining, logging and agricultural development on the fauna and flora of the forest.
- Use the maps to identify the current national parks, world heritage areas in the South Pacific.
- Do a role-play: representatives of government, logging company, portable sawmill operators or agricultural developers and resource owners to resolve conflict on a land-use practice.
- Discuss and debate the significance of the carbon trade concept by the tropical rainforest nations.
- Discuss advantages and disadvantages of conservation in the context of Papua New Guinea.

Suggested assessment tasks

- Report: field trip to observe an undisturbed and disturbed forest to make comparison of the forest types.
- Oral presentation: investigate and describe the threatened species of plants and animals in Papua New Guinea.
- Report: In consultation with the local landowners investigate if there are any forest conservation practices.

Grade 12 units

12.1 Measurements

Suggested activities

- Define forest measurement.
- Use the surrounding environment to measure the height and diameter of the trees.
- Discuss different formulas used in calculating log volume.
- Use logs to measure the length and diameter and calculate volume.
- Identify a forest area to carry out sampling to determine the population density.
- Use topographic and vegetation maps to interpret features on the map in relation to the field.
- Carry out traverse survey on school ground and plot it

Suggested assessment tasks

- Practical exercise: take diameter and height measurement on trees on the school ground and its surroundings.
- Practical exercise: take diameter and length measurements of logs or any cylindrical objects to calculate the volume using Huber's or Smilian's formulas.

- Practical exercise: in consultation with local landowners carry out sampling techniques exercised in their forests.
- Practical exercise: carry out traverse survey on school ground and plot it

12.2 Harvesting, Processing and Marketing

Suggested activities

- Define terms such as selective logging, clear fell and sustainable management.
- Compare and contrast harvesting and logging.
- Discuss the advantages and disadvantages of timber harvesting.
- Explain the logging code of practice.
- View and discuss video or DVD presentation on topics such as harvesting and processing of timber.
- Case study of the logging industry in Papua New Guinea or another tropical location focusing on impacts on local community and environment (sustainability, timber rights, soil degradation or invasion of unwanted plants)
- Construct and interpret flow charts and diagrams describing the harvesting, processing and marketing of timber.
- Where applicable, make a field trip to observe a logging operation or sawmill (including portable sawmill), or a cottage industry such as cane, orchid or pot plants.
- Explain the different prices of royalty to landowners, premium and non-premium species for log export.
- Calculate prices for sawn timber according to species and sizes.
- Explain the importance of other forest products.

Suggested assessment tasks

- Essay writing: discuss the socioeconomic costs and benefits of logging in Papua New Guinea.
- Calculate volumes of sawn timbers and determine their prices.
- Write report on field trip to observe operations of a sawmill in local area.

12.3 Forestry Economics and Marketing

Suggested activities

- Research government policies on the forestry industry.
- Brainstorm forestry products that are in demand in Papua New Guinea compared to forestry products that are in demand in countries such as Malaysia and Australia.

- Research on other countries where forestry is a major industry such as Canada.
- Develop a business plan for a forestry enterprise.
- Construct and interpret flow charts and diagrams describing steps in marketing forestry products.
- Where applicable, make a field trip to a national or provincial forestry government department.
- Draw maps showing the destination of Papua New Guinea forestry products.
- Case study of the logging industry in Papua New Guinea focusing on impacts on the economy and GDP.

Suggested assessment tasks

- Essay writing: discuss the socioeconomics costs and benefits of logging in Papua New Guinea.
- Write a report on a field trip to a national or provincial government forestry department.

12.4 Agroforestry

Suggested activities

- Discuss subsistence farming in Papua New Guinea.
- Discuss local tree cultivation and conservation in Papua New Guinea.
- Compare and contrast various agroforestry systems.
- Discuss benefits of agroforestry.
- Discuss problems of agroforestry in Papua New Guinea and suggest ways to solve them.
- List trees suitable for each system (combinations).
- Discuss nitrogen-fixing trees or plants.

