# Agriculture

## Senior High

## Grade 11

## Teacher Guide

Standards-Based

Papua New Guinea

Department of Education

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### Grade 11

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Papua New Guinea
Department of Education

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# Contents

# Acknowledgements

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The Curriculum Panel (CP), Subject Advisory Committee (SAC) and Board of Studies (BOS) are acknowledged for their recommendations and endorsement of this Teacher Guide.

# Acronyms

| | |
|---|---|
| **AAL** | Assessment AS Learning |
| **AFL** | Assessment FOR Learning |
| **AOL** | Assessment OF Learning |
| **BoS** | Board of Studies |
| **CDD** | Curriculum Development Division |
| **CP** | Curriculum Panel |
| **DA** | Diagnostic Assessment |
| **IHD** | Integral Human Development |
| **GoPNG** | Government of PNG |
| **OBC** | Outcomes-Based Curriculum |
| **OBE** | Outcomes-Based Education |
| **PNG** | Papua New Guinea |
| **SAC** | Subject Advisory Committee |
| **SBC** | Standards-Based Curriculum |
| **SBE** | Standards-Based Education |
| **SCG** | Subject Curriculum Group |
| **STEAM** | Science, Technology, Engineering, Arts and Mathematics |

# Secretary's Message

The ultimate aim of Standards-Based Education in Papua New Guinea (PNG) is to prepare students for careers, higher education, and citizenship. Agriculture will therefore focus on providing students with careers, higher education, and citizenship preparedness knowledge, skills, values and attitudes that they can use work, study and live in the 21st century.

The review of the Agriculture content will provide learners with a range of competencies important in the world of work and in a knowledge based society. It is envisioned that the realignment and new inclusions of the subject content will develop in students the scientific knowledge, skills, attitudes and values of the 21st Century. The knowledge, skills, values and attitudes learnt will equip them to be scientifically, technologically and environmentally literate and productive members of society who will be critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers and effective communicators of this resourceful nation.

Thus, students will be able to learn and make informed decisions, problem solving and management knowledge, skills, values and attitudes in Agriculture. This will enable them to function effectively in the work and higher education environments as productive and useful citizens of a culturally diverse and democratic society in an independent society.

Teachers are encouraged to use the Teachers Guides in conjunction with the Syllabus and other relevant resources to generate creative teaching and learning activities to deliver the Agriculture content. Ensure that safety measures are taken at all times to avoid injuries.

I commend and approve this Agriculture Teachers Guide for Grade 11 to be used in all Senior High/Secondary Schools throughout Papua New Guinea..

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**UKE W. KOMBRA, PhD, OBE**
Secretary for Education

# Introduction

PNG shapes and is being shaped by the 21st Century social, economic, political, cultural, religious, and environmental discourses and practices. It is important to provide opportunities for students to learn in-depth and master the 21st century knowledge, skills, values, and attitudes to prepare them for careers, higher education, and citizenship. There is an increasing demand for knowledge-based workers and workers with qualifications in STEAM globally. PNG children should be equipped with the necessary 21st century and STEAM knowledge, skills, values, and attitudes to ensure that they are marketable globally and can contribute meaningfully to the development of PNG.

Agriculture activity is a feature of everyone's life. Throughout the world people engage in a web of agricultural activities to cultivate, raise, produce, market, deliver and support a range of goods and services. In addition, investors, consumers and employees depend on the agriculture sector for much of their quality of life. The teaching of Agriculture as part of the Standards-Based Curriculum is crucial as it encompasses the theoretical and practical aspects of crop, animal, aquaculture, natural resource management and agribusiness in contexts which students will encounter throughout their lives. Conceptually, it offers learning from the planning of a small-scale agriculture farm to the management of operations, marketing, finance and human resources in large agriculture businesses.

The teaching of Agriculture as part of the Standards Based Curriculum is crucial as it encompasses the theoretical and practical aspects of Agriculture in contexts which students will encounter throughout their lives. Conceptually, it offers learning from crop and animal farming, aqua farming, natural resource management and sustainable practices, marketing, agribusiness.

These skills enhance their confidence and ability to participate effectively, not only as members of the agriculture world, but also as citizens dealing with issues arising from farming activity. Agriculture fosters intellectual, social and moral development and in-demand proficiencies so that students can make a meaningful contribution towards improving the material and social welfare of people. Thus, creating and living sustainable and resilient livelihoods, and sustaining an acceptable quality of life through the sustainable use of natural resources and creative and innovative farming and production methods to meet people's needs.

Students' employability will be enhanced through the study and application of STEAM principles. STEAM is an integral component of the core curriculum. It is envisioned that the study of STEAM will motivate students to pursue and take up academic programs and careers in STEAM related fields. Equal opportunities should be provided for all students to learn, apply and master STEAM principles and skills when integrated into the Agriculture study.

Time allocation for Agriculture is 200 minutes per week. Teachers are urged to fully utilise the allocated time for programming and timetabling

# Structure of the Teacher Guide

There are four main parts to this teacher guide. They provide essential information on what all teachers should know and do to effectively implement the Agriculture.

***Part 1*** provides generic information to help the teachers to effectively use the teacher guide and the syllabus to plan, teach and assess students' performance and proficiency on the national content standards and grade-level benchmarks. The purpose of the teacher guide, syllabus and teacher guide alignment, and the four pillars of PNG SBC, that is, morals and values education, cognitive and high level thinking, and 21st Century thinking skills, STEAM, and core curriculum are explained to inform as well as guide the teachers so that they align SBE/SBC aims and goals, overarching and SBC principles, content standards, grade-level benchmarks, learning objectives and best practice when planning lessons, teaching, and assessing students.

***Part 2*** provides information on the strands, units, topics and learning objectives. How topics and learning objectives are derived is explained to the teachers to guide them to use the learning objectives provided for planning, instruction and assessment. And to develop additional topics and learning objectives to meet the learning needs of their students and communities where necessary.

***Part 3*** provides information on SBC planning to help guide the teachers when planning SBC lessons. Elements and standards for SBC lesson plans are described as well as how to plan for underachievers, use evidence to plan lessons, and use differentiated instruction, amongst other teaching and learning strategies.

***Part 4*** provides information on standards-based assessment, inclusive of performance assessment and standards, standards-based evaluation, standards-based reporting, and standards-based monitoring. This information should help the teachers to effectively assess, evaluate, report and monitor demonstration of significant aspects of a benchmark.

The above components are linked and closely aligned. They should be connected to ensure that the intended learning outcomes and the expected quality of education standards are achieved. The close alignment of planning, instruction and assessment is critical to the attainment of learning standards.

# Purpose of the Teacher Guide

This teacher guide describes what all teachers should know and do to effectively plan, teach, and assess Grade 11 Agriculture content to enable all students to attain the required learning and proficiency standards.

The overarching purpose of this teacher guide is to help teachers to effectively plan, teach, assess, evaluate, report and monitor students' learning and mastery of national and grade-level expectations. That is, the essential knowledge, skills, values and attitudes (KSVAs) described in the content standards and grade-level benchmarks, and their achievement of the national and grade-level proficiency standards.

Ample information with thorough guidelines is provided for the teacher to use to achieve the essential KSAV embedded in the set national content standards and grade level benchmarks.

Thus, the teacher is expected to:

- understand the significance of aligning all the elements of Standards-Based Curriculum (SBC) as the basis for achieving the expected level of education quality;
- effectively align all the components of SBC when planning, teaching, and assessing students' learning and levels of proficiency;
- effectively translate and align the Agriculture syllabi and teacher guide to plan, teach and assess different Agriculture units and topics, and the KSVAs described in the grade-level benchmarks;
- understand the Agriculture national content standards, grade-level benchmarks, and evidence outcomes;
- effectively make sense of the content (KSVAs) described in the Agriculture national content standards and the essential components of the content described in the grade-level benchmarks;
- effectively guide students to progressively learn and demonstrate proficiency on a range of Agriculture skills, processes, concepts, ideas, principles, practices, values and attitudes;
- confidently interpret, translate and use Agriculture content standards and benchmarks to determine the learning objectives and performance standards, and plan appropriately to enable all students to achieve these standards;
- embed the core curriculum in their Agriculture lesson planning, instruction, and assessment to permit all students to learn and master the core KSVAs required of all students;
- provide opportunities for all students to understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems relating to both the natural and physical (man-made) worlds as well as problems created by STEAM;
- integrate cognitive skills (critical, creative, reasoning, decision-making, and

problem-solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustaining values), and attitudes in lesson planning, instruction and assessment;

- meaningfully connect what students learn in Agriculture with what is learnt in other subjects to add value and enhance students' learning so that they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content;
- formulate effective SBC lesson plans using learning objectives identified for each of the topics;
- employ SBC assessment approaches to develop performance assessments to assess students' proficiency on a content standard or a component of the content standard described in the grade-level benchmark;
- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain students' status of progress towards meeting grade-level and nationally expected proficiency standards, and use evidence from the assessment of students' performance to develop effective evidence-based intervention strategies to help students' making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning and performance.

# How to use the Teacher Guide

Teacher Guide provides essential information about what the teacher needs to know and do to effectively plan, teach and assess students learning and proficiency on learning and performance standards. The different components of the teacher guide are closely aligned with SBC principles and practice, and all the other components of PNG SBC. It should be read in conjunction with the syllabus in order to understand what is expected of teachers and students to achieve the envisaged quality of education outcomes.

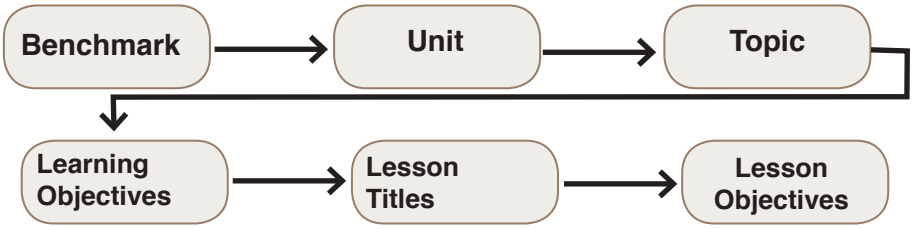
The first thing teachers should do is to read and understand each of the sections of the teacher guide to help them understand the key SBC concepts and ideas, alignment of PNG SBC components, alignment of the syllabus and teacher guide, setting of content standards and grade-level benchmarks, core curriculum, STEAM, curriculum integration, essential knowledge, skills, values and attitudes, strands, units and topics, learning objectives, SBC lesson planning, and SBC assessment. A thorough understanding of these components will help teachers meet the teacher expectations for implementing the SBC curriculum, and therefore the effective implementation of Agriculture Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to do the following:

A thorough understanding of these components will help teachers meet the teacher expectations for implementing the SBC curriculum, and therefore the effective implementation of Grade 10 Agriculture Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to do the following:

***Determine Learning Objectives and Lesson Topics***

Topics and learning objectives have been identified and described in the Teacher Guide. Learning objectives are derived from topics that are extracted from the grade-level benchmarks. Lesson topics are deduced from the learning objectives.

Teachers should familiarize themselves with this process as it is essential for lesson planning, instruction and assessment. However, depending on the context and students' learning abilities, teachers would be required to determine additional learning objectives and lesson titles. Teachers should use the examples provided in this teacher guide to formulate additional learning objectives and lesson titles to meet the educational or learning needs of their students,



### *Identify and Teach Grade Appropriate Content*

Grade appropriate content has been identified and scoped and sequenced using appropriate content organisation principles. The content is sequenced using the spiraling sequence principles. This sequencing of content will enable students to progressively learn the essential knowledge, skills, values and attitudes as they progress further into their schooling. What students learn in previous grades is reinforced and deepens in scope with an increase in the level of complexity and difficulty in the content and learning activities.

It is important to understand how the content is organised so that grade appropriate content and learning activities can be selected, if not already embedded in the benchmarks and learning objectives, to not only help students learn and master the content, but ensure that what is taught is rigorous, challenging, and comparable.

### *Integrate the Core Curriculum in Lesson Planning, Instruction and Assessment*

Teachers should use this teacher guide to help them integrate the core curriculum values, cognitive and high level skills, 21st Century skills, STEAM principles and skills, and reading, writing, and communication skills in their lesson planning, instruction and assessment. All students in all subjects are required to learn and master these skills progressively through the education system.

### *Integrate Cognitive, High Level, and 21st Century Skills in Lesson Planning, Instruction and Assessment*

Teachers should integrate the cognitive, high level and 21st century skills in their annual teaching programs, and give prominence to these skills in their lesson preparation, teaching and learning activities, performance assessment, and performance standards for measuring students' proficiency on these skills. Agriculture addresses skills, processes and competencies in the study of Crops, Animals, Aquaculture, Natural Resource Management and Agribusiness. Thus, students will be able to make informed decisions in a variety of Agriculture contexts. This enables them to function effectively in the work place and higher education environments as productive and useful citizens of a culturally diverse and democratic society in an interdependent world.

In addition, it envisaged all students attaining expected proficiency levels in these skills and will be ready to pursue careers and higher education academic programs that demand these skills, and use them in their everyday life after they leave school at the end of Grade 12. Teachers should use the teacher guide to help them to effectively embed these skills, particularly in their lesson planning and in the teaching and learning activities as well as in the assessment of students' application of the skills.

***Ingrate Agriculture values and attitudes in Lesson Planning, Instruction and Assessment***

In Agriculture, students are expected to learn, promote and use work, relationship, peace, health, social, personal, family, community, national and global values in the work and study environments as well as in their conduct as community, national and global citizens. Teachers should draw from the information and suggestions provided in the syllabus and teacher guide to integrate values and attitudes in their lesson planning, instruction, and assessment. They should report on students' progression towards internalizing different values and attitudes and provide additional support to students who are yet to reach the internalization stage to make positive progress towards this level.

***Integrate Science, Technology, Engineering, Arts and Mathematics (STEAM) Principles and Skills in Lesson Planning, Instruction and Assessment***

Teachers should draw from both the syllabus and teacher guide in order to help them integrate STEAM principles and skills, and methodologies in their lesson planning, instruction and assessment. STEAM teaching and learning happens both inside and outside of the classroom. Effective STEAM teaching and learning requires both the teacher and the student to participate as core investigators and learners, and to work in partnership and collaboration with relevant stakeholders to achieve maximum results. Teachers should use the syllabus, teacher guides and other resources to guide them to plan and implement this and other innovative and creative approaches to STEAM teaching and learning to make STEAM principles and skills learning fun and enjoyable and, at the same time, attain the intended quality of learning outcomes.

***Identify and Use Grade and Context Appropriate, Innovative, Differentiated and Creative Teaching and Learning Methodologies***

SBC is an eclectic curriculum model. It is an amalgam of strengths of different curriculum types, including behavioural objectives, outcomes, and competency. Its emphasis is on students attaining clearly defined, measurable, observable and attainable learning standards, i.e., the expected level of education quality. Proficiency (competency) standards are expressed as performance standards/criteria and evidence outcomes, that is, what all students are expected to know (content) and do (application of content in real life or related situations) to indicate that they are meeting, have met or exceeded the learning standards.

The selection of grade and contextually appropriate teaching and learning methodologies is critical to enabling all students to achieve the expected standard or quality of education. Teaching and learning methodologies must be aligned to the content, learning objective, and performance standard in order for the teacher to effectively teach and guide students towards meeting the performance standard for the lesson. They should be equitable and socially inclusive, differentiate, student-centred, and lifelong. They should enable STEAM principles and skills to be effectively taught and learned by

students. Teachers should use the teacher guide to help them make informed decisions when selecting the types of teaching and learning methodologies to use in their teaching of the subject content, including STEAM principles and skills.

### *Plan Standards-Based Lessons*

SBC lesson planning is quite difficult to do. However, this will be easier with more practice and experience over time. Effective SBC lesson plans must meet the required standards or criteria so that the learning objectives and performance standards are closely aligned to attain the expected learning outcomes. Teachers should use the guidelines and standards for SBC lesson planning and examples of SBC lesson plans provided in the teacher guide to plan their lessons. When planning lessons, it is important for teachers to ensure that all SBC lesson planning standards or criteria are met. If standards are not met, instruction will not lead to the attainment of intended performance and proficiency standards. Therefore, students will not attain the national content standards and grade-level benchmarks.

### *Use Standards-Based Assessment*

Standards-Based Assessment has a number of components. These components are intertwined and serve to measure evaluate, report, and monitor students' achievement of the national and grade-level expectations, i.e., the essential knowledge, skills, values and attitudes they are expected to master and demonstrate proficiency on. Teachers should use the information and examples on standards-based assessment to plan, assess, record, evaluate, report and monitor students' performance in relation to the learning standards.

### *Make informed Judgments About Students' Learning and Progress Towards Meeting Learning Standards*

Teachers should use the teacher-guide to effectively evaluate students' performance and use the evidence to help students to continuously improve their learning as well as their classroom practice.

It is important that teachers evaluate the performance of students in relation to the performance standards and progressively the grade-level benchmarks and content standards to make informed judgments and decisions about the quality of their work and their progress towards meeting the content standards or components of the standards. Evaluation should not focus on only one aspect of students' performance. It should aim to provide a complete picture of each student's performance. The context, inputs, processes, including teaching and learning processes, and the outcomes should be evaluated to make an informed judgment about each student's performance; Teachers should identify the causal factors for poor performance, gaps in students learning, gaps in teaching, teaching and learning resource constraints, and general attitude towards learning. Evidence-based decisions can then be made regarding the interventions for closing the gaps to allow students to make the required progress towards meeting grade-level and national expectations. based decisions can then be made regarding the interventions for closing

the gaps to allow students to make the required progress towards meeting grade-level and national expectations.

***Prepare Students' Performance Reports***

Reporting of students' performance and progress towards the attainment of learning standards is an essential part of SBC assessment. Results of students' performance should be communicated to particularly the students and their parents to keep them informed of students' academic achievements and learning challenges as well as what needs to be done to enable the students' make positive progress towards meeting the proficiency standards and achieve the desired level of education quality. Teachers should use the information on the reporting of students' assessment results and the templates provided to report the results of students' learning.

***Monitor Students' Progress Towards Meeting the National Content Standards and Grade-Level Benchmarks***

Monitoring of student's progress towards the attainment of learning standards is an essential component of standards-based assessment. It is an evidence-based process that involves the use of data from students' performance assessments to make informed judgements about students' learning and proficiency on the learning standards or their components, identify gaps in students' learning and the causal factors, set clear learning improvement targets, and develop effective evidence-based strategies (including preplanning and re-teaching of topics), set clear timeframes, and identify measures for measuring students' progress towards achieving the learning targets.
Teachers should use the teacher guide to help them use data from students' performance assessments to identify individual students' learning weaknesses and develop interventions, in collaboration with each student and his/her parents or guardians, to address the weaknesses and monitor their progress towards meeting the agreed learning goals.

***Develop additional Benchmarks***

Teachers can develop additional benchmarks using the examples in the teacher guide to meet the learning needs of their students and local communities. However, these benchmarks will not be nationally assessed as these are not comparable. They are not allowed to set their own content standards or manipulate the existing ones. The setting of national content standards is done at the national level to ensure that required learning standards are maintained and monitored to sustain the required level of education quality.

***Avoid Standardisation***

**The implementation of Agriculture curriculum must not be standardised.** SBC does not mean that the content, lesson objectives,

teaching and learning strategies, and assessment are standardised. This is a misconception and any attempt to standardise the components of curriculum without due consideration of the teaching and learning contexts, children's backgrounds and experiences, and different abilities and learning styles of children will be counterproductive. It will hinder students from achieving the expected proficiency standards and hence, high academic standards and the desired

What is provided in the syllabus and teacher guide are not fixed and can be changed. Teachers should use the information and examples provided in the syllabus and the teacher guide to guide them to develop, select, and use grade, context, and learner appropriate content, learning objectives, teaching and learning strategies, and performance assessment and standards. SBC is evidence-based hence decisions about the content, learning outcomes, teaching and learning strategies, students' performance, and learning interventions should be based on evidence. Teaching and learning should be continuously improved and effectively targeted using evidence from students' assessment and other sources.

# Syllabus and Teacher Guide Alignment

A teacher guide is a framework that describes how to translate the content standards and benchmarks (learning standards) outlined in the syllabus into units and topics, learning objectives, lesson plans, teaching and learning strategies, performance assessment, and measures for measuring students' performance (performance standards). It expands the content overview and describes how this content identified in the content standards and their components (essential KSVAs) can be translated into meaningful and evidence-based teaching topics and learning objectives for lesson planning, instruction and assessment. It also describes and provides examples of how to evaluate and report on students' attainment of the learning standards, and use evidence from the assessment of students' performance to develop evidence-based interventions to assist students who are making slow progress towards meeting the expected proficiency levels to improve their performance.

Grade 11 Agriculture comprises of the Syllabus and Teacher Guide. These two documents are closely aligned, complimentary and mutually beneficial.
They are the essential focal points for teaching and learning the essential Social Science knowledge, skills, values and attitudes.

| Syllabus and Teacher Guide Alignment | |
|---|---|
| **Syllabus** | **Teacher Guide** |
| Outlines the ultimate aim and goals, and what to teach and why teach it | Describes how to plan, teach, and assess students' performance |
| • Overarching and SBC principles<br>• Content overview<br>• Core curriculum<br>• Essential knowledge, skills, values and attitudes<br>• Strands and units<br>• Evidence outcomes<br>• Content standards and grade-level benchmarks<br>• Overview of assessment, evaluation, and Reporting | • Determine topics for lesson planning,<br>• instruction and assessment<br>• Formulate learning objectives<br>• Plan SBC lesson plans<br>• Select teaching and learning strategies<br>• Implement SBC assessment and<br>• evaluation<br>• Implement SBC reporting and monitoring |

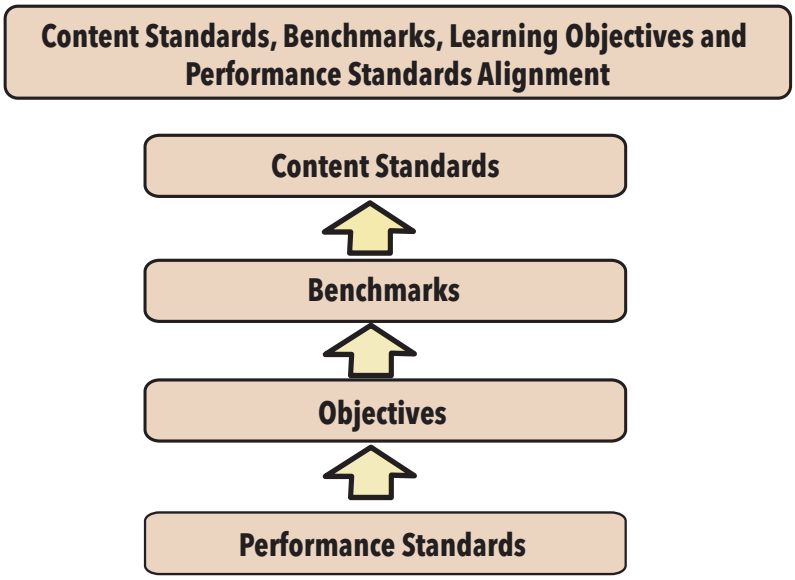
The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what is outlined in the syllabus by describing the approaches or the how of planning, teaching, learning, and assessing the content so that the intended learning outcomes are achieved.

This teacher guide should be used in conjunction with the syllabus. Teachers should use these documents when planning, teaching and assessing Grade 12 Agriculture content.

Teachers will extract information from the syllabus (e.g., content standards and grade-level benchmarks) for lesson planning, instruction and is for measuring students' attainment a content standard as well as progress to the next grade of schooling.

## Learning and Performance Standards Alignment

Content Standards, Benchmarks, Learning Objectives, and Performance Standards are very closely linked and aligned (see figure 3). There is a close linear relationship between these standards. Students' performance on a significant aspect of a benchmark (KSVA) is measured against a set of performance standards or criteria to determine their level of proficiency using performance assessment. Using the evidence from the performance assessment, individual student's proficiency on the aspect of the benchmark assessed and progression towards meeting the benchmark and hence the content standard are then determined.




Effective alignment of these learning standards and all the other components of PNG SBE and SBC (ultimate aim and goals, overarching, SBC and subject-based principles, core curriculum, STEAM, and cognitive, high level, and 21st Century skills) is not only critical but is also key to the achievement of high academic standards by all students and the intended level of education quality. It is essential that teachers know and can do standards alignment when planning, teaching, and assessing students' performance so that they can effectively guide their students towards meeting the grade-level benchmarks (grade expectations) and subsequently the content standards (national expectations).

# Learning and Performance Standards

Standards-Based Education (SBE) are underpinned by the notion of quality. Standards define the expected level of education quality that all students should achieve at a particular point in their schooling. Students' progression and achievement of education standard (s) are measured using performance standards or criteria to determine their demonstration or performance on significant aspects of the standards to determined their levels of proficiency or competency. When they are judged to have attained proficiency on a content standard or benchmark or components of these standards, they are then deemed to have met the standard(s) that is, achieved the intend level of education quality.

Content standards, benchmarks, and learning objectives are called learning standards while performance and proficiency standards (evidence outcomes) can be categorised as performance standards. These standards are used to measure students' performance, proficiency, progression and achievement of the desired level of education quality. Teachers are expected to understand and use these standards for lesson planning, instruction and assessment

***Content Standards***

Content standards are evidence-based, rigorous and comparable regionally and globally. They have been formulated to target critical social, economic, political, cultural, environment, and employable skills gaps identified from a situational analysis. They were developed using examples and experiences from other countries and best practice, and contextualised to PNG contexts.

Content standards describe what **(content-knowledge,skills,values, and attitudes)** all students are expected to know and do **(how well students must learn and apply what is set out in the content standards)** at each grade-level before proceeding to the next grade.

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the national level;
- state or describe the expected levels of quality or achievement;
- are clear, measurable and attainable;
- are linked to and aligned with the ultimate aim and goals of SBE and SBC and overarching and SBC principles;
- delineate what matters, provide clear expectations of what students should progressively learn and achieve in school, and guide lesson planning, instruction, assessment;
- comprise knowledge, skills, values, and attitudes that are the basis for quality education;
- provide teachers a clear basis for planning, teaching, and assessing lessons;
- provide provinces, districts, and schools with a clear focus on how to develop and organise their instruction and assessment programs as well as the content that they will include in their curriculum.

