Agriculture

Lower Secondary

Teacher Guide

Papua New Guinea
Department of Education

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Secretary's message

This teacher guide is to be used by teachers when implementing the Lower Secondary Agriculture Syllabus (Grades 9 and 10) throughout Papua New Guinea.

Agriculture is very important to Papua New Guinea as the majority of people live in rural areas and are engaged in some form of agricultural activities. It is important that students learn about both traditional and modern agricultural practices and how to add value to agriculture products. It is also important that they learn a range of agricultural skills so that they can participate in and add value to the agricultural activities of their communities.

The Lower Secondary Agriculture teacher guide contributes to integral human development as it is based on the students' physical environments, societies and cultures. It links to the *National Education Plan's* vision which is that secondary education enables students to achieve their individual potential to lead productive lives as members of the local, national and international community as they undertake a range of projects and work related activities at school that can be used in everyday life.

This teacher guide shows teachers how to integrate the theoretical and practical aspects of agriculture in their planning and programming, so that students can participate in innovative agricultural projects throughout Grades 9 and 10.

I commend and approve this Agriculture teacher guide for use in all schools with Grades 9 and 10 students throughout Papua New Guinea.

DR. JOSEPH PAGELIO
Secretary for Education

Introduction

The purpose of this teacher guide is to help you implement the Agriculture syllabus. It is designed to stimulate you to create exciting and meaningful teaching programs and lessons by enabling you to choose relevant and purposeful activities and teaching strategies. It will encourage you to research and look for new and challenging ways of facilitating students' learning.

*The teacher guide and the syllabus must be used side by side***.** The syllabus states the learning outcomes for the subject and each unit, and outlines the content and skills that students will learn, and the assessment requirements. The teacher guide provides teaching and learning strategies, ideas for planning and programming and suggested activities to help students achieve the learning outcomes.

The teacher guide provides direction for you in using the outcomes approach in your classroom using a step by step approach. Although the syllabus provides the assessment tasks at the end of each unit, the outcomes approach requires you to consider the assessment requirements early in your planning. This is reflected in the teacher guide.

In the teaching and learning section, the teacher guide gives examples of how students learn. Because the education reform uses an outcomes approach, teaching and learning strategies evolve around a student-centred approach to learning. You as a teacher facilitate learning. Allow your students to take ownership of their learning by picking and choosing different activities suggested in *Step 4: Elaboration of content and activities* to increase their skill competency levels. The order of activities in the units is only a suggestion.

The teacher guide also outlines principles and procedures for developing students' skills because agriculture is a practical subject where students actually grow and raise live plants and animals. To help you recognise skills level, Bloom's taxonomy of skills is included for your reference. The teacher guide has an assessment glossary on page 67, an agriculture glossary on page 68 and teaching and learning strategies for you to use where applicable which are explained on page 89 so you can become familiar with them.

This teacher guide provides sample programs for each unit which show you how to integrate the theoretical and practical units. The sample programs do not have suggested times for each activity. This means you are required to draw up your own program according to your local school calendar. You could use the detailed sample program in Appendix 2A on page 101 and Appendix 2B on page 104 as guides.

There is also detailed information on how to mark assessment tasks and the resources needed to teach Agriculture. Appendix 1 on page 95 has a sample test for your reference. The section on recording and reporting shows you how to record students' marks and how to report against the broad learning outcomes.

Teaching and learning

How students learn

What I hear I forget.

What I hear and see I remember a little.

What I hear, see and discuss I begin to understand.

What I hear, see, discuss and do, I acquire knowledge and skill.

What I teach to another, I master.

(*Active Learning Credo* statement by Silberman, 1996)

In support of this are the findings that we remember:

- 20% of what we hear
- 40% of what we see
- 90% of what we see, hear, say and do or what we discover for ourselves.

A student-centred approach to learning

Different students learn in different ways. Some students learn best by writing, others by talking and discussing, others by reading and others by listening. Most students learn by using a combination of these. All learn skills through practising and repetition. You need to use a variety of teaching strategies to cater for the different ways your students learn.

Teaching and learning strategies

To assist and encourage students to learn, you perform certain tasks. These are referred to as teaching strategies. You need to engage students directly in learning but there are times when you have to take charge of the learning in the class and teach particular concepts or ideas.

Teaching strategies include:

- group work
- role play/drama
- skills practice
- directed assignments, research/inquiry
- class discussions/debates
- problem-solving activities
- teacher talk – instructions, explanations, lectures or reading aloud
- directed question and answer sessions
- audio-visual presentations
- text books or worksheets
- demonstration and modelling
- guest speakers

- field work
- classroom displays

Using groups as a teaching and learning strategy

Using groups is an important strategy in Agriculture as students learn from each other, not just from the teacher. Group work encourages students to participate in achieving a shared goal and collaborative learning. In deciding whether to use groups or not, you need to consider:

- your intended outcomes
- the extent to which the outcomes can be achieved by a group
- the lesson content
- the time allocated for the completion of the task
- the classroom setting
- available materials and resources
- the structure of the group based on gender, ability, cultural background and student preferences.

Groups work well when:

- the group decides upon their goal, timelines and tasks
- students realise that success depends on the achievement of the whole group, not individuals
- the task is broken into subtasks which must be finished to successfully complete the overall task
- the whole class is involved in the activity
- everyone has a role to play, eg field trips
- membership of small groups is changed regularly to provide a variety of learning experiences for all students.

Strategies for organising and managing groups:

- mixed-ability groups – the more able learners in the group can help the others to master the work so that you need not teach some parts
- same-ability groups – the teacher can leave the groups of faster learners to get on with the work on their own. You can give extra help to individual learners in the slower groups.
- using group leaders/monitors – you appoint faster, more able learners as group leaders or monitors who can help slower learners.

Developing skills

Principles and procedures

Students need to develop skills to help them learn. Skills development should happen as a part of a student's learning experience and the learning and practising of skills needs to occur in the context of the units being taught.

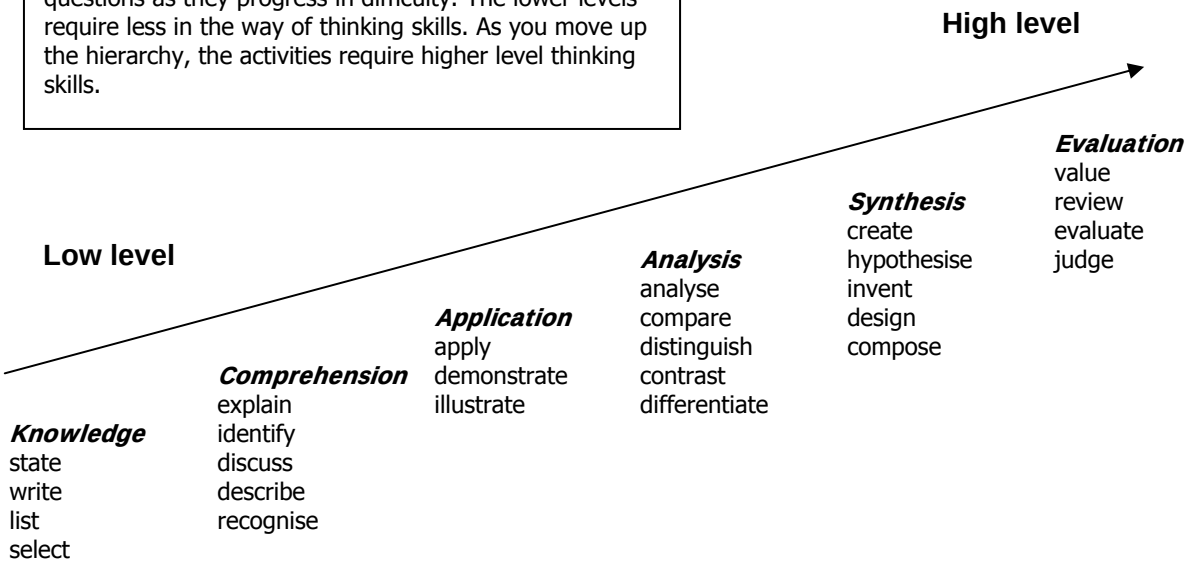
Skills learning tend to be most effective when:

- students go from the known to the unknown
- students understand why it is necessary to gain mastery of 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
- students are encouraged to record and diagnose their performance
- 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.

To teach skills effectively you need to include learning activities that span the range from teacher-directed to student-centred learning, use groups of different sizes ranging from the whole class to small groups and use a range of teaching strategies which use higher order skills as your students progress.

Bloom's taxonomy of skills

Bloom's Taxonomy is a way to classify skills, activities or questions as they progress in difficulty. The lower levels require less in the way of thinking skills. As you move up the hierarchy, the activities require higher level thinking skills.



Language skills for Agriculture

Students need to learn how to speak and listen, read and write, view and observe. Students can learn oral language skills through, for example:

- discussions
- oral and written reports
- interviewing opportunities

Provide opportunities for your students to listen and record information carefully. Guest speakers, talks during field trips or excursions, tapes, radio, television, CDs, videos, stories and concepts about agriculture read aloud are listening resources. When students come to expect a listening experience as a regular part of their classroom routine, their ability to attend to details in what they hear about agricultural concepts is quite likely to improve.

Place of vernacular in Agriculture

Maintenance of the student's language is something that continues at Lower Secondary as stated in the Department of Education's Language policy in all schools. At times it will be appropriate to use vernacular, Motu or Tok Pisin to explain concepts or ideas. Vernacular can be used to describe and illustrate those things that do not have English translations. For example, it would be appropriate to use the vernacular, Motu or Tok Pisin when finding information from the community or selling agricultural produce in the local market.

Writing skills

Students must be able to choose the right word to get the agriculture message across and be able to put words together in a way that makes sense to the reader. The ability to write well and use appropriate vocabulary and agriculture terms in order to impart agriculture messages takes a lot of practice. Writing skills and techniques should be emphasised in agriculture lesson activities.

Thinking and questioning skills

Agriculture lesson activities assist students to analyse and think critically about information they come across. By processing information rather than rote learning, students are more likely to understand and retain what they have learnt. Students must be involved in the process of thinking instead of simply accepting the end products of someone else's thoughts. The ability to think critically can be taught effectively by asking the types of questions listed below:

- what do you notice/see/find?
- what difference do you ...?
- what similarities do you ...?
- which ones belong together? why?
- why don't these belong to this group ...?
- what could have happened if ...?
- what would ... be like if ...?
- how would you ...?
- what explanation would you give for ...?
- is this always so?
- does evidence of ... change the original explanation?
- how can this be tested/checked?
- suppose ... what would happen?

- what makes you think this would happen?
- what would be needed for that to happen?
- is there a different explanation?
- if … happened, what would happen next?

Teaching and learning strategies for Agriculture

Here are teaching and learning strategies which can be used to make learning more meaningful and interesting in Agriculture. You should vary your lessons by using different teaching strategies, making sure that the ones you use for the lesson are suitable for your lesson outcomes. Many of these strategies work together, for example developing *consequence charts* during *class discussions* helps students make realistic *decisions*. For detailed explanations see the glossary on page 89.

Problem solving

- Brain storming
- Situation/problem needs analysis
- Identify strategies to solve problems
- Research
- Investigation
- Jawsaw groups
- Class meetings
- Discussions
- Questionnaires

Field application

- Research
- Field work
- Classroom display
- Guest speakers
- Interviews
- Photographs
- Questions and questionnaires
- Cultural activities
- Presentations

Multimedia

- Photos
- Pictures
- TV
- Classroom display
- Radio
- Internet
- Presentations

Decision making

- Consequence charts
- Diagrams
- Mapping
- Matrix
- Questions and questionnaires
- Tables
- Graphs
- Presentations

Evaluation

- Questions and questionnaires
- Reflections
- Tables of evaluation results
- Graphs of evaluation results
- Discussions
- Presentations
- Classroom display
- Value reinforcement.

Assessing Agriculture

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

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

Assessment in Agriculture measures students' achievements of the unit learning outcomes described in the syllabus. It is an ongoing process of identifying, gathering and interpreting information about students' achievement of the learning outcomes and can be integrated into the students' normal learning activities.

Assessment *for* learning

Assessment *for* learning is often called formative assessment (evaluation of competencies) 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 student learn better. It also helps you plan your program to make student learning and your teaching more effective. Often it is informal and students can mark themselves or their friends. An example is a quick class quiz to see if students remember the important points of the previous practical or theory lesson.

Assessment *of* learning

Assessment of learning is often called summative assessment. It 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 Agriculture units

In the Agriculture syllabus, the unit learning outcomes, which link to the broad learning outcomes, are assessed through specified assessment tasks using a range of assessment methods. Assessment criteria for each unit outcome provide clear indications of how, and to what extent, the achievement of the learning outcomes may be demonstrated. Performance standards, marking guides and assessment criterion help you with the marking process and ensure that assessment is consistent across schools.

Students must complete the assessment tasks for the unit. You will expand each task and 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 are provided to the student so that they know what it is that they have to do
- any sources or stimulus material used are clear and appropriate to the task
- achievement is measured in terms of more than one outcome
- 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.

Feedback

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

Feedback should be:

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

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 student either in written or verbal form
- formative – given during the topic with the purpose of helping the student know how to improve
- summative – given at the end of the topic with the purpose of letting the students know what they have achieved.

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 teaching and learning process if they are integrated into the regular class routine and not treated merely as a summative strategy. They allow students to monitor their progress and provide valuable information for you in planning further teaching and learning activities.

Tests 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 at the earliest opportunity and that students are given feedback on their performance.

There are many different types of tests. Tests should be designed to find out about student knowledge of content and about the development of 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/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 sufficient time for all students to finish.

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/check the students' written exercises, class tests, homework activities
- 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 the performance standards provided in each unit of this Teacher Guide when making a decision about the achievement of your students in relation to the unit 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 the student 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 ensure that you are interpreting the performance standards correctly when assessing your students, it is important to undertake subject 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 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 in Agriculture

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

Self and peer assessment:

- continues the learning cycle by making assessment part of learning

- shows students their strengths and areas where they need to improve
- engages students actively in the assessment process
- enables students to be responsible for their learning
- helps students understand the assessment criteria and performance standards.

Managing assessment tasks for Agriculture

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 Agriculture there are a number of 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 ensure that all students are informed of the criteria before they begin. Discuss the assignment 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: This 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 assignments and projects.

Assess in class: Use class time to carry out and to assess tasks. Oral presentations and multiple choice tests marked in class enable instant developmental evaluation and feedback. On-the-spot reports on projects or practical work, take less time to mark, and are useful, because they give immediate feedback to students on their projects.

Feedback to the whole class: 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 report 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 is: each member of the group uses 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 through the submission of late work.

Shift the responsibility

Introduce self and peer assessment: Develop in students the skills to evaluate their own work and that of their peers. Help the students' use the performance standards, marking guides and assessment criteria against which work is judged. Self-assessment increases the amount of feedback students get. It can supplement 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 teaching and learning experience for the teacher and the learner, not just to accredit students.

Use observation sheets and spotlighting

You might record student achievement while observing your students by using observation sheets. The most common observation sheets are individual student checklists and whole class grids. They can be used for all the projects that students undertake.

Spotlighting uses individual student checklists. This method can be used to focus on a few selected aspects of student performance, such as planning for a project. 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 in conjunction with spotlighting. With focused questioning you can gain a deeper awareness as to whether or not students understand the concept being taught.

Portfolios

Portfolios provide evidence for judgments of student achievement for a range of projects. In the option units students are required to present a portfolio for assessment purposes. It contains a specific collection of student work or evidence. This collection of work provides a fair, valid and informative picture of the student's accomplishments.

How to minimise marking times of portfolios:

- specify the pieces of work and keep the number low
- mark as you go – ask that one of the pieces of work be completed at the end of week 3 and mark it then. Do not leave the assessment of the whole portfolio until the end of term
- use self-assessment – the student can self assess some of the work.

The portfolio does not have to be a folder or binder; it can be in the form of an exercise book with the student marking the pages they want to have marked as part of their portfolio.

Reports

Reports are an authentic form of assessment. They encourage students to develop observation and recording skills, and require organisational skills in both collecting and analysing information and communicating information clearly.

Reports in Agriculture can be oral, written or in graphic form or a mixture of these. Duration of reports vary according to the task. Reporting in groups is a common strategy used in big classes however each student should be allowed a turn at reporting during the year.

Experiments

There is a great deal of time involved in marking experiments and projects. However, the end result is that you have a better picture of what students truly know, understand, and are able to do. To help you, generic performance standards and checklists are provided for assessing experiments.

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 plan with the other teachers who teach the same grade. By planning together, you will *all* have better lessons and make better use of your limited resources.

Points to consider when programming

- Which unit learning outcomes are students working towards?
- What is the purpose of this unit/topic/learning experience?
- Which learning experiences will assist students to develop their knowledge and understandings, skills, and values and attitudes in the subject?
- 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/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 unit learning outcomes and enhance the learning?
- How can the assessment be part of the teaching and learning program?
- Which options and projects can be done to make best use of the school's resources?
- How can a balanced program be developed?

The planning process

In this teacher guide, ideas for programming and organising each unit 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 unit learning outcomes

The first step is to read the unit description in the syllabus and then study the unit learning outcomes 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 see what skills and knowledge are embedded in

the outcome. Remember the unit learning outcomes link to the broad learning outcomes.

This teacher guide gives you a brief description of the main requirements of each learning outcome.

Step 2 – Planning for assessment

It is necessary to study the assessment requirements of the unit early in your planning to ensure that you teach the content and skills students need to achieve the unit learning outcomes.

The assessment tasks are described in the syllabus. They indicate what specific knowledge and skills students will need to demonstrate that they have achieved the unit learning outcomes.

You will have to decide when to schedule the 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 the performance standards and/or marking guide which you must use when you are marking the tasks. This is to ensure consistency with marks awarded to students in all schools in Papua New Guinea. However you must develop clear and detailed instructions for completing the task yourself and ensure 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. You may follow the topics in the order they are listed in the syllabus or you may cover the topics through integrated activities or a thematic approach. 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 the learning activities that will best provide students with the opportunity to learn the content and practice 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.

Once you have completed your unit plan you will have to consider each topic in more detail. For example, if you have allocated two weeks for a topic that means you have ten lessons available (five lessons per week). You will have to develop a plan for each topic that includes in more detail what you will cover in each lesson. Your topic plan must include a sequence of student activities and teaching points that contribute to the overall achievement of the unit outcomes. Your topic plan should include what you think your students will do in each lesson, but you must remember that the individual lessons must flow logically, one from the previous and must be adjusted

according to how students are progressing through the topic. You may develop outcomes for the topic and for each lesson, but these must be related to the unit outcomes.

This teacher guide provides a sample program for each unit. It does not provide individual lesson plans.

Step 4 – Elaboration of content and activities

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 text books and teaching resources you have access to and list chapters, pages or items that you will use for each topic in your program**.** The text books 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 examples in each unit of some activities you might like to use to ensure active learning. It also gives background information on some of the content.

Remember that Agriculture practical option units should be taught alongside the core units in both Grades 9 and Grade 10.

Agriculture requirements

All units in Agriculture require students to develop knowledge and skills by completing practical activities and projects. *Schools must have sufficient land to grow crops and raise animals.* Agriculture cannot be taught from the blackboard.

There are four core units and ten option units in Agriculture. All students must complete the four core units in sequence from Grade 9 to 10. Students must study a minimum of three option units. Schools may use the options in the syllabus or develop their own to suit the local context. using the framework provided in Unit 9.9 and 10.7.

Each grade has two core units, which must be taught in sequence. Core Unit 9.1 must come before Core Unit 9.2 and Core Unit 10.1 comes before Core Unit 10.2. There are a number of option units which students can choose from. Certain of the option units relate more closely to one or other of the core units. Offering the core unit and a related option unit concurrently and over two terms, allows more time for students to observe the growth cycles of the plants or animals being studied.

Using this model a Grade 9 program might look as follows:

Term 1 and 2	Term 3 and 4
Core unit 9.1 and choice of option units 9.3; 9.4; 9.6; or 9.9.	Core unit 9.2 and choice of option units 9.5; 9.7; 9.8 or 9.9

Similarly the grade 10 program might also be as follows:

Term 1 and 2	Term 3 and 4
Core unit 10.1 and choice of option units10.3; 10.4; or 10.7.	Core unit 10.2 and choice of option units 10.5; 10.6 or 10.7

Given the heavy emphasis on practical (applied) learning in Agriculture it would be helpful if schools could program at least one double period per week in this subject. It is highly recommended to program for two double periods per week.