Suggested assessment tasks

- Essay: discuss the role of nitrogen-fixing trees in subsistence farming.
- Do a poster on raising animals under the trees with appropriate spacing.
- Do a poster of growing food crops with trees using an appropriate agrisilvicultural pattern.

12.5 Introduction to Applied Research

Content
- rationale
- principles of research
- methods and designs
- research project areas
- implementation of research
- report writing and presentation

Suggested activities

- Explain the purpose and importance of research.
- Discuss different ways of doing research.
- Explain the different types of field experimental designs such as random block designs.
- Explain how to write up a research report.

Suggested assessment tasks

- Germinate seeds in trays using sterile and non-sterile soils to evaluate presence of pathogen.
- Sow seeds on seed beds or trays using different soils to determine the germination rate.
- Carry out study on effects of timber harvesting or continuous burning of grassland.
- Carry out survey on the forest products sold in the local market.

Learning activities and assessment tasks: Fisheries

Examples of learning activities and assessment tasks for each of the Fisheries units are provided in the following sections. Some examples are explained in detail.

Grade 11 units

11.1 Introduction to Fisheries

Suggested activities

- Ask students what they know about functions of PNG Fisheries Authority and how it provides service to the people
- State the role of fisheries in Papua New Guinea's economy
- Undertake research on basic stock assessment skills in assessing behaviour of fish stocks as a result of fishing pressure

Suggested assessment tasks

- Evaluate and describe the consequences of mismanagement of natural fisheries resources
- Ask students how they can sustain the levels of fish population in their local areas consistent with the National Fisheries Development Plan and policies

11.2 Marine Biology 1

Suggested activities

- Discuss with students the ecology of marine and freshwater plans and animals.
- Select some freshwater and marine plant or animals and ask students to study their anatomy and physiology and relate these to how they adapt in their various environments
- Take students to a river or sea and name plants and animals found in a locality. Provide sustainable strategies if in case they are endangered

Suggested assessment tasks

- Describe the ocean and its features
- Conduct research on issues affecting fishing and fish farming and make recommendations to improve productivity

11.3 Fishing Technology 1

Suggested activities

- Construct and or maintain fishing gears
- Use fishing equipment to undertake fishing activities using different skills

Suggested assessment tasks

- Identify and analyse issues affecting fisheries management and make recommendations for improvement

11.4 Basic Seamanship (option)

Suggested activities

- Students demonstrate handling of boats
- Show students how to do different types of rope work and ask them to demonstrate their skills
- Show students techniques of operating and maintenance of small marine outboard motors

Suggested assessment tasks

- Demonstrate appropriate skills of safety on the water to minimise mishaps
- Demonstrate first aid skills on the water

11.5 Aquaculture and Mariculture

Suggested activities

- 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 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.

Suggested assessment tasks

- Demonstrate an understanding of the reproductive biology and nutrition of aquaculture organisms
- Demonstrate an understanding of environmentally sustainable aquaculture development

11.6 Fisheries Management

Suggested activities

- Ask students to explain what sustainable practices in fisheries management are
- Teacher to guide students in explaining the principles of marine resource management is and develop strategies for its sustainability.

Suggested assessment tasks

- Students undertake research on how to monitor fisheries management measures that can be taken to raise juveniles' fish to reach maturity.

11.7 Handling, Processing and Storage

Suggested activities

- Ask students to list important hygiene procedures in the fishing industry.
- Teacher demonstrates detailed steps in handling fish and seafood products
- Students demonstrate the competency of handling fish and seafood products and cleanliness of the work area during and after production

Suggested assessment tasks

- An assignment on the procedures of the occupational health and safety standards and food regulation acts so that the fish and seafood products made met these standards

11.8 Fisheries Business

Suggested activities

- State the business and economic principles and factors of fisheries production
- Use record keeping in fish or seafood production as a business entity.