### *Benchmarks*

Benchmarks are derived from the content standards and benchmarked at the grade-level. Benchmarks are specific statements of what students should know (i.e., essential knowledge, skills, values or attitudes) at a specific grade-level or school level. They provide the basis for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

*Grade-level benchmarks:*

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the grade level;
- are linked to the national content standards;
- are clear, measurable, observable and attainable;
- articulate grade level expectations of what students are able to demonstrate to indicate that they are making progress towards attaining the national content standards;
- provide teachers a clear basis for planning, teaching, and assessing lessons;
- state clearly what students should do with what they have learned at the end of each school-level;
- enable students' progress towards the attainment of national content standards to be measured, and
- enable PNG students' performance to be compared with the performance of students in other countries.

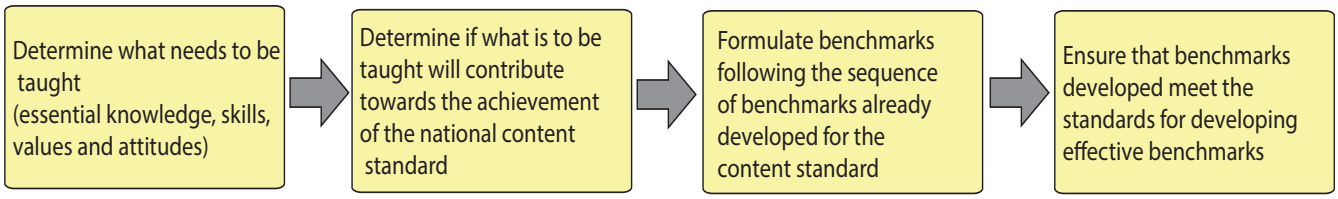
**Approach for Setting National Content Standards and Grade - Level Benchmarks**


### *Development of Additional Benchmarks*

Teachers should develop additional benchmarks to meet the learning needs of their students. They should engage their students to learn about local, provincial, national and global issues that have not been catered for in the grade-level benchmarks but are important and can enhance students' understanding and application of the content.

However, it is important to note that these benchmarks will not be nationally examined as they are not comparable. Only the benchmarks developed at the national level will be tested. This does not mean that teachers should not develop additional benchmarks. An innovative, reflect, creative and reflexive teacher will continuously reflect on his/her classroom practice and use evidence to provide challenging, relevant, and enjoyable learning opportunities for his/her students to build on the national expectations for students. Teachers should follow the following process when developing additional grade-level benchmark

**Benchmark Development Process**




### *Learning Objectives*

*Learning or Instructional Objectives* are precise statements of educational intent. They are formulated using a significant aspect or a topic derived from the benchmark, and is aligned with the educational goals, content standards, benchmarks, and performance standards. Learning objectives are stated in outcomes language that describes the products or behaviours that will be provided by students. They are stated in terms of measurable and observable student behaviour. *For example,* students will be able to identify all the main towns of PNG using a map.

### *Performance Standards*

Performance Standards are concrete statements of how well students must learn what is set out in the content standards, often called the ***"be able to do"*** of "what students should know and be able to do." Performance standards are the indicators of quality that specify how competent a students' demonstration or performance must be. They are explicit definitions of what students must do to demonstrate proficiency or competency at a specific level on the content standards.

Performance standards:

- measure students' performance and proficiency (using performance indicators) in the use of a specific knowledge, skill, value, or attitude in real life or related situations
- provide the basis (performance indicators) for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude
- are used to plan for individual instruction to help students not yet meeting expectations (desired level of mastery and proficiency) to make adequate progress towards the full attainment of benchmarks and content standards
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards

### *Proficiency Standards*

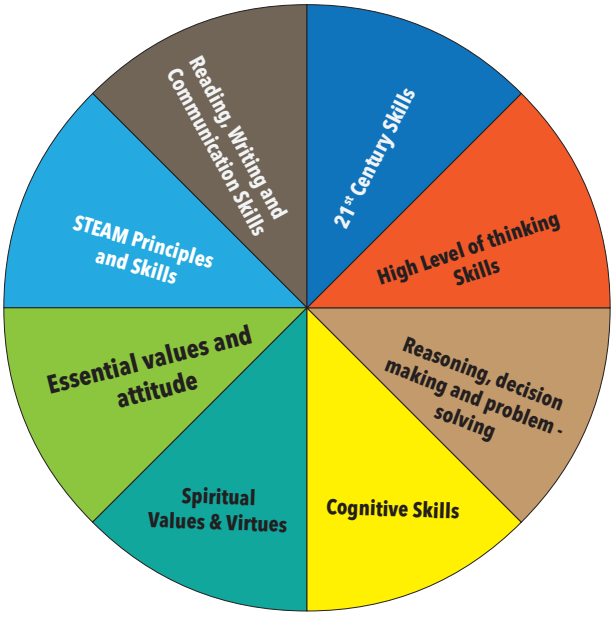
Proficiency standards describe what all students in a particular grade or school level can do" at the end of a strand, or unit. These standards are sometimes called evidence outcomes because they indicate if students can actually apply or use what they have learnt in real life or similar situations. They are also categorized as benchmarks because that is what all students are expected to do before exiting a grade or are deemed ready for the next grade.

# Core Curriculum

A core set of common learnings (knowledge, skills, values, and attitudes) are integrated into the content standards and grade-level benchmarks for all subjects. This is to equip all students with the most essential and in-demand knowledge, skills, and dispositions they will need to be successful in modern/ postmodern work places, higher-education programs and to be productive, responsible, considerate, and harmonious citizens. Common set of learnings are spirally sequenced from Preparatory - Grade 9 to deepen the scope and increase the level of difficulty in the learning activities so that what is learned is reinforced at different grade levels.

The core curriculum includes:

- cognitive (thinking) skills (Refer to the syllabus for a list of these skills);
- reasoning, decision-making and problem-solving skills
- high level thinking skills (analysis, synthesis and evaluation skills);
- 21st Century skills (Refer to illustrative list in the Appendix);
- reading, writing and communication skills;
- STEAM principles and skills;
- essential values and attitudes (Core personal and social values, and sustaining values), and
- spiritual values and virtues.




The essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship.

All teachers are expected to include the core learnings in their lesson planning, teaching, and assessment of students in all their lessons. They are expected to foster, promote and model the essential values and attitudes as well as the spiritual values and virtues in their conduct, practice, appearance, and their relationships and in their professional and personal lives. In addition, teachers are expected to mentor, mould and shape each student to evolve and possess the qualities envisioned by society.

Core values and attitudes must not be taught in the classroom only; they must also be demonstrated by students in real life or related situations inside and outside of the classroom, at home, and in everyday life. Likewise, they must be promoted, fostered and modeled by the school community and its stakeholders, especially parents. A whole of school approach to values and attitudes teaching, promoting and modeling is critical to students and the whole school community internalising the core values and attitudes and making them habitual in their work and school place, and in everyday life. Be it work values, relationship values, peace values, health values, personal and social values, or religious values, teachers should give equal prominence to all common learnings in their lesson planning, teaching, assessment, and learning interventions. Common learnings must be at the heart of all teaching and extracurricularprograms and activities.

## Integrating Core Curriculum in the Teaching and Learning

The above knowledge, skills, values and attitudes should be taught and assessed by all teachers from Prep to Grade 12 across subject's fields and subjects through the assessment of evidence outcomes. Teachers must ensure that the core curriculum are reinforced at each school grade and school level to enable students to become proficient in their application in different career, higher education and citizenship contexts. Students' learning is based on their ability to master and demonstrate proficiency in the use of essential knowledge, processes, skills, values, and attitudes in real life or related situations.

### A practical example of integrating core curriculum in Teaching and Learning

Teachers can identify a set of core curriculum to teach in one lesson, For example, In Technology and Industrial Arts, Students may be posed with the dilemma to find solutions on how technology can be used to improve food security in their area.

Students will be required to use what they learnt in Social Science about the casual effects of climate change on the livelihood of people. They can use STEAM principles and skills in finding cause and solutions, use high level thinking skills to analyze and evaluate the effects and how to improve food security, use decision making and critical thinking skills to find the solutions for food security, use technology to design the best food security model and be able to confidently and boldly communicate their findings and present intelligent and convincing arguments, then we can conclude that learning of the core curriculum is evident. If students can be able to demonstrate mastery, proficiency and competency of core curriculum in such a manner, then the learning of core curriculum has been achieved.

# Science, Technology, Engineering, Arts and Mathematics

STEAM education is an integrated, multidisciplinary approach to learning that uses Science, Technology, Engineering, Arts and Mathematics as the basis for inquiring about how STEAM has and continues to change and impact the social, political, economic, cultural and environmental contexts and identifying and solving authentic (real life) natural and physical environment problems by integrating STEAM-based principles, cognitive, high level and 21st Century skills and processes, and values and attitudes.

Agriculture as a science field is focused on both goals of STEAM rather than just the goal of problem solving. This is to ensure that all students are provided opportunities to learn, integrate, and demonstrate proficiency on all essential STEAM principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

## Objectives

Students will be able to;

- Examine and use evidence to draw conclusions about how STEAM has and continues to change the social, political, economic, cultural and environmental contexts.
- Investigate and draw conclusions on the impact of STEAM solutions to problems on the social, political, economic, cultural and environmental contexts.
- Identify and solve problems using STEAM principles, skills, concepts, ideas and process.
- Identify, analyse and select the best solution to address a problem.
- Build prototypes or models of solutions to problems.
- Replicate a problem solution by building models and explaining how the problem was or could be solved.
- Test and reflect on the best solution chosen to solve a problem.
- Collaborate with others on a problem and provide a report on the process of problem solving used to solve the problem.
- Use skills and processes learnt from lessons to work on and complete STEAM projects.
- Demonstrate STEAM principles, skills, processes, concepts and ideas through simulation and modelling.
- Explain the significance of values and attitudes in problem-solving.

STEAM is a multidisciplinary and integrated approach to understanding how Science, Technology, Engineering, Arts and Mathematics shape and is shaped by our material, intellectual, cultural, economic, social, political and environmental contexts. And for teaching students the essential in demand cognitive, high level and 21st Century skills, values and attitudes, and empower them to effectively use these skills and predispositions to identify and solve problems relating to the natural and physical environments as well as the impact of STEAM-based solutions on human existence and livelihoods, and on the social, political, economic, cultural, and environmental systems.

STEAM disciplines have and continue to shape the way we perceive knowledge and reality, think and act, our values, attitudes, and behaviours, and the way we relate to each other and the environment. Most of the things we enjoy and consume are developed using STEAM principles, skills, process, concepts and ideas. Things humans used and enjoyed in the past and at present are developed by scientists, technologists, engineers, artists and mathematicians to address particular human needs and wants. Overtime, more needs were identified and more products were developed to meet the ever changing and evolving human needs.

What is produced and used is continuously reflected upon, evaluated, redesigned, and improved to make it more advanced, multipurpose, fit for purpose, and targeted towards not only improving the prevailing social, political, economic, cultural and environmental conditions but also to effectively respond to the evolving and changing dynamics of human needs and wants. And, at the same time, solutions to human problems and needs are being investigated and designed to address problems that are yet to be addressed and concurred. This is an evolving and ongoing problem-solving process that integrates cognitive, high level, and 21st Century skills, and appropriate values and attitudes.

STEAM is a significant framework and focal point for teaching and guiding students to learn, master and use a broad range of skills and processes required to meet the skills demands of PNG and the 21st Century. The skills that students will learn will reflect the demands that will be placed upon them in a complex, competitive, knowledge-based, information-age, technology-driven economy and society. These skills include cognitive (critical, synthetic, creative, reasoning, decision-making, and problem-solving) skills, high level (analysis, synthesis and evaluation) skills and 21st Century skills (see Appendix 4). Knowledge-based, information, and technology driven economies require knowledge workers not technicians. Knowledge workers are lifelong learners, are problem solvers, innovators, creators, critical and creative thinkers, reflective practitioners, researchers (knowledge producers rather than knowledge consumers), solutions seekers, outcomes oriented, evidence-based decision makers, and enablers of improved and better outcomes for all.

STEAM focuses on the skills and processes of problem solving. These skills and processes are at the heart of the STEAM movement and approach to not only problem solving and providing evidence-based solutions but also the development and use of other essential cognitive, high level and 21st Century skills. These skills are intertwined and used simultaneously to gain a broader understanding of the problems to enable creative, innovative, contextually relevant, and best solutions to be developed and implemented to solve the problems and attain the desired outcomes. It is assumed that by teaching students STEAM-based problem-solving skills and providing learning opportunities inside and outside the classroom will motivate more of them to pursue careers and academic programs in STEAM related fields thus, closing the skills gaps and providing a pool of cadre of workers required by technology, engineering, science, and mathematics-oriented industries.

Although, STEAM focuses on the development and application of skills in authentic (real life) contexts, for example the use of problem –solving skills to identify and solve problems relating to the natural and physical worlds. It does not take into account the significant influence that values and attitudes have on the entire process of problem solving. Values and attitudes are intertwined with knowledge and skills. Knowledge, skills, values and attitudes are inseparable. Decisions about skills and processes of skills development and application are influenced by values and attitudes (mindset) that people hold. In the same light, the use of STEAM principles, processes and skills to solve problems in order to achieve the outcomes envisaged by society are influenced by values and the mind set of those who have identified and investigated the problem as well as those who are affected by the problem and will benefit from the outcome

## STEAM Problem-Solving Processes

Problem-solving involves the use of problem-solving methods and processes to identify and define a problem, gather information to understand its causes, draw conclusions, and use the evidence to design and implement solutions to address it. Even though there are many different problem-solving methods and approaches, they share some of the steps of problem-solving, such as;

- identifying the problem,
- understanding the problem by collecting data,
- analyse and interpret the data,
- draw conclusions,
- use data to consider possible solutions,
- select the best solution,
- test the effectiveness of the solution by trialling and evaluating it, and
- review and improve the solution.

STEAM problem solving processes go from simple and technical to advance and knowledge-based processes. However, regardless of the type of process used, students should be provided opportunities to learn the essential principles and processes of problem solving and, more significantly, to design and create a product that addressed a real problem and meets a human need. The following are some of the STEAM problem solving processes.

## 1. Engineering and Technology Problem Solving Methods and Approaches

Engineering and technology problem-solving methods are used to identify and solve problems relating to the physical world using the design process. The following are some of the methods and approaches used to solve engineering and technology related problems.

### *Parts Substitution*

It is the most basic of the problem-solving methods. It simply requires the parts to be substituted until the problem is solved.

***Diagnostics***
After identifying a problem, the technician would run tests to pinpoint the fault. The test results would be used either as a guide for further testing or for replacement of a part, which also need to be tested. This process continues until the solution is found and the device is operating properly.

***Troubleshooting***
Troubleshooting is a form of problem solving, often applied to repair failed products or processes.

***Reverse Engineering***
Reverse engineering is the process of discovering the technological principles underlying the design of a device by taking the device apart, or carefully tracing its workings or its circuitry. It is useful when students are attempting to build something for which they have no formal drawings or schematics.

Divide and Conquer
Divide and conquer is the technique of breaking down a problem into sub problems, then breaking the sub-problems down even further until each of them is simple enough to be solved. Divide and conquer may be applied to all groups of students to tackle sub-problems of a larger problem, or when a problem is so large that its solution cannot be visualised without breaking it down into smaller components.

***Extreme Cases***
Considering "extreme cases" – envisioning the problem in a greatly exaggerated or greatly simplified form, or testing using extreme condition – can often help to pinpoint a problem. An example of the extreme-case method is purposely inputting an extremely high number to test a computer program.

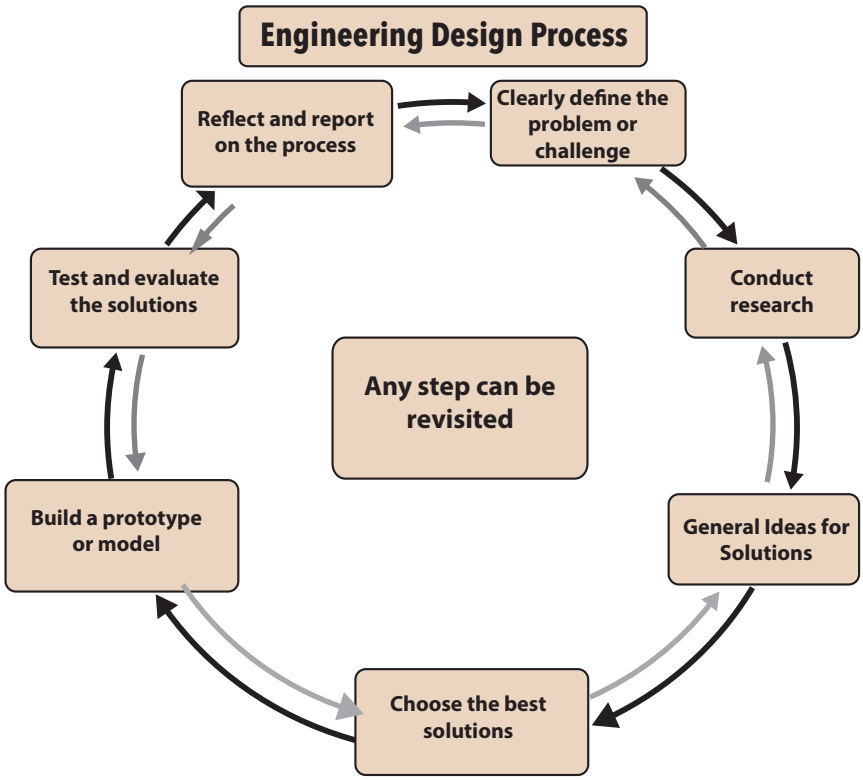
***Trial and Error***
The trial and error method involve trying different approaches until a solution is found. It is often used as a last resort when other methods have been exhausted.

## 2. Engineering Design Process

Technological fields use the engineering design process to identify and define the problem or challenge, investigate the problem, collect and analyse data, and use the data to formulate potential solutions to the problem, analyse each of the solutions in terms of its strengths and weaknesses, and choose the best solution to solve the problem. It is an open-ended problem-solving process that involves the full planning and development of products or services to meet identified needs. It involves a sequence of steps such as the following;

1. Analyse the context and background, and clearly define the problem.
2. Conduct research to determine design criteria, financial or other constraints, and availability of materials.
3. Generate ideas for potential solutions, using processes such as brainstorming and sketching.

4. Choose the best solution.
5. Build a prototype or model.
6. Test and evaluate the solution.
7. Repeat steps as necessary to modify the design or correct faults.
8. Reflect and report on the process.




## 3. The Scientific Method and Approach to Problem-Solving

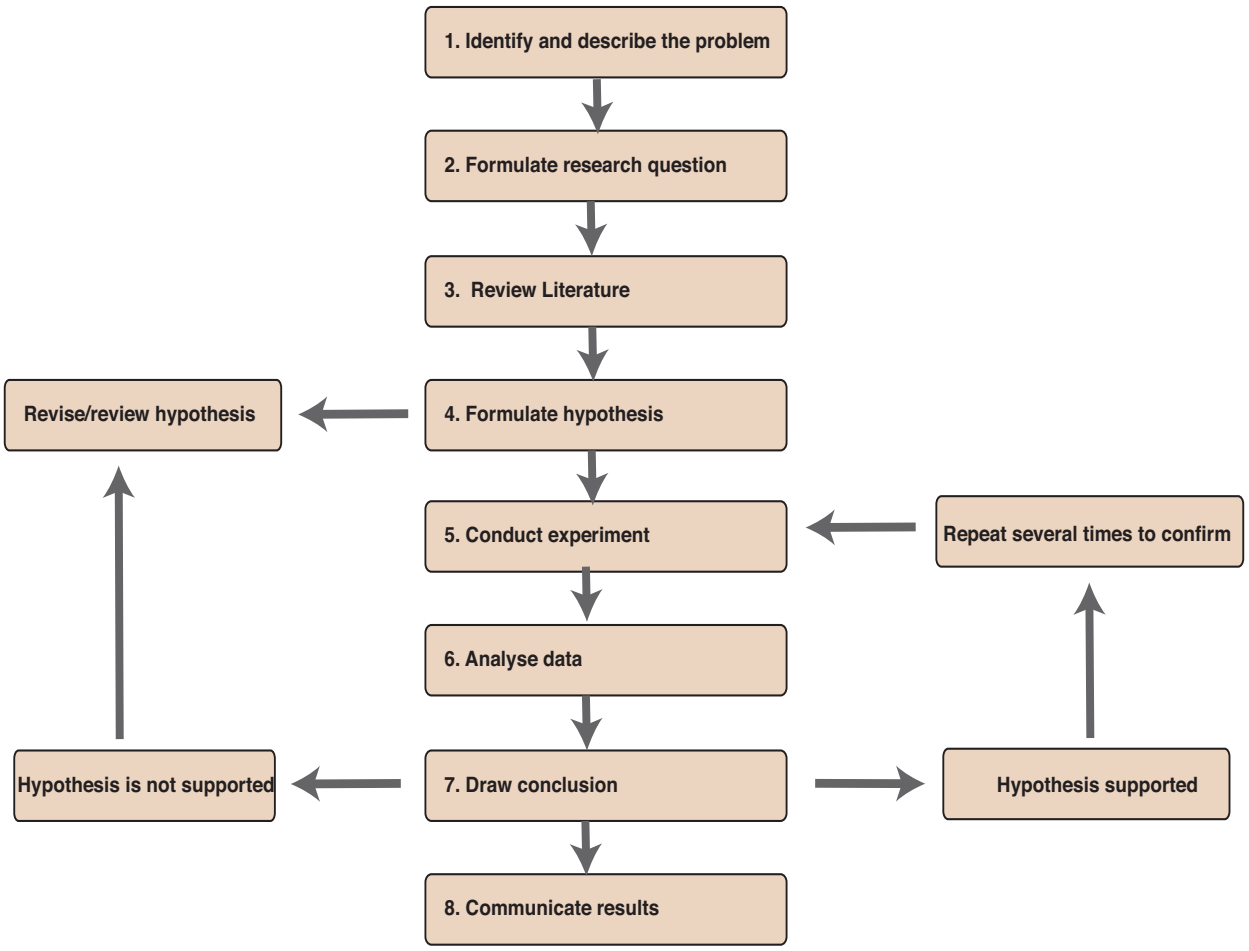
Science uses predominantly the quantitative-scientific inquiry process to investigate, understand, and make informed decisions about problems relating to the natural world. The steps in the process vary, depending on the purpose of the inquiry and the types of questions asked. There are six basic science process skills:

- Observation
- Communication
- Classification
- Measurement
- Inference
- Prediction

These processes are at the heart of the scientific inquiry and problem-solving process.

The steps above should be taught and demonstrated by students separately and jointly before they implement the inquiry process. Students should be guided through every step of the process so that they can explain it and its importance, and use the steps and the whole process proficiently to identify, investigate and solve problems. A brief explanation and examples of each step are provided below to help teachers plan and teach each step.

Students should be provided with opportunities to practice and reflect on each step until they demonstrate the expected level of proficiency before moving on to the next one.




The steps above should be taught and demonstrated by student separately and jointly before they implement the inquiry process. Students should be guided through every step of the process so that they can explain them, their importance and use the steps and the whole process proficiently to identify, investigate and solve problems. A brief explanations and examples of each step are provided below to assist teachers plan and teach each step. Students should be provided with opportunities to practice and reflect on each step until they demonstrate the expected level of proficiency before moving on to the next step.

**Step 1: Identify and describe the problem**

Problems are identified mainly from observations and the use the five senses – smell, sight, sound, touch and taste. Students should be guided and provided opportunities to identify natural and physical environment problems using their five senses and describe what the problem is and its likely causes.

*Example: Observation*

When I turn on a flashlight using the on/off switch, light comes out of one end.

**Step 2: Formulate research question**

After the problem is identified and described, the question to be answered is then formulated. This question will guide the scientist in conducting research and experiments.

*Example: Question*

What makes light come out of a flash light when I turn it on?

**Step 3: Review literature**

It is more likely that the research problem and question have already been investigated and reported by someone. Therefore, after asking the question, the scientist spends some time reading and reviewing papers and books on past research and discussions to learn more about the problem and the question asked to prepare for his or her own research. Conducting literature review helps the scientist to better understand his or her research problem, refine the research question and decide on experiment/research approach before the experiment is conducted.

*Example:* ***Literature review***
The scientist may look in the flashlight instruction manual for tips or conduct online search on how flashlight work using the Manufacturer's or other relevant websites. Scientist may even analyse information and past experiments or discoveries regarding the relationship between energy and light.

**Step 4: Formulate hypothesis**
With a question in mind, the researcher decides on what he/she wants to test (The question may have changed as a result of the literature review). The research will clearly state what he/she wants to find out by carrying out the experiment. He or She will make an educated guess that could answer the question or explain the problem. This statement is called a **hypothesis**. A hypothesis guides the experiment and must be testable.

*Example:* ***Hypothesis***

The batteries inside a flashlight give it energy to produce light when the flashlight is turned on.

**Step 5: Conduct experiment**

This step involves the design and conduct of experiment to test the hypothesis. Remember, a hypothesis is only an educated guess (a possible explanation), so it cannot be considered valid until an experiment verifies that it is valid.

*Example***: *Experimental Procedure***

Remove the batteries from the flashlight, and try to turn it on using the on/off switch.

*Result: The flashlight does not produce light*
Reinsert the batteries into the flashlight, and try to turn it on using the on/off switch.
*Result: The flashlight does produce light.*
Write down these results

In general, it is important to design an experiment to measure only one thing at a time. This way, the researcher knows that his/her results are directly related to the one thing he/she changed. If the experiment is not designed carefully, results may be confusing and will not tell the researcher anything about his/her hypothesis. Researchers collect data while carrying out their experiments. Data are pieces of information collected before, during, or after an experiment. To collect data, researchers read the measuring instruments carefully. Researchers record their data in notebooks, journals, or on a computer.

**Step 6: Analyse data**

Once the experiment is completed, the data is then analyzed to determine the results. In addition, performing the experiment multiple times can be helpful in determining the credibility of the data.

*Example:* ***Analysis***

Record the results of the experiment in a table.
Review the results that have been written down.

**Step 7: Draw conclusions**

If the hypothesis was testable and the experiment provided clear data, scientist can make a statement telling whether or not the hypothesis was correct. This statement is known as a **conclusion**. Conclusions must always be backed up by data. Therefore, scientists rely heavily on data so they can make an accurate conclusion.
If the data support the hypothesis, then the hypothesis is considered correct or *valid*.
If the data do not support the hypothesis, the hypothesis is considered incorrect or *invalid.*

*Example:* ***Valid Hypothesis***

The flashlight did not produce light without batteries. The flashlight did produce light when batteries were inserted. Therefore, the hypothesis that batteries give the flashlight energy to produce light is valid, given that no changes are made to the flashlight during the experiment.