Essential resources/equipment for Agriculture units	
All units that involve soil testing and crop production or forestry (agriculture and horticulture)	Land for gardens or nursery; soil samples; seeds and/or seedlings; agricultural plants; tools and machinery for planting, tilling and harvesting crops; fertilisers; weed and pest control products;
All units that involve livestock production	Land to run the livestock; food and shelter for the livestock; fencing materials; machinery and equipment to feed and care for livestock
Specialist options eg worm farming, aquaculture, farm technology	Worms and soil beds; ponds or tanks; fish or fingerlings; aquatic herbs and/or weeds; equipment and resources to construct simple farm tools

Guide to planning and programming Agriculture

Individual units

In Agriculture, how you program the core units together with the option units will depend on the crop that your students grow, or the animals they raise for their project. There will be times when the students are very busy in the field, garden or orchard preparing the ground, planting, weeding etc, and other times when the crop is growing where they are not so busy outside. Collaborate with Design and Technology teachers to construct animal or plant housings in order for you and your students to have more time for actual growing or looking after animal activities. There will be other times when your students will be very busy looking after young animals, and other times when they are not so busy with outside activities. You need to look at the growth cycle or life cycle calendar of the project crop, fruit or animals and plan your program around it. For example:

Crop – Peanuts		
Time-line for peanut project **18–20 weeks**	**Project activities**	**Core unit**
Week 1	Prepare soil, fertilise	
Week 2	Plant the seeds	
Weeks 3–16	Plants bloom Weeding and watering. Check for pests and diseases. Treat plants if necessary Mulch	Core unit work and activities 50 periods in total
Weeks 17–18	Dig the plants and dry them	
Week 19	Harvest the pods	
Week 20	Market the crop	Evaluate

Livestock – chickens		
Time-line for chicken project **10 weeks**	**Project activities**	**Core unit**
Week 1	Plan the project	
Week 2 –4	Arrange for purchase of chickens	
Weeks 5–12	Looking after chickens Feeding and watering Check for pests and diseases and treat if necessary Weigh for growth rate and keep records	Core unit work and activities such as experiments 50 periods in total
Weeks 13	Slaughter or market live chickens	
Week 14–18	Remove chicken manure, clean up shelter Market or apply to gardens	
Week 19–20	Complete records Finalise finances	Evaluate/test

It is possible that you will decide that the students could run two projects simultaneously – such as crop/fruit and animal project together – and then your program will be for four terms. It is also possible that you could combine a long term school project, such as growing oil palm or vanilla, with a short term class project such as growing a crop of tomatoes or strawberries. The short term project will enable students to experience the satisfaction of successfully undertaking and completing a small project while contributing to the long term school project.

As outlined in the syllabus document, each core unit is integrated over twenty weeks with an option unit to allow sufficient time to complete the project. Option 9.3 and 9.4 integrate best with core unit 9.1. However any option unit can be done alongside core unit 9.1 including school developed units.

Option units 9.5, 9.6, 9.7 and 9.8 integrate best with core unit 9.2. However any option unit can be done alongside core unit 9.2 including school developed units.

A project

It is important to teach students how to plan when they are undertaking class or individual activities such as projects. Students can apply knowledge and skills from Business Studies and Design and Technology to Agriculture. The process which students undertake when planning and undertaking a project is:

Planning

Research

- What to do for the project? – decide on what plants or animals or type of simple farm machinery or equipment to produce
- Special requirements of the plant or animal or type of simple farm machinery or equipment chosen
- Time needed to complete the project
- Possible markets for the products
- Possible risks and problems
- Possible sources of help and support

Decide on the goals

- What and how much to produce?
- Timelines

Physical planning

- Select site
- Determine facilities needed
- Determine infrastructure needed eg housing, equipment, etc

Financial planning

- Start up costs
- Sources of funding
- Estimates of profit
- Estimates of cash flow
- Determine how records would be kept

Reporting and evaluation

- Decide how the project will be monitored
- Decide how goals will be measured and evaluated
- Decide how the project will be reported.

Implementation

When implementing the project students:

- organise the necessary tools or equipment
- obtain the required seeds/plants/animals
- learn and practice the appropriate skills
- undertake the activities required to grow the crop or raise the animal over the required length of time
- undertake the activities required to harvest and market the product
- clean up the area, and dispose of, or use waste appropriately.

Grade 9 units and options

9.1 Agriculture in Papua New Guinea 1 and one option

Term 1 and 2, 20 weeks

Step 1 – Interpreting the unit learning outcomes

The unit description and the unit learning outcomes of both core unit 9.1 and the selected option need to be looked at carefully when planning your program for term one and two.

Outcome 9.1.1 Describe various farming systems of Papua New Guinea and illustrate the roles of agriculture in the local economy

Outcome 9.1.2 Investigate and analyse soil properties

Outcome 9.1.3 Investigate and analyse the structure and functions of agricultural plant processes

Outcomes 9.3.1 or 9.4.1 or 9.8.1 or 9.9.1 Use a range of tools, skills and techniques to produce the chosen crop or forestry product

Outcomes 9.3.2 or 9.4.2 or 9.8.2 or 9.9.2 Investigate, design and undertake a crop or agro-forestry or livestock project that is ecologically suitable, using appropriate codes and practices.

Outcomes 9.3.3 or 9.4.3 or 9.8.3 or 9.9.3 Reflect and comment on the success of the crop or agro-forestry.

Teaching the core and the option simultaneously requires you to cluster these six unit learning outcomes for the purpose of planning and programming. For students to achieve the core outcomes you will need to teach them about farming systems, the different types of farming systems used in Papua New Guinea and the importance of agriculture in the local economy i.e. in the student's local area. You must also provide opportunities for students to do simple experiments and investigations related to soil properties and plant processes.

These investigations link to the practical project and students use the results of their investigations when planning their project and selecting an appropriate crop or forestry project.

During the project students will demonstrate that they can use appropriate tools, skills and techniques when producing the chosen crop or forestry product. At the end of the project students must be given the time to reflect and comment on the success of the crop or forestry project

Step 2 – Planning for assessment

Study the assessment requirements of the option and the core unit. These will tell you what specific knowledge and skills students will need to demonstrate they have achieved the unit learning outcomes.

Students complete a project as part of the requirements for the option. They are also assessed on the project and the portfolio which shows evidence of the processes undertaken in the project.

For the core unit 9.1, the first assessment task is a number of practical experiments and activities where students:

- collect local soil samples and investigate their properties using sight and touch
- analyse fertile and non-fertile local garden soil using sight and touch
- carry out simple experiments on seed dormancy and germination under different conditions
- observe, draw and label reproductive parts of agricultural plants
- carry out simple experiments to demonstrate photosynthesis and respiration principles

Assessment task two for core 9.1 is a test. When setting and marking the test you should make sure that your students demonstrate knowledge and understanding of various farming systems and the role of agriculture in Papua New Guinea, demonstrate knowledge and understanding of plant nutrition in the growth of plants and demonstrate knowledge and understanding of the structure and functions of agricultural plant processes and growth.

During the course of the unit you will have to make sure students are taught these skills and that they apply them to different topics.

The check list for marking the project and portfolio, and the performance standards for marking the experiments and activities are at the end of this unit.

Step 3 – Programming a learning sequence

The following table sets out the activities and core topics that must be undertaken in term 1 and 2. How the time is allocated depends on the crop chosen for the project. You will progress at a pace appropriate to your students and their projects. For further information on the core and option activities, refer to Step 4 on the elaboration of the contents and the activities as indicated in the suggested programming table below. Also see Appendix 2A page 101 and Appendix 2B page 104 for examples of a detailed program.

Sample program Term 1 and 2		
Core Activities	**Option Activities**	**Assessment**
Use PNG map to show historical farm/gardening areas or sites and give brief descriptions of the activities List types of farming systems in PNG Describe the role of agriculture in the local economy in which a particular school is located and relate this to how it contributes to food security and to the national economy. Use official documents to discuss PNG government policy on food security Research data on the impact of HIV/AIDS on the PNG economy and discuss in class. Identify examples of integrated agricultural systems and discuss and analyse the key features. Look at specific examples of where science and/or technology have caused a change in agricultural practices in PNG. Discuss and evaluate why these changes have occurred Teacher demonstrates various soil types and testing techniques. Students collect soil samples and use basic testing techniques to analyse the samples collected. Students use basic soil testing equipment and techniques to do simple soil tests such as pH testing, identification of key elements and their concentration to determine the soils fertility Collect samples of various plants, observe, dissect and identify various plant parts, draw and label. Collect various seeds and set up experiments Undertake experiments to demonstrate relationship between photosynthesis and light.	Begin to plan the project. Outline the steps in deciding on a project and how to implement it. Introduce the steps in planning a project and help students decide on their project Students do simple research to make sure the project is suitable for local conditions eg physical, financial, supply and demand and marketing aspects. Use that research to set realistic goals and timelines Practical activities such as preparing soil, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg housing for animals) Continuous activities such as weeding and watering of plants, or feeding and watering livestock, monitoring for threats, recording growth rates and maintaining records. Harvesting and processing and marketing the products Assessing the viability of the project. Complete the project and the portfolio	**Core 9.1** Students gradually compile a record of their experiments using a practical book The teacher can progressively mark the practical book so students are being continuously assessed. **Option** Students record their planning processes for their portfolio Results of research included in portfolio Plans for project included in portfolio Notes on progress of project included in portfolio Evaluation of the project included in portfolio Continuous assessment of the portfolio. Teachers should regularly assess the students' progress and give feedback Summative short answer test

Step 4 – Elaboration of activities and content

Factors of crop systems and production

Activity 1: Historical farming sites in Papua New Guinea

Research historical farming sites. You might want to get resources from Social Science teachers, libraries, or local knowledge to help students with these activities.

Activity 2: Local area farming systems

Brainstorm farming systems in your local area. Some examples of farming systems in Papua New Guinea include:

- slash, burn and cultivate as done in grassland areas of Papua New Guinea
- slash, chop tropical trees, burn and plant
- terracing as done by some Simbu people
- 'Kuk valley' system in the early farms of the Western Highlands people. For hundreds of years, their garden beds were well laid out with organised irrigation systems in place
- wet land farming systems – crops grown in swamps.

Activity 3: Discussions

Discuss some practices of Papua New Guineans in order to have food:

- nomadic life as food gatherers
- permanent settlers – subsistence gardening
- villages formed because of improved farming systems
- specialisations and barter systems
- modern farming systems and commercial enterprises.

Discuss some important roles of agriculture in the local economy in Papua New Guinea. Some examples include:

- skills in using limited farm land to maximise agricultural productivity
- provision of nutritious food for families which improves health. This helps save costs so families can have some money left over each fortnight
- provides jobs where people are paid in cash
- some local products can be dispatched to other provinces in exchange for cash.

Some core content notes

- Food security:
  - Papua New Guinea government does not want any of its citizens to starve due to lack of nutritious food for life sustenance
  - Agriculturalists, food technologists and farmers are encouraged to look for ways to store food in safe conditions for long periods of time so there is enough to feed the population when disaster strikes any

part of the country. Techniques include drying staple foods such as fruit, smoking foods such as fish, canning, bottling, etc so food is kept safe for longer periods.

- HIV/AIDS is threatening our labour force who work the land and provide food for the family and soon there might be few people left to work on the farms to provide food for Papua New Guinea.
- Examples of integrated agriculture systems in Papua New Guinea economy:
  - in food gardens there are some tree crops grown for shade and/or nitrogen supply; poles are used for propping, staking, timber etc
  - sometimes honey bees are kept to encourage fast pollination while honey products are obtained.
- Impact of science and technology on agriculture in Papua New Guinea:
  - use of hybrid plants or animals for producing large quantities of food
  - improvement of crops and domestic animals through selective breeding
  - biological resources and their exploitation such as ethanol and methane gas production
  - food production/processing such as bakers using yeast, growing mushrooms, etc
  - use of microbial pesticides or live insects to control crop pests.
- Introduction to soil science:
  - give some simple definitions
  - soil formation through physical and chemical weathering agents
  - physical properties of soil such as soil profile, structure, texture
  - soil types
  - soil constituents
  - soil water
  - soil nutrients
  - soil pH.
- Soil management theories and techniques:
  - organic matter
  - green manuring
  - steps in soil management practices.
- Plant studies:
  - basic study of angiosperms especially dicotyledonous plants related to agriculture
  - basic study of monocotyledonous plants related to agriculture
  - important plant processes such as physical and chemical processes. Physical processes include transpiration, translocation, pollination, etc.
  - Chemical processes include, photosynthesis, respiration, fertilisation, etc.

Step 5 – Elaboration of project activities

The four regions of Papua New Guinea have different climates and topography and therefore different crops are best suited to different regions. Below are the types of crops that could be grown for Agriculture projects.

Regions	Types of crops
Highlands	Coffee, mushrooms, vegetables, fruits, pyrethrum, wheat, tea leaf,
Momase	Vanilla, cocoa, rice, coffee, copra Vegetables, oil palm
New Guinea Islands	Cocoa, copra, oil palm, rice, vanilla balsa, vegetables, bananas, cassava, coffee
Southern	Oil palm, cocoa, copra, rice, vanilla, rubber, vegetables, cassava, coffee.

Estimated time-frames for selected crop projects	
Type of crops	**Maturity period**
Aibika	2 months
Banana	12 months
Broccoli	4–5 months
Chinese cabbages	3–4 months
Corn	3–4 months
Cucumber	3–4 months
Eggplants	3–4 months
Lettuce	4 months
Peanut	4 months
Pumpkin	4.5 months
Rice	3–4 months
Snake bean	3 months
Sweet potatoes/kau-kau	5–6 months in the lowlands and 6–7 months in the highlands
Taro	6–7 months
Tomatoes	3 months
Winged bean	3 months
Yams	9–12 months

Sample horticulture project

Dwarf and climbing beans

Beans are a warm-season vegetable that with regular picking will crop over a long period. Dwarf and climbing beans can be sown all year round in Papua New Guinea. Beans are legumes so they draw nitrogen from the air and fix it into the soil on their roots. This means whatever you grow after your beans will benefit from the extra nitrogen in the soil.

Operational steps

1. Prepare the land in a sunny, well drained position with compost materials thoroughly mixed.
2. Mark 50–60 cm apart as distance between rows.

3. Sow seeds in depths of 25mm into moist, well prepared soil with spacing of 7–10cm between seeds.

Management steps

1. Apply mulch with open spaces left for the seeds to germinate and to grow upward. After sowing, apply water and continually keep the seeded area moist.
2. After sprouting, keep the mulch 5cm away from the main stems to prevent them coming in contact with the micro-organisms which are composting down the mulch.
3. If growing dwarf beans, hill up soil around growing plants for support and if growing climbing beans, provide stakes using sticks or bamboos splits, and tie.
4. Provide wind break if your area is windy.
5. Apply soluble fertiliser about 7–10 days when first flowers appear.
6. Continue to apply management practices to protect the beans from pests eg from snails, aphids, caterpillars, etc.
7. Keep management records.

Harvesting steps

1. To avoid damaging the plant always harvest beans by cutting their pods off with scissors or a knife.
2. Pick your beans frequently, it encourages flowering.
3. When the beans are almost finished cut them off at the ground, leaving their nitrogen fixed roots in the soil.
4. Keep harvest records.

Reporting and evaluation

1. Report how the project was monitored.
2. Report on the harvests.
3. Make a written or oral evaluation of the project.

Note

Dwarf beans are ready to pick between 8–10 weeks. Pick beans young for maximum yield every 4–5 days.

Normally climbing beans take longer to produce (12–14 weeks), but yield more heavily than the dwarf beans over a longer duration.

Sample botany activities

Activity 1

Students soak some bean seeds in water for 2 days. Remove testa and half the seed. Look at the embryo and draw the seed

Activity 2

Students germinate corn and bean seeds in soil. Let the plants grow to 4 leaf stage. Carefully dig up the seedlings and wash the roots. Can you see two kinds of roots? What are they called? Draw the roots.

Activity 3

Students collect some pollen grains and place on glass slides. Using magnifying glasses draw what you see.

Activity 4

Students cut through female part of selected flowers with razor blades. Find ovules and draw them.

Sample experiment: Impact of light on seed germination

Problem: How much light does a seed need to germinate?

Possible hypotheses

A seed needs to have light all day to germinate.

A seed needs some light to germinate.

A seed doesn't need light to germinate.

Materials

Three potting containers with potting soil

Bean seeds

Water

Decomposable bags eg brown paper bags

Procedure

Plant three seeds in each potting container.

Give all pots the same amount of water.

Place one pot in a sunny place all day every day for two weeks.

Place one pot in a sunny place for an hour a day for two weeks. Cover the pot with a paper bag the rest of the time.

Cover one pot with a paper bag all of the time for two weeks.

Observe the germinating seeds.

Analysis and conclusion

Which seeds germinated and grew the best?

What did the students learn about a seed's need for sunlight?

Write up the experiment in a prac book.

Sample experiment: Effects of change of a plant's light source on vegetation

Problem: Does the amount of light affect the growth of a plant?

Hypothesis

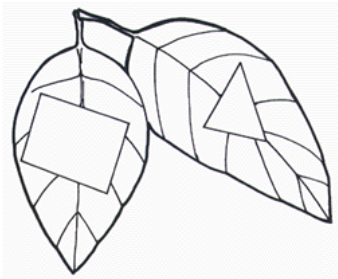
Without enough sunlight, plants cannot use the process of photosynthesis to produce food.

Materials

- Small shrub, tree or plant
- Cardboard or aluminium foil
- Scissors
- Paper clips

Procedure

1. Pick a shrub, tree or plant that you can use for an experiment.
2. Using the cardboard or aluminium foil cut out some geometrical shapes like a circle, square or triangle. Make sure your shapes are big enough to make a patch that will cover nearly half of the plant leaf.
3. Paperclip each shape on a different leaf.
4. If you use a pot plant, place it where it will get plenty of sunlight. Make notes about the weather each day and add them to your observations.
5. After four days, remove the shapes from the leaves and observe each of the leaves that had a shape covering it.
6. Compare the areas on the leaf that were covered with the shape to other parts of the leaf.



Analysis and conclusion

- What has happened to the leaves?
- Describe the effects that the lack of sunlight has on leaves. What has or hasn't happened in the different parts of the leaf?
- What is the best environment for a plant or garden? Why?
- Where have you seen effects like these in nature?
- Where would you expect to find fewer plants outside because of a lack of sunlight?

Additional class activities

Group activities

- Make lists of all the field crops grown in the district. Group these crops according to the uses they serve.
- Make lists of all the vegetables grown locally. Are there any vegetables that cannot be grown locally?
- Make lists of fruit trees grown locally. Which varieties are most popular?
- Choose the most important crop in the district and find out all about the worst diseases which attack it. How are these diseases controlled by the farmer?
- List some crops. Students research
  - the most important crop
  - what is the highest and average yield obtained?
  - what reasons can they find for low yields?
- What are the worst insect pests of the district? Choose one of these and research the life cycle and how to control it.

- What fertilisers are used commonly in the district?
- Find about the local climate. What are the average day and night temperatures? What is the average rainfall yearly and when does the rain fall most?
- Make a list of appropriate farm technology used in the local area
- Find out the level of production of particular crops or animals in the local area.

Task cards for groups with topics such as:

- find out which are the most fertile soils in the local area – describe them.
- find out whether earth dams in the local area hold water well or if there is any leakage
- what are main nutrient deficiencies in the local soils?
- what is the common tillage implements use in the local area and find out why they are preferred?
- are most of the soils in local district acid, alkaline or neutral?
- is lime ever used in the local area and if yes, for which crops is it used?
- many tillage implements are now designed to cultivate the soil while leaving weeds and crop residues on the surface. – why is this a good idea?
- examine an erosion gully and measure its depth and width. What measures could be taken by students to stop the erosion?
- find out how gullies in the area began.