Suggested assessment tasks

- Students develop a detailed fishing or fish-farming business plan to generate a profitable income

Grade 12 units

12.1 Introduction to Applied Research

Suggested activities

- Teacher and students describe the importance of research in fisheries

Suggested assessment tasks

- Students undertake a research project on a selected fisheries issue

12.2 Marine Biology 2

Suggested activities

- Students make classifications of different groups of organisms in marine ecosystems
- Name primary producers in the marine ecosystems
- Go to the sea or bring sample of seawater, using microscopes, students make sketches of marine invertebrates and name the common ones
- Students are provided with a list of dangerous marine organisms and ask them to study their behaviour patterns and suggest ways to avoid their attacks
- Identify anatomical structures of common marine organisms and clearly state their functions
- Name major mangrove species and indicate on the map where they are distributed.
- List common crustaceans and fish found in the mangrove forests
- Students with the help of a teacher study estuaries, seagrass beds, coral reefs and open oceans.

Suggested assessment tasks

- Students do an assignment on marine organisms and human interaction

12.3 Fishing Technology 2

Suggested activities

- Students construct and maintain fishing nets
- Students use a range of nets and techniques to catch fish
- Teacher teach the students in identifying problems encountered in deploying and retrieving nets
- Students apply safety skills in deploying and retrieving nets

Suggested assessment tasks

- Teacher helps students describe different net fishing methods.

12.4 Seamanship (option)

Suggested activities

- Demonstrate skills of planning and organising a fishing trip
- Apply and demonstrate skills of boat handling and safe navigation
- Demonstrate skills in troubleshooting and maintenance
- Apply and demonstrate skills of sea safety and survival techniques.

Suggested assessment tasks

- Identify and describe main components of an inboard engine

12.5 Fisheries Extension

Suggested activities

- Students apply the methods and processes of fisheries extension

Suggested assessment tasks

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

Learning activities and assessment tasks: Integrated Resource Management

Examples of learning activities and assessment tasks for each of the Integrated Resource Management units are provided in the following sections. Some examples are explained in detail.

Grade 11 units

11.1 Integrated Farming 1

This is a flexible unit where teachers choose the type of agriculture, forestry and fisheries enterprise they wish to adopt to satisfy requirements of this subject. Teaching strategies outlined below are examples only—teachers may choose rice growing, raising chickens and raising fish in a pond—to approach this subject. Teaching strategies are based on these; however, teachers are encouraged to develop their own integrated farm enterprises.

In this case three enterprise projects have to be planned, operated and taught concurrently over the 2-year period in Grade 11 and Grade 12. At the end of Grade12 the school should establish a model farm that integrates various components of agriculture, fisheries and forestry. The enterprises they want to include in the integrated farming system will depend on the suitability of their school conditions. The following suggested learning and teaching activities are based on the example given earlier, where integrated components are chicken, tilapia fish and rice.

Suggested activities

- Define the term *integrated farming system* as a farming practice where two or more enterprise activities are carried out on the same farm area— cattle (animal) mixed with oil palm (animal and plant mixture), coconut (plant) mixed with cocoa (plant) (plant and plant mixture), tilapia fish, rice and broiler chickens raised in an area (fish, plant and animal mixture).
- Research and discuss traditional and modern integrated farming systems practised in Papua New Guinea and overseas; for example, New Britain Palm Oil Company is raising cattle under oil palm trees in West New Britain Province, farmers are growing rows of cocoa under coconut trees; in Eastern Highlands Province some farmers are keeping bees in hives around their coffee blocks; in Asia some farmers raise chickens in houses built over ponds where they keep fish (animal and fish mixture).
- Explain the benefits of integrated farming systems including:
  - enhancement of biological processes: honey bees easily pollinate coffee flowers thus resulting in higher fruit production
  - economical benefits: two or more enterprises give higher production output per unit of land thus increasing farm value
  - self-sufficiency and sustainability: what is regarded as waste can be better utilised; for example, chicken manure can substitute for

        organic fertilisers to supplement nutrients needs of rice plants in the field, offal from animals can be fed to tilapia fish in a pond (recycling)

-     – environmental benefits: recycling of waste products from the farm creates a healthy environment for humans.