*Example:* ***Invalid Hypothesis***

The flashlight did NOT produce light when the batteries were inserted. Therefore, the hypothesis that batteries give the flashlight energy to produce light is invalid. In this case, the hypothesis would have to be modified to say something like, "The batteries inside a flashlight give it energy to produce light when the batteries are in the correct order and when the flashlight is turned on." Then, another experiment would be conducted to test the new hypothesis.

An invalid hypothesis is not a bad thing! Scientists learn something from both valid and invalid hypotheses. If a hypothesis is invalid, it must be rejected or modified. This gives scientists an opportunity to look at the initial observation in a new way. They may start over with a new hypothesis and conduct a new experiment. Doing so is simply the process of scientific inquiry and learning.

**Step 8: Communicate findings**

Scientists generally tell others what they have learned. Communication is a very important component of scientific process and problem solving. It gives other people a chance to learn more and improve their own thinking and experiments. Many scientists' greatest breakthroughs would not have been possible without published communication or results from previous experimentation.

Every experiment yields new findings and conclusions. By documenting both the successes and failures of scientific inquiry in journals, speeches, or other documents, scientists are contributing information that will serve as a basis for future research and for solving problems relating to both the natural and physical worlds. Therefore, communication of investigative findings is an important step in future scientific discovery and in solving social, political, economic, cultural, and environmental problems.

*Example:* ***Communication of findings***

Write your findings in a report or an article and share it with others, or present your findings to a group of people. **Your work may guide someone else's research on creating alternative energy sources to generate light, additional uses for battery power, etc.**

**Artistic Design Process**

Science uses predominantly the quantitative-scientific inquiry process to investigate, understand, and make informed decisions about problems. The steps in the process vary, depending on the purpose of the inquiry and the types of questions asked. There are six basic science process skills:

The equipping and enabling of students to become proficient in a broad range of STEAM skills, processes and predispositions can also lead to the attainment of many other societal goals, including national and global development goals and aspirations. These goals include:

- sustainability goals;
- peaceful related goals;
- work related goals;
- academic goals;
- relationship goals;
- health goals;
- adoption and internalization of values and attitudes accepted by society, and
- improved social, political, economic outcomes.

Even though the original purpose and the drive of STEAM was to develop a pathway to engage students in learning about, experiencing, and applying STEAM skills in real life situations to motivate and hopefully get them to pursue careers in STEAM related fields and undertake STEAM related higher education programs to meet the demand for STEAM workers, STEAM education can also be used to teach and engage students in study more broadly the impact of STEAM on the social, economic, political, intellectual, cultural and environmental contexts. This line of inquiry is more enriching, exciting, empowering and transformative.

## STEAM-Based Lesson Planning

Effective STEAM lesson planning is the key to the achievement of the expected outcomes. STEAM Skills can be planned and taught using separate STEAM-based lesson plans or integrated into the standards- based lesson plans. To effectively do this, teachers should know how to write effective standards and STEAM-based lesson plans.

### *Developing STEAM-based Lesson Plans*

An example of a standards- based lesson is provided in the **Appendix.** Teachers should use this to guide them to integrate STEAM content and teaching, learning and assessment strategies into their standards- based lesson plans.

### *Integration of STEAM problem-solving skills into standards-based lesson plans*

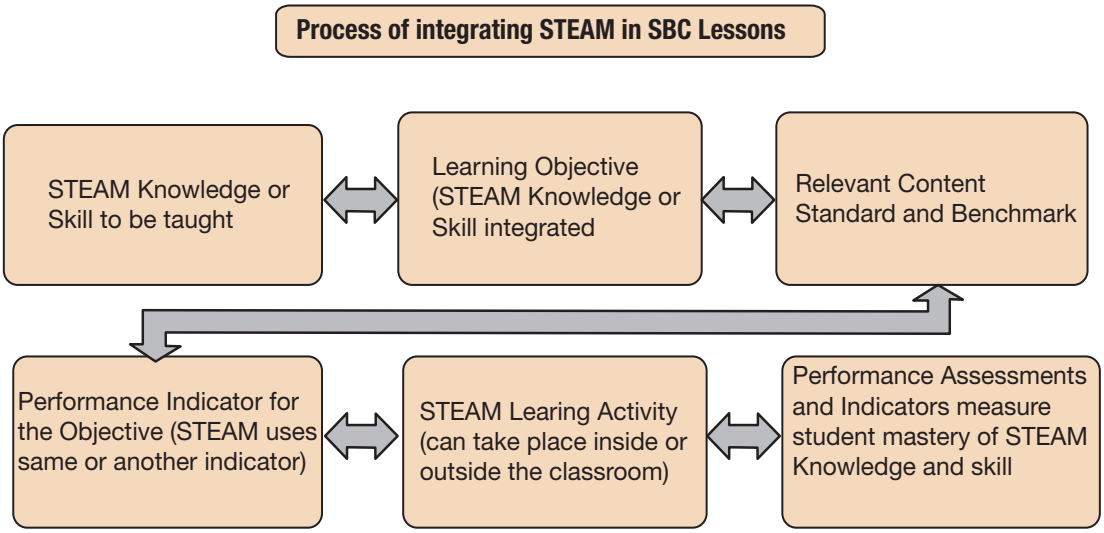
Knowing about how to integrate STEAM problem- solving skills, principles, values and attitudes as well as STEAM teaching, learning, and assessment strategies into standards-based lesson plans is essential for achieving the desired STEAM learning outcomes. When integrating STEAM problem-solving skills into the standards- based lesson plans, teachers should ensure that these skills are not only effectively aligned to the learning objectives and performance standards, they must also be effectively taught and assessed.

STEAM principles and problem-solving skills are integrated into the content standards and grade level benchmarks. A list of these skills, including 21st Century skills is provided in the Agriculture syllabus. Teachers should ensure that these skills are integrated in their standards- based lesson plans, taught

and assessed to determine student's level of proficiency on each skill or specific components of the skill. Teachers should use the following process as a guide to integrate STEAM principles and problem-solving skills into the standards-based lesson plans.

Teachers are expected to integrate the essential STEAM principles, processes, skills, values and attitudes described in the Agriculture benchmarks when formulating their standards-based lesson plans. Opportunities should be provided inside and outside of the classroom for students to learn, explore, model and apply what they learn in real life or related situations. These learning experiences will enable students to develop a deeper understanding of STEAM principles, processes, skills, values and attitudes and appreciate their application in real life to solve problems.

## Process for Integrating STEAM Principles and Problem-Solving Skills into Standards-Based Lessons




Teachers should follow the steps given below when integrating STEAM problem-solving principles and skills into their standards-based lesson plans.

**Step 1:** Identify the STEAM knowledge or skill to be taught (From the table of KSVAs for each content standard and benchmark). This could already be captured in the learning objective stated in the standards-based lesson plan.

**Step 2:** Develop and include a performance standard or indicator for measuring student mastery of the STEAM knowledge or skill *(e.g.* level of acceptable competency or proficiency) if this is different from the one already stated in the lesson plan.

**Step 3:** Develop student learning activity (An activity that will provide students the opportunity to apply the STEAM knowledge or skill specified by the learning objective and appropriate statement of the standards). Activity can take place inside or outside of the classroom, and during or after school hours.

**Step 4:** Develop and use performance descriptors (standards or indicators) to analyse students' STEAM related behaviours and products (results or outcomes), which provide evidence that the student has acquired and mastered the knowledge or skill of the learning objective specified by the indicator (s) of the standard (s).

## STEAM Teaching Strategies

STEAM education takes place in both formal and informal classroom settings. It takes place during and after school hours. It is a continuous process of inquiry, data analysis, making decisions about interventions, and implementing and monitoring interventions for improvements.

There are a variety of STEAM teaching strategies. However, teaching strategies selected must enable teachers to guide students to use the engineering and artistic design processes to identify and solve natural and physical environment problems by designing prototypes and testing and refining them to effectively mitigate the problems identified. The following are some of the strategies that could be used to utilise the STEAM approach to solve problems and coming up with technological solutions.

1. Inquiry-Based Learning
2. Problem-Based Learning
3. Project-based learning
4. Collaborative Learning

Collaborative learning involves individuals from different STEAM disciplines and expertise in a variety of STEAM problem solving approaches working together and sharing their expertise and experiences to inquire into and solve a problem.

Teachers should plan to provide students opportunities to work in collaboration and partnership with experts and practitioners engaged in STEAM related careers or disciplines to learn first-hand about how STEAM related skills, processes, concepts, and ideas are applied in real life to solve problems created by natural and physical environments. Collaborative learning experiences can be provided after school or during school holidays to enable students to work with STEAM experts and practitioners to inquiry and solve problems by developing creative, innovative and sustainable solutions. Providing real life experiences and lessons, e.g., by involving students to actually solve a scientific, technological, engineering, mathematical, or Arts problem, would probably spark their interest in a STEAM career path. Developing STEAM partnerships with external stakeholders e.g. high education institutions, private sector, research and development institutions, and volunteer and community development organizations can enhance students' learning and application of STEAM problem solving principles and skills.

Some examples of STEAM-related partnership experiences may include:

- Participatory Learning
- Group-Based Learning
- Task Oriented Learning
- Action Learning
- Experiential Learning
- Modelling
- Simulation

## STEAM Learning Strategies

Teachers should include in their lesson plans STEAM learning activities. These activities should be aligned to principle or a skill planned for students to learn and demonstrate proficiency at the end of the lesson to expose students to STEAM and giving them opportunities to explore STEAM-related concepts, they will develop a passion for it and, hopefully, pursue a job in a STEAM field. Providing real life experiences and lessons, *e.g.*, by involving students to actually solve a scientific, technological, engineering, or mathematical, or arts problem, would probably spark their interest in a STEAM career path. This is the theory behind STEAM education.

## STEAM-Based Assessment

STEAM-based assessment is closely linked to standards-based assessment where assessment is used to assess students' level of competency or proficiency of a specific knowledge, skill, value, or attitude taught using a set of performance standards (indicators or descriptors). The link also includes the main components such as the purpose, the assessment principles and assessment strategies and tools.

In STEAM-based assessment, assessments are designed for what students should know and be able to do. In STEAM learning, students are assessed in a variety of ways including portfolios, project/problem-based assessments, backwards design, authentic assessments, or other student-centered approaches. When planning and designing the assessment, teachers should consider the authenticity of the assessment by designing an assessment that relates to a real world task or discipline specific attributes such as simulation, role play, placement assessment, live projects and debates. These tasks should make the activity meaningful to the student, and therefore be motivating as well as developing employability skills and discipline specific attributes.

## Effective STEAM-Based Assessment Strategies

The following are the six assessment tools and strategies shown to impact teaching and learning as well as help teachers foster a 21st Century learning environment in their classrooms.

1. Rubrics
2. Performance-Based Assessments (PBAs)
3. Portfolios
4. Student self-assessment
5. Peer-assessment
6. Student Response Systems (SRS).

Although the list does not include all innovative assessment strategies, it includes what we think are the most common strategies, and ones that may be particularly relevant to the educational context of developing countries in this 21st Century. Many of the assessment strategies currently in use fit under one or more of the categories discussed. Furthermore, it is important to note that these strategies also connect in a variety of ways.

***1. Rubrics***

Rubrics are both a tool to measure students' knowledge and ability as well as an assessment strategy. A rubric allows teachers to measure certain skills and abilities not measurable by standardized testing systems that assess discrete knowledge at a fixed moment in time. Rubrics are also frequently used as part of other assessment strategies including; portfolios, performances, projects, peer-review and self-assessment which are also elaborated in this section.

***2. Performance-Based Assessments***

Performance-Based Assessments (PBA), also known as project-based or authentic assessments, are generally used as a summative evaluation strategy to capture not only what students know about a topic, but if they have the skills to apply that knowledge in a "real-world" situation. By asking them to create an end product. PBA pushes students to synthesize their knowledge and apply their skills to a potentially unfamiliar set of circumstances that is likely to occur beyond the confines of a controlled classroom setting. The implementation of performance-based assessment strategies can also impact other instructional strategies in the classroom.

***3. Portfolio Assessment***

Portfolios are a collection of student work gathered over time that is primarily used as a summative evaluation method. The most salient characteristic of the portfolio assessment is that rather than being a snapshot of a student's knowledge at one point in time (like a single standardized test), it highlights student effort, development, and achievement over a period of time; portfolios measure a student's ability to apply knowledge rather than simply regurgitate. They are considered both student-centred and authentic assessments of learning.

***4. Self-assessment***

While the previous assessment tools and strategies listed in this report generally function as summative approaches, self-assessment is generally viewed as a formative strategy, rather than one used to determine a student's final grade.

Its main purpose is for students to identify their own strengths and weakness and to work to make improvements to meet specific criteria. Self-assessment occurs when students judge their own work to improve performance as they identify discrepancies between current and desired performance". In this way, self-assessment aligns well with standards-based education because it provides clear targets and specific criteria against which students or teachers can measure learning.

Self-assessment is used to promote self-regulation, to help students reflect on their progress and to inform revisions and improvements on a project or paper. In order for self-assessment to be truly effective four conditions must be in place: the self-assessment criteria is negotiated between teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments and teachers help students use assessment data to develop an action plan.

***5. Peer assessment***

Peer assessment, much like self-assessment, is a formative assessment strategy that gives students a key role in evaluating learning. Peer assessment approaches can vary greatly but, essentially, it is a process for learners to consider and give feedback to other learners about the quality or value of their work. Peer assessments can be used for variety of products like papers, presentations, projects, or other skilled behaviours.

Peer assessment is understood as more than only a grading procedure and is also envisioned as teaching strategy since engaging in the process develops both the assessor and assessee's skills and knowledge.

***6. Student Response System***

Student response system (SRS), also known as classroom response (CRS), audience response system (ARS) is a general term that refers to a variety of technology-based formative assessment tools that can be used to gather student-level data instantly in the classroom. Through the combination of hardware, (voice recorders, PC, internet connection, projector and screen) and software.

Teachers can ask students a wide range of questions (both closed and open ended), where students can respond quickly and anonymously, and the teacher can display the data immediately and graphically. The use of technology also includes a use of video which examines how a range of strategies can be used to assess students' understanding.

The value of SRS comes from teachers analysing information quickly and then devising real-time instructional solutions to maximize student learning. This includes a suggested approach to help teachers and trainers assess learning.

# Curriculum Integration

Curriculum integration is making connections in learning across the curriculum. The ultimate aim of curriculum integration is to act as a bridge to increase students' achievement and engage in relevant curriculum. (Susan M. Drake and Rebecca C. Burns)

Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or fragmented teaching to one who is knowledge based and who should be perceived as a 21st Century innovative educator. Curriculum integration is a holistic approach to learning thus curriculum integration in PNG SBC will have to equip students with the essential knowledge, skills, values and attitudes that are deemed 21st Century.

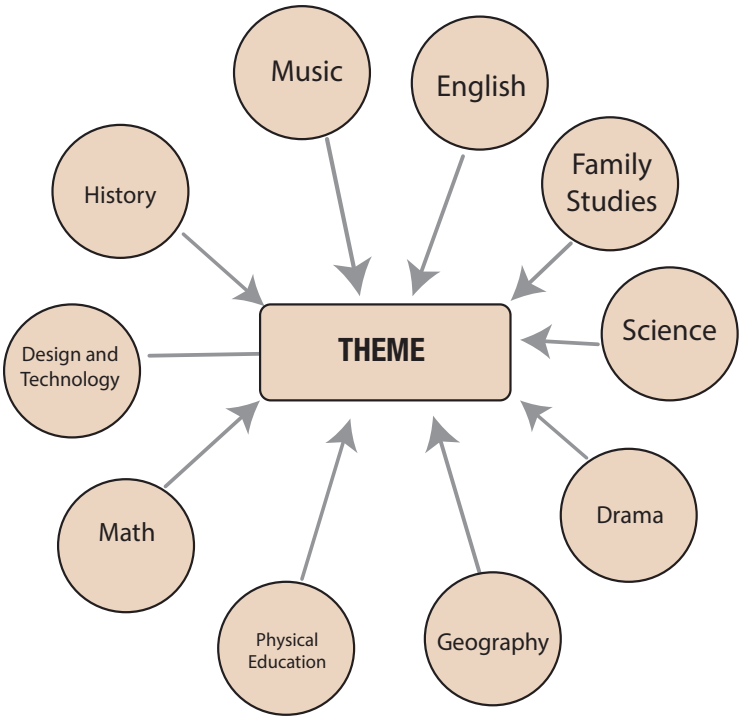
There are three approaches that PNG SBC will engage to foster conducive learning for all its children whereby they all can demonstrate proficiency at any point of exit. Adapting these approaches will have an immense impact on the lives of these children thus they can be able to see themselves as catalyst of change for a competitive PNG. Not only that but they will be comparable to the world standards and as global citizens.

Engaging these three approaches in our curriculum will surely sharpen the knowledge and ability of each child who will foresee themselves as assets through their achievements thus contribute meaningfully to their country. They themselves are the agents of change. Integrated learning will bear forth a generation of knowledge based populace who can solve problems and make proper decisions based on evidence.

Thus, PNG can achieve its goals like the Medium Term Development Goals (MTDG) and aims such as the Vision 2050 for a happy, healthy and wealthy society whereby, all its citizens should have access and fair distribution to income, shelter, health, education and general good and services improving the general standard of living for PNG in the long run.

## 1. Multidisciplinary Approach

In this approach learning involves a theme or concept that will be taught right across all subject area of study by students. That is, content of a particular theme will be taught right across all subjects as shown in the diagram below. For instance, if the theme is global warming, subject areas create lessons or assessment as per their subjects around this theme. Social Science will address this issue, Science and all other subject likewise.



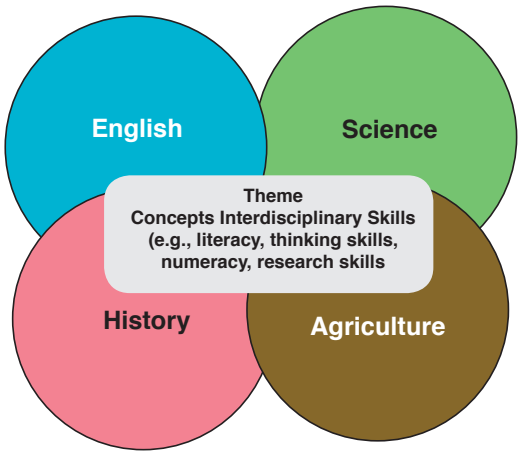

## 2. Interdisciplinary Approach

This approach addresses learning similarly to the multidisciplinary approach of integrated learning whereby learning takes place within the subject area.

However, it is termed interdisciplinary in that the core curriculum of learning is interwoven into each subject under study by the students. For instance; in Social Science under the strand of geography students write essay on internal migration however, apart from addressing the issues of this topic, they are to apply the skill of writing text types in their essay such as argumentative essay, informative, explanatory, descriptive, expository and narrative essay while writing their essay.

They must be able to capture the mechanics of English skills such as grammar, punctuation and so forth. Though these skills are studied under English they are considered as core skills that cut across all subjects under study. For example; if Science students were to write about human development in biology then the application of writing skills has to be captured by the students in their writing. It is not seen as an English skill but a standard essential skill all students must know and do regardless.

Therefore, essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship in this learning.




## 3. Interdisciplinary Approach

This approach involves teachers integrate sub disciplines within a subject area. For instance, within the subject Social Science, the strands (disciplines) of geography, environment, history, political science and environment will all be captured studying a particular content for Social Science. For example, under global warming, students will study the geographical aspects of global warming, environmental aspect of global warming and likewise for history, political science and economics. Thus, students are well aware of the issues surrounding global warming and can address it confidently at each level of learning.

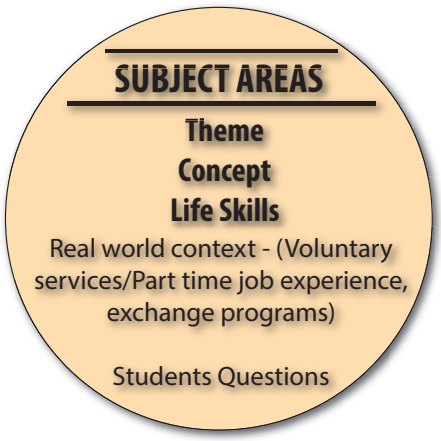
## 4. Trans disciplinary Approach

In this approach learning goes beyond the subject area of study. Learning is organized around students' questions and concerns. That is, where there is a need for change to improve lives, students develop their own curriculum to affect these needs. The trans-disciplinary approach addresses real-life situations thus giving the opportunity to students to attain real life skills. This learning approach is more to do with Project-Based Learning also referred to as problem-based learning or place-based learning.

Below are the three steps to planning project based curriculum.

1. Teachers and students select a topic of study based on student interests, curriculum standards, and local resources.
2. The teacher finds out what the students already know and helps them generate questions to explore. The teacher also provides resources for students and opportunities to work in the field
3. Students share their work with others in a culminating activity. Students display the results of their exploration and review and evaluate the project. For instance; students may come up with slogans for school programs such as 'Our culture – Keep our city clean for a healthier PNG'. The main aim could be to curb betel nut chewing in public areas especially around bus stops and local markets. Here, students draw up their own instructions and criteria for assessment which is; they have to clean the nearest bus stop or local market once a week throughout the year. They also design and create posters to educate the general public as their program continues. They can also involve the town council and media to assist them especially to carry out awareness.

1. year. They also design and create posters to educate the general public as their program continues. They can also involve the town council and media to assist them especially to carry out awareness.




These integrated learning approaches will demand for teachers to be proactive in order to improve students learning and achievements. In order for PNG Standards-Based Curriculum to serve its purpose fully, these three approaches must be engaged for better learning for the children of Papua New Guinea now and in the future.

Studies have proven that Project based-programs have led to the following:

- Students go far beyond the minimum effort
- Make connections among different subject areas to answer open-ended questions
- Retain what they have learnt
- Apply learning to real-life problems
- Have fewer discipline problems
- Lower absenteeism

# Essential Knowledge, Skills, Values, and Attitudes

Students' level of proficiency and progression towards the attainment of content standards will depend on their mastery and application of essential knowledge, skills, values, and attitudes in real life or related situations. Provided here are examples of different types of knowledge, processes, skills, values, and attitudes that all students are expected to learn and master as they progress through the grades. These are expanded and deepen in scope and the level of difficulty and complexity are increased to enable students to study in-depth the subject content as they progress from one grade to the next.

These knowledge, skills, values and attitudes have been integrated into the content standards and benchmarks. They will also be integrated into the performance standards. Teachers are expected to plan and teach essential knowledge, skills, values and attitudes in their lessons, and assess students' performance and proficiency, and progression towards the attainment of content standards.

## Types of Knowledge

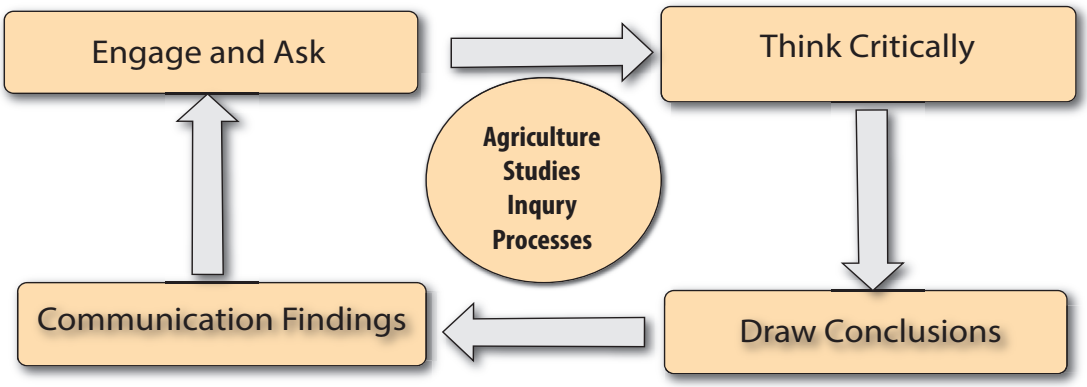
| There are different types of knowledge. These include; | |
|---|---|
| • Public and private (privileged) knowledge<br>• Specialised knowledge<br>• Good and bad knowledge<br>• Concepts, processes, ideas, skills, values, attitudes<br>• Theory and practice<br>• Fiction and non-fiction<br>• Traditional, modern, and postmodern knowledge | • Subject and discipline-based knowledge<br>• Lived experiences<br>• Evidence and assumptions<br>• Ethics and Morales<br>• Belief systems<br>• Facts and opinions<br>• Wisdom<br>• Research evidence and findings<br>• Solutions to problems |

## Types of Processes

| There are different types of processes. These include; | |
|---|---|
| • Problem-solving<br>• Logical reasoning<br>• Decision-making<br>• Reflection | • Cyclic processes<br>• Mapping (e.g. concept mapping)<br>• Modeling<br>• Simulating |
| Inquiry processes include:<br><br>• Gathering information<br>• Analysing information<br>• Evaluating information<br>• Making judgements<br>• Taking actions | |

## Critical Inquiry Processes

| | |
|---|---|
| **Engage and Ask** | How will I engage my students in the topic and prompt them to ask questions?<br><br>• Determine the enduring understandings about the topic being studied.<br>• Engage your students with the topic by grabbing their interest with a hook connected to the enduring understandings.<br>• Allow students to generate questions based upon the topic and hook.<br>• Determine what questions will be essential to achieving the enduring understandings. (Student generated or teacher determined<br>• With students, determine what other information is needed in order to fully answer the questions. |
| **Think Critically** | How will students access and analyse information about this topic?<br><br>• Have students think about where they can find answers to the questions posed about the topic.<br>• Gather and organize multiple primary and secondary sources.<br>• Ensure that sources used expose students to different perspectives and viewpoints about the topic.<br>• Students should use sources to collect, analyse, and interpret data.<br>• Ensure students are analysing sources for credibility, bias, and perspective in order to identify gaps in the research. |
| **Draw Conclusion** | How will students synthesize ideas to answer the questions posed based on sources used?<br><br>• Students should engage in civic discussion to answer the questions posed while respecting diverse opinions.<br>• Engage students in evaluating possible courses of action and their consequences.<br>• Students should make and justify an informed decision or choice and/or design an action plan supported by evidence from sources.<br>• Have students evaluate the consequences of a decision or choice.<br>• Allow students to make revisions based on feedback and further study. |
| **Communicate Findings** | How will students demonstrate what they have learned and take action on that learning?<br><br>• Determine how students will apply what they have learned and share their findings with others.<br>• Explore appropriate audiences for students to present conclusions.<br>• Determine if there is an opportunity for students to take action and influence others to make more informed decisions.<br>• Have students develop strategies to persuade others, including policy makers when applicable.<br>• Prepare students to defend their analysis against alternative. |




Below is how the Agriculture will be taught in the classroom. Be specific as you make notes of the activities or prompts you will use to ensure students will have the opportunity to practice these skills as a requirement in the Agriculturer content standards.