Assessment checklists and performance standards

Use this sample checklist to develop a specific checklist for the crop or animal project undertaken in the option

Sample checklist for assessing the project 100 marks							
Assessment criteria	**5**	**4**	**3**	**2**	**1**	**0**	**Mark**
Used a range of sources for research to make selection of crops or agro-forestry product							**/5**
Chose an appropriate crop or agro-forestry product to grow: Crop or agro-forestry product chosen to grow was suitable to the local conditions: soil, climate and land forms							**/5**
Safely used a range of agricultural tools, skills and techniques • worked safely at all times • wore appropriate safety or protective gear • used correct agriculture techniques • selected appropriate tools and equipment to grow the crop or agro-forestry product • demonstrated high level skills							**/25**
Applied knowledge and understanding of agricultural processes and systems to grow the crop or agro-forestry product: • detailed plans done for growing crop or agro-forestry product • correct process followed to grow crop or agro-forestry product eg nursery established proper nursery management practices used correct direct planting techniques used correct management practices used when crop or agro-forestry product growing (weeding, mulching, fertilising, pest and disease control, watering etc) appropriate harvesting and marketing skills and techniques used							**/25**
Produced the crop or agro-forestry product appropriate to the available resources • crop or agro-forestry project completed							**/5**
Made suggestions for future improvements • evaluated the success of the project • used evaluation to say what would be done differently next time							**/10**
Communicated ideas and information in a variety of ways. Portfolio included • rough notes or sketches • checklists • plans of layout of planting, labelled drawings and diagrams • progressive records of the crop or agro-forestry product • budget or financial records • work samples with comments written by the teacher • brief written or oral report							**/25**
							/100

9.1 Performance standards for assessment task 1				Total marks – 20
Assessment Criteria	**Very High Achievement (18–20)**	**High Achievement (14–17)**	**Satisfactory Achievement (10–13)**	**Low achievement (0–9)**
understanding of soil properties including fertility	demonstrates a detailed understanding of physical properties of a range of soil types	demonstrates knowledge of physical properties of at least two soil types	demonstrates some knowledge of physical properties of at least one soil types	demonstrates little knowledge of physical properties of soil types

Checklist for practical experiments for assessment task one using the scientific method					
Assessment criteria		**Yes**	**No**	**Some times**	**Mark**
knowledge and skills of conducting simple experiments	generate a simple hypothesis closely related to the topic				/3
	hypothesis based on sound research				/2
	conclusions states whether or not hypothesis is correct				/2
	reasons given for the conclusion				/3
Ability to show correct techniques of simple experimentation	steps for experiment followed in correct order				/5
	data regularly collected at appropriate times(s)				/5
	measurements accurate				/5
Ability to label diagrams and make correct observations	results presented in appropriate forms				/4
	diagrams and graphs labelled correctly and neatly				/4
	observations clearly described				/5
	correct scientific terms used				/2
				Total marks: 40	

9.2 Agriculture Production Systems in Papua New Guinea 1 and one option

Terms 3 and 4, 20 weeks

Step 1 – Interpreting the unit learning outcomes

The unit learning outcomes of both core unit 9.2 and the selected option need to be looked at carefully when planning your program for term three and four.

Outcome 9.2.1: Explain effects of agricultural activities on the ecological and economic environments

Outcomes 9.2.2: Explain and identify important anatomical structures and physiological processes of animals responsible for reproduction, growth and development

Outcome 9.2.3: Identify appropriate agricultural technologies

Outcomes 9.5.1 or 9.6.1 or 9.7.1 or 9.8.1 or 9.9.1: Use a range of tools, skills and techniques to produce, for example, the chosen worm farming, aquaculture or farm technology project or raise the chosen livestock.

Outcomes 9.5.2 or 9.6.2 or 9.7.2 or 9.8.2 or 9.9.2: Investigate, design and implement a project that is ecologically suitable using appropriate codes and practices.

Outcomes 9.5.3 or 9.6.3 or 9.7.3 or 9.8.3 or 9.9.3: Reflect and comment on the success of the project.

Teaching the core and the option simultaneously requires you to cluster these six unit learning outcomes for the purpose of planning and programming. For students to achieve the core outcomes you will need to teach them about PNG agriculture in relation to local, provincial and national economic and ecological environments. Students also learn about the vital processes in animal reproduction, growth and development and animal physiology, husbandry and product marketing.

These outcomes require you to provide the opportunity for students to investigate technologies related to animal production and to assess the relevance of those technologies to Papua New Guinea conditions.

These investigations link to the practical project and students use the results of their investigations when planning their project and selecting a livestock, worm farming, aquaculture or farm technology project or a school developed project using the framework Unit 9.9.

During the project students demonstrate that they can use appropriate tools, skills and techniques. At the end of the project students must be given time to reflect and comment on its success and suggest ways they could do better next time and comment on whether or not the technology used was appropriate.

Step 2 – Planning for assessment

Students complete a project as part of the requirements for the option. They are also assessed on the portfolio which shows evidence of the processes undertaken in the project. The assessment checklist for the project is on page 44.

The assessment task for unit 9.2 is an assignment where students investigate operations of sustainable agricultural animal enterprises looking at planning, production, marketing and evaluation processes and procedures.

This means that students can either:

- investigate an existing agricultural enterprise and look at how they plan, produce, market and evaluate their business

or

- investigate setting up their own enterprise and show how they would plan, produce, market and evaluate the enterprise.

The performance standards for the assignment are on page 45.

Assessment task two is a test where students show they can describe how different types of agriculture industries link to global economic and ecological environments.

They are also tested on anatomical structures and physiological processes of selected animals in relation to reproduction, growth and development.

Step 3 – Programming a learning sequence

The following table sets out the activities and core topics that must be undertaken in term 3 and 4. How the time is allocated depends on the livestock chosen for the project. You will progress at a pace appropriate to your students and their projects. See Appendix 2B for an example of a detailed program on page 104.

Sample program Term 3 and 4		
Core Activities	**Option Activities**	**Assessment**
Brainstorm various agricultural production systems in use in the local area, provincially and nationally and map where they are used. Look at differences between places Discuss why there are differences Speculate on what changes might happen and their impact locally, provincially and nationally, such as drought Learn key stages relevant to animal growth and production, fertilisation and reproduction of the chosen animal. Select an animal and learn about the stages of growth relevant to that animal Develop diagrams of the basic anatomical structure of the selected animal. Research a particular animal production system in PNG for the assignment looking at animal husbandry, aspects of management, procedures involved in obtaining animal products and aspects of packaging and marketing. Design an evaluation for the project.	Begin to plan the project. Outline the steps in deciding on a project and how to implement it Introduce the steps in planning a project and help students decide on their project Students do simple research to make sure the project is suitable for local conditions eg physical, financial, supply and demand and marketing aspects. Use the research to set realistic goals and timelines Practical activities such as preparing sites, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg housing for animals). Activities such as providing food and water for the stock, monitoring for threats, recording growth rates and maintaining records. Harvesting and processing and marketing the products Assessing the viability of the project. Complete the project and the portfolio	**Option** Students record their planning processes for their portfolio Results of research included in portfolio Plans for project included in portfolio Notes on progress of project included in portfolio Evaluation of the project included in portfolio Continuous assessment of progress and feedback on the portfolio. Investigation: Students are given the assignment topic in Week 11. Assignment due in Week 17. Summative short answer test

Step 4 – Elaboration of content and activities

Factors of animal systems and production

Suggested student activities

- Identify on a Papua New Guinea map the main areas where sheep, beef cattle, dairy cattle, poultry and pigs are raised.
- Find out which are the most popular breeds of farm animals in the local area.
- Find out about high quality breeds of sheep, beef cattle, dairy cattle, poultry and pigs.

- List all the animals kept on one farm and give reasons
- Choose the most important animal in the district and find out about the worst diseases which attack it. How are these diseases controlled by the farmer?
- Research on the worst insect pests of the most important animal of the district. Choose one of these and research the life cycle and how to control it.

Notes for teachers

This core focuses on Papua New Guinea agriculture activities in relation to local, provincial and national ecological environments. You might guide the students to study first their local ecological environment. List features of the ecological environment before and after introduction of agriculture activities in the local area and discuss advantages and disadvantages of these activities. If there are some positive contributions made by these activities, ask them to add some more. If there are negative effects give reasons why and indicate measures that can be taken to avoid negative impact on the ecological environment.

Students will be doing a livestock or animal / fishing project therefore it is important that they learn about important anatomical structures of the selected animal and the physiological processes responsible for reproduction, growth and development. Use a good text book to help you teach this section. Give basic information only in this section of study. Avoid too many theory lessons. Give students lot of practical activities.

Agricultural technology

Students learn about appropriate agricultural technology that they will use in the project.

Activity 1

Students make some agricultural tools that could be used by hand or animals for soil cultivation

Activity 2

Students use organic materials to make organic nutrients or mulch

Activity 3

Students use a wood rice thresher

Activity 4

Students make dams with local materials to allow water to channel into the garden areas, etc.

There are so many aspects of appropriate agriculture technology you can explore with your students that could be interesting and encourage learning.

Project

Planning, implementing and evaluating a project (see page 25)

Sample worm farming option

Earthworms can be bred intensively using stacked boxes, or more simply by using shallow excavations in the ground with wooden or brick borders and hessian covers.

The by-products of the worms' activities are known as castings, which are rich piles of excreta and are excellent when mixed with poorer soils, potting mixes or garden mulch and compost. Adding one to two thousand worms to a compost bin on the ground will really speed things up and give very high quality compost. Good round, crumbly castings may take as long as six months to produce.

The ideal bedding (a mixture of soil and organic matter) within the pit in which the worms live and breed is:

- able to retain moisture;
- of neutral pH;
- well drained; and
- fairly light and crumbly.

Good bedding consists of a mixture containing sand or soil and other materials such as animal manures, sodden cardboard strips, grass cuttings, food scraps, egg shells, leaf mould and coffee or tea grounds. Allow this mixture to decompose slightly before introducing the worms

Once the worms are established they must still be fed. Food scraps, manure and poultry pellets are good food, but worms should not be over-fed. Dig their food under slightly to make it more accessible to them – worms hate the light! As a rough guide, 1 kg of worms (3000 to 5000) needs 3 to 4 kg of such food per week. If the worms are overfed the pit will become rancid and smell bad. A healthy pit should smell nice and earthy.

Water the pit regularly with a light spray to keep the bedding moist, not wet, yet still crumbly. It is also a good idea to aerate the bedding *carefully* about every two weeks with a light pitchfork. Contrary to common beliefs, worms do not survive a shovel wound. Once cut in half, they will probably perish, not become two.

Keep the pit covered with wet hessian or wet canvas. This keeps light and flies out, moisture and odours in, and helps to stabilise temperature.

Keep the pH of the bedding about neutral (pH 7). If it is too acid (pH 5 or less), light sprinklings of crushed limestone or dolomite will help to neutralise it. Unsuitable alkalinity (pH 9 or more) may be corrected by adding peat moss and shredded newspaper.

Under ideal conditions, the numbers of some worm species can reach 5000 individuals in only the space of a large bucket, and they may double their collective weight each month if given enough room. When the worms reach large numbers or the pit is full with castings, move the worms to another prepared bed and collect the castings. Lure the worms to a corner of the old bed using a favoured food, or collect them manually after spreading the bedding and castings out on to a flat area.

Worms are hermaphrodites – they posses both male and female reproductive organs but they will use a partner to breed. Eggs are laid within capsules in the soil and will hatch in about three weeks and mature 60 to 90 days later. They may then lay an egg capsule about once a week for several years if all goes well.

Assessment checklists and performance standards

Use this sample checklist to develop a specific checklist for the project undertaken in the option.

Sample checklist for assessing the option project 100 marks							
Assessment criteria	**5**	**4**	**3**	**2**	**1**	**0**	**Mark**
Used a range of sources to do some research to make selection for project							**/5**
Chose an appropriate product to grow or produce: Product chosen to grow or raise was appropriate to the local conditions; soil, climate, land forms							**/5**
Safely used a range of agricultural tools, skills and techniques • worked safely at all times • wore appropriate safety or protective gear • used correct agriculture techniques • selected appropriate tools and equipment to grow or raise the product • demonstrated high level skills							**/25**
Applied knowledge and understanding of agricultural processes and systems Detailed plans done for project Correct processes followed • established project • undertook practical activities required for project • maintained project • monitored project • harvested and marketed where appropriate							**/25**
Produced the product appropriate to the available resources • project completed							**/5**
Made suggestions for future improvements • evaluated the success of the project • used evaluation to say what would be done differently next time							**/10**
Communicated ideas and information in a variety of ways Portfolio included • rough notes or sketches • checklists • plans of habitat or building or shelter • progressive records of the growth of the product • work samples with comments written by the teacher • labelled drawings and diagrams • brief written or oral report							**/25**
							/100

The following performance standards must be used when marking the assignment.

9.2 Performance standards for assessment task 1 – Assignment Total marks – 40				
Assessment Criteria	**Very High Achievement**	**High Achievement**	**Satisfactory Achievement**	**Low achievement**
Demonstrate understanding of proper planning stages for a livestock enterprise	demonstrates detailed knowledge and understanding of all the appropriate steps involved in planning a livestock enterprise	demonstrates knowledge and understanding of the appropriate steps involved in planning a livestock enterprise	demonstrates some knowledge of the appropriate steps involved in planning a livestock enterprise	demonstrates little knowledge of the steps involved in planning a livestock enterprise
Identify specific animal products to be obtained and estimate quantities of production	accurately identifies all products to be obtained and accurately estimates the quantities produced	identifies most of the products to be obtained and reasonably estimates the quantities produced	identifies some of the products to be obtained and attempts to estimate the quantities produced	does not identify the products to be obtained or does not estimate the quantities produced
Explain evaluation procedures based on estimated costs and profits and describe likely problems	outlines a clear and logical evaluation process based on well researched costs and profits and describes a comprehensive range of likely problems	outlines a reasonable evaluation process based on researched costs and profits and describes a range of likely problems	makes an attempt to outline an evaluation process based on estimated costs and profits and describes some of the likely problems	makes little or no attempt to describe an evaluation process or to describe likely problems
Marks 40	36–40	28–35	20–28	0–19

Grade 10 units

10.1 Agriculture in Papua New Guinea 2 and one option

Terms 1 and 2, 20 weeks

Step 1 – Interpreting the unit learning outcomes

The unit learning outcomes of both the core unit 10.1and selected option need to be looked at carefully when planning your program for term one and two so that you know what to teach, and the skills and knowledge the students should gain.

Outcome 10.1.1: demonstrate knowledge of sustainable agricultural practices

Outcome 10.1.2: describe and explain the economic value of agro-industries in Papua New Guinea

Outcome 10.1.3: describe and explain the environmental impact of agro-industries in Papua New Guinea

Outcome 1 for the option: Use a range of tools, skills and techniques to undertake the project and/or identify, analyse and describe the impact of the chosen pest or disease for the local and / or national economy

Outcome 2 for the option: Plan and conduct pest or disease control measures on the selected crops or animals or investigate, design and undertake a project that is ecologically suitable using appropriate codes and practices

Outcome 3 for the option: Evaluate the pest or disease management project or make evaluation of the success of the project.

Teaching the core and the option simultaneously requires you to cluster these six unit learning outcomes for the purpose of planning and programming. For students to achieve the core outcomes you will need to teach the concepts of sustainability and how different practices can affect agricultural sustainability. You need to give students the opportunity to conduct experiments which investigate sustainability by looking at the effect of common soil management practices.

Students must also be provided with the resources and opportunities to investigate the economic benefits and environmental impact of various industries of Papua New Guinea.

These investigations link to the practical project and students use the results of their investigations when planning their project and selecting an appropriate project. During the project students are given further opportunities to become competent in the use of agricultural tools, skills and techniques so that income is generated and sustained. At the end of the project students must be given the time to reflect and comment on the success of the project.

Step 2 – Planning for assessment

Study the assessment requirements of the option and the core unit. These will tell you what specific knowledge and skills students will need to demonstrate they have achieved the unit learning outcomes.

Students complete a project as part of the requirements for the option. They are assessed on the project and on the portfolio which shows evidence of the processes undertaken in the project.

The assessment task for the core 10.1 is an investigation of the changes to soils and their properties over time after applying common soil management practices.

Early term 1 students collect soil samples from four different sites and analyse the soil properties. They then:

- apply manure to site 1
- fertilisers to site 2
- mulch to site 3
- compost to site 4

During term 2, students take soil samples from the four sites and analyse the properties again.

Record the results of the investigation and experiments using a practical book including such things as:

- simple hypothesis
- equipment used
- method
- results
- findings

Assessment task two for unit 10.1 requires students to write extended responses on the following topics:

- discuss the effects a selected agro-industry has on the environment.
- select a specific agro-industry and state its economic benefits to Papua New Guinea and show how it can be sustained.
- discuss effects of the world economy on two selected agro-industries and give examples of how these effects can be managed to reduce their impact.

The check list for marking the project and portfolio, and the performance standards for marking the experiments and activities are at the end of this unit.

Step 3 – Programming a learning sequence

The core unit is integrated over twenty weeks with an option unit to allow sufficient time to complete the project.

The following table sets out the activities and core topics that must be undertaken in term 1 and 2. How the time is allocated depends on the project. You will progress at a pace appropriate to your students and their projects. Also see Appendix 2A for an example of a detailed program on page 101 and adopt them appropriately for Grade 10.

Sample program - Term 1 and 2

Core activities	Option activities	Assessment
Types of agriculture industries in Papua New Guinea and specific examples. Sustainable agricultural practices Case-studies of agro-industry and their effects on the environment, societies and communities Case-study of benefits of agricultural industries to the local economy in relation to : - food security - poverty alleviation - enhanced nutritional status - income generation opportunities Effects of the world economy on Papua New Guinea agriculture industries Soil management and conservation Principles of soil conservation: Experiments to determine effect of soil management practices on soils Sustainable crop and animal husbandry practices	Begin to plan the project. Outline the steps in deciding on a project and how to implement it Introduce the steps in planning a project and help students decide on their project Students do simple research to make sure the project is suitable for local conditions eg physical, financial, supply and demand and marketing aspects. Use that research to set realistic goals and timelines Practical activities such as preparing sites, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg housing for animals). Activities such as providing food and water for the stock, monitoring for threats, recording growth rates and maintaining records. Harvesting, processing and marketing the products Assessing the viability of the project. Complete the project and the portfolio	**Core 10.1** Investigation into soil properties and the effect of the application of manure, fertilisers, mulch and compost. Assignment on case studies given in Week 10 **Option** Students record their planning processes for their portfolio Results of research included in portfolio Plans for project included in portfolio Notes on progress of project included in portfolio Evaluation of the project included in portfolio Continuous assessment of the portfolio. Teachers should regularly assess the students' progress and give feedback Summative short answer test

Step 4 – Elaborations of content and activities

Soil experiments

Soil properties and the effects of the application of manure, fertilisers, mulch and compost over time

Collect four soil samples from four different sample sites.

Activity 1

Students carry out simple soil pH tests on the different garden soils to determine their nutrient status

Activity 2

Students place soil samples in 500ml beakers or empty jam glass bottles, add water with few drops of hydrogen peroxide to loose the particles and keep them for 24 hours after which percentage of sand, silt, clay and organic matter can be calculated.

Activity 3

Students determine the water content of the soil sample by weighing the beaker, beaker plus soil sample and drying the soil to oven dry. The difference of the reading should indicate percentage of water in the soil sample

Activity 4

Students grow one type of quick growing crop on all different soils sample above, record the differences observed regularly until harvesting of the final product. Then write up the results of the experiments and succinctly communicate this information.

After collecting the sample, apply:

- manure to site 1
- fertiliser to site 2
- mulch to site 3
- compost to site 4

and water, weed and dig the sample sites for the next 10 weeks.

Then investigate the properties of the soils by doing the same experiments as before and record the results.

Write up the investigation to show the effects of the use of manure, fertilisers, mulch and compost on the properties of the sample soil sites.

Sample activities for core unit

Activity 1

Students research and identify agro-industries in Papua New Guinea.

Activity 2

Students brainstorm or research best varieties or breeds appropriate for specific ecologies in Papua New Guinea settings. Encourage students to consider rainfall, wind, weather patterns, temperature, soil pH and nutrients availability to sustain selected crops or animals in order to gain maximum economic value.

Activity 3

Brainstorm common and best husbandry practices.

Activity 4

Students research and identify major pests and diseases that can attack or effect crops or animals or animal products and suggest ways to control their outbreak.

Activity 5

Students research the demand for Papua New Guinea crops or animals or animal products, how much Papua New Guinea produces annually, how many tonnes of particular products are produced and how much is exported.