- Visit an ideal site for the establishment of an integrated farming system and discuss factors that need to be considered for production of rice, broiler chickens and tilapia fish. Factors to be discussed may include soil (structure, water retention, and drainage), topography, and altitude, accessibility to water source, natural rivers and ponds.

- Discuss the climatic conditions requirements for optimum growth and reproductive performance of rice plants, broiler chickens, and tilapia fish including light, wind, temperature and habitat.

- Observe and discuss the anatomy of the animal and plants: rice, broiler chicken, and tilapia fish.

- Students survey and produce map of an area identified for establishing an integrated farming system. The map should show dimensions of the area, natural vegetation, drainage system, enterprise plots.

- Draw a detailed sketch plan giving the dimensions of the chicken house, fish pond and rice plot.

- Determine materials, equipment and other cost items required for setting up each enterprise (rice, chicken, and tilapia fish) to produce a cost budget.

- Students in groups plan and implement a viable and profitable integrated farming system.

Suggested assessment tasks

- Students research one integrated farming system practised in the local area or in Papua New Guinea and discuss the benefits of the system (economic, biological, environmental).

- Students determine densities for rice, fish, chicken to raise in a given area using standard rates and determine materials, equipment and other cost items required to set up each enterprise (rice, chicken, tilapia fish).

- Students determine the production estimates and projected income for all enterprises to produce a cash flow budget.

- Students in groups plan and implement a viable and profitable integrated farming system.

Grade 12 units

12.1 Integrated Farming 2

This unit is a continuation of Integrated Farming System 1. At this stage the teacher should work with the school administration to ensure that chicken house, fish pond and land clearing required for establishing each component of the integrated farming system are completed or in progress.

12.2 Extension

Suggested activities

- Students state roles and importance of an agriculture extension officer.
- Students discuss and demonstrate simple extension techniques in small groups.
- Students do a case study on the extension problems affecting their communities and suggest possible solutions (action plan).
- Invite a guest speaker from the Provincial Department of Agriculture and Livestock to talk to students about extension activities.
- Students plan visitation program as change agents (middle persons) disseminating knowledge and skills to farming community or vice versa.
- Organise and participate in field days to disseminate information through skill demonstration or promoting a new innovation.
- Students organise with their community leaders in carrying out extension tasks during school holidays; for example, transferring knowledge and skills on a newly introduced crop or livestock, management practices, marketing or a social issue.

Note: teachers to collaborate with relevant line agencies (research institutions, government departments, NGOs) to promote activities that will sustain this unit. Relevant textbooks must be consulted for the unit activities.

Suggested assessment tasks

- Students define and demonstrate roles of an extension officer.
- Students list problem areas in their communities and develop action plans.
- Students organise field days and transfer relevant information through posters, demonstration, public speeches and so on.
- Students present written extension reports.

Grade 11 and 12 Examples of Enterprises

Enterprise 1: Broiler Chicken Production

Suggested activities and assessment tasks

Since broiler production is one component in the integrated farm design, the teacher must follow the suggested activities and assessment tasks as prescribed in Agriculture unit 11.4 Animal Production (Monogastric) in this teacher guide. In addition they must follow the content for Agriculture unit 11.4 Animal Production (Monogastric) as prescribed in the syllabus.

Enterprise 2: Tilapia Fish Production

Suggested activities and assessment tasks

Since tilapia fish is the second component of the farm design, the teacher must follow the suggested activities and assessment tasks as prescribed in Fisheries unit 11.3 Fishing Technology, 11.5 Aquaculture and Mariculture in this teacher guide as well as following the content for the same subject units as prescribed in the syllabus.

Enterprise 3: Rice Production

Suggested activities and assessment tasks

Since rice is the third component of the farm design, the teacher must follow the learning and teaching activities as prescribed in Agriculture unit 11.3 Annual Crop Production in this teacher guide as well as following the content for the same subject units as prescribed in the syllabus.