## Types of Skills

There are different types of skills. These include:

### 1. Cognitive (Thinking) Skills

Thinking skills can be categorized into **critical thinking** and **creative thinking** skills.

#### *i. Critical Thinking Skills*

| **A person who thinks critically always evaluates an idea in a systematic manner before accepting or rejecting it. Critical thinking skills include;** | |
|---|---|
| • Attributing<br>• Comparing and contrasting<br>• Grouping and classifying<br>• Sequencing<br>• Prioritising<br>• Analysing | • Detecting bias<br>• Evaluating<br>• Metacognition (Thinking about thinking)<br>• Making informed conclusions. |

#### *ii. Creative Thinking Skills*

| **A person who thinks creatively has a high level of imagination, able to generate original and innovative ideas, and able to modify ideas and products. Creative thinking skills include;** | |
|---|---|
| • Generating ideas<br>• Deconstruction and reconstruction<br>• Relating<br>• Making inferences<br>• Predicting<br>• Making generalisations<br>• Visualizing | • Synthesising<br>• Making hypothesis<br>• Making analogies<br>• Invention<br>• Transformation<br>• Modeling<br>• Simulating |

2. **Reasoning Skills** - Reason is a skill used in making a logical, just, and rational judgment.
3. **Decision-Making Skills** - Decision-making involves selection of the best solution from various alternatives based on specific criteria and evidence to achieve a specific aim.
4. **Problem Solving Skills** – These skills involve finding solutions to challenges or unfamiliar situations or unanticipated difficulties in a systematic manner.
5. **Literacy Skills**

   A strong emphasis must be placed on various types of literacy, from financial to technological, from media to mathematical, from content to cultural. Literacy may be defined as the ability of an individual to use information to function in society, to achieve goals and to develop her or his knowledge and potential. Teachers emphasize certain aspects of literacy over others, depending on the nature of the content and skills they want students to learn.

| **The following literacy skills are intended to be exemplary rather than definitive** | |
|---|---|
| • Listens, read, write, and speak with comprehension and clarity<br>• Define and apply discipline-based conceptual vocabulary<br>• Describe people, places, and events, and the connections between and among them<br>• Arrange events in chronological sequence<br>• Differentiate fact from opinion<br>• Determine an author's purpose<br>• Determine and analyse similarities and differences<br>• Analyze cause and effect relationships<br>• Explore complex patterns, interactions and relationships<br>• Differentiate between and among various options | • Listens, read, write, and speak with comprehension and clarity<br>• Define and apply discipline-based conceptual vocabulary<br>• Describe people, places, and events, and the connections between and among them<br>• Arrange events in chronological sequence<br>• Differentiate fact from opinion<br>• Determine an author's purpose<br>• Determine and analyse similarities and differences<br>• Analyse cause and effect relationships<br>• Develop an ability to use and apply abstract principals<br>• Explore and/or observe, identify, and analyse how individuals and/or societies relate to one another |

6. **High Level Thinking Skills** - These skills include analysis, synthesis, and evaluation skills.

*i.* ***Analysis Skills*** – Analysis skills involve examining in detail and breaking information into parts by identifying motives or causes, underlying assumptions, hidden messages; making inferences and finding evidence to support generalisations, claims, and conclusions.

| Key Words | | | | |
|---|---|---|---|---|
| Analyse | Differences | Find | List | Similar to |
| Appraise | Discover | Focus | Motivate | Simplify |
| Arrange | Discriminate | Function | Omit | Take part in |
| Assumption | Discussion | Group | Order | Test for |
| Breakdown | Distinction | Highlight | Organize | Theme |
| Categorize | Distinguish | In-depth | Point out | |
| Cause & effect | Dissect | Inference | Research | |
| Choose | Divide | Inspect | See | |
| Classify | Establish | Isolate | Select | |
| Comparing | Examine | Investigate | Separate | |

**ii. Synthesis Skills -** Synthesis skills involve changing or creating something new, compiling information together in a different way by combining elements in a new pattern proposing alternative solutions.

**iii. Evaluation Skills** - Evaluation skills involve justifying and presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on set criteria.

## Types of Values

Personal engagement and civic engagement strategies help young people to acquire and apply skills and dispositions that will prepare them to become competent and responsible citizens.

### 1. Personal Values (importance, worth, usefulness, etc.)

| Core values | Sustaining values |
|---|---|
| • Sanctity of life<br>• Truth<br>• Aesthetics<br>• Honesty<br>• Human<br>• Dignity<br>• Rationality<br>• Creativity<br>• Courage<br>• Liberty<br>• Affectivity<br>• Individuality | • Self-esteem<br>• Self-reflection<br>• Self-discipline<br>• Self-cultivation<br>• Principal morality<br>• Self-determination<br>• Openness<br>• Independence<br>• Simplicity<br>• Integrity<br>• Enterprise<br>• Sensitivity<br>• Modesty<br>• Perseverance |

## 2. Social Values

| Core values | Sustaining values |
|---|---|
| • Equality<br>• Kindness<br>• Benevolence<br>• Love<br>• Freedom<br>• Common good<br>• Mutuality<br>• Justice<br>• Trust<br>• Interdependence<br>• Sustainability<br>• Betterment of human kind<br>• Empowerment | • Plurality<br>• Due process of law<br>• Democracy<br>• Freedom and liberty<br>• Common will<br>• Patriotism<br>• Tolerance<br>• Gender equity and social inclusion<br>• Equal opportunities<br>• Culture and civilisation<br>• Heritage<br>• Human rights and responsibilities<br>• Rationality<br>• Sense of belonging<br>• Solidarity<br>• Peace and harmony<br>• Safe and peaceful communities |

## Types of Attitudes

| Attitudes - Ways of thinking and behaving, points of view | |
|---|---|
| • Optimistic<br>• Participatory<br>• Critical<br>• Creative<br>• Appreciative<br>• Empathetic<br>• Caring and concern<br>• Positive<br>• Confident<br>• Cooperative | • Responsible<br>• Adaptable to change<br>• Open-minded<br>• Diligent<br>• With a desire to learn<br>• With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment. |

# Teaching and Learning Strategies

Agriculture emphasises and embraces the use of cognitive, reasoning, decision-making, problem solving and higher-level thinking skills to teach to enhance students' understanding of inter-disciplinary concepts and issues in relation to environment, geography, history, politics and economic within PNG and globally.

It aims to provide a meaningful pedagogical framework for teaching and learning essential and in demand knowledge, skills, values, and attitudes that are required for the preparation of students for careers, higher education and citizenship in the 21st century. Students must be prepared to gather and understand information, analyse issues critically, learn independently or collaboratively, organise and communicate information, draw and justify conclusions, create new knowledge, and act ethically.

These teaching and learning strategies will help teachers to;

- familiarise themselves with different methods of teaching indoors and outdoors.
- develop an understanding of the role of a teacher for application of various methods in and out of the classroom.

Successful teachers always keep in view that teaching must "be dynamic, challenging and in accordance with the learner's comprehension. He/she does not depend on any single method

Please find a list of the different teaching and learning strategies in Appendices (Appendix 2)

The strategies utilised in teaching;

- make learning more engaging
- make learning more effective
- make learning fun
- encourage higher motivational level
- improve attention spans
- develop higher order thinking and reflective skills
- improve communication skills
- develop the spirit of teamwork /collaboration
- develop leadership skills and qualities
- encourage discovery learning

# Content Expansion

Content expansion is a set of sequenced teaching and learning activities with assessment tasks, designed to help students achieve selected learning outcomes within a specific time frame. Content expansion helps the teacher:

- identify essential knowledge, skills and attitudes that the students need to develop
- write suitable learning activities and assessment tasks for each theme
- make sure that assessment tasks allow students to demonstrate the knowledge, skills and attitudes given in the outcomes
- identify locally relevant resources for the unit of work
- plan the activities to cater for the duration of the unit

This expansion indicates the scope of content outlined with the Knowledge, Skills, Attitudes, Values, ( KSAVs) and derived from the Benchmarks. The lesson activities should be developed in line with the KSAVs specified from this table.

This table provides the scope of lesson content based on the Benchmarks to plan your teaching and learning programs. The lesson activities should have the components of relevant Knowledge, Skills, Attitudes and Values that can be assessed in the beginning of the lesson (Input), during the lesson (process) and at the end of the lesson (output). This will lead up to achieving the Content Standards and the Benchmarks in Agriculture subject. Use the tables that follow to help guide you in planning your teaching programs.

The diagram below illustrates how the content in the Teachers Guide is organised. It is arranged into topics, benchmarks together with the essential, knowledge, skills, attitudes and values. Learning objectives are provided for each topic in the units of work for the teacher to utilize in developing their lesson objectives.

# Grade 11 Agriculture
## Teaching Content

# Strands, Units and Topics

Table of strands, units and topics

The table below outlines the contents of Grade 11 Agriculture in strands, units, topics and with the suggested lesson tittles to be taught in an academic year.

Teachers are provided with what will be taught under each of the five strands in a year. This overview will guide the teachers on how to plan their teaching programs for each term in a school year.

| Strands | Units | Topics | Lesson Titles |
|---|---|---|---|
| **Crops** | **Unit 1: Soil** | Soil nutrient | Nutrients |
| | | | Micro - Nutrient |
| | | | Macro-Nutrient |
| | **Unit 2: Types of Crops** | Principles and Practices of Crop Protection | Characteristics of biennial crops |
| | | | Physiology of biennial crops |
| | **Unit 3: Crop Farming Practices and Management Systems** | Systems and practices of crop management | Practices of crop management |
| | | Crop Pests | Practices of crop protection |
| | **Unit 4:Crop Farming and Technology** | Crop breeding | Genetics and Clonning |
| | | | Genetic Modified (GM) Crops |
| | **Unit 5: Types of Plants** | Types of aromatic plants | Aromatic Plants |
| | | | Species of Aromatic Plants |
| | | Characteristics and Benefits of Aromatic Plants | Characteristics of Aromatic Plants |
| | | | Benefits of Aromatic Plants |
| | | Cultivation and Propagation of Aromatic Plants | Cultivation of Aromatic Plants |
| | | | Propagation of Aromatic Plants |
| | | Propagation and Preservation Techniques of Aromatic Plants | Preservation Techniques of Aromatic Plants |
| | | | How to preserve Herbs |
| | **Unit 6: Plant Farming Practices and Management Systems** | Processing Aromatic Merchandise | Production, processing and utilisation of Aromatic Plants |
| | | Climatic Growing Conditions of Aromatic Plants | Climatic Effects of |
| | | | growing Aromatic Plants |
| | | | How to grow an Aloe Plant |
| | **Unit 7: Plant Farming and Technology** | Manual Husbandry of Aromatic Plants | How to Harvest Aloe Vera |
| | | | Picking Aloe Vera |
| | | Advantages and disadvantages of Aromatic Plant Technology | Advantages of Aromatic Plants |
| | | | Disadvantages of Aromatic Plants |

| | | | |
|---|---|---|---|
| **Animals** | **Unit 1: Types of Animals** | Introduction to apiculture | Types of apicultural animals |
| | | | Suitable environment for apiculture |
| | | Management system and cultivation practices of apiculture | Cultivation practices of apiculture |
| | | | Purposes and benefits of apiculture |
| | | Processes in apiculture | Main methods and processes involved in apiculture |
| | | | Common husbandry practices |
| | | Cultivation methods of apiculture | Apiculture production |
| | | | Apiculture processes |
| | **Unit 2:Animal Farming Practices and Management Systems** | Managing livestock | Feeding regime |
| | | | Grazing land tenure |
| | | | Herding arrangements |
| | | | Husbandry principles |
| | | Principles and practices in mass production | Husbandry practices |
| | | Animal production | Importance of technology in animal production |
| | **Unit 3: Animal Farming and Technology** | Technologies in animal farming | Animal farming technologies |
| | | | Animal production technologies |
| | | | Technologies used in animal products |
| | | Information communication technology | Communications technology in animal farming |
| | **Unit 4: Types of Birds** | Domestication of Birds | Different environments for Domestic Birds |
| | | | Farmed Birds |
| | | | Purpose and Benefits of birds |
| | | Birds farming | Types of environment |
| | | | Breeds of birds farmed in different environment |
| | **Unit 5: Bird Farming Practices and Management Systems** | Production and Preserving Birds Products | Processing and preserving meat |
| | | | Processing and preserving eggs |
| | | Regulation of Poultry Production | Regulations on production and processing poultry |
| | | | Policy and regulation on marketing and consumption of poultry |
| | **Unit 6: Bird Farming and Technology** | Bird Farming | Problems encountered and solutions |

| | | | |
|---|---|---|---|
| **Aquaculture** | **Unit 1: Types of Aqua farming Plants, Animals, and Fish** | Characteristics of fish species | Types of fish species in fresh water, brackish and salt water |
| | | | Characteristics of each species in fresh water, brackish and salt water |
| | | Cultivation of fish | Cultivation of fish in brackish environment |
| | | | Cultivation of fish in salt water environment |
| | **Unit 2: Aqua farming Practices and Management Systems** | Factors of aquaculture production | Factors affecting aquaculture production; climate, physical, environmental, water availability and quality |
| | | Processing and marketing aquaculture products | Processing aqua farming products |
| | | | Marketing aqua farming products |
| | | Aquaculture regulations | Farming regulations |
| | | Post-harvest technologies | Post-harvest technologies; handling, processing, marketing, price determination |
| | | | Advantages and disadvantages of post- harvest technologies |
| | **Unit 3: Aqua farming and technology** | Sales and marketing technology | Communication technologies in marketing – Quality and safety |
| | | | Communication technologies in sales – Quality and safety |
| | | | Global trading of aqua farming products |
| | | Rules and regulations | Fisheries Management Regulations; harvesting, processing, obtaining licence |

| | | | |
|---|---|---|---|
| **Natural Resource Management** | **Unit 1: Types of Capture Fishery** | Capture fishery cultivation | Sea ranching |
| | | | Coastal lagoon farming |
| | | | Stocking of inland lagoons |
| | | | Flood plain fisheries management |
| | | Capture fishery organisms and environments | Characteristics of capture fishery organisms |
| | | | Capture fishery organisms and habitats |
| | **Unit 2: Capture Fishery Harvesting Practices and Management Systems** | Factors affecting capture fishery production | Capture fishery production factors |
| | | Capture fishery and marketing processes | The fishery process |
| | | | The marketing process |
| | | Capture fishery and consumption regulations | Capture fishery regulations |
| | | | Consumption regulations |
| | **Unit 3: Capture Fishery and Technology** | Post-harvest technology | Post-harvest technology |
| | | Communication technology processes in capture fishery | Communication technology in capture fishery – their uses |
| | **Unit 4: Types of Forestry and Forests** | Identifying forest products | Properties and functions |
| | | | Purposes and benefits |
| | | Classifying forest products | Species |
| | | | Properties and functions |
| | | | Purposes and benefits |
| | | Processing forest products | Cultivation and maintenance |
| | | | Harvesting and processing |
| | **Unit 5: Forest Harvesting Practices and Management Systems** | Producing and preserving forests products | Nursery |
| | | | Plantation establishment |
| | | | Saw milling |
| | | Forestry Regulations | Forestry Act |
| | **Unit 6: Forestry and Technology** | Plantation and growing timber species | Silviculture – fertilizer application |
| | | Constrains and solutions | Land tenure |
| | | | Labor |
| | | | Maturity time (harvest) |
| **Agribusiness** | **Unit 1: Starting Up and Managing an Agribusiness** | Financial Management | Managing finances |
| | | | Record keeping |
| | | Credit Organisations | Formal & Informal credit organisations |
| | | Management of Debt | Debt and equity financing |
| | | | Impact of debt and equity financing |
| | | Financial Statements | The importance of financial statements |
| | | Cash Flow | Preparing a cash flow statement |

## Strand 1: Crops

| Units | Benchmarks | Topics | Lesson Titles |
|---|---|---|---|
| **Content Standard 11.1.1** Students will be able to explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and investigate strategies and processes for improving soil fertility to support crop cultivation and maximise crop production returns in different environments | | | |
| **Soils** | **11.1.1.1**. Investigate and explain how different types of soil obtain their nutrients. | Soil Nutrients | Nutrients<br>Macro-nutrients<br>Micro-nutrients |
| | **11.1.1.2.** Analyze each soil type to determine the composition of different types of nutrition. | Soil Composition | Biotic Factors<br>Abiotic Factors |
| **Content Standard 11.1.2** Students will be able to identify and examine the characteristics and physiology of different types of crops, categorize them according to their characteristics, purposes and benefits and explore the different contexts, environments and places where they are farmed. | | | |
| **Types of Crops** | **11.1.2.1**. Investigate and explain the botany of different crops | Crop Botany | Characteristics of biennial crops |
| | **11.1.2.2** Examine the anatomy of different crops and explain how different environments influence the formation of different parts of crops. | Crop anatomy and Environment | Anatomy of crops<br>Factors affecting formation of different crop parts. |
| **Content Standard 11.1.3** Students will be able to investigate and analyse crop farming, processing, marketing, regulation, and management principles, systems and practices used in different contexts, environments and places | | | |
| **Crop Farming Practices and Management Systems** | **11.1.3.1**. Identify and explain the factors of crop production. | Principles and Practices of Crop Production | Factors affecting crop production<br>Soil fertilizer and availability of water<br>Climate, pest and diseases |
| | **11.1.3.2** Investigate the principles of marketing and explain how these can be used for marketing and sale of crops | Marketing Principles and sale of crops | Importance of marketing<br>Marketing concepts |
| **Content Standard 11.1.4** Students will be able to examine how technology is used in cultivation, regulation, and management of crops in different societies and environments, and analyse their advantages and disadvantages. | | | |
| **Crop Farming and Technology** | **11.1.4.1.** Evaluate the use of internet and mobile phones to communicate and disseminate crop farming information and market crop products. | ICT in crop farming and marketing | Importance of ICT in agri-culture marketing<br>Advantages and disadvantages of internet and mobile phones in crop farming and marketing |
| | **11.1.4.2.** Identify and evaluate the effectiveness of different technology used for regulating and monitoring the cultivation, production, marketing, and consumption of different crops. | Technologies in mon-itoring, producing and consuming crops | Monitoring Technology in crop farming<br>Production and consumption technologies in marketing<br>Effectiveness of crop monitoring technology |

| | | | |
|---|---|---|---|
| **Content Standard 11.1.5** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits and explore the different contexts, environments, and places where they are farmed. | | | |
| **Plants** | **11.1.5.1.** Identify and examine different types of aromatic and herbal plants, and analyse their functions, purposes, and benefits. | Types of aromatic and herbal plants | Aromatic and herbal plants<br>Species of aromatic and herbal plants |
| | **11.1.5.2**. Research and classify aromatic and herbal plants according to their species, functions, purposes, and benefits. | Characteristics and benefits of aromatic and herbal plants | Characteristics of aromatic and herbal plants<br>Benefits of aromatic and herbal plants |
| | **11.1.5.3.** Investigate and explain how aromatic and herbal plants are cultivated and processed in different environments and places. | Cultivation and processing | Cultivation of aromatic and herbal plants<br>Processing of aromatic and herbal plants |
| | **11.1.5.4.** Examine and explain how aromatic and herbal plant products are processed, preserved, and marketed in different contexts and environments | Processes and preservation techniques of aromatic and herbal plants | Preservation Techniques of aromatic plants |
| **Content Standard 11.1.6** Students will be able to investigate and analyse the different types of horticulture and management principles, systems and practices used in different environments and places to cultivate, process, preserve, market, regulate and consume different types of plants | | | |
| **Plant Farming Practices and** | **11.1.6.1** Assess different approaches and practices for producing and preserving horticulture products. | Horticulture products | Horticulture Products |
| | **11.1.6.2.** Investigate and explain how the cultivation, processing, preservation, sales and marketing, and consumption of horticulture products are regulated in different places. | Horticulture regulations | Marketing Functions<br>Marketing Channels |
| **Content Standard 11.1.7** Students will be able to examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyze their advantages and disadvantages. | | | |
| **Plant Farming and Technology** | **11.1.7.1** Investigate and explain how technology could be used to mass produce and commercialise herbal, aromatic, spice, and ornamental plants in PNG at a large scale. | Technology in Enhancing Horticulture Farming | Herbal plants<br>Aromatic plants<br>Ornamental plants<br>Spices |
| | **11.1.7.2** Investigate and identify a problem related to the cultivation, production, and marketing of products from horticulture plant, and develop appropriate solutions to solve the problem. | Constraints in Cultivation and Marketing Horticulture Plant | Constraints faced in production of horticulture plants<br>Solutions to problems related to production of horticulture plants |

## Strand 1: Crops — Unit 1: Soils

**Content Standard 11.1.1**Students will be able to explain the process of soil formation, examine the nutrients, characteristics, uses and functions of different types of soil, and investigate strategies and processes for improving soil fertility to support crop cultivation and maximise crop production returns in different environments

**Benchmark 11.1.1.1**. Investigate and explain how different types of soil obtain their nutrients.

### Topic 1: Soil Nutrients

**Learning Objectives:** By the end of this topic, students will be able to:

- Explain macro nutrients
- Distinguish between micro nutrients and macro nutrients

**Essential questions:**

1. What are soil nutrients?
2. What is the difference between macro and micro nutrients?

| ESSENTIAL KNOWLEDGE, SKILLS, ATTITUDES, VALUES | |
|---|---|
| **Knowledge** | Macro nutrients and micro nutrients |
| **Skills** | Describe macro and micro nutrients |
| **Attitudes** | Appreciate, show curiosity towards learning about soil nutrients |
| **Values** | Value different types of soil nutrients |

**Content Background:**

Soil nutrients-any substances that the plants take in from the soil in order to grow and reproduce. Plants also can get their food from the remains of animals and plants.

The nutrients are divided into two groups which are macro nutrients and micro nutrients.
These two groups of nutrients are present in the soil in order to make it fertile.

Macro nutrients are required by the plant in relatively large amounts.
Micro nutrients are required by plants only in small quantities.

| Macro nutrients | Deficiency signs |
|---|---|
| **Non-mineral elements** | |
| Carbon (C), hydrogen (H) and oxygen (O). | These nutrients don't have deficiency signs, they are always available. |
| **Primary nutrients** | |
| Nitrogen (N) | The older leaves of plants become yellow or light green in colour. Slow and dwarfed plant growth |
| Phosphorus (P) | Older leaves develop purple colour, stunted growth of plants |

| | |
|---|---|
| Potassium (K) | Older turn yellow on the leave margins and stunted growth. |
| Secondary nutrients | |
| Magnesium (Mg) | Older leaves show yellowing between leave veins |
| Calcium (Ca) | Poor growth of roots and shoots of young plants. |
| Sulphur (S) | Yellowing in young and old leaves. |

| **Micro nutrients** | **Deficiency signs** |
|---|---|
| Boron (B) | Terminal buds die |
| copper | Leaves are dark green and stunted growth |
| iron | Yellowing occurs on the vines of leaves. |
| Manganese (Mn) | Palm fronds are stunted and deformed. Slow growth of plant parts. |
| zinc | Yellowing occurs between the veins of the leaves. |

**Assessment Task**: Conduct a soil test and analyse the nutrient level in different soil samples in small groups.

**Reference:** https://www.slideshare.net/amadabbott/soil-nutrients-

## Strand 1: Crops Unit 1: Soils

**Benchmark 11.1.1.2**. Analyse each soil type to determine the composition of different types of nutrition.

### Topic 2: Soil Composition

**Learning Objectives:** By the end of this topic, students will be able to:

- Explain biotic and abiotic factors as part of soil composition
- Differentiate between biotic and abiotic factors

**Essential questions:**

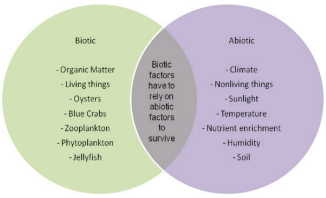
1. What are biotic factors?
2. What are abiotic factors?

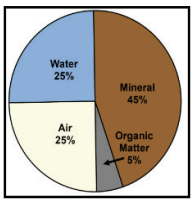
| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Biotic and abiotic factors |
| **Skills** | Distinguish between biotic and abiotic factors |
| **Attitudes** | Being appreciative that soil comprised of both biotic and abiotic factors |
| **Values** | Value the importance of biotic and abiotic factors in soil composition |

### Content background

Soil is one of the most important elements of an ecosystem. It is comprised of different components such as organic matter, minerals, gaseous and water. The organic matter of the soil composition is mainly made up of plants and animals and insects including both living and once living. All these makes up the biotic factors in the ecosystem. Minerals, gaseous, and water are also important components of soil composition. They make up the abiotic factors.

Generally, biotic factors include living and once living things such plants and insects and abiotic factors include nonliving factors such as minerals, water and air. They both played significant roles in the growth and development of plants.




**Source:**
https://socratic.org/questions/what-are-some-examples-of-biotic-factors-in-an-ecosystem

**Assessment Task:** Plan and carry out an excursion to a site. Identify and describe the biotic and abiotic factors of the particular ecosystem and write a report.

**Reference:** https://byjus.com/biology/what-is-soil/
https://socratic.org/questions/what-are-some-examples-of-biotic-factors-in-an-ecosystem
https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/7thru12/

## Strand 1: Crops — Unit 2: Types of Crops

**Content Standard 11.1. 2** Students will be able to identify and examine the characteristics and physiology of different types of crops, categorize them according to their characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed.

**Benchmark 11.1.2.1**. Investigate and explain the botany of different crops.

### Topic 1: Crop botany

**Learning Objectives:** By the end of this topic, students will be able to:

- Identify and examine the characteristics and physiology of different types of biennial crops

**Essential questions:**

1. What are the characteristics of biennial crops?
2. How is the characteristics of biennial crops different from each other?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | • Botany of different biennial crops |
| **Skills** | • Identify and examine the botanical features of biennial crops |
| **Attitudes** | • Appreciative about the botanical features of different types of biennial crops |
| **Values** | • Being optimistic in examining the characteristics of biennial crops |

**Content background**

Biennial are plants that completes their life cycle in two years. In the first season, plant growth occurs, and in the second season, flowers, fruits and seeds appear followed by the entire plant's death.