Activity 6

Students calculate how much in kina value is generated for crop or animal products that are exported, and the value of those that are sold within Papua New Guinea.

Activity 7

Students identify crops or animals that can be grown locally and encourage them to engage in projects to grow or raise the crops or animals that are in high demand.

Case studies

When students do a case study they describe in detail, compare and contrast or give examples of cause and effect of a particular issue or problem. Students describe the characteristics or conditions of specific agriculture industries and provide details of their impact on the environment and the economic benefits of the chosen industry to Papua New Guinea. Students can present their case studies in a variety of ways, for example as charts or flow charts, posters, oral presentations or extended writing.

Agronomy project such as vegetables

Activity 1

Students propagate vegetables from seeds.

Activity 2

Students demonstrate the skills of choosing a site and preparing a vegetable bed.

Activity 3

Students demonstrate correct planting depths during transplanting or sowing of seeds.

Activity 4

Students provide shelter from strong winds.

Activity 5

Students incorporate some commercial fertilisers and the use of manures from school's animals, compost to improve soil organic matter and soil structure, legumes as green manure crop or worm castings into soils.

Activity 6

Students research pests and diseases common to the vegetables grown in the agriculture plot/local area and control pests and diseases successfully.

Activity 7

At least one vegetable crop is grown and when it is ready correct techniques are used to harvest and market if appropriate.

Activity 8

Students conduct soil pH testing

Activity 9

Students provide adequate drainage/aeration of the garden or school area.

Assessment checklists and performance standards

Use this sample checklist to develop a specific checklist for the project undertaken in the option

Sample checklist for assessing projects 100 marks							
Assessment criteria	**5**	**4**	**3**	**2**	**1**	**0**	**Mark**
Used a range of sources for research to make selection of agronomy, wildlife farming project, pests or disease or school based crop or animal project							**/5**
Chose an appropriate pest or disease to minimise its spread , or product to grow: Pest or disease is chosen in order to minimise its spread Product chosen to grow or raise was appropriate to the local conditions soil, climate, and land forms							**/5**
Safely used a range of agricultural tools, skills and techniques • worked safely at all times • wore appropriate safety or protective gear • used correct agriculture techniques • selected appropriate tools and equipment to grow the crop or raise the animal • demonstrated high level skills							**/25**
Applied knowledge and understanding of agricultural processes and systems to plan and implement the project • detailed plans done • correct process followed • nursery or eradication process established • proper practices used • correct management practices used throughout the growth of the crop or animal • correct techniques used • appropriate harvesting and marketing skills and techniques used if appropriate							**/25**
Produced product appropriate to the available resources Or showed evidence of control of pest or disease • project completed							**/5**
Made suggestions for future improvements • evaluated the success of the project • used evaluation to say what would be done differently next time							**/10**
Communicated ideas and information in a variety of ways Portfolio included • rough notes or sketches • checklists • plans • progressive records of the product • work samples with comments written by the teacher • labelled drawings and diagrams • brief written or oral report							**/25**
							/100

Checklist for Assessment task one: Investigation

Collect local soil samples at different periods of time from four different areas and investigate their properties before and after the application of soil conservation measures using a scientific approach:

- mechanical analysis
- calculate the organic matter content
- determine pH of the soil.

Assessment criteria		Yes	No	Some times	Marks
Determine the fertility of soil	develop a simple hypothesis closely related to the topic				/2
Demonstrate comprehensive knowledge and understanding of soil properties	steps for experiment followed in correct order				/5
	data regularly collected at appropriate times(s)				/5
	measurements are accurate				/5
	results are presented in appropriate forms				/3
demonstrate knowledge and skills in using simple experiment techniques and make conclusive statements and recommendations	diagrams and graphs labelled correctly and neatly				/5
	observations clearly described				/5
	correct scientific terms used				/3
	conclusive statements and recommendations made				/5
	hypotheses proved or disproved				/2
	Total marks: 40				

The following performance standards must be used when marking the case studies

Performance standards for assessment task 2 – Case studies				**60 marks**
Criteria	Very High Achievement	High Achievement	Satisfactory Achievement	Low achievement
Identify ways agricultural industries can contribute towards sustainability	accurately identifies a wide range of ways in which agricultural industries can contribute towards sustainability and describe in detail how these ways can be sustained 18–20 marks	accurately identifies a number of ways in which agricultural industries can contribute towards sustainability and the describe how these ways can be sustained 14–17 marks	identifies some ways in which agricultural industries contribute towards sustainability 10–13 marks	identifies few if any ways in which agricultural industries can contribute towards sustainability 0–9 marks
Explain the effects of agricultural industries on the environment and communities and illustrate with recent examples	explains in detail advantages and disadvantages of selected agricultural industries on the environment and the communities using clear recent examples 18–20 marks	explains advantages and disadvantages of two agro-industries on the environment and the communities using recent examples 14–17 marks	explains the effect of two agro-industries on the environment and the communities using some examples 10–13 marks	very little explanation about the effects of an agro-industry on the environment and the communities with no examples used. 0–9 marks
Analyse the effects of the world economy on Papua New Guinea agriculture and provide suggestions for managing these effects	analyses in detail the effects of the world economy on a range of Papua New Guinea agriculture industries and provides logical suggestions for managing these effects 18–20 marks	analyses the effects of the world economy on some Papua New Guinea agriculture industries and provides suggestions for managing these effects 14–17 marks	lists some positive and negative effects of the world economy on Papua New Guinea agriculture and provides some suggestions for managing these effects 10–13 marks	lists one or two effects of world economy on Papua New Guinea agriculture 0–9 marks

10.2 Agriculture Production Systems in Papua New Guinea 2

Step 1 – Interpreting the unit learning outcomes

Study the unit learning outcomes to determine what students will know and be able to do by the end of the unit.

Outcome 10.2.1: demonstrate an understanding of agricultural systems and their sustainability

This outcome requires you to teach about agricultural systems in Papua New Guinea and discuss how these systems affect the natural environment and their impact on Papua New Guinea economy, locally, provincially and nationally. Students must be given the opportunity to look at a variety of systems and make connections with their project activities.

Outcome 10.2.2: explain the concept of interrelated systems

This outcome requires you to teach how different elements in an agricultural system are interrelated and give students the opportunity to look at ways to use technological skills to establish a sustainable and profitable agricultural enterprise

Outcome 10.2.3: analyse a system in depth

This outcome requires you to give students the opportunity to investigate, analyse, describe and explain a specifically selected agricultural system in depth and suggest ways it brings economic benefits to Papua New Guinea and how it can be sustained.

Step 2 – Planning for assessment

Study the assessment requirements of the core unit. These will tell you what specific knowledge and skills students will need to demonstrate they have achieved the unit learning outcomes. The check list for the performance standards for marking the investigation is at the end of this unit.

For assessment task one students do an assignment where they explain the interactions within and between a crop and agricultural systems, and an animal and agricultural systems. This means that students must be able to demonstrate how different elements in an agricultural system are interrelated and suggest ways to use technological skills to establish a sustainable and profitable agricultural enterprise

Assessment task two is a test where students demonstrate an understanding of agricultural systems.

Step 3 – Programming a learning sequence

The following table sets out the activities and core topics that must be undertaken in term 3. How the time is allocated depends on the livestock chosen for the project. Teachers will progress at a pace appropriate to their students and their projects.

Week	Sub-topic/s	Activities	Assessment
1 – 2	Agriculture bio systems	Flow charts of different types of production systems	Assignment task given
3 – 4	Agriculture systems – Plant cultivation (production) Agriculture production systems Animal husbandry (production)	Drawing, diagrams of intensive and extensive production systems for a plant or an animal product Simple experiments	
5 – 6	Inter-dependence of systems relevant to agriculture	Research and investigate for assignment task in groups or individually Task cards for groups to find out about particular systems	
7 – 8	Agriculture production systems and sustainability	Field trip to local agriculture industries to look at systems and practices for sustainability.	Assessment Task One due: Investigation
9 – 10	A single system and its place in the total agricultural system	Investigate one system in detail	Test to be given in a double period

Step 4 – Elaboration of activities and content

Activity 1

Students use drawings, diagrams and flow charts to show relationships between systems: plants, animals, soils, climate and micro-organisms

Activity 2

Students use drawings, diagrams and flow charts to show relationships between systems: climatic factors affecting plant and animal production including:

- humidity
- solar radiation
- wind patterns
- temperature
- rainfall

Activity 3

Students measure and assess climatic factors affecting plant and animal production. Tabulate and graph climatic conditions in the local region relative to a chosen enterprise.

Agriculture production systems – sustainability and inter-dependence of systems relevant to agriculture

Activity 4

Students discuss or debate biotic environments and their importance to agricultural systems

Activity 5

Students discuss the difference between farm ecosystem and a natural ecosystem. Results displayed on charts.

Activity 6

Students outline concept of environmental balance using charts or diagrams.

Activity 7

Students find out about natural agricultural remedies versus artificial agricultural remedies

Activity 8

Students discuss or debate appropriate versus inappropriate technologies, planting and animal industries in terms of microbial pesticides, tissue culture, artificial insemination, genetic modification and use consequence charts to record their findings

Activity 9

Students debate ethics of logging practices and use of chemicals in large scale industries. Use current newspaper articles as resources.

Activity 10

Students draw flow charts of agriculture bio-systems such as:

- biomass, for example, charcoal production from wood or coconut shells
- ethanol production from cassava as an alternative fuel
- methane gas production from wastes of poultry or pigs
- insulin production from animals or microbes
- use of microbial bacteria as pesticides
- production of penicillin
- production of yeasts, cheese and mushrooms for commercial use
- fermentation and alcohol production
- cell and tissue culture through genetic engineering.

Activity 11

Students use drawings, diagrams and flow charts to show interactions within and between agricultural enterprises on the school farm such as re-cycling of farmyard manure and management of compost.

The following performance standards must be used when marking the investigation

Explain the interactions within and between a crop and agricultural enterprises and systems and an animal and agricultural enterprises and systems				**40 marks**
Criteria	**Very High Achievement**	**High Achievement**	**Satisfactory Achievement**	**Low achievement**
Analyse a crop and its interdependence with physical and other biological factors	identifies components of, and the complex relationship between a crop with a range of physical and biological factors and suggests a number of ways to sustain them	identifies components of a crop and the relationship between the crop with other physical and biological factors and suggests ways to sustain them	identifies components and the relationship between a crop with other physical and biological factors	identifies components of a crop
Communicate information clearly and succinctly	detailed analytical information is communicated clearly and succinctly 18–20 marks	communicates information clearly and succinctly 14–17 marks	some information communicated clearly 10–13 marks	very little information is communicated and message not easily understood 0–9 marks
Demonstrate knowledge of the principles of the agricultural animal selected and discuss its interdependence with physical and other biological factors	demonstrates a detailed knowledge of the principles of the agricultural animal selected identifies components of, and the complex relationship between the animal with other physical and biological factors and suggests a variety of ways to sustain them	demonstrates knowledge of the principles of the agricultural animal selected identifies components and the relationship between the animal with other physical and biological factors and suggests ways to sustain them	demonstrates some knowledge of the principles of the agricultural animal selected identifies components and the relationship between the animal with other physical and biological factors	demonstrates very little knowledge of the principles of the agricultural animal selected.
Communicate information clearly and succinctly	detailed analytical information is communicated clearly and succinctly 18–20 marks	communicates information clearly and succinctly 14–17 marks	some information communicated clearly 10–13 marks	very little information is communicated and message not easily understood 0–9 marks

Recording and reporting

All schools must meet the requirements for maintaining and submitting student records as specified in the *Grade 10 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 judgment about the overall achievement, or progress towards achievement, of the broad learning outcomes.

To help you do this, broad descriptions of the levels of achievement of the broad learning outcomes are provided in the Broad Learning Outcome Performance Standards. 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 then marks.

Remember that the final school-based marks will be statistically moderated using the external exam results. The students overall level of achievement may change.

Levels of achievement

The level of achievement of the broad 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 five week unit. The marks show the student's level of achievement in the unit, and therefore *progress* towards achievement of the broad learning outcomes.

There are four levels of achievement:

1. Very high achievement
2. High achievement
3. Satisfactory achievement
4. Low achievement
5. Below the 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 limited or very limited level of competence in the processes and skills.

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

Total Marks	Very High Achievement	High Achievement	Satisfactory Achievement	Low Achievement	Below Minimum Standard
700	630 – 700	490 – 629	350 – 489	200 – 349	0 – 199
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 – 199	100 – 139	40 – 99	0 – 39
100	90 – 100	70 – 89	50 – 69	20 – 49	0 – 19
50	45 – 50	35 – 44	25 – 34	10 – 24	0 – 9

Sample format for recording assessment task results over two years

Grade 9		
Unit	**Assessment task**	**Marks**
9.1	Investigation and experiments	60
	Test	40
9.2	Assignment: Investigation	40
	Test	60
One option unit	Project	100
One option unit	Project	100
Grade 9	**Total marks**	**400**

Grade 10		
Unit	**Assessment task**	**Marks**
10.1	Investigation	40
	Case studies	60
10.2	Assignment	40
	Test	60
One option unit	Project	100
Grade 10	**Total marks**	**300**
	Total marks Grade 9 and 10	**700**

Broad learning outcomes and levels of achievement

Levels of achievement in Grade 9 and Grade 10 are recorded and reported against the broad learning outcomes. There are six broad learning outcomes in Agriculture. The performance standards for the levels of achievement are described in the following table.

Broad Learning Outcome Performance Standards					
	Very High Achievement	**High Achievement**	**Satisfactory Achievement**	**Low Achievement**	**Below minimum standard**
1 Develop and apply agricultural knowledge and skills to increase food production in sustainable ways	Independently select and competently develop and apply agricultural knowledge and skills to increase food production in sustainable ways	Independently develop and apply agricultural knowledge and skills to increase food production in sustainable ways	Apply some agricultural knowledge and skills to increase food production in sustainable ways	Limited development and application of agricultural knowledge and skills to increase food production in sustainable ways	Has failed to meet the minimum standard required.
2 Apply a range of tools, skills and techniques to agricultural enterprises	Independently select and proficiently apply a wide range of tools, skills and techniques to agricultural enterprises	Independently select and apply a range of appropriate tools, skills and techniques to agricultural enterprises	Apply some tools, skills and techniques to agricultural enterprises	Limited or no application of tools, skills and techniques to agricultural enterprises except with help	Has failed to meet the minimum standard required.
3 Demonstrate knowledge of a range of plants and animals in relation to their usefulness in agriculture	Demonstrate extensive knowledge and understanding of a range of plants and animals in relation to their usefulness in agriculture	Demonstrate sound knowledge and understanding of a range of plants and animals in relation to their usefulness in agriculture	Demonstrate knowledge of some plants and animals in relation to their usefulness in agriculture	Identify one or two plants or animals in relation to their usefulness in agriculture	Has failed to meet the minimum standard required.
4 Demonstrate an understanding of agricultural systems and processes in Papua New Guinea	Demonstrate extensive knowledge and understanding of a range of agricultural systems and processes in Papua New Guinea	Demonstrate sound knowledge and understanding of agricultural systems and processes in Papua New Guinea	Demonstrate knowledge of some agricultural systems and processes in Papua New Guinea	Identify one or two agricultural systems and processes in Papua New Guinea	Has failed to meet the minimum standard required.
5 Investigate, design and undertake agricultural projects that are ecologically suitable using appropriate codes and practices	Independently investigate, design and undertake proficiently a range of agricultural projects that are ecologically suitable using appropriate codes and practices	Independently investigate, design and undertake agricultural projects that are ecologically suitable using appropriate codes and practices	Investigate, design and undertake agricultural projects using appropriate codes and practices	Limited ability to investigate, design and undertake agricultural projects that are ecologically suitable using appropriate codes and practices except when helped.	Has failed to meet the minimum standard required.
6 Reflect on and evaluate projects	Reflect on and evaluate projects by explaining in detail positive and negative aspects and make valid judgment about the success of the project	Reflect and evaluate in detail positive and negative aspects and success of the projects.	Reflect on and evaluate the projects with little detail.	Little or no analysis or evaluation of the projects.	Has failed to meet the minimum standard required.

Steps for awarding final student level of achievement

1. Assess unit tasks using assessment criteria unit performance standards and marking guides.
2. Record results for each task in each unit.
3. Add marks to achieve a unit result and a 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 broad learning outcome performance standards

Example of reporting using the Broad Learning Outcomes performance descriptors

Student: **Noema**

Subject: **Agriculture**

School-based assessment: **High achievement**

This means **Noema** can:

- independently develop and apply agricultural knowledge and skills to increase food production in sustainable ways
- independently select and apply a range of appropriate tools, skills and techniques to agricultural enterprises
- demonstrate sound knowledge and understanding of a range of plants and animals in relation to their usefulness in agriculture
- demonstrate sound knowledge and understanding of agricultural systems and processes in Papua New Guinea
- independently investigate, design and undertake agricultural projects that are ecologically suitable using appropriate codes and practices
- reflect and evaluate in detail positive and negative aspects and success of the projects

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Resources

Learning becomes more interesting and meaningful when you use a variety of resources and materials in your teaching of Agriculture. There are local people who can be invited to talk to students. Visiting farms, gardens, plantations, fish farms or livestock enterprises with students makes learning more interesting.

Newspapers are an extremely useful resource for Agriculture. Up-to-date, relevant information can be found almost every day in the local newspapers. You should be always trying to adapt, improvise or make teaching materials, tools and equipment that will be useful for practical lessons. There are many resources in schools which can be useful. One of the biggest resources is other teachers, especially teachers with local area knowledge.

It is important to relate people to topics being taught. For example when doing agriculture use a range of people such as a village mother with a small garden, an employee of a large plantation, someone who is growing a crop for sale at the market. Use people who make good role models, for example a businesswoman rather than a businessman. It is important for students to know about people who are a success in non-traditional roles.

Selecting and using resources

Selecting and using appropriate resources for agriculture is a very important part of your task. Resources can help students learn more effectively by:

- helping to gain and maintain interest in a lesson
- encouraging mental involvement and the use of different senses while learning
- making learning more meaningful by linking in with previous knowledge
- catering for students who learn best through different senses – for example, some students learn best through listening, while others learn best through seeing, touching, tasting, or a combination of these four ways
- helping in the recall of information
- making explanations of difficult concepts and skills clearer
- encouraging independent learning.

Examples of resources for Agriculture

- Papua New Guinea maps
- Papua New Guinea atlas
- Newspapers
- NARI publications
- Department of Agriculture and Livestock publications and journals
- National Research Institute bulletins and publications
- Department of Lands and Physical Planning resource information
- Papua New Guinea AIDS Council resource information
- UPNG
- Unitech

- UoV
- Unitech and UoG journals and bulletins
- Agricultural related cooperate bodies eg CIC, Cocoa Board, Copra Marketing Board, etc.
- Ramu Sugar
- Mining companies bulletins
- Chemcare
- Brian Bell Agricultural supplies
- Steamships Hardware
- UoG
- New Britain Palm Oil Limited
- Department of Environment and Conservation resource information
- Farmset
- Ag Mark
- Niugini Building Supplies
- Carpenters

General guidelines for selecting and using resources

The effectiveness of the resource very much 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 required.
- Use the resource at the right place and time in the lesson. The resource should fit in with the flow and sequence of the lesson. It should serve a definite teaching purpose.
- Should the resource be 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.

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 additional teacher support at unexpected times
- Consider methods of troubleshooting, eg 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 and familiarity with the way texts are presented on the World Wide Web.

- Ensure that all students have an understanding of how to access the Internet and how to perform basic functions, eg 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 information gathered on the Internet just as they would for any other text. They should be aware that material posted on the World Wide 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 (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. By itself this information provides very little evidence of student effort or student achievement. Students must make judgments about the validity and safety of information when working from the World Wide 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 important to recognise how students have accessed the particular information, what value they place on it and how they have used it for the particular 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.

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Fundamental Biology

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Glossaries

Assessment glossary

Syllabus outcomes, criteria and performance standards, and examination questions 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 responses to examinations and assessment tasks.