Recording and reporting

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

Recording and reporting student achievement

When recording and reporting student achievement you must record the achievement of the students in each unit and then, at the end of the year, make a final judgement about the overall achievement, or progress towards achievement, of the learning outcomes. To help you do this, descriptions of the levels of achievement of the learning outcomes are provided in the 'Learning outcome performance standards' table.

When reporting to parents, the school will determine the method of recording and reporting. In an outcomes-based system, student results should be reported as levels of achievement rather than marks.

Levels of achievement

The level of achievement of the learning outcomes is determined by the students' performance in the assessment tasks. Marks are given for each assessment task, with a total of 100 marks for each 10-week unit, or 50 marks for each 5-week unit.

The marks show the students' level of achievement in the unit, and hence their progress towards achievement of the learning outcomes. There are five levels of achievement:

- Very high achievement
- High achievement
- Satisfactory achievement
- Low achievement
- Below minimum standard

A **very high achievement** means overall that the student has an extensive knowledge and understanding of the content and can readily apply this knowledge. In addition, the student has achieved a very high level of competence in the processes and skills and can apply these skills to new situations.

A **high achievement** means overall that the student has a thorough knowledge and understanding of the content and a high level of competence in the processes and skills. In addition, the student is able to apply this knowledge and these skills to most situations.

A **satisfactory achievement** means overall that the student has a sound knowledge and understanding of the main areas of content and has achieved an adequate level of competence in the processes and skills.

A **low achievement** means overall that the student has a basic knowledge and some understanding of the content and has achieved a limited or very limited level of competence in the processes and skills.

Below the minimum standard means that the student has provided insufficient evidence to demonstrate achievement of the learning outcomes.

Achievement level					
Total marks	Very high achievement	High achievement	Satisfactory achievement	Low achievement	Below minimum standard
600	540–600	420–539	300–419	120–299	0–119
500	450–500	350–449	250–349	100–249	0–99
400	360–400	280–359	200–279	80–199	0–79
300	270–300	210–269	150–209	60–149	0–59
200	180–200	140–179	100–139	40–99	0–39
100	90–100	70–89	50–69	20–49	0–19
60	54–60	42–53	30–41	12–29	0–11
50	45–50	35–44	25–34	10–24	0–9
40	36–40	28–35	20–27	8–19	0–7

Sample format for recording Applied Natural Resource Management subjects assessment task results over two years

Student name:

Grade 11 assessment task results			
Unit	Assessment task	Mark	Student mark
11.1			
11.2			
11.3			
11.4			
11.5			
11.6			
	Total marks Grade 11	300	

Student name:

Grade 12 assessment task results			
Unit	**Assessment task**	**Marks**	**Student mark**
12.1			
12.2			
12.3			
12.4			
	Total marks Grade 11	**300**	
	Total marks Grade 11 and 12	**600**	

Learning outcomes and levels of achievement

Levels of achievement in Grade 11 and Grade 12 are recorded and reported against the learning outcomes. The performance standards for the levels of achievement are described in the section on assessment.

Steps for awarding final student level of achievement

1. Assess unit tasks using unit performance standards and assessment criteria.
2. Record results for each task in each unit.
3. Add marks to achieve a unit result and term result.
4. Add term marks to get a year result.
5. Determine the overall achievement using the achievement level grid.
6. Report results using the learning outcome performance standards.

The following is an example of reporting using the learning outcomes performance standards descriptors.

Using the learning outcomes performance standards descriptors

Student Applied Natural Resource Management School-based assessment	Geno Agriculture High achievement
This means Geno:	
Demonstrates sound knowledge and understanding of socioeconomic benefits and values of crops and animals	
Demonstrates sound knowledge and understanding of concepts and fundamental principles that underpin crop and animal production	
Selects technology and applies skills to undertake sustainable practical activities	
Independently identifies some issues affecting farm management, describes them in detail and makes practical recommendations for improvement	
Applies entrepreneurial skills effectively in project planning, implementation, reporting	
Communicates well-researched concepts effectively using several appropriate mediums of communication	
Demonstrates sound knowledge and understanding of agriculture policies and organisations that support agricultural production at national and international levels	
Demonstrates sound knowledge and understanding of socioeconomic benefits and values of crops and animals	

Resources

Applied Natural Resource Management subjects become more interesting and meaningful when you use a variety of resources and local materials in your teaching.