*Biennial Foxglove*

**Types of biennial plants**

Biennials can be grouped according to their uses. Some of them can be used for various purposes.

1. Seasonal Flowers: a few flowers used in gardening are biennial plants, however, some of them are perennial depending on their place of origin or when they are grown in areas that present similar conditions like their area of origin. For example, pansies or foxgloves. They are perennials when grown and cultivated in there are of origin, however when they are cultivated in other colder sites, they are biennials

2. Food: Some vegetables are obtained from biennials plants, for example cabbage, parsley, carrots, etc. For instance, cabbage, it is usually during the

first year when the leaves of their basal rosette develop which is the edible part that is used as food. If not pulled out off the ground, then in the second season it develops a vertical stem from which their yellow flowers grow.

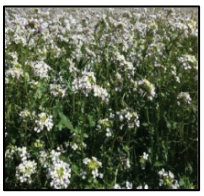
3. Wild herbs: This group of herbs are not as common as annual herbs, it contains species that are particularly prevalent in cultivated fields such as thistles or white rocket *(Diplotaxis erucoides)*

**Assessment Task:**

- Research about (3) different biennial crops and outline the similarities and differences in their characteristics in their local context. Do a presentation.

**Reference**:

https://byjus.com/biology/classification-of-plants/
https://www.britannica.com/science/biennial
https://aggie-horticulture.tamu.edu/wildseed/growing/annual.html
https://www.botanical-online.com/en/botany/plants-biennial-characteristics
https://www.botanical-online.com/en/botany/milk-thistle-characteristics

## Strand 1: Crops — Unit 2: Types of Crops

**Content Standard 11.1. 2** Students will be able to identify and examine the characteristics and physiology of different types of crops, categorise them according to their characteristics, purposes, and benefits, and explore the different contexts, environments, and places where they are farmed.

**Benchmark 11.1.2.2**. Examine the anatomy of different crops and explain how different environments influence the formation of different parts of crops.

### Topic 2: Crop Anatomy and Environment

**Learning Objectives:** By the end of this topic, students will be able to:

- Examine and describe the anatomy of crops?
- Explain the influence of environment on the formation of different parts of crops

**Essential questions:**

1. What is crop anatomy?
2. How does environment influence the formation of different parts of crops?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Structure and functions of different crops, |
| **Skills** | Identify and examine anatomy of different crops |
| **Attitudes** | Appreciate the structure and functions of different crops |
| **Values** | Be responsible and take care of plants. |

### Content background

In botany, (scientific study of plants) plant/crop anatomy merely focuses on the structural or body parts and systems that make up a plant. A typical plant or crop consists of three major vegetative organs; the root, the stem, and the leaf as well as a set of reproductive parts that include flowers, fruits and seeds.

| PLANT PART | FUNCTIONS |
|---|---|
| **Root** | A plant's roots acts as a foundation to the plant which help it to stay upright. It also absorbs water and dissolved minerals from the ground and give the plant what it needs to make its own food. |
| **Stem** | Plant stems perform two functions; supports the upper parts of the plant aboveground, the buds, leaves and flowers, and they carry water and food from place to place within the plant itself. |
| **Leaf** | The primary function of leaves is to absorb sunlight for the manufacture of plant sugars during the process of photosynthesis. In photosynthesis, the chlorophyll (green pigment) in the leaf absorbs energy from the Sun, combines it with water and minerals from the soil and carbon dioxide from the air and produces the plant's food. |

| | |
|---|---|
| Reproductive Part; Flower, Seeds and Fruit | The reproductive part of a seed- producing plant is called flower. They consist of a male and female cell that produces a seed when unite. The stamen is the male part and pistil is the female part. |
| | Seeds have three main parts: the coat, the embryo, and the food storage tissue. The coat protects the embryo, which is the beginning of a plant and grows by using food stored in the seed. |
| | The fruit is mainly the structure that protects the seeds as they develop. It also functions as a dispersal mechanism, as in the milkweed pod. A fleshy such as an apple keeps the seeds moist until they are ready to germinate |

**Environmental influences on growth of plants**

Unlike animals, plants cannot move when the environment changes. They are often at the mercy of the climate and the gardener because they are rooted in place. Hence, the entire growth of plant and distribution are influenced by the environment in which it lives and grow. If one environmental factor is less than ideal, it will become a limiting factor in the plant growth. Listed below are four main environmental factors that influence the plant growth and development;

- Water
- Light
- Temperature
- Air

**Assessment Task:**

In groups of 4 – 5 pupils, select a particular type of crop and examine its structure and functions. Create a 3D model of the crop.

**Reference:**

https://www.encyclopedia.com/social-sciences/applied-and-social-sciences-magazines/plant-

## Strand 1: Crops
## Unit 3: Crop Farming Practices and Management Systems

**Content Standard 11.1. 3** Students will be able to investigate and analyse crop farming, processing, marketing, regulation, and management principles, systems and practices used in different contexts, environment and places

**Benchmark 11.1.3.1**. Identify and explain the factors of crop production.

### Topic 1: Principles and Practices of crop Production

**Learning Objectives:** By the end of this topic, students will be able to:

- Explain the principles and practices of crop production
- Identify and describes pest and diseases of crops

**Essential questions:**

1. What are the factors affecting crop production?
2. What pest and diseases affect crop production?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Factors affecting crop production |
| **Skills** | Identify and describe different pest and diseases of crops |
| **Attitudes** | Being appreciative and open -minded towards one another when sharing ideas |
| **Values** | Value the importance of principles and practices of crop production |

**Content background**

Crop Production is the art and science of the genetic improvement of crops to produce new varieties with increased productivity and quality. There are various principles and practices attached to highly yields of crops.

**Types of Principles and Practices of Crop Production**

The following are some principles and practices that promotes an increased productivity of crops. Each of them plays essential role in sustaining the growth and development of crops without being damaged.

1. Preparation of soil
2. Sowing
3. Managing soil nutrients
4. Proper selection of crop sequence
5. Irrigation or moisture conservation
6. Protection from weeds, pests and diseases
7. Harvesting
8. Proper Storage
9. Human activities; for instance, there could be increase in yield if he practices crop rotation.

**Factors affecting Crop Production**

There are several factors that affects a higher crop productivity in agriculture today. These factors can be environmental, technological and social etc. The environmental factors can be further classified as biotic and abiotic factors. The biotic factors include diseases and pests, parasites, weeds, predators, etc., while the abiotic includes; climatic conditions, drought, frost, soil salinity, air and soil pollution.

**Types of Pest and Diseases**

Plant diseases are caused by different micro organisms such as viruses, bacteria and fungi. In addition, there are other various soil – borne and above ground insect pest which also affect crop production. The term pest refers to organisms, often insects, which can cause damage to a crop.

**Assessment Task:**

Develop a sustainable crop management strategy to address factors affecting crop production in the context of climate change in P.N.G.

**Reference:**

https://www.intechopen.com/chapters/70658
https://www./85517-principle_practices_crop_rotation_2017.pdf

**Strand 1: Crops Unit 3: Crop Farming Practices and Management Systems**

**Content Standard 11.1. 3** Students will be able to investigate and analyse crop farming, processing, marketing, regulation, and management principles, systems and practices used in different contexts, environment and places

**Benchmark 11.1.3.2**. Investigate the principles of marketing and explain how these can be used for marketing and sale of crops.

**Topic 2: Marketing Principles and sale of crops**

**Learning Objectives:** By the end of this topic, students will be able to:

- Explain the principles of marketing and sale of crops
- Describe the importance of marketing of crops

**Essential questions:**

1. What principles are involved in marketing and sale of crops?
2. What is the importance of marketing?

| **Essential Knowledge, Skills, Attitudes and Values** | |
|---|---|
| **Knowledge** | • Principles of marketing and sale of crops, importance of marketing |
| **Skills** | • Describe principles of marketing |
| **Attitudes** | • Being appreciative, open -minded |
| **Values** | • Value the importance and principles of marketing and sale of crops |

**Content background**

Agricultural marketing plays an important role not only in stimulating production and consumption, but also in accelerating the pace of economic development. It is the most important multiplier of agricultural development. In the process of shifting from traditional to modern agriculture, marketing emerges as the biggest challenge because of production surpluses generated by the shift.

**What is Marketing?**

Marketing is a series of activities involved in moving a product or service from the point of production to the point of consumption. It involves finding out what the customers want and supplying it to them at a profit. Some activities which closely associates with marketing include cleaning, drying, sorting, grading and storage, as well as things like transport, processing, packaging, advertising, finding buyers and selling the product. Apparently, the marketing principles are centered around the four P's, **Product**, **Promotion, Place, Price**

1. Product. Goods and services (creating offerings).
2. Promotion. Communication.
3. Place. Getting the product to a point at which the customer can purchase it (delivering).
4. Price. The monetary amount charged for the product (exchange).


**Assessment Task:**

Propose and construct a market plan for different crops in local context.

**Reference:**

https://assets.publishing.service.gov.uk/media/57a08c57ed-915d622c0012a1/RALF2_003.pdf
https://fscluster.org/sites/default/files/documents/session_3._crop_value_addition_and_marketing_7072022.pdf
https://byjus.com/commerce/agricultural-marketing/
https://2012books.lardbucket.org/pdfs/marketing-principles-v1.0.pdf

## Strand 1: Crops Unit 4: Crop Farming and Technology

**Content Standard 11.1. 4** Students will be able to examine how technology is used in the cultivation, regulation, and management of crops in different societies and environments, and analyze their advantages and disadvantages.

**Benchmark 11.1.4.1**. Evaluate the use of internet and mobile phones to communicate and disseminate crop farming information and market crop products

### Topic 1: ICT in crop farming and Marketing

**Learning Objectives:** By the end of this topic, students will be able to:

- Explain and outline the importance of ICT in crop farming and marketing
- Describe the advantages and disadvantages of mobile phones and other source of ICT in crop farming and marketing.

**Essential questions:**

1. What is the importance of ICT in crop farming and marketing?
2. What are the advantages and disadvantages of ICT in crop farming and marketing?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | • Importance of mobile phones and internet in crop farming and marketing, Advantages and disadvantage of usage of ICT in crop farming |
| **Skills** | • Outline importance of ICT in crop farming, Describe the advantages and disadvantages |
| **Attitudes** | • Being appreciative and enthusiastic |
| **Values** | • Value the use of internet and mobile phones in crop farming and marketing |

**Content background**

Today in the world, the use of information and communication technology (ICT) particularly the mobile phones and internet has empowered many farmers to communicate from local to administrative levels regarding the agricultural trade, information exchange, and buying and selling inputs and farm commodities.

It has reduced the cost of traveling and improved the production efficiency of farming communities living in remote areas. The mobile phone has tremendously been diffused even into the marginalized and underdeveloped farming communities because of its flexibility, affordability and user-friendly nature as compared to other ICT tools.

**Advantages and Disadvantages of use of mobile phones in crop farming and marketing**

The use of mobile phones compared to other ICT tools has brought in good number of benefits and advantages. However, it also has some disadvantages of being used widely around the world. Some of these includes:

- Provides communication links between farmers and buyers or retailers
- Promotes innovative payment methods. E.g. SMS banking, internet banking
- Encourages making informed decisions in relation to crops, weather forecasting, seeds, fertilizers etc.
- Promotes stronger social network in farming

Disadvantages:

- Poor network signal and internet connectivity,
- Illiterate with phone features,
- Unavailability of phones 'accessories,
- Inaccessibility to recharge voucher

**Assessment Task**: Carryout research on effectiveness of ICT and mobile phones in crop production and marketing and do a presentation.

**Reference:** (https://www.scielo.br/j/cr/a/v4VvTspq6JLYCKR5YdxM6PR/

**Content Standard 11.1. 4** Students will be able to examine how technology is used in the cultivation, regulation, and management of crops in different societies and environments, and analyze their advantages and disadvantages.

**Benchmark 11.1.4.2**. Identify and evaluate the effectiveness of different technology used for regulating and monitoring the cultivation, production, marketing, and consumption of different crops.

**Topic 2: Technologies in Monitoring, Producing and Consuming crops**

**Learning Objectives:** By the end of this topic, students will be able to:

- Identify different technologies used in monitoring, producing and consuming crops.
- Explain the effectiveness of technologies in monitoring, producing and consuming different crops.

**Essential questions:**

1. What types of technologies are used in monitoring, producing and consuming different crops?
2. How effective is the use of technology in monitoring, production and consuming different crops?

| **Essential Knowledge, Skills, Attitudes and Values** | |
|---|---|
| **Knowledge** | • Types of technologies in monitoring, producing, consuming different crops |
| **Skills** | • Examine effectiveness of monitoring, production and consuming technologies in crop farming |
| **Attitudes** | • Being appreciative and enthusiastic |
| **Values** | • Value the use of different technologies in crop farming and marketing |

**Content background**

The adoption of technology has been important to production agriculture in the 21st century. Technology has improved and aggregate agriculture to new dimensions.

Technologies in Monitoring, Producing and Consuming various crops

1. Biotechnology and Nutritional Technology

   It manipulates the growth, attribute development and deteriorate processes in plant production. Biotechnology also the advances the capacity to control the plant attributes composition (for example, starch or amino acid composition) through genetic manipulation. Innovations in sensors are often use in monitoring and control systems, communication technologies, and data analytics.

2. Monitoring, Measuring and Information Technology

The emphasis of this technology is to trace the development and/or deterioration of attributes in the plant growth process and measures the impact of controllable and uncontrollable variables affecting growth process. examples of such include yield monitors, global positioning system (GPS), global information system (GIS), aerial images and weather monitoring and measuring systems, plant and soil sensing system are all part of this technology

3. Process Control Technology.

This particular technology function is to intervene with proper adjustments or controls in closing gaps in any time actual performance of process deviates from potential performance. Greenhouse production increasingly utilizes such technology to manipulate sunlight, humidity, temperature, and other characteristics of the plant growth environment. Automated irrigation systems are examples of such technology.

**Assessment Task**:

Use a set of guided questions to analyse the effectiveness of technology in monitoring, producing and consuming crops.

**Reference** :

https://farmdocdaily.illinois.edu/2021/03/importance-of-new-technologies-for-crop-farming.html

## Strand 1: Crops — Unit 5: Plants

**Content Standard 11.1.5** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits and explore the different contexts, environments, and places where they are farmed.

**Benchmark 11.1.5.1.** Identify and examine different types of aromatic and herbal plants, and analyse their functions, purposes, and benefits.

**Topic: Aromatics and Herbal Plants**

**Learning Objective**
- Research and analyse the cultivation and propagation of aromatic plants.

**Essential Questions**
1. How are aromatic plants cultivated and propagated?

| | |
|---|---|
| **Essential Knowledge** | Cultivation and Propagation of Aromatic Plants |
| **Essential Skills** | Research and analyse characteristics of aromatic plants |
| **Essential Attitudes & Values** | Appreciate and value the cultivation and propagation processes of aromatic plants. |

**Assessment**

Cultivate and process an aromatic plant in your area

**Content Background**

**Lemon balm (Melissa officinalis)**
With a delicious lemony taste, the lemon balm plant leaves are used for both culinary and medicinal purposes. Use it in place of lemon peel to flavor sauces and vinegars, or add it to your homemade pesto for a bright, citrusy flavor.

Lemon balm loves a home on a sunny windowsill in your kitchen, where it can get at least 6 hours of direct sunlight every day. The pot can be moved outside to enjoy the beautiful weather during the summer months in warmer climates. When the leaves are rustled, they release their aroma, which acts as a natural mood booster.

**Mint (Mentha spp.)**

One of the most common herbs grown, mint plants, come in many different types that vary slightly in their characteristics, including flavor. There are about two dozen species and over seven thousand varieties, but the two main types that are grown are peppermint and spearmint. All types have broad leaves in green shades that release a distinctive, albeit minutely different, menthol-based scent when bruised or crushed.

Mint can be a nuisance plant in your aromatic garden, taking over any free space it can infringe, which is why it's a great herb to grow indoors as a container plant. The container forces it to stay in its area and keeps its growth in check.

**Lavender (Lavandula spp.)**

One of the quintessential herbs and known for its revered scent, lavender is grown as a small, perennial shrub in most parts of the United States. There are five main types of lavender grown: English, French, Spanish, Portuguese, and Lavandin, a hybrid. It can be challenging to grow, though, as it prefers hot, arid conditions. This means it is very temperamental when given too much water or grown in high humidity.

When growing your own lavender, it almost appreciates being neglected to a certain degree. Allow the top one or two inches of soil to dry out before watering, and go easy on the fertilizer.

**Chamomile (Matricaria chamomilla)**

Growing chamomile indoors not only extends your outdoor growing season, providing you with fresh herbs all year round, but the beautiful white blossoms bring a touch of spring into your home. Chamomile grows very quickly, filling containers with full blooms in about ten weeks.

Keep the potting soil moist at all times, and place pots where the plant receives full sun during the day. They aren't picky about the types of containers as long as they have adequate drainage in the bottom. It is crucial to make sure the pots are heavy enough they won't tip over when plants start growing tall.

**Rosemary (Salvia rosmarinus)**

Rosemary is typically grown outdoors as a highly aromatic evergreen shrub but can be grown as a container plant indoors if given enough light. Ensure plants receive 6 to 8 hours of direct sun daily, and be careful not to overwater them, causing root rot. For the hardiest plants, choose standard green rosemary over the decorative, variegated varieties.

When rosemary sprigs are harvested, its strong flavoring pairs well in meat dishes such as lamb, pork, and veal. The flat, needle-like leaves dry down incredibly well, so you can store the herb for later use.

**Basil (Ocimum basilicum)**

Known for its essential role in Italian cuisine, basil{: target="_blank" rel="noopener"} is the key ingredient in pesto, and it is also paired often with tomatoes and used in a wide array of pasta dishes. Basil plants enjoy the conditions of summertime – hot with full sun. Put plants in a sunny windowsill or a garden spot where they received a minimum of 6 to 8 hours of direct sun daily. In the fall, when day lengths shorten, growth decreases, so it may be helpful to supplement plants with a grow light throughout the winter.

Basil is very sensitive to cold temperatures, so it's essential to keep plants away from draft windows in the winter or air conditioning vents in the summertime.

**Pineapple sage (Salvia elegans)**

While all sage plants are known for their aroma – which reminds many of elaborate home-cooked Thanksgiving dinners – pineapple sage adds a unique, exciting scent to your herb garden. The fresh leaves are used in summertime beverages or fruit salads.

Pineapple sage plants bloom in the late fall, displaying scarlet-red, tubular flowers revered by hummingbirds. Compared to many of the other 700 cultivars of sage, the foliage on pineapple sage is lighter in color, closer to a yellow-green or greenish-yellow instead of the darker green. This adds excellent contrast when grown next to vibrantly green herbs.

**Bay laurel (Laurus nobilis)**

Grown as an evergreen tree or shrub, bay laurel's leaves are typically used to season many slow-cooked dishes like casseroles and stews. Shrubs are hardy and incredibly easy to grow, requiring little care. Growing them in containers outdoors restricts their overall size, keeping them smaller and more manageable.

Bay laurel grows well in containers – whether indoors or outside – as the containers restrict their overall growing habit, keeping plants shorter and more manageable. When grown indoors, regularly prune plants, so they don't exceed more than 5 or 6 feet in height. Keep plants in a brightly lit spot in your home, so they receive a minimum of six to eight hours of direct sunlight each day.

**Catnip (Nepeta cataria)**

Also known as catmint, catnip is a hardy perennial herb belonging to the mint family. It can be used by both cats and humans, giving you plenty of reasons to add this plant to your list of fragrant herbs to grow. There are many reasons to add catnip plants to your indoor herb garden with uses for both cats and humans.

Catnip contains the essential oil which mimics a specific feline pheromone, triggering brain receptors and the associated euphoric side effects. If catnip is consumed, it acts as a sedative for your cat; if sniffed, it acts as a stimulant. In humans, it doesn't induce the same euphoric responses but has many medicinal uses.

**Thyme (Thymus vulgaris)**

One of the popular culinary herbs, thyme bears heady aromatic leaves on a low-growing evergreen plant. The flavor varies slightly depending upon the specific variety grown; thyme is usually used to season soups, stews, and meat dishes.

When grown in a container, plant thyme in a clay pot to let the soil dry out between waterings; it hates having soggy roots, preferring the soil to be a touch on the dry side. Regularly pinch the tops off your plants and prune back woody stems to encourage fuller, bushy plants full of new growth. When grown outside, it makes an excellent ground cover.

**Marjoram (Origanum majorana)**

Native to the Mediterranean, marjoram{: target="_blank" rel="noopener"} is well suited for growing indoors in containers since this tender perennial loves warm, sunny, arid climates. Plants spread like ground covers, so they grow best in wide, shallow containers with plenty of room for the trailing stems.

Marjoram is drought resistant, so allow the potting soil to dry out before watering your plant. Too much water causes root rot and encourages both insect pests and disease problems. When plants are six inches tall, begin harvesting from the plant's tips to keep it bushy and full.

**Oregano (Origanum vulgare)**

Oregano seasons many Mexican and Mediterranean and dishes and is gaining popularity in indoor herb gardens. Plants are perennial, coming back year after year when grown outside. Indoors they prefer light, well-drained soils and little to no fertilizer. Allow the soil to dry out between watering. When grown outdoors, it acts as a perennial plant, coming back every spring.

The more you harvest oregano, the fuller the plant will be, continuing to put out new growth. The subtly flavored purple to white flowers should be removed from the plants as soon as they appear – instead of throwing them away, use them as a topping for salads.

**Anise hyssop (Agastache foeniculum)**

With a flavor comparable to anise, the herb anise hyssop is confusing as it is neither anise seed nor hyssop, and it isn't even a blend of the two. A member of the mint family, it adds a mild, minty, licorice flavor to vegetable dishes and salads. The seeds are used as a substitute for anise when baking; the leaves are used either fresh or dried to make herbal tea.

Anise hyssop grows well as a companion plant with most other herbs. Impressive spikes of lavender-colored blooms add a beautiful touch to your herb garden, whether indoors or out.

**Content Standard 11.1.5** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits and explore the different contexts, environments, and places where they are farmed.

**Benchmark 11.1.5.2**. Research and classify aromatic and herbal plants according to their species, functions, purposes, and benefits.

**Topic: Aromatic and Herbal Plants**

**Learning Objective**

- Classify aromatic and herbal plants according to their species, functions, purposes and benefits

**Essential Questions**

1. How can aromatic and herbal plants be classified in terms of their species, functions, purposes and benefits?

| | |
|---|---|
| **Knowledge** | Aromatics and herbal plant species, uses and benefits |
| **Skills** | Research and classification of aromatic and herbal plants |
| **Attitudes** | Appreciative of the different species of aromatic and herbal plants |
| **Values** | Creative in using of aromatic and herbal plants |

**Assessment**

Create a chart and present different species of aromatic and herbal plants

**Content Background**

The production and consumption of essential oils, because of their multipurpose application is increasing continuously: essential oils are used in perfumery, the food industry, households, condiments, making sweets, beverages as well as pharmaceutical and aromatherapeutic products of plant origin. Occurrence of essential oils, or volatile oils, is very widespread in the plant kingdom. They are synthesised and accumulated in oil cells, in secretion ducts or cavities or in grandular hairs of plants. The ancient Greeks and Romans knew the majority of them because of their multipurpose utilisation. Today, according to market data, essential oils are produced on a large scale and commercialised from about 400 species, from 67 plant families. Hundreds of essential oil plants are collected or cultivated in all part of the world, including tropical, Mediterranean and temperate regions. This article contains data about the chemical characteristics, distribution and production of essential oils as a whole, and more detailed description is given about species of eight genera, three of tropical (lemongrass, eucalyptus, tea-tee and related species), three of Mediterranean (bitter orange, lavender, rose) and two of temperate origin (peppermint, lovage).

Figure 3. Cultivation of lemongrass *C. flexuosus* in India, Bangalore (photo: Bernáth, J.)
Source: https://www.botanical-online.com/en/medicinal-plants/aromatic-plants-list

## Strand 1: Crops — Unit 5: Plants

**Content Standard 11.1.5** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits and explore the different contexts, environments, and places where they are farmed.

**Benchmark 11.1.5.3.** Investigate and explain how aromatic and herbal plants are cultivated and processed in different environments and places.

**Topic: Cultivation and Processing**

**Learning Objective**

- Research and analyse the cultivation and processing of aromatic and herbal plants.

**Essential Questions**

1. How are aromatic and herbal plants cultivated and processed?

| | |
|---|---|
| **Knowledge** | Cultivation and processing of aromatic and herbal plants |
| **Skills** | Research skills in cultivation and processing of aromatic and herbal plants |
| **Attitudes & Values** | Appreciate an d value the cultivation and processing of aromatic and herbal plants |

**Assessment:** Conduct a class project on cultivation of herbal plants

**Content Background**

Aromatic plants have now conquered everyone. They are usually found in supermarkets, in seedlings or even shredded and ready to use for the preparation of tasty dishes. In some places in Italy, very lucky, there are those who are used to collect them directly from their own vegetable garden, for a totally green experience. The city's vegetable gardens are very widespread, green oases immersed in the daily chaos where you can recover a slow modus vivendi without neglecting the ancient and genuine flavors of km0.

**Aloe vera, the "plant of immortality"**

By growing aloe vera you will have a true source of well-being. From the leaves of this plant of Mediterranean and North African origin, a gel rich in active ingredients is extracted. The gel has nourishing, purifying, healing and anti-inflammatory properties and, thanks to steroids, gives relief in case of osteoarticular problems. Important are the benefits at the gastroenteric level and in cell regeneration thanks to the presence of acemannan.

Get a sandy and therefore draining soil and position it in the sun: it is a perennial plant, it resists well even at the lowest temperatures, but it is always better that in case of frost you cover the plant and prepare a mulch of the ground. It does not require many waterings as it is enough only 2-3 in a month, but it is recommended to fertilize it with fertilizer rich in potassium sulfate in October.

https://www.almanac.com/plant/aloe-vera Source Reference:

1. Health and wealth from medicinal aromatic plants - FAO http://www.fao.org/3/a-i2473e.pdf Livelihoods and sustainable development. Benefits of Medicinal Aromatic Plants. Contribution to sustainable livelihoods.