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, and employ in a particular situation
Appreciate	Make a judgment about the value of
Assess	Make a judgment of value, quality, outcomes, results or size
Calculate	Ascertain/determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes/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 (analysis/evaluate)	Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to analyse/evaluate
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/indicate as being distinct or different from; to note differences between
Evaluate	Make a judgment 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

Agriculture glossary

Abomasum	Fourth section of the stomach of a sheep, goat, cattle, or other ruminant animal. This is the true stomach of the ruminant animal and contains structures that produce juices which digest food
Acid soil	Soil that has more hydrogen ions than hydroxyl ions, soil whose pH is below 7, soil that requires additional of agricultural lime to make it neutral. Some crops such as water melon, soy bean, rubber, pandanus, sweet potato and swamp rice grow best in acid soils. Instrument for measuring level of acidity in the soil is called a pH meter
Afforestation	Planting of trees where the natural forest has been destroyed
Agriculturalist	Person who looks after crops and/or animals
Agriculture	The science of cultivating the land and looking after crops and/or animals and maintaining farm tools and equipment
Agronomy	The science of crop and soil management for crop production
Alkali soil	Soil containing an excess amount of alkaline salts (hydroxyl ions), usually sodium carbonate, soil with pH above 8.5
Alkaline soil	Soil with pH above 7.0. Crops such as mint, ginger, eucalyptus and palms grow best in soils that are slightly acid to alkaline
Anatomy	The science of dealing with the parts of animals, plants or humans
Animal behaviour	The way animals act, either individually or in a group
Animal husbandry	The science of looking after and breeding farm animals

Animal manure	Animal waste that is applied to the soil in a garden to help improve the soil and so increase crop yield
Animal nutrition	The science that studies the quantity and proportions of nutrients needed or found in animal food
Animal pest	Any animal that injures another animal by living on it, inside it or by killing it for food
Animal power	Power got from farm animals such as horses, buffaloes for doing work on the farm, eg land preparation, transportation, pumping of water and crop processing can be done using animal power
Annual crop	Crop that grows, reproduces and dies within one year, eg corn, beans, rice, cabbages, etc
Apiculture	The science of beekeeping
Aquaculture	Growing, looking after and harvesting plants or fish in water. Aquaculture is a commercial enterprise in many countries, eg fish, clams, crabs, prawns, lobsters, etc are kept, fed and harvested for sale
Aquatic plant	Plant that lives in water
Arable land	Land capable, without much improvement, of producing crops
Aviculture	Looking after and breeding birds
Bacterium	Very small (microscopic) plant that causes diseases in other plants or animals. eg bacterial leaf blight of rice caused by *Xanthomonas oryzae*
Balance sheet	Statement indicating the financial position of a farm business on a specified date, and consisting of all assets and liabilities of the farm. The totals of the two columns (assets and liabilities) of the balance sheet must balance
Band application	The application of solid fertiliser in the form of a line or band beside a crop growing in a garden
Basal application	Method of applying fertiliser in which the fertiliser is mixed into the soil before a crop is planted
Battery system	A method of keeping chickens, in which the birds are confined to cages inside a building; cage system. Though costly, this system is good for egg-laying chickens. Meat-chickens can be more cheaply raised using the deep litter system. In recent years, animal-protection groups have raised objections to the battery system
Beijerinckia	Type of free-living bacterium that is commonly found in tropical soils, and helps to provide nitrogen to plants
Bemissia species	Type of white fly that sucks the juice of cassava plants and passes on the disease, cassava mosaic, from infected plants to healthy ones
Biennial crop	Crop that requires two years to reach maturity. In the first year, it produces leaves and in the second it flowers and produces seeds and then dies, eg cabbages, onions, leeks
Biological control	Pest control method in which the natural enemies of the pest are used to feed on the pest. The use of cats to kill rats in a grain store is an example of biological control. In weed control, insects, disease-causing organisms and parasitic plants have been used to biologically control weeds

Biotic factor	Relating to the association between living things; a situation that involves the inter-relationships between living individuals of two species and influences the life process of both and may change the normal pattern of growth of the individuals
Black pod	Disease of cocoa pods in which the pods turn black because of the attack by the fungus, *Phytopthora palmivora*
Black-eyed bean	Legume crop grown for its edible seeds, eg cowpeas, pigeon peas
Blight	Disease such as mildew, smut or rust in plants, caused by fungal or bacterial parasites
Boll weevil	Beetle whose larva destroys cotton bolls and is the most common cotton pest; *Anthonomus grandis*
Bolting	Sudden production of a flower stalk by a cabbage plant. Flowers and seeds are formed after bolting but the cabbage leaves become less nutritious
Boron	Trace element required by plants involved in sugar transport and in cell development in the plant. Symbol is B
Brahman	Type of cow or bull that has a hump on its back, large ears and horns
Bran	By-product of rice or wheat milling. It consists of the removed outer layers of the grains. It is used as animal feed and is rich in vitamins and minerals
Broadcast	1. Scattering of fertiliser particles uniformly over the garden usually before planting a crop and later tilling the particles into the soil 2. sowing of small seeds by scattering them over the seedbed.
Broiler	A meat chicken
Brood	Collection of developing bees or to sit on eggs to hatch them
Brooder	Place used for giving warmth to young chickens
Brucellosis	Bacterial disease of the uterus and testis of pigs, caused by *Brucella suis*. Disease can pass on to humans who contact infected animals.
Budding	Method of producing new plants in which a piece of bark containing a bud is removed from one plant and attached to another plant through a cut in the bark
Budding knife	Knife used for making cuts on a tree bark in order to insert a bud or young stem into it. It can also be used for grafting
Bud wood	The branch of a tree from where buds are removed and attached to another stem in the budding process
Buffer solution	Compound or solution that can maintain the pH of another solution within a narrow range when small amounts of an acid or base are added.
Bulb	Swollen structure with fleshy leaves or leaf bases covered by scale leaves and attached to a flattened stem. eg onion, garlic, shallot
Bulbil	Small, potato-like structures growing on the stems of yams above the ground. The aerial yam (*Dioscorea bulbifera*) is a typical bulbil

Bush fallow	Farming system in which a piece of land is left unused for some years before it is planted again. It is our traditional farming system in the Pacific
By-product	Substance or material obtained in the process of making another product; a secondary product. When coffee is processed, coffee skins and husks are by-products
Calcium oxalate	Salt of the substance, oxalic acid in the form of crystals. These crystals are present in taro and are responsible for causing itching of the throat when improperly cooked taro is eaten
Caponizing	Surgical removal of the testes of a male chicken. It makes the chicken grow big, the meat more tender and full of flavour and juices. The surgery is done on he birds when they are about 18 days old
Carbon cycle	Movement of carbon in the environment occupied by living things, in which plants change carbon dioxide to organic compounds that are used by plants and animals. The carbon is sent back to the environment when plants or animals decay and through respiration
Castration	Removal of the testes or cutting off the spermatic cord of a male animal. These animals grow faster and do not have the male smell that is found in some livestock such as goats
Casuarinas	Casuarinas are on-leguminous plants that fix nitrogen in the soil. They are used as shade trees in coffee plantations where they shade the coffee, produce nitrogen for the coffee and their fallen leaves act as mulch to cover the soil, control weeds and reduce soil temperature
Chlorophyll	Green colouring matter of plants that enables green plants to make their own food. Chlorophyll is contained in structures called chloroplasts
Chlorosis	Yellowing of leaves or other plant parts because of the loss of chlorophyll
Climate	The weather conditions of a place over several months or years. It includes rainfall, amount and duration of sunshine, temperature, winds etc. It affects agriculture in many ways
Commercial farming	Large-scale farming in which many hectares of land are cultivated, usually using machines
Companion crop	Useful plant grown together with another crop
Contour farming	Making ridges and planting beds across hill slopes
Cover crop	Plant of the legume family, planted to cover the soil while the land is not planted with any crop
Creep feed	Type of feed given to young animals. This feed is very high in protein and helps the young animals to grow strong
Crop mixture	Any type of crop combination in the garden, eg potato, corn, sugar cane, cassava, are grown in the garden together
Crop pest	Any plant or animal that injures a crop in the garden or in the place where the crop is stored, eg insects, rodents, mammals and birds
Crop rotation	Alternate growing of two or more types of crops on the same land; rotational cropping involves a legume in order to enrich the soil and protect the land

Crop sanitation	Keeping a garden clean and free from germs, eg burning of diseased plant parts or cleaning of animal housings
Cropping system	Pattern of growing crops in garden, eg mixed cropping or intercropping
Cross breed	To make new plants or animals by mating two different varieties or breeds of a species
Crown grafting	Method of producing new plants in which a young branch about 9–15 cm long is inserted at the root crown just below the soil level
Cultivar	Plant that is grown but has no wild relative that gave rise to it
Cultivation	Shallow tillage or digging of the soil to loosen it so that water can soak into the soil. It is also for removing weeds
Cultural control	Use of cultural practices such as crop rotation, burning of plant remains after harvest, irrigation, destruction of harmful animals etc. in the control of plant or animal diseases
Cultural practice	Any farming practice that ensures that diseases or insects or other pests do not fully develop or that makes the environment unsuitable for pests to live and produce young ones
Damping off	Disease of young plants in which a fungus attacks the plants near the soil level, causing them to rot and drop their leaves
Deep litter system	Method of keeping chickens in which the floor is covered with such materials as sawdust, coffee husks, wood shavings, grass clippings etc
Deficiency symptom	Signs in a plant or an animal that show a certain element or type of food is missing. In cabbages or corn, for example, if the element phosphorus is missing, older leaves of the plants become purple. The application of the right type and amount of the missing element can improve the condition of the plant or animal
Denitration	Removal of nitrates or nitrogen
Denitrification	Changing the substance nitrate or nitrite to the gas or oxide form of the element; nitrogen process carried out in the soil by denitrifying bacteria.
Dibble	Short wooden stick used to make holes in the soil for planting crops. In the green house nursery the same size sticks are cut and inserted and glued or nailed in rows; used for making even holes in the seed boxes for thinning seedlings from the germinating boxes.
Dieback	Disease in which a plant starts to die from the ends of its branches
Disintegration	The reduction of large pieces of rock to smaller sizes. The process of rock disintegration and mixing of the pieces with dead plants and animals over the centuries, has given rise to soils
Double cropping	Method of planting crops in which two crops are grown in a garden at different times of the year, one crop following the harvest of the first crop provided there is sufficient rainfall, or irrigation is used. The usual crops are corn and rice
Ecological control	Changing the environment of the crop or animal so that germs are unable to live. The burning of diseased plant parts animals is a way of controlling further spread of diseases

Ecological system	Group of living things and their surroundings or environment; ecosystem
Ecology	Branch of biology that deals with the study of the relationships between living things and their surroundings; environmental biology
Ecosystem	Group or community of living things and their environment.
Environmental control	Modification of one or more of the external conditions that affect the life and development of plants and animals. For example, the amount of water in the soil can be controlled by either draining out the water or supplying more water and studying how this would affect crops or animals. The best place to control the environment is in a greenhouse
Environmental factor	Condition of the surroundings of plants and animals that affects their well-being. Three main environmental factors affect crop and animal distribution: climate, soils and the relationships between living things in that environment
Essential element	Is required for the normal growth, development and reproduction of a plant or animal. Three essential elements are nitrogen (N), phosphorus (P) and potassium (K). When these are lacking, plant or animals show deficiency symptoms
Evaporation	Combined loss of water in vapour form, from the soil surface, streams and lakes, and from the exposed surfaces of plants
Exotic	Rare, attractive and introduced plants or animals from another country or region
Fallow	Leave a garden unused for one or more growing seasons
Fallow period	Length of time when a piece of land is not used for making a garden. Nowadays fallow periods are shorter than during our grandparents' time due to demand for garden land as a result of population increase
Farming system	Different methods used to keep animals or grow crops. It includes the various ways of keeping animals in the houses or allowing them to roam, and cropping systems such as shifting cultivation, bush fallow system, continuous cropping, mixed cropping, etc
Fauna	Animals in an area
Feed conversion ratio	Amount of feed that an animal eats compared with the amount of weight that it gains, eg 5 kg feed and gains 1 kg weight, its feed conversion ratio is 5:1
Fixation	1. Process by which some elements in the soil are changed from a soluble form that is available to plants to a less soluble form that plants cannot use, eg phosphorus fixation. 2. Process in which the element nitrogen in the soil is changed to other substances such as nitrates that is useful to plants. Swellings called root nodules on legumes roots are the sites of nitrogen fixation in the soil
Flora	All the plants in an area
Fodder	Dried food used for food for animals such as dried grass, hay
Forage	Leaves and stems, fresh or preserved, collected and fed to animals

Genetic engineering	Changing genes in an effort to increase or decrease the strength of inherited characteristics, eg increasing fruit yield or resistance to a particular disease.
Green chop	Plant cut into very small pieces and fed to livestock especially during the dry season. Plants used are young lucerne, soft pipit or elephant grass
Green manure	Crop grown and later ploughed under the soil to enrich the soil.
Hardening	1. Putting young nursery–box plants out in the sun for several weeks before planting them out in the garden. 2. Leaving day old chicks in the box for 4–5 hours to make them strong before determining their sex
Heavy soil	Soil that is difficult to cultivate
Heterophyte	Plant that depends on dead or living plants or their products as its source of food
Heterotroph	Living things that get their food by breaking down organic matter. Many plants that do not have green colouring matter live in this way, and help to decompose rubbish in the environment
Horticultural crop	Any fruit or vegetable producing plant such as pineapple, banana, orange, cabbage, tomato
Horticulture	The science of growing vegetables, flowers and fruits
Humus	Part of the soil as source of food for plants made from rotten plants or parts of plants and animals
Hydrophyte	1. Plant that grows in an area with plenty of water; mangrove trees and swamp sago palms are hydrophytes. 2. Plant that requires a lot of water for its growth. Swamp rice is a hydrophyte
Hydroponics	Growing plants in a liquid that contains food substances. Clean river sand may be used as a medium to support the plant roots but not to supply any food substances. Vegetables and flowers can be produced for sale using hydroponics
Immobile nutrient	An element that cannot be moved from one part of the plant where it is present to another part where it is lacking. An example is the element, calcium
Inoculation	1. Injection of a medicine into an animal to prevent a certain type of disease. 2. Introduction of Rhizobium (a legume bacterium) to a seed before planting. This is done to help legume roots form nodules that are capable of changing element nitrogen into plant food. 3. Introduction of disease-causing organisms to plant or plant part in order to cause disease development. This is often done to study how different diseases develop under different experimental conditions
Inorganic fertiliser	Plant food made up of artificial substances, not from plant and animal matter
Inorganic matter	The part of the soil that was not formed from plant or animal material; mineral matter. Inorganic matter is the source of elements in the soil; plants and animals use these elements as food for their growth. Inorganic matter makes up 45% of soil by volume

Integrated agriculture	Method of combining farming activities to make a farm project more efficient and beneficial. A good integrated agricultural program involves planting crops, keeping animals, feeding the crops to the animals, using animal dung to fertilise the farm, controlling pests on the farm and taking good care of the soil
Intensive management	Method of looking after animals in which the animals (cattle, sheep, goats, chickens) are housed all the time and they are not allowed to go out of the house to look for food in the bush. Chickens are usually kept in cages and fed with feed produced from factories. This system of management protects the animals from other animals that might kill them but requires a lot of work in providing food, water and cleaning the animal house. Costs are high but it is an efficient system, so profits are high too.
Intercropping	Planting together more than one type of crop, in lines and with definite spacing
Internal drainage	Downward movement of water through the soil. Among the factors that affect the rate of movement are the size of soil particles, the arrangement of the particles and the depth of the upper surface of ground water
Ion exchange	Replacement of one charged atom (ion) by another ion of the same or similar number of positive or negative charges; ionic exchange. For example, potassium ion, $K^{+,}$ with one positive charge can replace sodium ion, $Na^{+,}$ also with one positive ion. In the same manner, the nitrate group, $(NO_3{}^{2)}$ with one negative charge. It is through such ion exchanges that elements attach to soil particles. The plant then uses these exchanged elements from the fertiliser for its growth and other activities
Land drainage	Removing water from the land so that crops and animals grow better.
Land form	Distinct natural feature of the land such as mountains, rivers, valleys. Land forms affect the choice of land for a garden. Where possible, flat land should be chosen but where the area is hilly, efforts should be made to check erosion
Laterite	Type of red soil made up of different forms of the element, iron
Lateritic soil	Soil made up of reddish material which are forms of the element, iron
Latex	The milky liquid from the rubber, paw paw trees, etc
Layering	1. Method of producing new plants from other plants by bending a branch, still attached to the parent, till the branch touches the soil, pinning it to the soil and covering part of the branch with soil. That part covered with soil produces roots and can then be cut off from the parent plant. 2. Group of plant types in a plant community, such as trees, shrubs and mosses in an area with wet spongy soil
Lime	Material applied to garden soil to reduce soil acidity. Such a material usually has the elements calcium and/or magnesium as part of it. Common materials used as lime are calcium oxide, ground limestone, hydrated lime, burnt lime and calcium magnesium carbonate
Liquid ammonia	Ammonia in liquid form used as a fertiliser that is injected into the soil under pressure
Loam	Rich type of soil made up of sand, silt and clay. Loam soils are the best for planting most crops

Macrofauna	Collective word used for all animals that can be seen with the naked eye in an area
Macroflora	Collective word used for all plants that can be seen with the naked eye in an area
Macroscopic	Large enough to be seen with the naked eye
Mechanize	To use machines for work instead of using the power of people or animals
Meteorology	The science that studies the weather, including rainfall, temperature, winds clouds, etc
Micro-organism	Living creature that is so small that it cannot be seen with the naked eye except with the use of microscope
Microbe	Small living creature that can be seen under a microscope; micro-organism
Microclimate	Uniform weather conditions of a small place compared with those of the whole area of which the place is a part
Microfauna	Collective word used for all animals that cannot be seen with the naked eye in an area. They include nematodes and protozoa
Microflora	Collective word used for all plants that cannot be seen with the naked eye in an area. They include fungi, actinomycetes, algae, viruses and bacteria
Micro mineral	Element required by plants and animals in very small amounts; micronutrients; trace elements. Some examples are copper, zinc, iron, manganese, molybdenum
Mildew	1. Disease that occurs as a white powdery growth on plants, caused by a type of plant without any green colouring matter. 2. Type of plant without green colouring matter and which produces a disease that shows as a white powdery growth on plant which commonly occurs in wet areas
Mineral	Food substances required by plants and animals for their proper growth and reproduction. Minerals are elements. They are needed by plants and animals include calcium, nitrogen (N), phosphorus (P), and potassium (K). NPK are primary elements while Ca, Mg, S are secondary elements, Fe, Mn, Cu, Zn, Mo, etc are trace elements
Mineralisation	Change of an element from an inorganic form to an organic form as a result of the activities of micro-organisms
Minimum tillage	Least amount of digging that the soil needs to make it suitable to sow seeds or plant young pants
Mite	Small creature of the spider family that lives on the body of the animals, sucking their blood
Mixed cropping	Method of planting crops in which more than one type of crop is planted in the same garden at the same time, without any definite spacing and without any rows or lines. Mixed cropping is the traditional method of planting crops in most parts of the Pacific region
Mixed farming	Agriculture in which the farmer keeps animals and also plants crops
Mobile nutrient	Element that can be moved from a part of the plant where it is present and distributed to parts of the plant where it is lacking. Three examples are N P K