You should be always trying to adapt, improvise, make, find or write material that will be useful for lessons. Applied Natural Resource Management subjects can be taught without expensive equipment by making use of what is around you, though there are some equipment and materials that are essential to teach the Applied Natural Resource Management syllabuses.

General guidelines for selecting and using resources

How effective a resource is depends on whether it is suitable for the knowledge or skill to be learned and the attitude of the students. Classroom organisation is the key to using resources successfully. You need to:

- prepare thoroughly. Make sure that you are familiar with the resource so that you use it with confidence and assurance. If equipment is involved, check that it is in working order, make sure that you know how to operate it and that it is available when you need it.
- use the resource at the right place and time—it should fit in with the flow and sequence of the lesson and serve a definite teaching purpose.
- (if the resource is radio, film, video or television), introduce the program by outlining the content. You might also set some questions to guide listening or viewing. Follow up after using the resource, by discussing and drawing appropriate conclusions.

Useful resource books: Forestry

Anderson, D A and Holland, II, 1982, *Forest and Forestry,* Interstate Printers and Publishers Inc., Illinois.

Independent State of Papua New Guinea 1993, *Forestry, Amendment Act 1993.*

Paijmans, K (ed.) 1976, *New Guinea Vegetation,* CSIRO and ANU Press, Canberra.

Papua New Guinea Ministry of Forests 1991, *National Forest Policy, 1991*.

Saunders, JC 1993, *Forest Resources of Papua New Guinea: Map with Explanatory Notes,* PNGRIS Publication No.2, AIDAB, Canberra.

Shrivastava, M B 1997, *Introduction to Forestry,* Vikas Publishing House, PVT Ltd, New Delhi.

Tesseverasinghe, K., (1988) *Introduction to Forestry,* Unitech, Lae.

11.2 Botany

Conn, J B 1979, *Botany Training Manual for the Forestry College*, vol.12, Office of Forests, Papua New Guinea.

Forman, L and Bridson, D 1989, *The Herbarium Handbook*, Royal Botanic Gardens, Kew, UK.

Havel, JJ 1975, *Forest Botany Part 2, Botanical Taxonomy*, Department of Forest, Port Moresby.

Johns, RJ 1976, *Common Trees of Papua New Guinea*, Training Manual for Forestry College, Bulolo.

11.3 Plantation Silviculture

Evans, J 1994, *Plantation Forestry in the Tropics, 2nd edn,* Clarendon Press.

Hilton, GH 1984), *Manual of Silviculture for the Indigenous Forests of Papua New Guinea,* Papua New Guinea University of Technology, Lae.

McKinty, MH 1999, *Silviculture of Mixed Tropical Forests*, Department of Forestry, Unitech, Lae.

Romijn, K 1982, *Plantation Silviculture, Training Manual for Forestry College*, vol. 18, Bulolo.

11.4 Forest Conservation

Department of Environment and Conservation (DEC) 1993, *Papua New Guinea Conservation Needs Assessment, vols 1 and 2..*

Flannery, TM 1994, *The Future Eaters*, ch. 8, 'The Diversity Enigma'; ch. 12, 'Lost Marsupial Giants of New Guinea', Reed Books, Chatswood, NSW.

Frankel, O,., Brown, A, and Budon, J 1995, *The Conservation of Plant Biodiversity*, Cambridge University Press.

Lamothe, L 1997, *Wildlife Training Manual for Papua New Guinea, vols 1-3*.

12.1 Measurements

Eaton, P 1982, *A Guide to Maps and Map Reading in Papua New Guinea*.