2. Aromatic Plants-How to Plant
https://njplantshow.com/aromatic-plants/24 Jul 2019 garden of plants right on yourbalcony, know that it only takes a few steps to grow aromatic plants and enjoy their scents, flavors and benefits,

## Strand 1: Crops — Unit 5: Plants

**Content Standard 11.1.5** Students will be able to identify and examine the characteristics and physiology of different types of plants, categorize them according to their characteristics, purposes, and benefits and explore the different contexts, environments, and places where they are farmed.

**Benchmark 11.1.5.4.** Examine and explain how aromatic and herbal plant products are processed, preserved, and marketed in different contexts and environments.

**Topic:** Aromatic and Herbal Plants

**Learning Objectives**
By the end of this topic, students will be able to:
- Research and analyse the preservation techniques of aromatic plants.

**Essential questions**
1. How are aromatic plants propagated and preserved?

| | |
|---|---|
| **Essential Knowledge** | • Cultivation and Propagation of Aromatic Plants |
| **Essential Skills** | • Research and analyse the preservative techniques of aromatic plants |
| **Essential Attitudes & Values** | • Appreciate and value propagation processes and preservative techniques of aromatic plants. |

**Content Background:**

Some methods that are used to preserve herbs include hang, wrap, cover and use of heat or microwave to dry specimens.

Tie eight to 10 herb stems together at the bottom of the stems. Hang the bundles upside down in a warm, dry place and let them dry for five to 14 days. The length of drying time will vary depending on humidity and herb type.

**How to preserve fresh herbs?**

There's no herb storage method that can retain the flavour of fresh herbs, but if you find yourself with more than you can possibly use, there are some methods that will work. Drying them in the microwave or oven is a great method if you want to have dried herbs on hand in the pantry. If you want to have something that more closely resembles fresh herbs for dressings and stews? In that case, the freezer is a good option.

**Freeze fresh herbs**

Parsley, basil and sage are difficult to dry, because their colour will change into brown, and to preserve the colour and taste it's best to freeze these kind of herbs. In fact freezing herbs is very easy, with these steps: Clean the herbs with a wet cloth and then chop them into fine pieces.

Place two tablespoons of the chopped herbs into an ice cube tray. Add 1 1/2 tablespoons olive oil to the herbs. Press the herbs down gently so they are compacted. Freeze the cubes and then transfer the frozen cubes from the tray to a freezer-safe container. You can use these herbs for stews, grilled fish and for a salad dressing.

**References websites.**


1. How to Freeze or Dry **Herbs**, **Herb** Garden | Gardener's Supply https://www.gardeners.com/how-to/freezing-herbs/5391.html27 Feb 2019 **...** When leaves are dry, remove them from **their** stems and store in an air-tight jar. Unless you live in **a**very arid climate, **herbs**

2. **How to Preserve Your Herbs** | Foodal https://foodal.com/knowledge/things-that-preserve/preserve-herbs/11 Oct 2018 **...** Garden **herbs** can be **preserved** in **a** variety of different ways. This guide will help teach you everything you need to know to **preserve your** own.

3. 9 Ways to **Preserve Your Herbs** and Use Them All Year Long https://morningchores.com/preserving-herbs/When your herb garden grows more than you can use, there are a couple of great ways to **preserve your herbs** and have them available all year long.

4. **How to Preserve Your Herbs** | Better Homes & Gardens https://www.bhg.com/recipes/how-to/cooking-basics/how-to-preserve-your-herbs/7 Jul 2016 **...** Wrap **herb** bunches in **a** damp paper towel and keep in an airtight resealable bag in the refrigeraton.

## Strand 1: Crops
## Unit 6: Plants Farming Practices and Management Systems

**Content Standard 11.1.6** Students will be able to investigate and analyse the different types of horticulture and management principles, systems and practices used in different environments and places to cultivate, process, preserve, market, regulate and consume different types of plants

**Benchmark 11.1.6.1** Assess different approaches and practices for producing and preserving horticulture products.

**Topic: Horticulture Products**

**Learning Objective**

- Identify and analyse the processing systems of aromatic plants

**Essential Questions**

1. How are aromatic plants propagated and preserved?

| | |
|---|---|
| **Knowledge** | Processing systems of Aromatic Plants |
| **Skills** | Research and analyse the processing systems of aromatic plants |
| **Attitudes** | Appreciate processing systems of aromatic plants |
| **Values** | Value aromatic plant processing systems |

**Assessment**
Design a plan on how to cultivate and process Aloe Vera

**Content Background**
Example. Processing of Aloe Vera gel

International Conference and Exhibition on Food Processing & Technology. November 22-24, 2012 Hyderabad International Convention Centre, India Ushakiran N. Scientific Tracks Abstracts: J Food Process Technol

Aloe bardadensis Miller species is the most popular and widely cultivated because of its medicinal and therapeutics values. Besides its medicinal values, Aloe Vera plant contains a number of nutrients such as vitamins, minerals, amino acids sugar, enzymes fatty acids and saponins which have positive effects on human body. Therefore at present it is often necessary to apply some type of processing i.e., Dehydration to get different Aloe Vera products; such as aloe soft drinks, tropical fruits juices with Aloe Vera, yogurt and yogurt drinks, instant Aloe Vera tea granules, Aloe Vera chewing gum for sore or bleeding gums. Aloe Vera leaves were processed into dehydrated Aloe Vera gel powder which could be used in food

formulation as a functional ingredient for health benefits.

Fresh Aloe Vera leaves were selected for uniformity according to harvest, colour, size and freshness were washed and scrubbed to remove mud, adhering material sand and bitter exudates on the rind surfaces. After washing, hand filleting was done to separate fillet from the rind and the fillet were cut into uniform slabs of 10 mm thickness which were dried at 60 degrees Celsius for 18 hours after drying the sample which is in flake form is scooped from the trays and powdered in a mixer.

**Processing** of **Aloe vera** gel - Longdom Publishing SL https://www.longdom.org/proceedings/processing-of-aloe-vera-gel-21539.html**Processing** of **Aloe vera** gel. International Conference and Exhibition on Food **Processing** & Technology November 22-24, 2012 Hyderabad International ...

1. **Processing** methods for **Aloe vera** leaf - International Aloe ... https://www.iasc.org/Portals/19/Documents/Scientific/16_0531_Decolorization_statement_final.p df?ver=2016-05-31-163902-97331 May 2016 **...** This purification step is usually accomplished via activated carbon filtration in a **process** known as decolorization. 2. Inner leaf **processing** method: ...
2. The **Process** - Lanzaloe **Aloe Vera** https://www.lanzaloe.com/en/el-aloe-vera/la-produccion/**Aloe vera** is cultivated from its off shoots: baby plants that sprout around the stem of adult plants and are ... Transportation of raw material to the **processing** plant.

## Strand 1: Crops

## Unit 6: Plant Farming Practices and Management Systems

**Content Standard 11.1.6** Students will be able to investigate and analyse the different types of horticulture and management principles, systems and practices used in different environments and places to cultivate, process, preserve, market, regulate and consume different types of plants

**Benchmark 11.1.6.2.** Investigate and explain how the cultivation, processing, preservation, sales and marketing, and consumption of horticulture products are regulated in different places.

### Topic: Horticulture Regulations

### Learning Objective

- Evaluate the horticulture regulations and make connections on how to apply it in daily lives.

### Essential Questions

1. How can horticulture regulations be applied in PNG?
2. Can we create a regulation of horticulture act in PNG

| | |
|---|---|
| **Knowledge** | Horticulture regulation |
| **Skills** | Evaluation process |
| **Attitudes & values** | Appreciate and be loyal to horticulture rules and regulations. |

### Assessment

After studying the food standards in primary production and processing requirements for horticulture, make relationships to PNG context and how it can be applied in PNG.

### Content Background

### Requirements applying to the production of horticultural produce Australia New Zealand Food Standards Code

The food standards apply to all food sold or traded at retail and wholesale level in Australia and New Zealand. These standards include labelling requirements; the maximum permitted levels for additives, processing aids, contaminants and natural toxicants; maximum residue limits for agricultural and veterinary chemical residues; requirements for articles and materials in contact with food; microbiological limits for food; as well as food product standards for certain individual food products.

Food Safety Standards apply only in Australia and only to food businesses involved in the handling of food intended for sale.

Primary food production means the growing, cultivation, picking, harvesting, collection or catching of food, and includes the following –

a) the transportation or delivery of food on, from or between the premises on which it was grown, cultivated, picked, harvested, collected or caught;
b) the packing, treating (for example, washing) or storing of food on the premises on which it was grown, cultivated, picked, harvested, collected or caught; and
c) any other food production activity that is regulated by or under an Act prescribed by the regulations for the purposes of this definition.

However, primary food production does not include –

a) any process involving the substantial transformation of food (for example, manufacturing or canning), regardless of whether the process is carried out on the premises in which the food was grown, cultivated, picked, harvested, collected or caught; or
b) the sale or service of food directly to the public; or
any other food production activity prescribed by the regulations under the Act for the purposes of this definition.

**Food Safety Standards**

Food Safety Practices and General Requirements specifies process control requirements to be satisfied at each step of the food handling process. Some requirements relate to the receipt, storage, processing, display, packaging, distribution disposal and recall of food. Other requirements relate to the skills and knowledge of food handlers and their supervisors, the health and hygiene of food handlers, and the cleaning, sanitising, and maintenance of premises and equipment.

Food Premises and Equipment sets out requirements for the design of food premises and equipment that, if complied with, will facilitate compliance by food businesses with the food safety requirements. This standard also includes requirements for storage facilities, toilet facilities and food transport vehicles.

**Maximum residue limits and contaminants**

Maximum Residue Limits lists the maximum permissible limits for agricultural and veterinary chemical residues present in food. If a maximum residue limit (MRL) for an agricultural or veterinary chemical in a food is not listed in Schedule 1 of Standard 1.4.2 there must be no detectable residues of that agricultural or veterinary chemical in that food. When agricultural chemicals are used under good agricultural practice and in accordance with prescribed use patterns, MRLs should not be exceeded.

Standard 1.4.1 – Contaminants and Natural Toxicants sets out the maximum levels (MLs) of specified metal and non-metal contaminants and natural toxicants in nominated foods. A ML has been established only where it serves an effective risk management function and only for those foods which provide a significant contribution to the total dietary exposure.

The levels set are consistent with public health and safety and are reasonably achievable from sound production and natural resource management practices. Maximum levels specified in Standard 1.4.1 include cadmium in leafy vegetables and root and tuber vegetables, and lead in vegetables.

**Labelling**

Standard 1.2.1 – Application of Labelling and Other Information Requirements, sets out the labelling requrements for food for sale and information that must be provided in conjunction with the sale of certain foods, where labelling is not required. There are exemptions for certain products to bear a label at retail sale, such as whole or cut fresh fruit and vegetables (except sprouting seeds or similar products) in packages that do not obscure the nature or quality of the fruit or vegetables. However, information should be able to be provided upon request.

In general, information requirements include:

- Name of the food
- Lot identification
- Name and address of the supplier of the food

Standard 1.2.11 – Country of Origin Requirements includes requirements specific to fresh whole or cut fruit and vegetables. Where such foods are displayed for retail sale there must be a label on or in connection with the display that identifies the country of origin of the food or provides a statement indicating that the foods are a mix of local or imported foods or both.

Standard 1.3.1 – Food Additives includes a range of additives that are permitted and not permitted to be added to unprocessed fruits and vegetables, untreated fruits and vegetables and surface treated fruits and vegetables. Definition of fruits and vegetables in this standard includes fungi, nuts, seeds and herbs.

Standard 1.3.3 - Processing Aids includes permitted bleaching, washing and peeling agents to be used in the course of fresh produce production. Also lists two permitted antimicrobial agents for fruits and vegetables.

Standard 1.4.4 - Prohibited and Restricted Plants and Fungi lists the species of plants and fungi that either must not be added to food or offered for sale as food. It also lists restricted plants and fungi that are can only be added to or be present in a food if they the requirements of natural toxicants as stated in clause 4 of the standard.

Standard 2.3.1 - Fruit and Vegetables provides definitions for fruit and vegetables, which include nuts, spices, herbs, fungi, legumes and seeds for the purposes of providing specific additive permissions.

### 3.2 Export requirements

Exporters must meet both the requirements of relevant export legislation and any importing country requirements for the Australian Quarantine and Inspection Service (AQIS) to provide the necessary documentation to enable products to be exported. Horticultural produce for export is regulated by the Export Control Act 1982, certain provisions of the Export Control (Prescribed Goods- General) Orders 2005, and the AQIS Export Control (Plants and Plant Products) Order 2011 (Plant and Plant Products Order).

The Export Control (Prescribed Goods – General) Order 2005 sets down general requirements for all prescribed goods and includes:

- Requirements for registration of establishments
- Trade description requirements
- Packaging requirements and export permits.

The Plant and Plant products Order applies to the export of the following prescribed goods:

- Prescribed grain
- Hay and straw
- Fresh fruit
- Fresh vegetables
- Any other plants and plant products for which a phytosanitary certificate or any other official certificate is required by an importing country authority.

It covers structural and operational and hygiene requirements for registered establishments. The requirements for registered establishments in Schedule 3 of the Plant and Plant Products Order include:

- Requirements for plans and specifications
- Records to be maintained (e.g. records for cleaning and pest control)
- Structural requirements for establishments
- Operational and hygiene requirements for establishments

While hygiene requirements are included in the Plant and Plant Products Order, their focus is on the control of pests for quarantine purposes rather than food safety.

#### Import requirements

The Quarantine Act 1908 requires that all imports of food comply with the quarantine conditions for their import. Quarantine restrictions apply to many raw foods and certain processed foods. Fresh fruit, vegetables and nuts are restricted items and cannot be imported into Australia unless they meet Australia's quarantine requirements and an import permit has been obtained. Australian quarantine conditions for the importation of plant produce (grains, seeds, nursery stock, fruit and vegetables) are administered by the AQIS Plant Program.

Food that meets quarantine requirements and enters Australia is subject to the Imported Food Control Act 1992, which provides for the inspection and control of imported food using a risk-based border inspection program, the AQIS Imported Food Inspection Scheme (IFIS). FSANZ advises AQIS on the risk categorisation of foods for inspection under the IFIS. Under the Imported Food control Act, importers are responsible for ensuring that all food imported into Australia complies with relevant standards in the Code.

Further information on importing foods into Australia and the Imported food Inspection Scheme can be accessed on the AQIS website.

**State legislation**

**Food safety**

To date, only NSW has developed specific food safety requirements for plant product industries (Plant Product Food Safety Scheme). These requirements apply to businesses conducting the following activities:

- Processing of fruit or vegetables to produce fresh cut ready-to-eat (RTE) products;
- Sprouting and processing of seed spouts;
- Extraction and/or packaging of juice from fruit or vegetables where the juice is not Subsequently pasteurised;
- Production of vegetables or fruit in oil;
- Refrigerated storage of these plant products, and
- Refrigerated distribution and/ or transporting of these plant products.

Food business engaged in the above activities must be licenced, have in place a certified food safety program and be independently audited for food safety. Requirements do not cover primary production activities.

**Chemical**

The regulation of agricultural and veterinary chemicals involves numerous state based control-of use legislation. The Australian Pesticides and Veterinary Medicines Authority (APVMA) undertakes the assessment and registration of AgVet chemical products nationally while states and territories are responsible for regulating AgVet chemical use after retail sale. There may be a number of State based Acts or regulations relating to chemical use. These cover control of use activities such as:

- Training and accreditation of users
- Licensing of professional operators
- Monitoring
- Surveillance and enforcement

**Strand 1: Crops** **Unit 7: Plant Farming and Technology**

**Content Standard 11.1. 7** Students will be able to examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environment, and analyse their advantages and disadvantages.

**Benchmark 11.1.7.1**. Investigate and explain how technology could be used to mass produce and commercialise herbal, aromatic, spice, and ornamental plants in P.N.G at a large scale.

### Topic 1: Technologies in Enhancing Horticulture Farming

**Learning Objectives:** By the end of this topic, students will be able to:

- Explain how technology could be used in mass production and commercialisation of horticulture plants.

### Essential Questions

1. What are some technologies that can enhance horticulture production?
2. How can technology impact the mass production of horticulture?
3. Why do you think technology is important for mass production of horticulture products?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Types of technologies in enhancing horticulture in mass production |
| **Skills** | Identify and describe use of technology in mass production of horticulture |
| **Attitudes** | Being appreciative and enthusiastic |
| **Values** | Value the influence of different technologies in mass production of horticulture |

### Content background

With the rapid global population growth, the total production of fruits, vegetables, and ornamental species has not been able to fulfill the growing demand. One of way achieving this is through using the tissue technique of propagation. Tissue culture has been widely used as a tool to improve plant characteristics and their development. However, the technique also has immense potential to clone a variety of horticulture plants in massive numbers.

This particular technique is called micropropagation botanically. It is used to propagate plants in a controlled environment using cells, tissues, or different parts of the plants, such as lead, lateral bud, shoot tip, stem, and root tissue. Over time the technique has been improved and developed to cover a vast application of growing plants.

In addition to this existing system, two more other systems have been developed for plant propagation for mass production purpose. This includes; Bioreactors and In vitro mycorrhization.

**Bioreactor**

Bioreactors are devices that provide a suitable active environment to plant cells for their better growth and development. The technique has been used to mass-produce over 80 crops and many are in experimentation.

**In Vitro**

The propagation technique requires the desired DNA copies of plants which can be further amplified by gene amplification method so that exact copies of desired DNA samples can be produced.

**Assessment Task:**

Watch a documentary video on types of technology used in Horticulture Farming and write a report based on the video.

**Reference**:

https://www.plantcelltechnology.com/blogtissue-culture-for-horticulture-crops-advancements-and-limitations/

**Content Standard 11.1. 7** Students will be able to examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environment, and analyse their advantages and disadvantages.

**Benchmark: 11.1.7.2** Investigate and identify a problem related to the cultivation, production, and marketing of products from horticulture plant, and develop appropriate solutions to solve the problem.

### Topic 2: Constraints in Cultivation and Marketing Horticulture Products

**Learning Objectives:** By the end of this topic, students will be able to:
- Identify and describe constraints and solutions related to cultivation and marketing horticulture products.

**Essential questions:**
1. What are some constraints and solutions related to cultivation and marketing in horticulture product?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Constraint and solutions in cultivating, production and marketing of horticulture plant |
| **Skills** | Research and analyse constraints and solutions in cultivating, production and marketing of horticulture plant |
| **Attitudes** | Promote openness and independence when expressing views related problems to cultivation, production and marketing of horticulture product |
| **Values** | Value each other opinions |

### Content background

Horticultural production is still characterized by low levels of farm output, low productivity, fluctuations in production and poor product quality.

In marketing, farmers are faced with high marketing costs, lack of access to main markets and low prices for their produce. Moreover, the quality of local produce is considered inferior to imported vegetables, thus prices fetched for locally produced vegetables are also lower. The low production, productivity levels and poor quality of vegetables can be attributed to the following constraints faced by farmers.

| Constraints | Solutions |
|---|---|
| Low Input Use | Improve the availability of inputs such as seeds and fertilizers so farmers can purchase them when needed. Farmers also need training in modern production techniques and product handling. |
| Lack of Technological Knowledge and Skills | More training is needed to enhance the farmers technological knowledge and skills in modern cultivation, production and marketing techniques in packaging, proper storage of the products |

| | |
|---|---|
| Poor road and Transport System | Improvements in the road conditions and other rural infrastructure such as storage and communication facilities will make it easier for farmers to reach markets and improve the terms of trade of farmers. |

**Assessment Task:**

Interview one or two people about constraints and challenges faced in the cultivation and production of horticulture products. Suggest ways to solve the problems in your local context.

**Reference:**

https://espace.curtin.edu.au/bitstream/handle/20.500.11937/35185/160902_160902.pdf?sequence=2

## Strand 2: Animals

**Content Standard 11.2.1.** students will be able to identify and appraise the characteristics of different types of domestic and farm animals, categorize them according to their characteristics, feeding systems, purposes and their benefits and investigate the different context, environments and places where they are farmed.

| Units | Benchmarks | Topics | Lesson Titles |
|---|---|---|---|
| **1. Types of Animals** | **11.2.1.1** Explain the terminology of apiculture and discuss types of insects used for apiculture and the environment which they are cultivated. | Introduction to apiculture | Insects |
| | | | Types of environment |
| | **11.2.1.1.** Examine the purposes and the cultivation and management systems and practices of apiculture**.** | Apiculture | Cultivation practices |
| | | | Management systems |
| | | | |
| | **11.2.1.3** Discuss the methods and processes used in apiculture cultivation and production in different contexts | Cultivation methods of apiculture | Apiculture production |
| | | | Apiculture processes |

**Content Standard 11.2.2** students will be able to investigate and analyse the different types of animal husbandry and management principles, systems and practices used in different environments and places to farm animals.

| Units | Benchmarks | Topics | Lesson Titles |
|---|---|---|---|
| 2. Animal farming practices and management systems | **11.2.2.1** Investigate and analyse the challenges of managing livestock using the feeding regime, grazing land tenure, and herding arrangements. | Managing livestock | Feeding regime |
| | | | Grazing land tenure |
| | | | Herding arrangements |
| | **11.2.2.2** Discuss and evaluate husbandry principles and practices used in mass production of animal products. | Principles and practices in mass production | Husbandry principles |
| | | | Husbandry practices |

**Content Standard 11.2.3**. students will be able to explore how technology is used in the farming, processing, preservation, marketing, consumption, regulation and management of animals in different contexts and environments and analyse their advantages and disadvantages.

| Units | Benchmarks | Topics | Lesson Titles |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **3. Animal farming and technology** | **11.2.3.1** Rationalize the importance of technology to animal production and the achievement of desired outputs. | Animal production | Importance of technology in animal production |
| | **11.2.3.2** explain how technology can be used to regulate the farming, production, and consumption of animal products. | Technologies in animal farming | Animal farming technologies |
| | | | Animal production technologies |
| | | | Technologies used in animal products |
| | **11.2.3.3** Investigate and report on the application of communications technology in animal farming. | Information communications technology | Communications technology in animal farming |
| **Content Standard 11.2.4** students will be able to identify and evaluate the characteristics of different types of domesticated birds, categorize them according to their characteristics, functions and benefits and investigate the different contexts, environments and places. | | | |
| **4. Types of birds** | **11.2.4.1** Investigate and explain how birds are domesticated in different environment and places. | Domestication of birds | Different environments for domesticated birds |
| | **11.2.4.2** Investigate and explain how birds are farmed in different environments and places. | Bird farming | Different environments for farmed birds |
| **Content Standard 11.2.5.** students will be able to investigate and analyse the different types of farm and management principles, systems and practices used in different environments and places to farm birds. | | | |
| **5. bird farming practices and management systems** | **11.2.5.1** investigate and analyse the different approaches and practices of producing and preserving bird products. | Bird products | Production practices of bird products |
| | | | Preservation of bird products |
| | **11.2.5.2** Investigate and explain how the cultivation, processing, preservation, sales and marketing and consumption of bird products are regulated in different places. | Regulation of bird products in different places | Cultivation regulations |
| | | | Processing, consumption and preservation |
| | | | Sales and marketing regulations |
| **Content Standard 11.2.6**.Students will be able to investigate how technology is used in bird farming, processing, preservation, marketing, consumption, regulating, and management in different contents and evaluate their strengths and weakness. | | | |
| **6. Bird farming and technology** | **11.2.6.1.** Investigate technology used for regulating, managing and monitoring poultry farming, production and consumption and evaluate their effectiveness. | Technology application in bird products | Technologies in regulating, managing and monitoring |
| | | | Farming, production and consumption |
| | **11.2.6.2**Investigate and identify poultry problems and develop appropriate solution | Bird farming | Constrains and solutions |

## STRAND 2: Animals Unit 1: Types of Animals

**Content Standard 11.1.6** Students will be able to investigate and analyse the different types of horticulture and management principles, systems and practices used in different environments and places to cultivate, process, preserve, market, regulate and consume different types of plants

**Benchmark 11.2.1.2** Examine the purposes and the cultivation and management systems and practices of apiculture

**Topic: Apiculture**

**Learning Objective**

By the end of the topic the students will be able to:

- Identify the purpose of apiculture farming and discuss the cultivation and management practices of apiculture

**Essential Questions**

1. How are bees cultivated to produce the desired output? What is the current cultivation practice involved in apiculture farming?
2. What are the purposes and benefits of apiculture farming?

| | |
|---|---|
| **Knowledge** | Purposes and the cultivation and management systems and practices of apiculture |
| **Skills** | Explore and outline the apiculture cultivation practices |
| **Attitudes** | Being creative and opened minded |
| **Values** | Sustainability and empowerment |

**Assessment:** Research-How can apiculture be beneficial to Papua New Guineans?

**Content Background**

Apiculture is important because it provides bees with a safe place to work and live. Since bees pollinate many of our food sources, it's important to keep the bee population healthy. Additionally, apiculture provides an environment in which to study bee habitat and behavior.

**Purpose**

Beekeeping is the practice of intentional maintenance of honeybee hives by humans. A beekeeper may keep bees in order to collect honey and bee wax, or for the purpose of pollinating crops, or to produce bees for sale to other beekeeper.

**Management practices**

Best management practice for beekeeping to prevent bees diseases and allow high quality products Good beekeeping practices that normally should be adopted in the apiary involve

Inspection the surroundings to place the apiaries in appropriate areas: non-humid, not exposed to cold winds, not subject to pollution sources such as intensive agriculture and industrialization; selection of suppliers, of bees and beekeeping equipment and verification of the health status of swarms, colonies and queen bees.

1. Observation of quarantine measures for all new introductions that have to be made in the apiary.

2. Identification of each hive by applying a unmistakable numerical code for purposes of hive individuation and subsequent documentation.
3. Regular verification of the health status of the colonies during the year through

4. the inspection of the bees, the new combs. The frequency of these checks depends on the season: reduction of the inspections during winter time and under unfavorable weather conditions.
5. Controls on the productivity and resistance to illness.

6. Frequent renewal of honeycombs (every two years) and regular replacement of queens (every one to two years), selection of queens who show resistance to diseases, hygienic behavior, docility, low tendency to swarm and high productivity.

7. Maintenance of colonies at similar strength, ensuring that hive capacity is sufficient to discourage swarming; preventing acts of looting (not having in apiary highly diseased, weakened colonies that are more subject to be sacked; perform maintenance of hives).