Moisture	Water that is distributed through a solid such as soil; water vapour that has changed into liquid on a surface. Soil moisture is the medium in which plant food is carried from the soil into plants
Molybdenum	Trace element (Mo) required in small amounts in plants useful for healthy growth of animals. Molybdenum plays a part in nitrogen fixation in root nodules and is also involved in nitrate reduction
Monocotyledon	Plant producing one seed-leaf in each seed; monocot opposite to dicotyledon has long narrow parallel arrangement of veins in the leaves and several small roots among other features eg banana, coconut, oil palm, ginger, sugar cane, yams
Monocropping	Planting only one type of crop throughout the garden or throughout a region
Mosaic	Disease of plants in which the leaves are not uniformly green in colour but have patches of yellow and light-green colour. Such a disease is often caused by a virus
Mound	Soil collected into a circular raised heap. Mounds are commonly used for planting yams, cassava, sweet potato, potato and other crops in the Pacific region
Mulch	Dried leaves, especially those of grasses, placed around the base of a plant to reduce water loss and soil temperature, control weeds and add plant food to the soil.
Multiple cropping	1. Planting more than one type of crop in the garden but each crop occupies a plot of its own, and the crops are arranged in lines or rows. 2. Planting a second crop into the stand of another crop grown in lines, when the first crop is fully established or is getting ready for harvest. 3. Harvesting a crop many times from the same original plant, without planting a new crop, as in sugar cane and rice
Mutation	Change in the hereditary materials of a plant or animal
Mutualism	Association in which two different kinds of plants or animals live together, benefiting each other; symbiosis. The bacteria that live in root nodules of legume plants exhibit mutualism. The bacteria change soil nitrogen into substances that legume uses as food and the legume provides energy-giving food and protection to the bacteria
Natural immunity	Ability to resist or overcome disease, possessed by individuals of a breed of animal or variety of a plant
Natural resource	Any materials provided by nature, eg forest trees and animals, land, rivers, fish, minerals, petroleum
Necrosis	Death of plant or animal parts as a result of injury or disease
Neem tree	Tree whose parts are made into medicines to kill insects. The oil from the seed is used to kill worms in the intestines of farm animals; Science name is *Melia azadirachta*
Nematode	Small worm which lives inside plants and animals, sharing their food and causing disease; Nematodes live in plants and form swellings on roots and tubers of yam, carrot, cassava, sweet potato and Irish potato. They are about 0.5–1.5 mm
Net profit	Amount of money remaining when all working expenses in a farm enterprise or other projects have been removed

Neuter	1. Neither male nor female; a plant without male or female parts 2. Sexually underdeveloped or sterile insects eg worker ants, 3. To castrate or remove the testis
Neutral soil	Soil that is neither acid nor alkaline, with a pH of 7.0. Practically soils with a pH between 6.6 and 7.3 are regarded as neutral
Nitrate	Substance containing the group NO_3. Nitrate is the major form of nitrogen that plants use as food. It is applied to the soil as a fertiliser such as ammonium nitrate (NH_4NO_3) or potassium nitrate (KNO_3).
Nitrification	Change of substances called ammonium salts to other substances called nitrites (NO_2) and further change of nitrites to substances called nitrates which plants use as food. These changes take place through processes called oxidation
Nitrobacteria	Group or genus of useful bacteria (nitrococcus) in the family of Nitrobacteraceae that change substances called nitrites to nitrates for plants to use as food
Nitrogen	Symbol N. N gives a plant its green colour. It is a part of chlorophyll, and is a part of some vitamins, hormones, and amino acids
Nitrogen cycle	Various changes that element N undergoes as it is used by living plants and animals. It is sent out of a living thing during breathing and when these plants and animals die and decay it is finally changed back to its original state
Nitrogen fixation	Process carried out by bacteria some of which are attached to the roots of some plants. It involves combining the element N, from the air with other elements to make nitrate available to plants as food
Nitrogen-fixing plant	Any plant that can change the free element N in the soil to plant food substances called nitrates. These plants are legumes and Casuarinas plants. Useful bacteria living in the swellings of legume roots help the legumes to change N into NO_3
Nitrogen fertiliser	Any artificial plant food that contains element N, which can be changed to a form that plants can use as food, eg potassium nitrate (KNO_3), sodium nitrate ($NaNO_3$), ammonium nitrate ($NH4NO_3$) and urea ($CO(NH_2)$
Nitrosomonas	Group of useful bacteria in the family Nitrobacteraceae that can change ammonia to nitrite (NO_2)
Nodule	A swelling formed on plant roots by beneficial bacteria
Nomad	A person who moves about with his animals without a fixed home
Nomadic farming	A method of looking after animals in which the animals are moved from one place to another in search of better grass, water and new markets. The men and their families do not live in houses but in tents
Nursery	Place where seeds and seed plants are raised so that they grow into young plants that are later taken out one by one and planted in another place
Nutrient	Substance that can be used as a source of food
Nutrient recycling	Bringing up of elements from the deeper layers of the earth. When plants and plant parts die, the nutrients in them are returned to the soil where they decay and are absorbed again by other plants

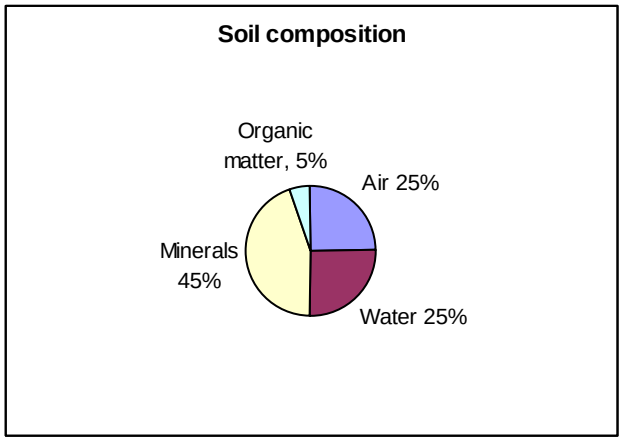
Nutrition	Study of the amounts and proportions of substances that can be used as food
Organic horizon	The topmost layer of the soil that has plenty of organic material
Omasum	The third chamber of the stomach of an animal that brings up food from its stomach, chews it properly to a nearly uniform state and sends it back to the stomach
Orchard	Garden in which fruit trees are grown
Organic farming	Growing crops with the use of compost, manures and other natural plant food without the use of any artificial fertilisers or commercially produced plant food
Organic fertiliser	Plant food made from the remains of plants and animals
Organic matter	Decayed remains of plants and animals added to the soil to enrich it. Organic matter makes up about 5% of the soil by volume
Organic phosphorus	A form of the element phosphorus present as a part of a compound of the element carbon
Organic rock	Rock formed by the deposition of materials that were mainly the remains of plants and animals
Organic soil	Soil that is wet for most parts of the year and contains at least 30% of decayed materials from plants or animals
Organically grown	Cultivated with the use of compost, manures and other natural plant food, without the use of any artificial medicines or man-made plant food
Organism	Living plant or animal of any size
Osteomalacia	Bone disease of adult animals lacking vitamin D
Ozone	A form of oxygen. Symbol O_3. The ozone layer in the atmosphere protects living things from the harmful rays of the sun. Because of the increased use of petrol, diesel and other fuels in vehicles, scientists believe that the ozone layer is being gradually destroyed, leading to more heat reaching the earth from the sun. Consequently some scientists warn that this will cause the earth to warm up, making the ice in the Polar Regions melt and the seal level rise. It also increases the concentration of atmospheric carbon dioxide and reduces oxygen levels. These causes an imbalance in nature and therefore a threat to every living organism on this earth
Parasitism	Relationship between two living organisms in which one lives on or inside the other, getting food from it, harming it and giving it no benefit, eg round worms living in pigs, or lice living on chickens
Parent material	Broken down remains of materials from rocks or those of plant and animal origin, from which the upper layers of the earth are formed
Parthenocarpy	Fruit development without seed formation. Natural parthenocarpy occurs in the banana and pineapple where the fruits are formed without seeds. Parthenocarpy takes place for a number of reasons: lack of pollination, lack of fertilisation, lack of embryo development, etc
Passive immunity	Temporary protection from a disease given to an animal by injecting it with material called anti-serum that can fight disease for a short time

Pasteurellosis	Disease of rabbit in which the sick animal sneezes, wheezes and coughs or snuffles. It is caused by Pasteurella bacteria
Pastoral farming	Methods of farming in which herdsmen or shepherds keep and care for domestic animals
Pasture	Grassland in which animals are fed on the grass. Pastures can have both grasses and legume plants
Pathogen	Any living thing that can cause disease, eg bacteria, fungi, viruses, parasites
Peg	Stalk of a peanut pod. It is a stem-like structure that develops after fertilisation and pushes the ovary into the ground to form the nut
Percolation	Downward movement of water into the soil
Perennial crop	Crop that grows for many years, eg cocoa trees, coffee trees, oil palm, coconut trees, mangoes and orange trees
pH	Measure of the hydrogen ion concentration of a substance; a measure of how acid or alkaline a soil or other material is. The pH scale runs from 0–14. The midpoint, pH 7.0 is neutral. Any substance with a pH below 7.0 is said to be acid and any substance with a pH above 7.0 is alkaline
Phenotype	Physical external appearance or observable characters of a living thing
Phloem	Structure in a plant through which food material moves from one part of the plant to another.
Phosphorus	Element symbol P that is essential to plant and animal life. It provides energy to plant and animal cells in the form of $(PO_4)^2$
Photosynthesis	Process in which green plants make carbohydrates, using the energy from the sunlight, carbon dioxide and water. This process changes the sun's energy (solar energy) to food energy
Phyomone	Medicine that is applied to pineapples to make them bear fruits early; alphanapthalene acetic acid. It is used to ensure uniform pineapple fruiting for export. One bottle of this medicine is sufficient for 8000 pineapple plants. To get the medicine ready for use, add 50 drops of it to 4.5 litres (half a bucket) of water. This is enough for 75 plants. Mix well and pour small quantities (10–15 ml) into the heart of the pineapple plant. Fruits should be ready for harvest from 26–30 weeks after application (smooth leaf pineapples) or 20–24 weeks in rough leaf pineapples
Plankton	Living things that are invisible to the naked eye but are food for fish. Those which are plants are called phytoplankton; the animals are called zooplankton
Plant hormone	Substance produced in small amounts in plants which helps to control growth or some other activities; phytohormone
Plough	Farm implement used to turn over the soil and prepare a seedbed or field for planting
Plough layer	The surface soil that is moved when the soil is tilled or ploughed for planting
Pollen	Yellowish powder made up of small grains produced in the anthers of flowers. Pollen contains the male sex cells of a plant. When pollen is transferred from one flower to another, seeds and fruits are eventually formed in plants

Pollination	Transfer of pollen grains from the anthers to the stigma of a flower
Pore space	Total space in the soil not occupied by soil solids. It is usually expressed as a percentage.
Porosity	Rate at which the soil allows water to drain through it or the rate at which the soil absorbs water. A soil that absorbs water rapidly or allows water to drain through it quickly is called a porous soil. A soil that does not easily absorb water or allow water to pass through it is called a non-porous soil
Potassium	Symbol K, from the Latin word, Kalium. It is involved in the production of proteins from amino acids, and in the opening and closing of stomata
Potassium fixation	Change of potassium salts in the soil into forms in which they are not readily available to plants
Prop root	Supporting root of a plant as in the mangrove.
Propagate	To increase the number of animals or plants by natural means
Pruning	Cutting off excess, old or diseased plant parts. This is done to encourage bigger fruits, allow more sunlight to get into the garden floor or reduce the number of pests and disease-causing organisms on the plant
Pseudostem	False stem. The trunk of the banana is not a true stem
Pulse	Seed or plant of the legume family, having small grains; grain legume, eg peanut, black eye beans, soya beans
Quarantine	Separation of sick animals or plants from healthy ones. Such separation ensures that the disease does not spread to healthy animals or plants. When an animal or plants or animal/plant materials is brought into a country from overseas, the animal or plant is normally housed or kept away from others until it is certain that it carries no disease. This is to ensure that no new diseases are introduced into the country. The rules of quarantine are called quarantine laws.
Quicklime	A white substance applied in gardens to reduce the level of soil acidity; calcium oxide
Rachis	1. Central stalk of the leaf of the coconut, oil palm or other compound leaf. 2. Central structure of a corn ear on which the grains are attached
Rain gauge	An instrument used to measure the amount of rain
Ramp	Sloping structure on which animals are loaded into or unloaded from a truck
Ration	Amount of food given to an animal in one day, fed at one time or at different times
Ratooning	Cutting the stem of a crop after harvest to produce one or more harvests from the same plants, without replanting. This method is commonly used in sugar cane and sometimes in rice production
Reticulum	Second chamber of the stomach of an animal whose stomach has four chambers; eg sheep or goat brings up food from the stomach, the food comes from the first chamber, the rumen. After re-chewing and re-swallowing the food, it goes into the reticulum

Resistant variety	Plant that is able to withstand a disease and still produce a reasonable yield. The planting of resistant varieties is one of the cheapest and most effective ways of controlling plant diseases. Resistant varieties of crops are available from the DAL or NARI
Restricted range system	System of keeping chickens or other farm animals indoors at night, but allowing them to go and look for food during the day, inside a fenced area; semi-intensive management
Rhizobium	Type of bacterium that lives in a mutually beneficial relationship with the swellings on legumes roots, and provides nitrogen to the plant. It obtains carbohydrate, water and protection from the legume plant
Rhizome	Underground stem, eg ginger
Ribbon method	Method of determining soil texture by rolling a soil sample on a board to get different shapes
Rickettsia	Very small living things, larger in size than bacteria but smaller than viruses that cause diseases in animals
Ridge	Long continuous seedbed with a triangular cross-section and a base of 30–45 cm
Rill erosion	Wearing away of the soil by rainwater, producing small channels
Ring application	Method of applying fertiliser to a crop, in which the fertiliser is spread in the form of a circle around the plant. This method is used to supply fertiliser to individual plants such as yam, cassava, young trees and sweet potato. For these plants, the ring or circle should have a radius of about 12–15 cm, the centre of the circle being the plant
Rodenticide	Medicine used to kill animals such as rats, mice, rabbits and other rodents. When using rodenticides to kill pests, care should be taken because they are also harmful to people
Roughage	Coarse feed eaten to provide bulk in food and to stimulate bowel movement. Examples of roughage feed include grasses, fruits such as oranges, and sugar cane skins
Rumen	First chamber of the stomach of an animal that has its stomach divided into four sections
Ruminant	Animal that brings up its food from the stomach chews it again and returns it to the stomach, eg cows, sheep, goats. Non-ruminant animals are pig, chicken, horse
Runner	Plant with a soft stem that creeps on the soil surface. Roots grow out of the stems of a runner and attach the plant to the soil; stolon. eg strawberry, sweet potato, clovers, etc
Rust	Plant disease that appears as yellow or reddish-brown spots on the leaves, stems or other parts of the plant. It is caused by fungi and is common in corn and rice
Savannah	Grassland area with a few stunted trees
Scion	Bud or young stem that is attached to an older plant part in grafting
Scouring	Disease of farm animals in which they frequently pass watery excrement
Screen analysis	Use of a screen with holes of various sizes to find the particle-size distribution of soil solids

Secateurs	A scissor-like tool used for cutting tree branches during pruning
Sediment	Materials that have been moved as a suspension in water and later deposited on the soil surface
Sedimentary rock	Type of rock formed by the deposition and sticking together of particles of materials
Seedbed	Soil surface on which a crop is grown. Seedbed types vary, depending on the crop to be planted. Vegetables are often grown on flat, raised or sunken seedbeds; yams are grown on mounds or ridged seedbeds
Seedbed nursery	Square or rectangular box used for planting seeds and taking care of the seedlings before they are taken out and planted in the garden. A seed box measure 40cm long, 40cm wide or 30 cm long and 40cm wide, with depth of 10cm. There should be holes at the bottom of the seed box to allow water to drain out
Sequential cropping	Planting one type of crop into a garden where another crop is already growing and harvesting the crops at different times when they are mature. It is a type of multiple cropping
Sheet erosion	Carrying away of a uniform layer of soil from the land by running water or wind. Sheet erosion takes place in areas where the land is fairly flat and may be unnoticed because no channels are formed
Shifting cultivation	Method of farming in which the farmer uses a garden until the crops stop growing well and then he moves the whole household to another place where he starts a new garden. He might or might not go back to the first place where he made the garden. It is less commonly practised nowadays because land is scarce; what is practised nowadays is the bush fallow system
Side dressing	Method of applying fertiliser in the form of a line or brand to a crop growing in close rows in the garden; band application
Sigatoka disease	Disease of banana leaves. It appears as spots on the leaves, with the spots on the leaf margins causing the margins to die. The disease is caused by the fungus *Mycosphaerella musicola*
Silage	Animal feed prepared by cutting up fresh plant stems and leaves and storing these under air-tight conditions
Silk cotton tree	Tree that produces seed fibres; kapok tree
Silk worm	Insect that secretes large amounts of a thread-like material called silk that is used for making clothes; *Bombyx mori*. In Papua New Guinea silkworms are kept by farmers who feed them with mulberry leaves. The silk produced by the silkworms is sold to DAL which in turn sells it to other countries
Single fertiliser	Artificial plant food that supplies one main type of element eg urea, and sulphate of ammonia which both supply nitrogen, sulphate of potash and ordinary super phosphate that supplies phosphorus
Smut	Fungal disease of grass-like and other plants in which the fungus produces large amounts of black powdery materials on the plant parts.

Soil	It is best illustrated by a pie diagram showing the volume composition of soil 
Soil Conditioners	Material added to the soil to improve its physical conditions, eg compost, or animal manures when added to the soil, improve the soil's ability to absorb and retain water
Soil conservation	Saving the soil from destruction, eg ridges and planting beds should be made across the slope and not along the slope; the soil should not be exposed to rain and winds but should be protected by planting cover crops
Soil fertility	Natural ability of the soil to provide essential elements in the correct amounts and proportions
Soil management	Taking good care of the soil so that it is beneficial to plants, animals and humans
Soil profile	Vertical section of the soil showing layers called horizons. What a soil profile looks like varies from one part of a region to another, eg in a river valley area, the topsoil will be thicker than on a steep slope
Soil solution	Water in the soil containing dissolved substances
Soil sterilisation	Best method is to: • weld a pipe onto the lid of a drum (over a hole) and drill holes into the pipe so that it is like a chimney • put two bricks onto the floor of the drum • fill one third of the drum with water • place the lid on the bricks in the drum • fill the rest of the drum with organically mixed soil • put two kau-kaus in the soil near the top • cover with hessian • light a fire under the drum, so that the fire boils the water. • hot steam coming out of the holes in the pipe will penetrate into the soil thus killing micro-organisms. • when the kau-kaus are cooked, the soil is sterile • cool the soil and use it in the nursery.
Soil structure	Arrangement of individual soil particles into natural units of varying sizes. If a soil has large units it has a coarse structure but if it has small units it has a fine structure

Soil texture	Relative amount or percentages of sand, silt and clay in soil and how a soil feels when rubbed between he fingers. Another method is the mechanical analysis and then using the results on the Textural Triangle to determine the texture of the local soil
Species	Sub-division of living things in the classification system that have common features and can give offspring when mated
Spice	Plant whose parts are used to flavour food. Examples are ginger, turmeric, peppers, cardamom, thyme and vanilla
Spore	A small living thing that can germinate and cause disease in weak plants or animals if the environment is right. Most spores are reproductive structures of fungi; but a few types of bacteria produce spores. Spores are light and are easily moved about by the wind from where they are produced to where they start to grow
Spot application	Method of applying fertiliser to a mature growing plant. In this method, small holes are dug, about 30 cm away from a plant depending on the size of the plant. A suitable amount of fertiliser is put into each hole and covered
Staking	Providing sticks to support plants with weak stems eg yams, winged beans, snake beans, tomatoes, cucumbers
Starter feed	Commercial name for a type of feed given to young animals to make them grow fast
Starter mash	First type of food that is given to chickens. It is rich in protein (20–22%) and helps the birds to grow fast
Stem borer	Larva of an insect (moth) which makes holes in plant stems, thus weakening or destroying the plant. Stem borers are major pests in rice, corn, wheat and other grasses like plants
Stock	Plant rooted in the soil and to which a bud or young stem is attached during budding or grafting
Stomata	These are small holes on a leaf surface through which a plant takes in or sends out gases and loses water in vapour form
Storage pests	Animals that destroy stored food, eg rats, mice
Stubble mulch	Unharvested lower part of crops such as corn, rice or other crops left in the garden to cover and protect the soil when the garden is abandoned
Subsoil	Layer of soil just below the topsoil. It is lighter in colour and poorer in plant food than the topsoil. Plant roots usually grow in the subsoil.
Succession of crops	1. Growing two or more crops in the same garden by planting them one after another, 2. Growing a crop in one season by planting the crop on different days, weeks or months or planting one variety of the crop that matures at different times. It is good for small holder farmers but not good for commercial farming
Succulent	Young, juicy or fleshy plant part that is not woody and is fed to animals eg cassava, paw paw, banana, taro, sweet potato tubers, cucumbers
Sucking insects	Insects whose mouth part is modified to suck plant or animal juices, eg whiteflies, cotton stainer, aphids, leaf hoppers, mealy bugs, scale insects and squash bugs. They pass on diseases form one plant to another