Philip, MS 1994, *Measuring Trees and Forests*, CAB International.

Training Manual for Forestry School, Forest Surveying, vol. 2.

12.2 Harvesting, Processing and Marketing

Food and Agriculture Organisation 1982, *Basic Technology in Forest Operations*, FAO Paper no. 36. FAO, Rome.

Papua New Guinea Forest Authority and Papua New Guinea Department of Environment and Conservation 1996, *Papua New Guinea Logging Code of Practice.*

Timber Forestry Training College nd, *Harvesting Manual*, Timber Forestry Training College, Lae.

12.4 Agroforestry

Clarke, WC and Thaman, RR (eds) 1993, *Agroforestry in the Pacific Islands: Systems for Sustainability,* United Nations University Press, Tokyo.

Frost, F, Forge, K and Balck, AW 2000, *Extension and Advisory Strategies for Agroforestry*, Rural Industries Research AusAID/RIRDC Publication No. 00/184, Australia.

Young, A. 1990, *Agroforestry for Soil Conservation*, CAB International

12.5 Introduction to Research Skills

Mead, R and Currow, RN, 1984, *Statistical Methods in Agriculture and Experimental Biology,* Chapman and Hall.

References

Anderson, D A and Holland, II*, 1982, *Forest and Forestry,* Interstate Printers and Publishers Inc., Illinois.

Conn, J B 1979, *Botany Training Manual for the Forestry College*, vol.12, Office of Forests, Papua New Guinea.

Department of Environment and Conservation and Papua New Guinea Forest Authority 1996, *Papua New Guinea Logging Code of Practice*, Papua New Guinea Forest Authority, Port Moresby.

Evans, J 1994, *Plantation Forestry in the Tropics, 2nd edn,* Clarendon Press.

Mayer, R 2004, 'Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction', *American Psychologist*, vol 59, no. 1, pp. 14–19.

Papua New Guinea Department of Education, 2007, *Agriculture Syllabus Lower Secondary*, Department of Education, Port Moresby.

Papua New Guinea Department of Education, 2007, *Agriculture Teacher Guide Lower Secondary*, Department of Education, Port Moresby.

Shrivastava, MB 1996, *Introduction to Forestry*, Vikas Publishing House, New Delhi.

Tesseverasinghe, K 1988, *Introduction to Forestry*, Department of Forestry Papua New Guinea, Unitech, Lae.

Glossary for assessment

Syllabus outcomes, criteria and performance standards, and examination questions all have key words that state what students are expected to be able to do. A glossary of key words has been developed to help provide a common language and consistent meaning in the syllabus and teacher guide documents.

Using the glossary will help teachers and students understand what is expected in response to examinations and assessment tasks.

Glossary of key words for assessment

Account	Account for: state reasons for, report on. Give an account of: narrate a series of events or transactions
Analyse	Identify components and the relationship between them; draw out and relate implications
Apply	Use, utilise, employ in a particular situation
Appreciate	Make a judgement about the value of
Assess	Make a judgement of value, quality, outcomes, results or size
Calculate	Ascertain or determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes or categories
Compare	Show how things are similar or different
Construct	Make; build; put together (items or arguments)
Contrast	Show how things are different or opposite
Critically (analyse, evaluate)	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to (analysis or evaluation)
Deduce	Draw conclusions
Define	State meaning and identify essential qualities
Demonstrate	Show by example
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note or indicate as being distinct or different from; to note differences between
Evaluate	Make a judgement based on criteria; determine the value of
Examine	Inquire into
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Extrapolate	Infer from what is known
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Plan, inquire into and draw conclusions about

Justify	Support an argument or conclusion
Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example, a point of view, idea, argument, suggestion) for consideration or action
Recall	Present remembered ideas, facts or experiences
Recommend	Provide reasons in favour
Recount	Retell a series of events
Summarise	Express, concisely, the relevant details
Synthesise	Putting together various elements to make a whole