8. Adoption of appropriate techniques to ensure the welfare of colonies, especially those younger / weaker (feeding colonies having no food stocks or in case of unfavorable weather conditions as in autumn, winter and excessively cold or rainy spring; ensuring good wintering; providing adequate

**Recommended Resources:** Newspapers, magazines, post

## STRAND 2: Animals — Unit 1: Types of Animals

**Content Standard 11.1.6** Students will be able to investigate and analyse the different types of horticulture and management principles, systems and practices used in different environments and places to cultivate, process, preserve, market, regulate and consume different types of plants.

**Benchmark 11.2.1.3** Discuss the method and processes used in apiculture cultivation and production in different contexts

**Topic: Apiculture**

**Learning Objective**

By the end of the topic the students will be able to:
- Investigate and describe the methods and processes used in apiculture cultivation and production in different contexts

**Essential Questions**

1. Where in PNG is honey produce?
2. What are the main methods and processes involved in apiculture cultivation?
3. What are the common husbandry practices in honey production?

| | |
|---|---|
| **Knowledge** | Methods and processes involved in apiculture cultivation and production |
| **Skills** | Illustrate the methods and processes |
| **Attitudes** | Being appreciative of apiculture products |
| **Values** | Sustainability and productivity in apiculture farming |

**Assessment:** Watch a short movie on apiculture.

**Content Background**

**Methods and processes used in apiculture production**

Choose an appropriate area in your backyard to start your **honey bee farm**. Start with one or two hives, and place them where there are lots of nectar- and pollen-producing flowering plants. There should be lots of shade, no wind, and in a discrete area where they won't disturb your non-**beekeeping** neighbors. The popular method used at the moment is where the bees are kept in a box to create a hive

**Basic beekeeping techniques used in apiculture**

- Starting a colony
- Working with a bee colony
- Inspecting a colony
- Collecting a swarm
- Dividing a colony
- Moving a colony

- Removing surplus honey
- Smoker maintenance

**Recommended Resources:** Newspapers, magazines, poster

## STRAND 2: Animals
## Unit 2: Animal Farming Practices and Management Systems

**Content Standard 2.2** Students will be able to investigate and analyse the different types of animal husbandry and management principles, systems and practices used in different environments and places to farm animals.

**Benchmark 11.2.2.1** Investigate and analyze the challenges of managing livestock using the feeding regime, grazing land tenure, and herding arrangements

**Topic: Managing Livestock**

**Learning Objective**

By the end of the topic the students will be able to:

- Examine the impacts and challenges of animal production on the natural environment, and stewardship of natural and farming resources.

**Essential Questions**

1. Traditional and modern animal farming practices have change drastically. What makes the changes to animal production?
2. How has the introduction of technology and innovations affect animal husbandry practices?
3. Why is there less labor and quality output from animal products currently then in the past?

| | |
|---|---|
| **Knowledge** | • Different types of animal husbandry and management principles, systems and practices used in different environments and places to farm animals. |
| **Skills** | • Animal husbandry and management practices |
| **Attitudes** | • Investigate and report on the types of husbandry practices and |
| **Values** | • systems used in different environments |

**Assessment:** Research and prepare a presentation on impacts of animal production on natural environment.

**Content Background**

Challenges exist in any aspect of life and livestock management is no different. The main challenges of managing livestock are;

**1. Title of ownership to land**
Land ownership is a problem. In PNG, land is owned by a family, clan or a tribe. That means every member of the group owns the property and may request a share of the property.

Rented property or land may be very expensive that many smallholder farmers may not afford to pay.

**2. Insufficient finances and investments**
Many farmers do not have enough finance to manage the livestock and go into build-up of debts.

**3. Poor veld conditions**
Veld condition refers to the condition of the vegetation in relation to some functional characteristics, generally sustained forage production and resistance to soil erosion. Veld condition is asses using; species composition, basal cover and production potential of the grass.

**4. Variable climates**
Changes in the climate are a factor beyond the farmer's capability to manage. The changes in the weather patterns may affect planning and many other husbandry practices of livestock production

**5. Insufficient land size**
Bigger animals require a larger land area to be farmed compared to smaller animals such as goats.

**6. Damaged or inadequate infrastructure**

**7. Poor management**

**8. Competition for scarce resources among other livestock.**

The Challenges may lead into these problems;

1. Feed shortage
2. Livestock disease
3. Low productivity
4. Water scarcity
5. Predator invasion

**Recommended Resources** Newspapers, magazines, posters

## STRAND 2: Animals
## Unit 2: Animal Farming Practices and Management System

**Content Standard 2.2** Students will be able to investigate and analyse the different types of animal husbandry and management principles, systems and practices used in different environments and places to farm animals.

**Benchmark** 11.2.2.2 Discuss and evaluate husbandry principles and practices use in mass production of animal products

**Topic: Mass Production of Animal Products**

**Learning Objective**

By the end of the topic the students will be able to:
- Identify husbandry practices applied in animal farms for mass production of animal products

**Essential Questions**
1. What is mass production?
2. What makes mass production possible?
3. What is high level management?

| | |
|---|---|
| **Knowledge** | • Mass production of animals is carried out to meet high demand for animal products |
| **Skills** | • Identify husbandry skills |
| **Attitudes** | • Analyze types of husbandry practices used in mass production |
| **Values** | • Creative and appreciative of use of technology for mass production |

**Assessment:** Prepare a chart on animal products.

**Content Background**

Mass production of animals is carried out to meet high demand for animal products be it, meat, eggs, manure etc. This requires high level of management to prevent diseases and meet high level output must target the following;

- General farm management
- Animal health management
- Veterinary medicines and biological
- Animal feeding and watering
- Environment and infrastructure
- Animal and product handling
- Some of the husbandry practices required would be;
- Temperature control for all ages of animals
- Feeding techniques and type of feed fed
- Castration
- Ear notching
- Waste disposal
- Weaning
- Others etc.

Factory farm is a term commonly used to describe an industrial facility that raises large numbers of farm animals such pigs, chickens or cows in intensive confinement where their movements are extremely inhibited. Animals are kept in cages or crates or are crowded together in pens

**Recommended Resources:** Newspapers, Magazines, Multimedia

## STRAND 2: Animals Unit 3: Animal Farming and Technology

**Content Standard: 2.3** Students will be able to explore how technology is used in the farming, processing, preservation, marketing, consumption, regulation, and management of animals in different contexts and environments, and analyse their advantages and disadvantages.

**Benchmark 11.2.3.1** Rationalize the importance of technology to animal production and the achievement of desired outputs.

**Topic: Animal Production**

**Learning Objective**

By the end of the topic the students will be able to:

- Explain the and justify the importance of technology to animal farming to produce desired outputs.

**Essential Questions**

1. How is technology important to animal production?
2. Name some technology equipment used by farmers to increase animal production

| | |
|---|---|
| **Knowledge** | Technologic instruments made farmers work more comfortable and |
| **Skills** | Increased animal production efficiency and profitability. |
| **Attitudes** | Rationalized and illustrate technologic equipment and tools which |
| **Values** | made animal husbandry easier |

**Assessment:** What are some technologies used in animal production?

**Content Background**

Technology is developing rapidly. In this development, the transfer of computer systems and software to the application has made an important contribution. Technologic instruments made farmers work more comfortable and increased animal production efficiency and profitability. Many technologic equipment and tools made animal husbandry easier and comfortable. Especially management decisions and applications are effected highly ratio with this rapid development.

In animal husbandry management decisions that need to be done daily are configured according to the correctness of the decisions to be made. At this point, smart systems give many opportunities to farmers. Milking, feeding, environmental control, reproductive performance constitutes everyday jobs most affected by correct management decisions. Human errors in this works and decisions made big effect on last product quality and profitability are not able to be risked.

**Recommended Resources** Textbooks, Newspaper Articles, Internet, Android phones, Magazines, and Other audiovisual media

## STRAND 2: Animals Unit 3: Animal Farming and Technology

**Content Standard: 2.3** Students will be able to explore how technology is used in the farming, processing, preservation, marketing, consumption, regulation, and management of animals in different contexts and environments, and analyse their advantages and disadvantages.

**Benchmark 11.2.3.2** Explain how technology can be used to regulate the farming, production, and consumption of animal products

**Topic: Technologies and Regulations**

**Learning Objective**

By the end of the topic the students will be able to:

- Examine types of technology and discuss how technology enhances regulating and marketing of animal products online.

**Essential Questions**

1. How can technology help to regulate farming of animal products?
2. Why are there regulations in place?

| | |
|---|---|
| **Knowledge** | Use of technology to regulate farming of animal products |
| **Skills** | Explore and explain how technology can help to regulate animal farming |
| **Attitudes** | Appreciative of the use of technology in animal farming |
| **Values** | Empowerment and sustainability |

**Assessment:** Choose an animal regulation and state why its importance to the class.

**Content Background**

**Electronic identification**

The Electronic identification system is started 1970s. However, current laws deal with the visual, readable markings that are placed on the animal there are numerous animal ID technologies available to livestock producers. Radio frequency identification (RFID) will likely be used to identify cattle. These devices have an electronic number that will be unique for an individual animal and link that animal to the database. Electronic ear tags, injectable transponders and boluses with a transponder, inside in the reticulum are the latest technology for animal identification technology.

Many types of RFID tags (boluses, ear tags, injectable glass tags) are used subcutaneous placement for animal identification. These systems work using radio frequency for sending data. Boluses retain in the first two stomachs of the

ruminants and accepted as safe for animal health. They can be administered even to lambs after weaning at the fifth week and the retention rate can reach 100%. The injectable transponders, on the other hand, can be applied easily after birth, while the preferable locations differ in each animal species

These technologies (implants, ear tags, and rumen boluses) are available on the market for cattle farmers. All these devices have special chip system for sending data for the base computer for evaluation. These devices have some specific components on their system regarding storing and evaluating data used for evaluating herd data. Some electronic tags has reader which can be receive and store the required many data for evaluation.

Some of tag works transferring the number to another storage system for another evaluation stage. Data sends using antenna for transfer data on the system. From a technological point of view, RFID tags can be grouped in two categories according to the carrier frequency band: LF (low frequency) tags function at 125–134.2 kHz, whereas HF (high frequency) tags function at 13.56 MHz. Electronic scales may be justified as a way to determine body condition score automatically.

Another technology which is very useful for farmers is electronic weighing system. An easy and powerful electronic weighing system that accurately measures cattle weight. So farmers can monitor cattle performance easily and continuously. These system established on the road the watered or cattle squeeze. Stored information sends to the main computer for evaluation. Complimenting this is auto-drafting, where cattle going through a race are automatically separated on the basis on age, sex, or weight, or any other criteria the producer preferences.

**Milking automation**

Milking automation system is also involving the dairy sector at 1990s. Suitable objective measuring systems are needed in animal husbandry to quickly and safely recognize illness, normal estrus cycle, quiet heat or stress in animals. An automatic milking system requires a completely different management system for milking, feeding, cow traffic, cow behavior and grazing, but also for safeguarding milk quality and animal health. Electronic devices or sensors are the tools that need to take over the human visual inspection for abnormality. In order to develop sensors to detect abnormal milk a definition of abnormal milk is still basic requirements.

Sensors have been in the market for a long time, but their use in milking systems is quite new. Because milks were being evaluated by milkers during milking. However, with the development of intelligent milking systems, the use of sensors in the milking systems has become widespread.

The milking robots equipped with sensors to detect signs of mastitis which measures the many characters of the abnormal milk pH, Somatic cell count, milk acidity, milk conductivity etc. systems also can be regarded milking specifications of the system such as parlor performances, milking efficiency etc.

Simple automatic cup removal devices monitor the milk flow rate from individual cows and at a threshold, the milking vacuum is shut off and the system is activated to withdraw the cups from the cow. Post-milking teat disinfection is an established component of many mastitis control strategies. This is normally performed manually in many farmers using either a pressure operated spray lance or more a dip cup. Behavior meter also installed to the milking systems for animal monitoring. The behavior meter continuously records the lying time, lying bouts and the activity of the individual animals. The cow-behavior observations enable animal welfare assessment in different environmental conditions and stressful situations, as well as reproductive and health status. Other options to separation gate usage at automatic management systems.

The cattle separation is a risky and challenging activity that needs to be done frequently. If milkers also make an animal separation, the milking efficiency and parlor performances decrease. Reducing the need and risk of this workforce for separation is an important advantage. The grouping and separation of cattle in the big herd constitutes an enormous workload for the farmers. Electronic separation gates are not common in many cattle farms.

Removing the labor required to separate animals can have a significant impact on the performance of the handling and management operations. To a lesser extent, diseased cows need to be brought to the attention of the dairy farmer. Some sensors are currently available for this purpose, but they do not fulfill all demands. When an operator is involved with animal separation, other tasks are not being done and performance suffers. With larger herds, identification and drafting of individuals are major tasks. Automatic drafting is not routinely installed on many dairy farms. Electronic tongue technology gives more advantage for farmers for many aspects. A number of other methods using visible and other light spectra have shown promise in detecting milk abnormalities and measuring various components of milk summarized the technology of main sensors used for mastitis detection.

**Recommended Resources:** Textbooks, Newspaper Articles, Internet, Android phones, Magazines, and Other audio-visual media

## STRAND 2: Animals Unit 3: Animal Farming and Technology

**Content Standard: 2.3** Students will be able to explore how technology is used in the farming, processing, preservation, marketing, consumption, regulation, and management of animals in different contexts and environments, and analyse their advantages and disadvantages.

**Benchmark 11.2.3.3** Investigate and report on the application of communications technology in animal farming

**Topic: Information Communication Technology**

**Learning Objective**

By the end of the topic the students will be able to:
- Investigate and report on the application of communications technology in animal farming.

**Essential Questions**

1. Identify technology use for large scale animal farming and explain how it is applied on farming, processing and marketing products
2. How is communication technology useful in animal farming?

| | |
|---|---|
| **Knowledge** | Application of communications technology in animal farming |
| **Skills** | Evaluate the effectiveness of the use of technology in animal farming |
| **Attitudes** | Creative thinkers and problem solvers |
| **Values** | Competent and empowerment |

**Assessment:** Conduct a research on the topic

**Content Background**

**Feeding automation**

Computer programmers designed many software to make the best option for farmers to ration preparation. Optimal feeding programs can be done for advanced options such as live weight, racing, lactation period and animal feed stock information. These programs use data from the National Research Council in animal feed and feed content.

Various systems for automated animal feeding will be used in many big dairy farms to get better production. They will comprise complete systems include each stage of feeding, feed preparation, mixing equipment and the installations for distributing feed. Feed components such as grass and maize/ corn silage as well as mineral feed and feed concentrate will be loaded, mixed and delivered to the feed table built up there by the systems. The Automation systems as simple consists of a control panel, a programmable command manager, a scale, a communication interface and finally all the needed equipment to organize the feeding process and feed provision to the animal of each age groups.

Computer-controlled calf feeders have many advantages over traditional calf feeding methods. Calves carry a transponder, and it is possible to follow the daily intake of individual calves. Calves learn to use the computer-controlled milk feeding system fairly easily and this technology offers a significant reduction in labor cost (73%). These systems can be combined with automatic weighing and health observation system for calf welfare. Calves reared in a group-pen had fewer days of medication than calves in hutches fed milk-replacer from buckets twice a day.

Electronic Concentrate Feeding system ensures that each cow is supplied with the exact ration of feed at the exact right time. The Belt Feeder feed distributor is the ideal introduction to the concept of automatic feed supply systems. Small, flexible, economical – the combination of a conveyor belt and sliding scraper. Many electronic sensors can be used for rumen pH and rumen temperature of cattle. Especially rumen bolus can work 100 days continuously and data stored every 15 minutes for future evaluation.

The rumination activity is a good indicator of cattle health condition. A certain level of wellbeing is a prerequisite for rumination] excitement and stress, states of anxiety and various diseases inhibit rumination. Another sensor used for collecting data for cow jaw movement to estimate chewing activity. This sensor works on the principle that the changing pressure of the animal is not detected during opening and closing of the mouth.

**Health observation**

The big hazard for animal production is to disease outbreak. The disease can spread quickly in the confined conditions. Many diseases have specific signals for detection, animals to look for signs of stress, disease, and damage caused by many agents. They alert staff or, potentially, other systems to find the affected animals and identify them report to manger before the problem spreads. An animal disease has serious economic implications on farm productivity. Public institutions and private groups are working collectively to assist individuals in addressing society's stake in disease prevention and control. The right time detects disease three to 5 days' sooner, reduce treatment costs, reduce mortality rates, and improve production efficiency.

The production, product quality, product composition, body condition, and behavior provide a good indication for the health status of animals. By closely monitoring normal pattern changes, the farmers ensure animal health status. Many firms provided programs developed and provided by data collection and analysis products for monitoring animal behavior for the best early detection system. To monitor the health conditions of each cow the sensors are mounted on the cow. Sensor networks consist of several tiny, low price devices and are logically self-organizing ad hoc systems.

The role of the sensor network is monitoring the health parameters of animals, gather and convey the information to other sink nodes. Sensors that collect data such as temperature, pH, etc., receive a lot of data, so it is possible to transmit data at intervals. Many new sensor technologies that will be useful in animal health and behavior are developed.

Another sensor usage results of an experiment in which a temperature sensor built into a bolus were placed in the rumen of a cow. On-farm scoring of behavioral indicators of animal welfare is challenging but the increasing availability of low cost technology now makes automated monitoring of animal behavior feasible. Furthermore, behavioral measures, such as the occurrence of aggression or stereotypic behavior, are important indicators of welfare problems. Including behavioral-based welfare criteria is, therefore, essential for an overall welfare assessment.

**Reproductive performances**

Estrus detection technology; Average calving interval in cattle farm is the best criteria for comparisons for reproductive performances of the farms which is varying between 13 and 18 months heat detection efficiency vary between 30 and 50% in most dairy herds. Research results showed that the 5–30% of the cows were not in or near estrus when inseminated. Results of estrus detection varied depending on the many factor such as threshold value, cow number, barn style, and the statistical method for data analysis. The detection error rates between 17 and 55% and indicate a large number of false warnings [. As a result of satisfying estrus detection and conception rates, purchase and maintenance costs of the estrus detection system should charge off. A number of both inexpensive to expensive aids and technologies are available to meet some but not all of these criteria.

Traditionally, estrus detection is performed by visual observation of the dairy herd in many countries but this procedure particularly difficult on large dairy farms because of short observation periods during feeding and milking

As a result of technical progress in monitoring cows using computers, automatic estrus detection has become possible. In many studies, different traits have been analyzed for utilization in automatic estrus detection. The electronic systems are an electronic device that detects cows that stand to be mounted by a herd mate and provides a continuous monitoring of activity, radio telemetry is a computerized estrus detection devices. Also patches give another possibilities using mounting activity of cows. I a cow mount another cow then the transmitter is depressed and a signal sent to a receiver. During this time, date, time and duration of the mount stored and send to the main computer. On computer all these data evaluated and prepared for final decision.

Although costs associated with computerized estrous detection are higher than other methods, the benefits may pay off with increased estrous detection accuracy. Estrus detection errors can result huge economic loses for dairy farms.

Using detection aids provide advantages because of the prevention of these losses. Pedometers are used to detect the estrus by storing past physical activity the current physical activity and comparing it previous activity data. After analyzing data programs prepare report for cow which is activity accepted as estrus. Beeper or flashing light is also using for alerts the farmer for control this cows.

**Recommended Resources:** Textbooks, Newspaper Articles, Internet, Android phones, Magazines, and Other audiovisual media

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## STRAND 2: Animals — Unit 4: Types of Birds

**Content Standard** 11.2.4 students will be able to identify and evaluate the characteristics of different types of domesticated birds, categorize them according to their characteristics, functions and benefits and investigate the different contexts, environments and places.

**Benchmark 11.2.4.1** Investigate and explain how birds are domesticated in different environment and places.

**Topic: Domestication of Birds**

**Learning Objective**
By the end of the topic the students will be able to:
- Distinguish different types of birds and their purposes and benefits.

**Essential Questions**
1. What is the purpose of domesticated birds?
2. What are their benefits respectively?
3. What types or species of birds are farmed or domesticated?

| | |
|---|---|
| **Knowledge** | Distinguishing different types of birds according to its purpose and benefits |
| **Skills** | Differentiating Birds according to its purpose and benefits |
| **Attitudes** | Appreciate birds according to their purpose and benefits. |
| **Values** | Competent and empowerment |

**Assessment:** Identify some bird and state how they are beneficial locally.

**Content Background**

Poultry is a term used for any kind of domesticated bird, captive raised for its utility. Poultry can be defined as domestic fowls including chickens, turkeys, geese and ducks, raised for the production of meat or eggs. Poultry is divided into two groups;

1. **Domesticated birds –** birds that are taken care of as pets, companions, or for sporting activities such as cockfighting (not common in PNG). Some are domesticated for social status or ornamental purposes.

2. **Farmed birds-** birds that are farmed for their meat or eggs. There are some birds that are farmed for both *meat* and *eggs*, they are called *dual-purpose* birds.

**Domesticated birds** are not really domesticated because they are no different to their ancestors in the wild because of their continuous vocalizing

(squawking, chirping, and talking). They can be destructive because of their noise. Common types of birds as pets are parrots, cockatoos, pigeons.

**Common pet birds**

## STRAND 2: Animals — Unit 4: Types of Birds

**Content Standard 11.2.4** students will be able to identify and evaluate the characteristics of different types of domesticated birds, categorize them according to their characteristics, functions and benefits and investigate the different contexts, environments and places.

**Benchmark 11.2.4.2.** Investigate and explain how birds are farmed in different environment .

**Topic: Bird Farming**

**Learning Objective**

By the end of the topic the students will be able to:
- Explain how birds are farmed in different environments.

**Essential Questions**
1. Where can we find birds that are farmed?
2. What types of birds can be farmed?
3. Why do humans farm birds?

| | |
|---|---|
| **Knowledge** | How birds are farmed in different environment |
| **Skills** | Investigate types of birds and the environment |
| **Attitudes** | Appreciate different types of birds and accept different environment |
| **Values** | Sanctity of bird life |

**Assessment:** Name some suitable conditions for bird farming.

**Content Background**

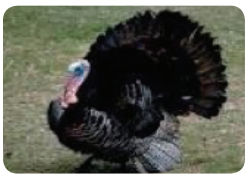
**Birds Farmed in Different Environment**

Environment refers to anything and everything around us. There are certain types or breeds of birds that grow best in specific environment. Environment in this context refers to the natural environment including the physical features vegetation, landforms, plains mountainous areas, etc. man-made environment includes buildings and other non-living materials surrounding the inhabitants.

Various environmental conditions affect the bird's well-being and its level of productivity. Tropical areas like Papua New Guinea relative importance of these vary from area to area. For example; humidity in the air is of more importance in rainforest areas near the equator whereas in hot desert areas temperature is of more importance. The management system are the same in any climate however, management practices may differ according to cold and warm climates. All breeds and strains can grow in any climate with proper management.

In Papua New Guinea, there are Native breeds and Introduced breeds and also crossbreeds. Natives birds are the birds that have originated in PNG are usually tougher and adapt to whichever climate or environmental conditions they are raised in.

Introduced breeds are those birds that have originated in another country and were brought into Papua New Guinea. There are several introduced breeds and have specific environmental requirements. Crossbreeds or hybrids are off springs of a native breed and an introduced breed. Hybrids or Crossbreeds require intensive management systems because they cannot survive the free range system.**Example of birds raised for meat**

| Birds | Names | Purpose | Picture |
|---|---|---|---|
| Chickens | Ross Cobb<br>Light Sussex | Broiler |  |
| | White leghorn<br>Australope Rhode Island Red | Layers |  |
| | New Hampshire<br>Light Sussex | Dual-Purpose | |
| Ducks | Aylesbury<br>pekin | Meat |  |
| | Khaki Campbell | Egg | |
| Turkey | Northfolk Black<br>Mammoth Bronze | meat |  |
| | Northfolk Black | Dual-Purpose | |

Farmed birds (poultry farming) have several benefits:

- It requires less investment compared to rearing other livestock
- It gives rapid return on investment
- Broilers intake of feed is comparatively very low while it produces maximum possible amount of food for us
- Provides a continuous source of income
- Its ability to provide good source of protein and essential vitamins and mineral from the meat and eggs. It is also a cheap source of protein for low earning families.

## STRAND 2: Animals
## Unit 5: Bird Farming Practices and Management Systems

**Content Standard 11.2.5:** Students will be able to investigate and analyze the different types of farm and management principles, systems, and practices used in different environments and places to farm birds.

**Benchmark 11.2.5.1** Investigate and analyse the different approaches and practices of producing and preserving bird products.

**Topic: Bird Product**

**Learning Objective**
By the end of the topic the students will be able to:
- Explain how birds are farmed in different environments.

**Essential Questions**
1. What are the common approaches of producing and preserving bird products?
2. How are bird products being produced?
3. Why are bird products being preserved?
4. What are the appropriate preservative methods used?

| | |
|---|---|
| **Knowledge** | Production and Preservation of Bird Products |
| **Skills** | Identifying appropriate methods for preservation of bird products. |
| **Attitudes** | Appreciate the methods of producing and preserving bird products. |
| **Values** | Production and Preservation of Bird Products |

**Assessment:** List some bird products.

**Content Background**

The two main bird products are meat and eggs. Feathers and manure are uncommon or by-products of birds. To obtain the best products of birds; they are raised using the intensive management system which is very labor intensive and expensive. However, has a high return compared to the other two management systems.

**A. Processing and Dressing a Chicken**

This process is same for chickens and turkey. This process is categories into four major processes.

1. Receiving and slaughtering
2. Cleaning and evisceration
3. Processing and preparation
4. Packaging and shipping

These four broad categories are broken down into ten (10) step by step procedures.

i. **Arrival at the processing plant;** the birds are moved from the farm to the processing plant which is usually not a long distance travel.

**ii. Stunning;** birds are suspended by their feet on a moving line and are rendered unconscious and unaware of pain.

**iii. Slaughter;** technology makes slaughter extremely quick to minimize discomfort, making a single cut through the throat.

**iv Evisceration;** the birds enter a process where their feathers are removed. The birds go through a hot bath to make the feathers soft and removable.

**v.Cleaning and chilling;** after the organs are removed, the carcasses are then cleaned before being inspected. As an added measure to further reduce bacteria, water and an organic rinse may be applied to each bird.