Sulphur	Element with symbol S. It forms a part of plant proteins and is a part of the substance that gives onion, garlic and mustard their special smells
Symptom	An outward sign of a disease, eg if a mature corn leaf yellows from the leaf tip along the leaf margin, it is a symptom of lack of potassium. If chickens produce bloody and watery excrement, droop their tails and do not eat much feed, these are symptoms of the disease coccidiosis
Tapeworm	Flat type of worm that lives and eats in the intestine of farm animals
Tapping knife	Hand-held tool with a V-shaped cutting edge used for tapping rubber
Tapping panel	Part of a rubber tree stem where cuts are made and tapping done. A tapping panel is made by cutting a half-spiral incision from the top left to the bottom right of the rubber stem, at an angle about 20–30 degrees
Taproot	Type of large root that grows deep into the soil and has smaller branches. Dicotyledonous plants produce taproots such as carrot, cabbages, beans, coffee, cocoa, etc produce taproots while monocotyledonous plants such as onions, corns, coconuts, oil palms, produce fibrous and adventitious roots
Taro	Plant whose young leaves and underground parts are used for food, eg. taro tru. Its science name is Colocasia esculenta is traditional to most Pacific countries while taro kong kong is brought into the Pacific. Its science name is Xanthosoma sagittifolium
Taungya	Method of planting and looking after both trees and crops in the same garden and harvesting them at different times when they are ready for harvest
Taxonomy	Method of grouping things such as plants, animals or soils based on their similarities and differences. These are principles of classification
Tea	Science name is Thea sinensis. It is planted in Papua New Guinea near Mt. Hagen and is an important export produce
Tick	Animal like a small spider that lives on the skin of farm animals and pets and sucks their blood
Till	Dig up the soil in preparation for planting seeds; to cultivate the soil
Tillage	Using tools or implements to dig the soil to prepare it for planting
Tilth	Condition of a soil in relation to its readiness for planting. Soil that is properly tilled has a good tilth
Top-dressing	Application of fertiliser added to the soil after the crop has been planted
Topography	The appearance of the natural features of a place including hills, mountains, valleys, flat land etc
Topsoil	Surface layer of the soil just a few millimetres thick; surface soil. The topsoil is usually dark in colour and is rich in plant food
Toxin	Poisonous substance produced by a plant or animal cell
Transpiration	Loss of water in vapour from the surface of the leaves, through the exposed parts of a plant

Transplant	To transfer a young plant from where it was initially grown and looked after to a permanent place in the garden
Treatment	One of the variables used in an experiment, eg levels of fertilisers, insecticide, feed, breeds of livestock etc
Trowel	Hand tool used for lifting young plants from seed boxes or the ground and planting them somewhere else in the garden. It has a curved blade and a wooden or plastic handle
Turmeric	Plant of the ginger family whose underground stems are used as a spice. Its rhizomes are dried and ground into an orange-red powder that is mixed with other ingredients to form curry powder. Turmeric is one of the spices grown in Goroka
Udder	Structure between the hind legs of a female animal from which milk is produced eg cows, sheep and goats have a prominent udder
Ultraviolet	Invisible kind of light that is part of sunlight. It is useful in making vitamins from the skin of animals. Too much of it can cause skin cancer
Vaccinate	Inject a medicine into an animal to protect it from disease
Variable cost	Cost of a farming or other business that changes directly with the number of resources used, eg labour costs, fuel costs, feed costs and fertiliser costs increase as more labourers are employed or more fuel, feed or fertiliser is used
Vegetable	Plant with soft leaves or stems used for food, eg cabbages, lettuce, tomatoes beans, carrots
Vegetation	Any plants large enough to be seen with the naked eye.
Vegetative propagation	Separation of a mature plant from its parent and planting it to form a new plant; eg banana, pineapple, cassava, taro, yam, sugar cane, sweet and English potatoes, aibika, etc
Viability	1. Ability of a seed to germinate if provided with all conditions necessary for germination. 2. Ability of an enterprise to succeed when carried out
Virus	Small living things that cause disease and only survive on living parts of plants or animals. Viruses are smaller in size than bacteria and cause many serious diseases that pass on form one sick creature to a healthy one. Diseases caused by viruses are difficult to control. HIV is a virus that becomes AIDS over time
Wattle	Reddish, fleshy structure on the throat and head of turkey and other birds
Wean	Separate a young animal from its mother.
Weathering	Breaking down or decomposition of rocks. This process leads to soil formation
Weed	Any plant that grows where it was not planted, especially amongst crops. Weeds compete with crops for food, sunlight and water and it is important to kill them when they are young and before they do too much harm to the crops.
Wether	Castrated male goat or sheep
Wind erosion	Separation of soil particles from one another and their movement from one place to another by the wind

Xerophyte	Plant that lives in a place where there is very little water; desert plant
Xylem	Pipe-like structure which moves water in a plant
Yam	Climbing plant with a swollen, edible, underground part; Dioscorea sp.
Yolk	The yellow centre of an egg. It contains food material for a chick to use in developing and growing before it hatches.
Zinc	Element symbol Zn. Zinc is required in protein production
Zoonosis	Disease eg anthrax, cowpox, TB, brucellosis which normally affects farm animals but can be passed on to human beings who are in contact with the sick animals or eat meat from an animal that has the disease
Zooplankton	Small animals that cannot be seen with the naked eye and which live in sea water. Fish feed on zooplankton.
Zucchini	Edible fruit vegetable that looks like cucumber; Cucurbita pepo

Teaching Strategies Glossary

Brainstorming	This is a technique in which a class or group meets in order to record all the information already known on a topic, to develop new ideas or to stimulate creative thinking. Participants let the ideas come into their heads, write them down or share them orally, sort them and decide which require further research. Brainstorming is a useful way of finding out what students already know about a topic.
Consequence charts	A consequence chart is used to record what students believe to be the likely consequences of a decision or action. Charts can take different forms and enable students to explore cause and effect relationships, alternative consequences or the likely consequences of alternative actions or decisions. Consequence charts are particularly useful in Agriculture to help decide for example, what crops to plant or what fertilisers to apply.
Class meetings	Class meetings provide an organised forum for students to contribute to decisions about class activities. In Agriculture, class discussions could be used to decide on the class crop or animal project and to discuss issues that arise during the project.
Classroom displays	A classroom display provides a way of focusing on the topic. It stimulates learning, provides a record of learning as well as encouraging students to interact and to respond to learning. Students could display plant/animal growth charts, collections of tools and equipment etc.
Charts	Helping students to learn to make chart, that is, to organise information in various groupings under different headings, is valuable. It helps them to make sense and summarise of information they have collected. Charts (for example, of PNG agricultural imports and exports) are a powerful organising tool and of considerable help in getting students to think about data.
Diagrams	Diagrams are employed in a variety of situations. They may be used to illustrate outlines and features of an object such as soil profiles or planting techniques. The best diagrams are clear, with all the necessary details, and labels to identify features and explain processes.
Flow charts	A flow chart is a diagram showing a series of step-by-step operations which make up a particular process. The main elements of the process are shown in picture form and are linked by arrows to indicate how one operation leads to the next. A flow chart can also be used to show stages in the development of a product.
Cultural activities	Through participation in cultural activities, students are exposed to a variety of activities that give them insight into their own culture or that of others. Programming should take into account local cultural events such as the yam festival or agricultural shows, as well as national events.

Decision-making	Decision-making is the process of choosing from two or more alternatives. Decisions are best made after gathering information about the situation/event, considering the formation of possible alternatives before choosing between alternatives. Part of the process is the analysis and evaluation the possible outcomes of the decision. Be aware of problems/situations in the class/community which require decisions to be made. Be prepared to allow students to make decisions with unexpected outcomes.
Evaluation	In Agriculture, difficult decisions have to be made about, for example, sustainable practices and profit margins. Students must be able to discuss and evaluate options and consider all consequences. The evaluation process often requires us to make decisions between values which are in apparent or real conflict.
Discussions	Discussions provide opportunities to express ideas and feelings and listen to others, to look at issues from other perspectives. However it is not practical with more than 20 people. If class discussions are going to be used in a large class, the class should be divided into two or more groups.
Fieldwork	Fieldwork is an essential part of the study of Agriculture. It is a means of understanding natural and changed environments and the nature of inquiry. Fieldwork can enhance learning opportunities for a wide range of students because it caters for a variety of teaching and learning styles. Fieldwork enables students to: • acquire knowledge about environments by observing, mapping and recording phenomena in the real world in a variety of places, including the school • understand the spatial and ecological dimensions of the environment • explore processes that form and transform environments.
Guest speaker or visitor	A guest speaker or visitor is a person who is invited to share his/her knowledge and skills with the students. This may be, for example, a local farmer, Department of Agriculture extension officer or a manager of a plantation.
Interviews (Field day visits)	An interview involves asking someone questions in order to find out more information about a subject. In this way, students can learn about things and peoples' opinions first hand. There are usually many people with special knowledge about a topic. Students can invite them to the classroom or meet them during fieldwork. To conduct an interview successfully students need to: • prepare their questions beforehand • make sure questions are simple and to the point and that they require more than a single word answer • make sure they tell the interviewee their purpose and thank them at the end • listen carefully to answers • take notes if possible.

Investigating issues	The essence of an issue is that there are different, often opposing views, most of which are based on reason. Different opinions about an issue may be due to: • conflicting value stances • use of power • humanitarian ethics • benefits gained by different groups eg resource development or conservation. It is recommended that opportunities are provided for students to: • discuss ideas, feelings and questions about activities regarded as right or wrong, good or bad • examine the personal and community factors involved in defining beliefs about what is right or wrong, good or bad • analyse how different contexts and situations influence personal values, attitudes, beliefs and behaviours • critically analyse how groups justify particular actions and behaviours.
Jigsaw groups	Jigsaw groups are a method of organising students so that the whole class can conduct an in-depth study of a topic or issue within a relatively short period of time, for example components of an agriculture system. Topics are analysed and broken down into discrete research tasks or activities. These tasks form the pieces of an information 'jigsaw'. A group of students is allocated one of the jigsaw tasks to investigate. Each expert jigsaw group then reports the results of its findings back to the other groups, thus gradually building up a detailed and complete 'picture' of the topic.
Mapping	It is important for students to develop a sense of place and space. References to maps, explanation and use of scale and symbols, comparisons between different kinds of maps; and drawing inferences from maps are all important for agriculture.
Matrix	A matrix (or table) is a concise classification of numbers, words, or symbols assembled in a grid layout in order to facilitate analysis and predictions.
Mind maps/concept maps	A mind or concept map is a way of recording information. It allows students to organise their ideas either as a class, small group or individually. A mind map is often associated with brainstorming and is useful for drawing connections between ideas and concepts, assisting in the further research of a topic.
Photographs and pictures	Photographs and pictures are visual texts. They can be used to develop numerous skills, eg observing, classifying, grouping, comparing and contrasting. Photographs allow for reinvestigation of first-hand experiences at a later date. They also clarify and stimulate further inquiry. Students can take/use photographs as a means of gathering and recording information. Computer technology enables photographs to be stored and reproduced in various ways.
Presentations	Presentations are used to share information obtained through individual and group research and study. Presentations can be spoken, written or multimedia. They give students experience in organising, planning and presenting information and material to a particular audience and are therefore valuable experiences for both the presenter and the audience.

Problem solving	A particularly relevant teaching and learning strategy for agricultural topics is problem solving. Students can be involved in identifying and working towards solutions to problems. The classroom, school garden, community and home all contain problems which are appropriate starting points for investigation by students. The purpose of learning through the application of problem solving skills is to link conceptual understandings with practical experiences. It is important that students be given opportunities according to their learning stages and levels of maturity, to apply problem solving techniques to a range of issues. The teacher's role is to: • assist students identify problems that are relevant and solvable • organise learning that develops skills in problem solving • choose learning activities which encourage responsible actions The following sequence is one approach to developing problem-solving skills which can easily be adapted for all ages and curriculum areas. In general, students respond best to those problems they identify themselves and those which are close at hand.

Steps in the problem solving process	**Teaching / learning strategies**	***Example*** Looking at the relationship between soil and plants.
Identify and define a problem that is realistic, relevant and solvable	Conduct surveys, field investigations, observations, discussions, brainstorming, and searches to understand problem areas	*What crop should I grow for my project?*
Find out about the problem	Investigate the relationships between soil and plants by: • Observing, recording, classifying data • Listing or illustrating known information • Measuring, surveying and recording aspects of the problem • Identifying effects of the problem • Expressing feelings about the problem	*What crops are currently being grown in the area? What problems are there with these crops?*
Identify alternative solutions to the problem	List proposals from those who may have had similar experiences in the past Research the library etc for suggestions on possible solutions	*Do we stay with the tried and proven crops? Do we try new and different crops? Do we experiment with changing the soil? Are there other alternatives?*
Evaluate alternative solutions to the problem	Construct alternatives and consequences chart Investigate costs and benefits of alternatives Debate and discuss merits of possible solutions Decide on the most desirable course of action	*How and when could the alternative crop be grown? What should they learn? What is the most effective and quick way to check out the alternatives?*
Develop a plan of action	Construct plans, flow charts, diagrams, time lines Allocate roles and responsibilities. Invite comments and review of plans	*Organise students to obtain necessary ingredients to develop their crops.*
Implement the plan of action	Record before and after data Monitor the implementation using checklists, keeping diaries	*Plant and monitor the selected crop(s).*
Evaluate the implementation	Check accuracy and adequacy of information Compare before and after situations Decide if further action is necessary	*After period of time observe the crops and Identify any changes. What has been learnt?*

Questionnaires	A questionnaire is a set of questions aimed at getting the opinions of a number of people on a particular topic or issue. It can be left for people to fill out, or the questions may be asked directly in an interview situation. A questionnaire is really only useful if a large number of people take part.
Reflective learning	Reflection is the act of thinking about what has been learnt. Teachers need to provide time both during and at the end of the projects for students to think about the content and processes in which they have engaged and how they could be done differently or better. As a result of reflective learning students should make changes and improvements to their plans and processes for the next project.
Research	One of the best ways to learn about any subject is to think of the questions you want answered or what you want to know and inquire about the things which interest you. This means doing your own research to find the answers. The same applies to your students. There are a number of steps involved in doing research and the best results are achieved if students do things in the right order and ask the following questions. *Defining* • What do I want to find out? • What is my purpose? • What are the key words and ideas of this task? • What do I need to do it? *Locating* • Where can I find the information I need • What do I already know? • What do I still need to find out? *Selecting* • What information do I really need? • What can I leave out? • How relevant is the information I have found? • How reliable is the information I have found? • How will I record all the information? *Organising* • How can I best use this information? • Do I need to use all the information? • How can I best combine information from different sources? *Presenting* • How can I present this information? • With whom will I share this information? • How does the audience affect my presentation? *Assessing* • What did I learn from all this? • Did I achieve what I set out to achieve? • How did I go with each step of the information process? • How did I go with presenting my information? • Where do I go from here?
Tables and graphs	Graphs are used to show how an item or items of information change over a given time. A table is useful for organising information.

Task cards	Task cards are teacher-defined activities or pieces of research work, presented in a written form and assigned to individual students or groups. They are a method of directing student learning. Teachers can devise task cards to direct activities on an aspect of a topic.
Using the internet for investigations	The Internet encompasses a number of facilities including the World Wide Web, electronic mail (e-mail), newsgroups and mailing lists. It is both a useful source of information on many topics and a means of communicating with people in other places and to work co-operatively with students in other schools. Specific skills are required to access information on the Internet and more importantly to critically evaluate and validate such information.
Values education	No educational activity is value free. You have a responsibility to impart to your students' Papua New Guinea values, and moral, ethical and educational values, such as: • respect • fairness • concern for the welfare of others • respect for diversity • justice • responsibility • honesty and integrity • ecological sustainability. The word 'values' can have different meanings for different people but basically our Papua New Guinea values are the principles or ideals that guide our decisions and actions. We express our values in the way we think and act. Our values have developed as a result of all the influences which have affected us and guide our behaviour.
Values reinforcement	Values reinforcement involves the class teacher in emphasising specific values within the class and school context. Such values should be consistently reinforced within the total school community. The process of values reinforcement can assist students to: • acquire a set of standards for developing personal values • understand and live by desirable community standards • become more effective learners • become more effective citizens.

Appendices

Appendix 1: Sample Test for Unit 10.2

What is being tested?

Student's ability to:

- show evidence of understanding of systems
- relate the single system to the big picture of agriculture
- identify the underlying principles of systems including sustainability.

Assessment criteria

Assessment task two will be assessed on the extent to which students can:

- demonstrate an understanding of a range of agricultural systems
- use a single system as an example relating to the big picture of agriculture
- demonstrate an understanding of the principles of agricultural systems
- logically analyse a system
- communicate information clearly and succinctly.

10.2 Performance standards for test Total marks – 60			
Very High Achievement	**High Achievement**	**Satisfactory Achievement**	**Low achievement**
54–60	42–53	30–41	0–29

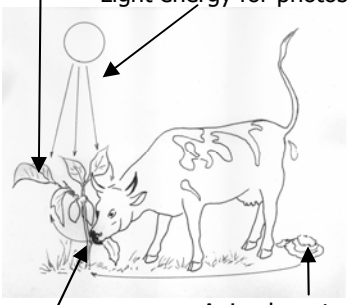
Part A: True or False		
Question	**Mark**	**Marking scheme / comments**
Read the following statements. Circle T for true and F for false		
1. Agriculture production systems are made of a series of interrelated and interdependent systems. T/F 2. Three examples of agricultural systems are plant cultivation, animal husbandry and control of pests and diseases. T/F 3. Interdependent in agriculture production means when one system depends entirely on others for its survival. T/F 4. Agriculture bio systems mean use of other living organisms to enhance agricultural production. T/F	**4**	1. T 2. T 3. F 4. T

Multiple choice. Circle the right answer or answers		
1. Pasture plants are grown for: A. human consumption B. grazing farm animals C. soil improvement D. green manures	**2**	Two marks– B, C and D should be circled. One and a half– circle two of B, C or D One mark– circle one of B, C or D If students circle A, they get zero marks
Circle the best answer (A, B, C or D) for each question) 1. The food chain is a succession of: A. organisms in natural environments that makes up a continuum of food energy preying from the lower member to a higher member B. only micro-organism in an ecological community that makes up a continuum of food energy preying from the lower member to a higher member C. only macro organisms in an ecological community that makes up a continuum of food energy preying from the lower member to a higher member D. physical factors in an ecological community that makes up a continuum of food energy preying from the lower member to a higher member	**1** each total **8**	1. answer is A
2. Habitat is the place where: A. the ecosystem meets the need of the animal for survival and growth B. habits are formed by the organisms for their survival and growth C. only large organisms meet for their survival and growth D. celestial objects rotate in space to produce harmony in the universe		2. answer is A
3. Crop cultivation is an agricultural system that involves the growing of: A. plants in natural environments B. aqueous cultivated plants only C. agriculture and horticulture related plants D. only the terrestrial plants		3. answer is C
4. Plant production is the basis of all agriculture because: A. only people use plant products B. plants store energy which is used by animals, humans and decomposers C. farm animals use chemically stored energy in their bodies D. all aqueous and marine organisms depend entirely on the stored energy produced by the plants		4. answer is B
5. Plant cultivation becomes much more efficient when: A. only manures are used B. only manufactured fertilisers are used C. organic and chemical fertilisers are used D. organic manures, legumes plants and fertilisers are used		5. answer is D

6. Examples of cereal plants are A. millet, rice, cane and oats B. wheat, sorghum, corn and rice C. corn, soybeans, beets and wheat D. wheat, rye, barley, and peas		6. answer is B
7. One of the major threats to the animal industry in agriculture in PNG is: A. steep land B. lack of vets C. diseases and pests D. diseases, pests and theft of animals		7. answer is D
8. Select the factors that determines quality of animal products A. characters, hereditary and genes B. genes, environment and management C. environment, husbandry, and management D. nutrients, water and food		8. answer is B
Short –answer and extended response questions		
1. Globalisation has an impact on PNG agriculture. Briefly describe: i. an example of an economic impact ii. an example of an environmental impact.	**4**	Good answers will include: i) fluctuation of world market prices dictate the prices of our export commodities which affects our national economy as well (2 marks) ii) deforestations due to large scale logging which cause increase in carbon dioxide level therefore destroy ozone layer and so affect climates of the world consequently affects agriculture (2 marks) Other examples of environmental impacts must be given full marks, eg global warming, El Nino, drought, etc. Answers are related to above but not complete, give one mark for half correct answers
Use a flow chart to show an example of an agriculture system	**8**	Good flow chart will include: <u>An example of Agriculture system</u> Climate ↑↓ Land ↑↓ Soil ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ Plants Animals Pests Diseases Micro-organisms Total: 8 marks If some systems are not included, give them marks according to the number of systems student indicated in their flow charts. Total: 8 marks

Give three example of problems caused to agriculture systems by introduced species	**6**	Good answers will include: i) introduced species are susceptible to environmental and biological factors (2) ii) introduced species provides competition to local species (2) iii) introduced species requiring mono system rather than integrated or mixed system approach (2) There are others you might like to include as part of the correct answers. Use them and give 2 marks for the complete answers students give. Total: 6 marks
Select and discuss management aspects of either agricultural plants or soil or pests or diseases and suggest sustainability	**8**	Good answers will include: Plants management aspects: (Consider likely responses below and give marks appropriately) • seeds and planting materials must be kept in safe places, away from pests, diseases, theft or extreme temperatures (2) • when seeding or propagating young plants, seedbeds or planting fields must have soil properly mixed with adequate organic matter application. Check that there is enough moisture in the soil and the temperature is warm for optimal germination and growth (2) • follow required planting distances between rows and between plants in order to avoid competition (2) • regular pruning of excessive vegetative growth and construct wind breaks or provide propping for support where necessary (2) • regularly control diseases and pests (2) • regularly remove weeds and add a lot of mulch (2) • select best yielding varieties with optimal resistance to internal and external destructive factors (2) Soil management aspects: • avoid working the soil during very dry and windy, and very wet conditions by following proper tillage management practices(2) • always add organic matter to arable land and keep excessive weed growth in control so that it doesn't rob the nutrients from plants(2) • if the soil is very wet, provide adequate drainage: if the soil is dry and landscape is hilly, provide appropriate contouring (2) • keep the soil moist by controlled application of water and allow essential soil nutrients to be added and retained in the soil (2) • avoid too much application of commercial fertilisers especially ammonium sulphate. If the soil is acidic , add lime to neutralise

		the soil (2) Pest management aspects: • use cultural controlling methods such as removing with your hands, burning plant parts that harbour pests, wrapping the bunches of fruits from insects, bats or birds, making fences to keep animals and thieves away, etc (2) • flow biological control method such as introducing ants, lady birds, preying mantis, wasps etc to control plant pests, use herbal sprays etc (2) • for animal pests, keep the animals clean, lay rat traps or poisons, use chemicals or herbal sprays to keep lice and fleas; wash animals using strong hose to remove some fleas etc (2) • use pest resistance crop varieties or animal breeds. Disease management aspects: • use cultural control methods such as removing diseased parts and burying or burning them, wrapping the bunches of fruits to avoid disease attack, etc (2) • fumigate the soil prior to seeding or planting of nursery plants with steam or chemicals to kill disease microbes (2) • use disease resistance plant varieties and animal breeds (2) • spray plants and animals with chemicals meant for controlling specific diseases. Chemicals are expensive. They should be the last resort after other methods have failed (2) Note: There are others that you know of which you have taught your students and if students answer others that are correct as far as above management aspects are concern, award them marks using your professional judgment. Total: 8 marks
Explain in detail how technology helps an agricultural enterprise to be profitable and sustainable.	**10**	Good answers will include: Farm tools and equipment are the product of technology without which the farm's physical plants and organised soil preparation will not be possible. Similarly there is equipment produced through technology which is used to make organic compounds for controlling of pests and diseases There are seeds and plant parts produced scientifically using technology, therefore fast, marketable plant and animal products are obtained in shortest possible time after growing or raising them. For example, maturity of animal or plant products within 6 weeks instead of 12 weeks, high yield coconuts, cocoa, cassava, yams, kau-kau and so on. Through technology chemicals are produced to control pests and diseases as well as fertilisers and animal feeds and hormones so that the crops and

		animals can grow fast and healthy appropriate to the needs of the consumers. Fortunately because of technology, computers, telephones, fax machines and other office equipment are made available for farmers' use which can help them run their business more efficiently. Similarly modern transport allows farmers to dispatch produce quickly to where the consumers need it. Note: There are others that you know of which you have taught your students and if students answer others that are correct as far as above management aspects are concern, award them marks using your professional judgment. Total: 10 marks
Explain giving examples and using diagrams, how two different agriculture systems are interdependent.	**10**	Good answers will include: Oxygen needed by an animal for respiration (2mks) Light energy for photosynthesis (2mks)  Animal wastes as organic nutrient for plant growth (2mks) Carbon dioxide needed by the plant for photosynthesis (2mks) Give 2 marks for neat drawing Total: 10 marks

Appendix 2A: Sample detailed program for Grade 9, Term 1 and 2

Week	Sub-topic/s	Activities	Assessment
1– 2	**Core 9.1** Papua New Guinea farming systems and the role of agriculture in the local economy **Option 9.3 or 9.4** Introduction to the option	**Core 9.1** Use PNG map to show where historical farm sites and give brief descriptions of their farming activities List types of farming systems in PNG Describe the role of agriculture in local economy in which a particular school is located and relate this to how it contributes to the national economy. **Option 9.3 or 9.4 or any other option** Begin to plan the project. Outline the steps in deciding on a project and how to implement it	**Core 9.1** Students gradually compile a record of their experiments using a practical book **Option** Students record their planning processes for their portfolio
3 – 4	**Core 9.1** Government policy– steps in food security programs and effects of HIV/AIDS on food production Roles of integrated agriculture systems in PNG economy **Option 9.3 or 9.4** Students select projects and develop a project plan and set goals.	**Core 9.1** Use official documents to discuss PNG Government policy on food security Research data on the impact of HIV/AIDS on the PNG economy and discuss in class. Students identify examples of integrated agricultural systems and discuss and analyse the key features. **Option 9.3 or 9.4 or any other option** Introduce the steps in planning a project and help students decide on their project Students do simple research to make sure the project is suitable for local conditions eg physical, financial, supply and demand and marketing aspects. Use that research to set realistic goals and timelines	**Option 9.3 or 9.4 or any other option** Results of research included in portfolio
5 – 6	**Core 9.1** Impacts of science and technology on agriculture in PNG. **Option 9.3 or 9.4** Students continuing research and begin preparing sites or facilities for their projects	**Core 9.1** Look at specific examples of where science and/or technology have caused a change in agricultural practices in PNG. Discuss and evaluate why these changes have occurred **Option 9.3 or 9.4 or any other option** Students research impact of any new knowledge on their chosen project. Students reflect on their work and to record their learning. Practical activities such as preparing soil, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg. housing for animals)	**Option** Results of research included in portfolio Plans for project included in portfolio

Week	Sub-topic/s	Activities	Assessment
7 – 8	**Core 9.1** Introduction to Soil Science and its importance Collect soil samples and begin testing soils **Option 9.3 or 9.4 or any other option** Students begin to implement their projects	**Core 9.1** Teacher demonstrates various soil types and testing techniques. Students collect various soil samples and use basic testing techniques to analyse the samples collected. **Option 9.3 or 9.4 or any other option** Continue practical activities such as preparing soil, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg. housing for animals)	**Option 9.3 or 9.4 or any other option** Notes on progress of project included in portfolio
9 – 10	**Core 9.1** Students learn soil management theories and techniques. **Option 9.3 or 9.4** Project management continues including record keeping, problem solving and journal maintenance.	**Core 9.1** Students use basic soil testing equipment and techniques to address such issues as understanding soil chemistry, pH testing, identification of key elements and their concentration. **Option 9.3 or 9.4 or any other option** Activities such as weeding and watering of plants, or feeding and watering livestock, monitoring for threats, recording growth rates and maintaining records.	**Option 9.3 or 9.4** Teachers should regularly assess the students' progress and give them feedback. Notes from teacher can be included in portfolio
11–12	**Core 9.1** Continue soil management theories and techniques. **Option 9.3 or 9.4** Continue the project including record keeping, problem solving and journal maintenance.	**Core 9.1** Continue using basic soil testing equipment and techniques to address such issues as understanding soil chemistry, pH testing, identification of key elements and their concentration. **Option 9.3 or 9.4 or any other option** Continue the project including such activities as weeding and watering of plants, or feeding and watering livestock, monitoring for threats, recording growth rates and maintaining records. Teachers should regularly assess the students' progress and give feedback	**Option** Continuous assessment of the portfolio. Teachers should regularly assess the students' progress and give feedback
13–14	**Core 9.1** Revision of basic plant anatomy, introduction to plant classification and factors affecting plant growth **Option 9.3 or 9.4** Continue the project including record keeping, problem solving and journal maintenance.	**Core 9.1** Students collect samples of various plants, observe, dissect and identify various plant parts, draw and label. **Option 9.3 or 9.4 or any other option** Continue activities such as weeding and watering of plants, or feeding and watering livestock, monitoring for threats, recording growth rates and maintaining records.	**Core 9.1** Needs elaboration: You give direction as to the kind of plants students should collect and parts of the plants to identify. **Option** You should regularly assess the students' progress and give feedback

Week	Sub-topic/s	Activities	Assessment
15–16	**Core** Students plan and implement simple experiments on seed dormancy and germination **Option 9.3 or 9.4** Continue the project including record keeping, problem solving and journal maintenance.	**Core** Experiment Students could collect various seeds and set up experiments using different germination methods, such use of cotton wool, damp paper, water (various forms), various soils and set up appropriate record keeping systems. **Option 9.3 or 9.4 or any other option** Continue the project including such activities as weeding and watering of plants, or feeding and watering livestock, monitoring for threats, recording growth rates and maintaining records.	**Core** Continuous assessment of the experiments written up and recorded in the practical book **Option** You should regularly assess the students' progress and give feedback
17–18	**Core 9.1** Students learn about photosynthesis and plant respiration and design simple experiments to demonstrate these principles. **Option 9.3 or 9.4** Begin to complete the project and start to prepare the evaluation report.	**Core 9.1** Students undertake experiments to demonstrate relationship between photosynthesis and light. **Option 9.3 or 9.4 or any other option** Students undertake such activities as harvesting and processing and marketing the products, assessing the viability of the project and producing a report.	**Core** Continuous assessment of the experiments written up and recorded in the practical book **Option** Regularly assessment and feedback on students' progress.
19–20	**Core 9.1** Experiments Test **Option 9.3or 9.4 or 9.6** Project completion	**Core 9.1** Students conduct experiments and write them up **Option 9.3or 9.4 or any other option** Complete the project and the portfolio	**Core 9.1** Summative short answer test.

Appendix 2B: Sample detailed program for Grade 9 Term 3 and 4

Week	Sub-topic/s	Activities	Assessment
1– 2	**Core 9.2** Effects of PNG agricultural activities on local ecological environment. Benefits of agricultural activities to the local, economy. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Introduction to the chosen option	**Core 9.2** Brainstorm various agricultural production systems in use in the local area and map where they are used. Look at differences between places Discuss why these differences exists Speculate on what changes might happen and their impact locally. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Begin to plan the project. Outline the steps in deciding on a project and how to implement it	**Core 9.2** Students given the assignment topic **Option** Students record their planning processes for their portfolio
3 – 4	**Core 9.2** Effects of PNG agricultural activities on the provincial ecological environment. Benefits of agricultural activities to provincial economy. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Students select projects and develop a project plan and set goals.	**Core 9.2** Brainstorm various agricultural production systems in use in your province and map where they are used. Look at differences between areas in the province Discuss why these differences exists Speculate on what changes might happen and their impact locally and provincially. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Introduce the steps in planning a project and help students decide on their project Students do simple research to make sure the project is suitable for local conditions eg physical, financial, supply and demand and marketing aspects. Use that research to set realistic goals and timelines.	**Option** Results of research included in portfolio
5 – 6	**Core 9.2** Effects of PNG agricultural activities on the national ecological environment Benefits of agricultural activities to the national economy. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Students continuing research and begin preparing equipment or facilities for their projects	**Core 9.2** Brainstorm main agricultural production systems in use in PNG and map where they are used. Look at differences between provinces Discuss why these differences exists Speculate on what changes might happen and their impact locally, provincially and nationally. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Students look at the impact of any new knowledge on their chosen project. Students to be taught how to reflect on their work and to record their learning. Practical activities such as preparing sites, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg housing for animals).	**Option** Results of research included in portfolio Plans for project included in portfolio

Week	Sub-topic/s	Activities	Assessment
7 – 8	**Core 9.2** Study of animal growth looking at stages of development maturity **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Students begin to implement their projects	**Core 9.2** You select an animal and work on the stages of growth relevant to that animal Students learn key stages relevant to animal growth and production **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Continue practical activities such as preparing sites, purchasing necessary supplies, constructing or providing any necessary infrastructure (eg housing for animals).	**Option** Notes on progress of project included in portfolio
9 – 10	**Core 9.2** Continue study of animal growth looking at fertilisation and reproduction, and anatomical features **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Project management continues including record keeping, problem solving and journal maintenance.	**Core 9.2** Fertilisation and reproduction of the chosen animal Anatomical features of the chosen animal **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Activities such as providing food and water for the stock, monitoring for threats, recording growth rates and maintaining records.	**Option** Regularly assess the students' progress and give feedback. Notes from teacher can be included in portfolio
11–12	**Core 9.2** Introduction to theory of physical and financial planning of a production enterprise **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Continue the project including record keeping, problem solving and journal maintenance.	**Core 9.2** Students research a particular animal production system in PNG **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Continue activities as providing food and water for the livestock, monitoring for threats, recording growth rates and maintaining records. Teachers should regularly assess the students' progress and give them feedback	**Option** Continuous assessment of the portfolio. Teachers should regularly assess the students' progress and give feedback
13–14	**Core 9.2** Continue theory of physical and financial planning of a production enterprise Construction of the shelter or buildings Management aspects Harvesting procedures **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Continue the project including record keeping, problem solving and journal maintenance.	**Core 9.2** Continue research of a particular animal production system in PNG for the assignment looking at aspects of management and procedures involved in obtaining animal products. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Regular monitoring of the project including such activities as providing food and water for the livestock, monitoring for threats, recording growth rates and maintaining records. Teachers should regularly assess the students' progress and give them feedback.	**Option** Regularly assess the students' progress and give feedback

Week	Sub-topic/s	Activities	Assessment
15–16	**Core 9.2** Continue theory of physical and financial planning aspects of a production enterprise Packaging of products Marketing of animal products **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Including record keeping, problem solving and journal maintenance and begin to prepare for the harvesting of their product.	**Core 9.2** Continue research of a particular animal production system in PNG for the assignment looking at aspects of packaging and marketing. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Regular monitoring of the project including such activities as providing food and water for the livestock, monitoring for threats, recording growth rates and maintaining records. Students should now be monitoring growth with a view to optimum time for harvesting.	**Core** Students continue work on the assignment **Option** Regularly assess the students' progress and give feedback
17–18	**Core 9.2** Students learn how to design and implement an evaluation process. **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Begin to complete the project and start to prepare the evaluation report.	**Core 9.2** Students learn key elements of an evaluation process and begin designing an evaluation for their project. They combine the core learning with the evaluation of their project **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Students undertake such activities as harvesting and processing and marketing the products, assessing the viability of the project and producing a report.	**Core 9.2** Students hand in assignment **Option** Regularly assess the students' progress and give feedback.
19–20	**Core 9.2** Completion of assignment test **Option** 9.5 or 9.7 or 9.8 or 9.9 Complete the project harvest and market the product complete the evaluation report Complete the portfolio	**Core 9.2** Students complete evaluation reports for portfolio Teacher sets test **Option** 9.5 or 9.6 or 9.7 or 9.8 or 9.9 Students complete project Students finalise portfolio for assessment	**Core 9.2** Summative short answer test

Appendix 3: Physiology and anatomy of common animals

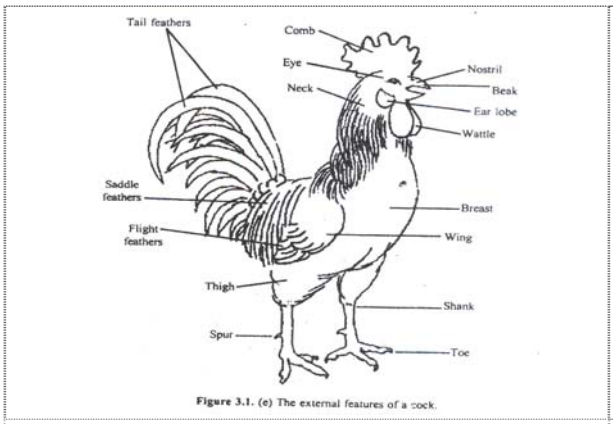


Figure 3.1. (e) The external features of a cock.

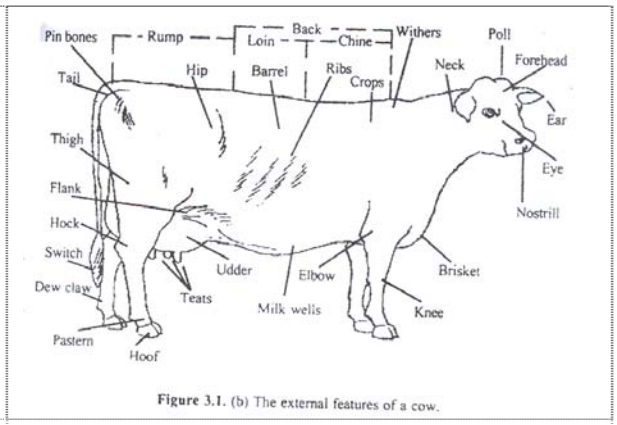


Figure 3.1. (b) The external features of a cow.

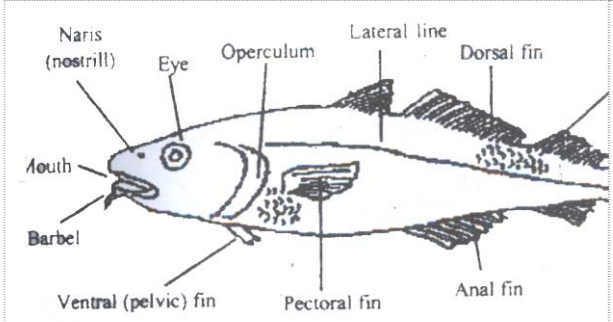


Figure 3.1. (g) The external feature of a bony fish.

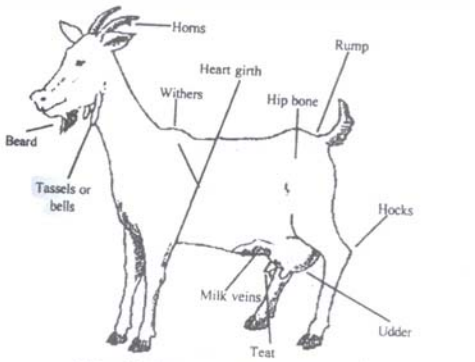
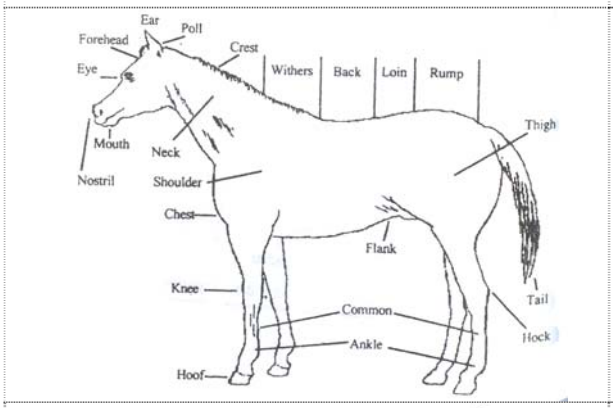


Figure 3.1. (f) The external features of a goat.



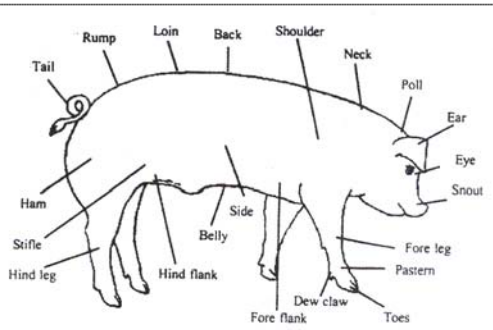


Figure 3.1. (d) The external features of a pig.