**vi. Inspection by the Department of Agriculture;** after the evisceration process, each bird is inspected by both a member of the processing plant and a Department of Agriculture inspector.

**vii. Additional testing;** after chickens are chilled, microbiology tests to further ensure food safety are conducted on equipment and products at chicken plants by companies and the Department of Agriculture. This includes tests for microorganisms such as Salmonella.

**viii. Second processing;** after properly tested and chilled, the carcass is cut and deboned to accommodate a variety of different products.

ix. Packaging; once chicken is cut up into parts, it is packed in trays and wrapped. The wrapped product is then inspected again to ensure that it meets or exceeds both consumer and customer expectations.

x. **Shipping;**

**Source:** chickencheck.http://www.britannica.com/technology/poultryprocessing

Egg products processing

The processing of egg products include:

- Receiving shell eggs
- Washing/ sanitizing/ candling eggs
- Breaking eggs
- Handling liquid egg products: -filtering
  - Filtering
  - Blending
  - Mixing
- Cooling
- Pasteurization
- Freezing or drying
- Packaging
- Storage
- Shipping

After processing the bird/chicken products, they can be preserved using several methods.

Preservation methods include;

- Canning
- Drying / dehydration
- Freezing

- Chilling
- Curing
- Smoking
- Radiation preservation

Preservation and maintenance of Eggs include;

- Egg cleaning
- Oil treatment
- Cold storage
- Thermostabilisation
- Immersion in liquids

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## STRAND 2: Animals — Unit 5: Bird Farming Practices and Management Systems

**Content Standard 11.2.5:** Students will be able to investigate and analyze the different types of farm and management principles, systems, and practices used in different environments and places to farm birds.

**Benchmark 11.2.5.2.** Investigate and explain how the cultivation, processing, preservation sales and marketing and consumption of bird products are regulated in different places.

**Topic: Regulations of Bird Product in Different Places**

**Learning Objective**

By the end of the topic the students will be able to:
- Research and explain the system of cultivation of birds and how they are regulated in different places.

**Essential Questions**

1. What are the regulations on processing and preserving of bird products?
2. What are the regulations on marketing and consumption of bird products?
3. Why is it important to have regulations?

| | |
|---|---|
| **Knowledge** | Explain Poultry Regulation |
| **Skills** | Investigating and Identifying the regulations on processing and preservation of bird products. |
| **Attitudes** | Appreciate poultry regulation policies |
| **Values** | Production and Preservation of Bird Products |

## Assessment:

**Content Background**

There are rules and regulations governing all industries in the country. Livestock industry also have regulations from the Department of Agriculture and Livestock (DAL) and NAQIA (National Agriculture Quarantine and Inspections Authority).

There are two types of regulations in livestock industry:

- Economic regulations
- Social regulations

All poultry processing and slaughtering operations are inspected and issued licenses in order to be qualified to part take in the processing industry by respective livestock and health authorities.

Some regulations or simple laws governing poultry products and processing such as;

- Poultry house must be clean and well ventilated, being regularly cleaned
- Slaughter house and equipment must all be well sanitized and sterilized
- Birds have to be seven to eight weeks old before being sold or slaughtered
- Healthy looking birds are to be sold or consumed
- Prices of the products must be within the range set by the ICCC

Small-scale and large-scale farmers or poultry productions have their own set of regulations or law to abide by for the well-being of producers and consumers.

Preserved poultry products also have regulations for packaging, selling and consumption. For example, the use-by dates for frozen products is within three months.

## STRAND 2: Animals Unit 6: Bird Farming and Technology

**Content Standard 11.2.6.** Students will be able to investigate how technology is used in bird farming, processing, preservation, marketing, consumption, regulating and management in different contexts and evaluate their strengths and weakness.

**Benchmark 11.2.6.1** Investigate technology used for regulating, managing and monitoring poultry farming, production and consumption and evaluate their effectiveness.

**Topic: Regulations of Bird Product in Different Places**

**Learning Objective**

By the end of the topic the students will be able to:
- Identify technologies used in regulating, managing and processing poultry farming
- Identify how technology influences poultry farming and its impact.

**Essential Questions**

1. What kinds of technology are used in regulating, managing and monitoring?
2. How does technology influence poultry farming?
3. Why is it important to have technological input in poultry farming?

| | |
|---|---|
| **Knowledge** | Different kinds of technology and its impacts in poultry farming |
| **Skills** | Identifying technologies and its impact on poultry farming |
| **Attitudes** | Appreciate and value the use of technologies and its impact in poultry farming |
| **Values** | Production and Technology of Bird Products |

**Assessment:**

**Content Background**

In every stage of poultry production, technology is involved in one way or the other. Technology in this context refers to machinery, equipment, devices or even ideas that enhance poultry production. It can be small simple tools and equipment such as feeders, water troughs, brooders to more complex and advanced equipment and devices such as solar lightings, digital device etc.

The aim of technology in poultry farming is to maximize potential for meat, eggs and easy collection of compost.

From the simple feeding and water troughs to advanced line feeding lines where they are self-refilled when feed lowers.

Thermal sensitive lights used to show intruders approaching as security measures. Automatic switches installed that switch off and on according to temperature and humidity levels in the farm house.

An example of a monitoring technology used by the Zenag chicken producers are that they are completely enclosed and equipped with automatic farming facilities that include feeding and ambient temperature control for minimal human intervention. Their isolated location and strict biosecurity protocol measures prevent the introduction of diseases.

With the advance in technology, poultry farmers have access to computers, mobile phones and internet. Monitoring and Managing systems can be programmed to help make their work easier and maximize their production. Mostly practiced by commercial productions and not the small scale farmers.

Students can be given the option to research on technological applications used by poultry farmers within the locality as practical work.

## STRAND 2: Animals Unit 6: Bird Farming and Technology

**Content Standard 11.2.6.** Students will be able to investigate how technology is used in bird farming, processing, preservation, marketing, consumption, regulating and management in different contexts and evaluate their strengths and weakness.

**Benchmark 11.2.6.2** Investigate and identify poultry farming problems and develop appropriate solution.

**Topic: Bird Farming**

**Learning Objective**

By the end of the topic the students will be able to:
- Investigate and identify poultry production/management problems and develop appropriate solutions

**Essential Questions**
1. What are some common problems of poultry farming?
2. How can these problems be solved?

| | |
|---|---|
| **Knowledge** | Identify poultry farming problems |
| **Skills** | Investigate problems and providing appropriate technologies to improve poultry production, preservation and management. |
| **Attitudes** | Accept and tolerate problems |
| **Values** | Value Bird farming |

**Assessment:**

**Content Background - Poultry farming problems**

Poultry farming is now a demanding and fast growing business in the country and the world as a whole. Due to the demographic increase demand for food has also increased. Poultry is the most affordable source of protein. Poultry farmers face a lot of problems and or challenges depending on where they are.

Some limitations of poultry farming include;

- Diseases
- Predators
- Poor nutrition
- Environmental stress

Depending on where poultry is being raised, farmers will be faced with problems or limitations. They may be due to;

- Environmental factors
- Geographical or topographical factors
- Management systems practiced
- Market instability and poor sales
- Unavailability of DOC in time
- High cost of commercial rations
- (https://www.science direct.com)

In order for appropriate solutions to be developed, proper investigation must be conducted to identify problems specific to the poultry farm. Problems associated with local conditions may be rectified locally while those that require capital and other resources farmers will have to assess and rectify depending on their own terms.

## STRAND 3: AQUACULTURE

| | | | |
|---|---|---|---|
| **Content Standard 11.3.1** Students will be able to define aquaculture, investigate the different types of plants, animals and fish cultivated using this method of farming, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments and places where they are farmed. | | | |
| **Units** | **Benchmarks** | **Topics** | **Lesson Titles** |
| **Types of Aqua Farming Plants, Animals and Fish** | **11.3.1.1** Examine the characteristics in species of fish farmed in different environments and places | Characteristics of Fish Species | Types of Fish species in Freshwater, Brackish and Saltwater<br>Characteristics of each species in Freshwater, Brackish and Saltwater |
| | **11.3.1.2** Investigate and examine the cultivation of different brackish and salt water fish in different environments. | Cultivation of Fish | Cultivation of Fish in Brackish environment<br>Cultivation of Fish in Saltwater environment |
| **Content Standard 11.3.2** Students will be able to investigate and analyse the different types of aqua farming and management principles, systems and practices used in different environments and places to farm, process, preserve, market, regulate and consume plants, animals and fish. | | | |
| Aqua Farming Practices and Management Systems | **11.3.2.1** Investigate and explain the factors of aqua culture production in different places and environments | Factors of Aquaculture Production | Factors Affecting Aquaculture Production – Climate ,<br>Physical factors<br>Environmental factors<br>Water availability and Quality |
| | **11.3.2.2** Research and explain the process and ways of processing and marketing aqua farming products | Processing and Marketing Aquaculture Products | Ways of processing aqua farming products - shrimp, salmon mollusc, tilapia, sea bass and sea bream seaweed<br>Ways of marketing aqua farming products - shrimp, salmon mollusc, tilapia, sea bass and sea bream seaweed |
| | **11.3.2.3** Examine how aqua farming and consumption of each product are regulated. | Aquaculture Regulations | Farming Regulations<br>Consumption Regulations |
| **Content Standard 11.3.3** Students will be able to examine how technology is used in aqua farming and the processing, preservation, marketing, consumption, regulation and management of plants, animals and fish in different environment and places and evaluate their strengths and weakness. | | | |

| | | | |
|---|---|---|---|
| **Aqua Farming and Technology** | **11.3.3.1** Examine post-harvest technologies and evaluate their advantages and disadvantages. | Post-Harvest Technologies | Post-Harvest technologies:<br>Handling<br>Processing<br>Marketing<br>Price Determination<br>Advantages and Disadvantages of Post-Harvest Technology |
| | **11.3.3.2** Research and discuss the processes of using communications technologies in sales and marketing of aqua farming products. | Sales and Marketing Technology | Communication Technologies in Marketing – Quality and Safety<br>Communication Technologies in Sales – Quality and Safety<br>Global Trading of Aqua Farming Products |
| | **11.3.3.3** Examine and explain the relevance of fisheries policies rules and regulations in monitoring and managing all aspects of aquatic resources. | Rules and Regulations | Fisheries Management Regulations<br>Harvesting Aqua Farming Products<br>Processing Aqua Farming Products<br>Obtaining License in Aqua farming practices |

## Strand 3: Aquaculture

## Units 1: Types of Aqua Farming Plants, Animals and Fish

**Content Standard 11.3.1** Students will be able to define aquaculture, investigate the different types of plants, animals and fish cultivated using this method of farming, categorising, them according to their characteristics, purposes and benefits, and investigate the different contexts, environments and places where they are formed.

**Benchmark 11.3.1.1** Examine the characteristics in species of fish farmed in different environments and places

**Topic: Characteristics of Fish Species**

**Learning Objectives:**

By the end of this topic, students will be able to:
- Explore types of fish species and their characteristics farmed in different environments and places.

**Essential Questions:**

1. What type of fish species are farmed in different environments and places?
2. What are their characteristics?

| | |
|---|---|
| **Essential Knowledge** | • Type of Fish species<br>• Characteristics of Fish Species farmed |
| **Essential Skills** | • Observe and discuss the type of fish species and describe their characteristics |
| **Essential Attitudes and Values** | • Is inquisitive and diligent to find out about fish species and their characteristics |
| | • Is courageous and affective in understanding about type of fish species that can be farmed in various environments. |

**Assessment Task:** Can be able to discuss the type of fish species and describe the characteristics of fish species farmed in various environments.

**Content Background**

Types of farmed freshwater species
**Systems and species**

Aquaculture systems range from very extensive, through semi-intensive and highly intensive to hyper-intensive. When using this terminology the specific characterisation of each system must be defined, as there are no clear distinctions and levels of intensification represent a continuum.

**Fish farming system includes:**

- Water-based systems (cages and pens, inshore/offshore).
- Land-based systems (rainfed ponds, irrigated or flow-through systems, tanks and raceways).
- Recycling systems (high control enclosed systems, more open pond based recirculation).
- Integrated farming systems (e.g. livestock-fish, agriculture and fish dual use aquaculture and irrigation ponds).

**Classification of aquaculture species**

Various aquatic organisms are grown in different ways including:

- Fish (ponds, polishing ponds, integrated pond systems).
- Seaweeds and macrophytes (floating/suspended culture, onshore pond/ tank culture).
- Molluscs (bottom, pole, rack, raft, long-line systems also culture based fisheries)
- Crustaceans (pond, tank, raceway, culture based fisheries).
- Other minor invertebrates, such as echinoderms, coelenterates, seahorses, etc (tanks, ponds, culture based fisheries).

The phases of aquaculture include brood stock holding, hatchery production of seed, nursing systems, grow-out systems, and quarantining.
Together, this mix of intensity, culture systems, species, farming systems and different phase of culture create an extreme diverse collection of aquaculture systems and technologies.

## Strand 3: Aquaculture Unit 1: Types of Aqua Farming Plants, Animals and Fish

**Content Standard 11.3.1** Students will be able to define aquaculture, investigate the different types of plants, animals and fish cultivated using this method of farming, categorising, them according to their characteristics, purposes and benefits, and investigate the different contexts, environments and places where they are formed.

**Benchmark 11.3.1.2** Investigate and examine the cultivation of different brackish and salt water fish in different environments.

**Topic: Cultivation of Fish**

**Learning Objectives:**

By the end of this topic, students will be able to:

- Examine the cultivation of different brackish fish species in different environments.
- Examine the cultivation of different salt water fish species in different environments.

**Essential Questions:**

1. What different brackish fish species can be cultivated?
2. What different salt water fish species can be cultivated?
3. Which environments can they be cultivated?

| | |
|---|---|
| **Essential Knowledge** | • cultivation of different brackish fish species in different environments<br>• cultivation of different salt water fish species in different environments |
| **Essential Skills** | • Explore and examine the fish species that are cultivated in salt water and brackish water for different environments |
| **Essential Attitudes and Values** | • Diligent and participates in using skills to explore and examine fish species for cultivation in brackish and saltwater farms |
| | • Is courageous and self- determination in understanding the fish species that are cultivated in brackish and salt water farms. |

**Assessment Task:**

Describe the fish species that are cultivated in brackish and saltwater farms and in different environments.

## Content Background

### The Main Cultivated Species in Freshwater Aquaculture

Carps (Grass Carp, Silver Carp, Bighead Carp, and Common Carp)

Tilapia ( Nile, Blue, Red, Gift, and Mozambique)

Trout (brook, rainbow, and brown trout)

Cat fish (fork-tailed catfishes , gudgeons, gobies , grunters and jacks)

Barramundi (Lates calcarifer)

Pacu ( red belly ball cutter)

Prawns

Eel

## Species introduced in PNG

In an attempt to increase fish stocks, more than 25 exotic species of fish have been introduced to Papua New Guinea since 1949. By the early 1990s, some 11 species had potential for aquaculture or were found in rivers and lakes. Common carp and rainbow trout were farmed in the highlands.

Between 1993 and 1997, the ambitious FISHAID stock enhancement program introduced nine new species to the Sepik-Ramu River systems, including redbreast tilapia, giant gouramy, Java carp, snow trout, golden and chocolate mahseer, pacu and curimbata. Some species like golden mahseer are breeding in Yonki Reservoir, and a new fisheries resource has been developed.

The most significant recent introduction of fish for aquaculture occurred in 2002-2003, when a genetically improved farmed tilapia (GIFT) strain was distributed to farmers from the Highland Aquaculture Development Centre, the nation's main hatchery at Aiyura in Eastern Highlands Province. This strain of tilapia has the potential to help overcome the bottlenecks that constrain aquaculture in Papua New Guinea.

Rainbow trout (Oncorhynchus mykiss) was introduced to PNG in the 1960s for the colonial angling fraternity. Many highlanders reside at high altitudes between 1300 and 1800 metres where the water temperatures of the streams range between 13°C and 17°C, which is the optimum temperature for farming trout culture. However, to reproduce trout, the water temperature has to be lower than 13°C. The only commercial trout hatchery is at the foot of Mt Wilhelm in the Chimbu Province (2280 metres) where water temperatures are 10°C. There is no indigenous species of edible fish in the temperate streams aside from eel or shrimp, so trout meat is considered a delicacy and an important food during social occasions.

Common carp (Cyprinus carpio) were introduced to PNG for subsistence farmers on account of their adaptability to harsh environments, disease resistance, omnivorous diet and fast growth rates. Carp spawn in waters above 18°C and so are distributed in both the PNG Highlands and Lowlands. There are two species of tilapia (Tilapia rendalli and T. mossambicus) commonly found in PNG. T. mossambicus escaped from ponds in the Highlands and became well established in PNG's river systems, particularly the Sepik River.

Tilapia is now one of the most important food sources in this area. Because of its high fecundity, however, this species of tilapia is not good for aquaculture. There is considerable interest in a new genetic strain of the Nile tilapia (Oreochromis niloticus) bred during a project known as —Genetic Improvement of Farmed Tilapiasll or the GIFT project. GIFT tilapia grows up to 60 per cent faster than the most commonly farmed species of tilapia.

## Strand 3: Aquaculture
## Unit 2: Aqua Farming Practices and Management Systems

**Content Standard 11.3.2** Students will be able to investigate and analyse the different types of aqua farming and management principles, systems and practices used in different environments and places to farm, process, preserve, market, regulate and consume plants, animals and fish.

**Benchmark 11.3.2.1** Investigate and explain the factors of aqua culture production in different places and environments

**Topic: Factors of Aquaculture Production**

**Learning Objectives:**
By the end of this topic, students will be able to:
- Research and identify the factors of aqua culture production in different places and environment

**Essential Questions:**
1. What are some of the factors of aqua culture production?
2. How are aqua culture production done in various places and environments?

| | |
|---|---|
| **Essential Knowledge** | Factors of aqua culture production |
| **Essential Skills** | Research and identifying factors of aqua culture production |
| **Essential Attitudes and Values** | Appreciate the factors of aqua culture production<br>Creativity in aqua culture production processes |

**Assessment Task:** Conduct a Research on factors of aquaculture production.

**Content Background**
There are a numerous factors that affect the development of aqua culture either in a positive or negative way. The discussion in this level will focus on 5 major factors with 15 sub-factors.

**1. Environment**
The factor environment, and its three sub-factors: (1) physical, (2) institutional and (3) social, clearly are vital since they are pivoted towards the sustainability of geographical areas for aqua culture development.

The physical environment determines whether a selected species can be grown successfully in a certain area without providing a controlled habitat to meet their environmental requirements.

Institutional environment includes governmental policies, planning, programs such as training, extension services and financial assistance, and controls, any of which can have a positive or negative impact on the development of aqua culture.

The third type of environment can be termed social. This includes traditions, customs, religious beliefs which affect fish consumption and the social acceptability of aqua culture as an individual, group or community activity.

**2. Space**

Second major factor is the availability of suitable space on land, or in lakes, rivers, estuaries or protected coastal bays for aquatic farming. Land or water space must be obtained at an acceptable cost and, for private farming, must permit private control similar to that needed for agriculture. This factor and the sub-factors (1) land and (2) water include the problem of competition among user groups for attractive areas such as residential or recreational waterfront and established agricultural lands.

**3. Technology**

Technology and its sub-factors: (1) culture technology and (2) product technology include the state-of-the-art for growing selected species, preparing or preserving the resulting products and delivering them to the consumers in good condition.

This factor also includes the local availability of adequate information concerning culture and product technology. Information dissemination, training and extension service activities are usually needed to provide a sound technological basis for this development of aqua culture.

**4. Production**

This factors concerns the application of technology and its four sub-factors: (1) planning and management (2) inputs, (3) operations and (4) cost, cover all of the activities directly related to the growing the selected species. The sub-factor planning and management includes development of the initial concept, species, and site selection, capital formation, design and construction of the farm and business management of the operation.

The second sub-factor, inputs includes the availability of seed, feed, water, energy and various materials and supplies at acceptable costs. This also includes the logistics of providing the required inputs for the farm.

The third sub-factor, operations includes all of the day to day activities needed to grow fish, molluscs, crustaceans or aquatic plants and to harvest the products and to prepare them for delivery to processors or distributors. The final sub-factor, costs, is considered separately to emphasize the importance of production cost in the development of aqua culture.

**5. Marketing**

The factor marketing includes its four sub-factors: (1) planning and management, (2) demand, (3) operations and (4) revenues covers processing, preserving, and packaging of aqua cultural products, transportation to population centres and sale to distributors, wholesalers, retailers or consumers.

The firs sub-category, planning and management, includes the selection of product form, processing or preservation methods and marketing strategy. It also covers the business management of the processing/marketing functions including scheduling the harvesting of fish farms to provide continuity of supply and minimizing seasonal overproduction.

Demand, income and price considerations are the major incentives for selecting certain species for production. Both are affected by the availability of the same or similar products from capture fisheries.

The third sub-factor, operations includes all of the day to day activities required to process, preserve and package the fish, molluscs, crustaceans or marine plants produced in aquatic farms and to transport them to selected levels of the marketing chain. This sub-factor also may include transportation of the raw products from the farm to processing plants and delivery and sale of the finished products to various buyers using procedures which will prevent deterioration of the product. Individuals trained in quality control and marketing are required for this activity.

The final sub-factor, revenue together with production costs determines the profitability of the fish farm. Logical marketing strategies and market development can increase revenues. High perceived revenues will encourage expansion of aqua culture.

## Strand 3: Aquaculture

## Unit 2: Aqua Farming Practices and Management Systems

**Content Standard 11.3.2** Students will be able to investigate and analyse the different types of aqua farming and management principles, systems and practices used in different environments and places to farm, process, preserve, market, regulate and consume plants, animals and fish.

**Benchmark 11.3.2.2** Research and explain the process and ways of processing and marketing aqua farming products

**Topic: Processing and Marketing Aquaculture Products**

**Learning Objectives:**
By the end of this topic, students will be able to:
- Comprehend the strategies in processing and marketing of aquaculture products.

**Essential Questions:**
1. What are some ways of processing aquaculture products?
2. How does marketing occur in aquaculture products?

| | |
|---|---|
| **Essential Knowledge** | Processing and marketing of aquaculture products |
| **Essential Skills** | Processing and marketing skills in aquaculture products |
| **Essential Attitudes and Values** | Creative in marketing and processing aquaculture products<br>Self-cultivation through marketing and processing of aquaculture products. |

**Assessment:** Prepare an oral presentation on processing strategies

**Content Background**

Marketing is as important as production, financing, cash flow and other profit determining factors in aquaculture enterprises. Similar principles are applicable to small- or large-scale operations. Before beginning production, or selecting a specific marketing alternative, some general marketing principles should be considered, and a marketing strategy developed. Most fish producers are production oriented rather than market oriented. The producer who develops a sound marketing strategy, and considers marketing as important as production, will have a definite economic advantage over those who don't.

Developing a marketing strategy involves three elements: 1) determining present situation; 2) determining final marketing goals; and 3) developing a logical plan for getting from the present situation to the final goal.

Determining the present situation often involves the most work and time. Make assessments of the market, personal financial circumstances and available marketing alternatives. An understanding and assessment of a particular market is required, including the importance of supply and demand and maintaining a timely awareness of the current market situation and trends. Use enterprise

budgets to help in assessing various marketing alternatives. The most profitable marketing alternative may be unacceptable because of time required, unacceptable cash flow, or incompatibility with other personal or business goals.

The second element, determining marketing goals, is based on assessments made during the determination of the present situation. If attainable marketing goals are not established, the producer may drift aimlessly through sales opportunities. Relate goals to operating costs. Know how much different levels of operation will cost and establish goals that will at least cover costs. The level that goals exceed operating costs will depend on the willingness to accept risks and other personal and business goals.

Finally, consider all **reasonable alternatives, and develop** a marketing plan. Evaluate the operation, labor and financial requirements, and other advantages and disadvantages of each alternative. The selection of a specific or combination of marketing alternatives should be tailored to the market assessments, individual financial circumstances and the size of the operation.

After a marketing strategy has been developed, write it down. Test the strategy through several hypothetical cases and modify as necessary. Think through all the things that could happen. Once a final strategy has been selected, follow it. Lack of marketing discipline is a common management problem.

The purpose of developing a marketing strategy is to provide direction for actions. The objective is to maximize the probability of achieving marketing goals. Marketing management is an obligation that can't be ignored

**Marketing Alternatives**

Aquaculture products marketed on a small-scale include sport fish such as channel catfish and rainbow trout, baitfish (e.g., golden shiners and fathead minnows), and aquatic invertebrates such as crayfish. The previously discussed marketing considerations apply regardless of the species involved. The most common species produced and marketed on a small scale in the southern United States is the channel catfish. The following discussion of marketing alternatives deals primarily with channel catfish.

**Fee Fishing or Pay Lakes**

Fee fishing is an attractive marketing alternative for many small-scale producers. The increased demand for fishing opportunities and per capita consumption of fisheries products have led to rapid expansion and development in this market. A major benefit is the premium price paid for fish. The price per pound may be as much as double that paid by large processing plants.

The initial step in establishing a fee fishing operation is determining what the customer wants. Fishermen's preferences vary from one geographic area to another. This determination should include not only the species and size of fish to use, but also conveniences such as concessions, bait, tackle, restrooms, shaded areas, benches, etc.

Additionally, the potential fee fishing operator must determine where, how and when to sell. Location is an important consideration in determining if fee fishing is a viable marketing alternative. Ideally, fee fishing ponds should be easily accessible from a heavily traveled road near an urban center. Fee fishing customers appreciate convenient parking areas and easy access to ponds. The site should be identified with large signs on the nearest major road, and additional signs on secondary roads. Most fee fishing operations depend on word-of-mouth advertising to attract customers. It is essential that potential customers be able to locate the fee fishing operation.

Most fee fishing operators sell fish by the pound. This requires someone to be present to weigh the fish and collect money the entire time the facility is open for fishing. Thus, labor costs are an important consideration. The expected volume of sales has to justify high labor costs. Some operators charge only an entrance fee and customers are allowed an unlimited catch. This option involves less labor, but managing the fish population is difficult without detailed knowledge of what is being taken out of the pond. A combination of entrance fee and per weight charge beyond a specified poundage is another option.

Fee fishing ponds are usually operated seasonally. Most operations are open daily from early morning until dark during spring, summer, and fall. Many operators reduce hours or days of operation during colder months. Hours should be specific and clearly stated on signs and in advertisements, and posted in a conspicuous location at the facility.

**Family Operations**

Pay lake operations tend to be family operated and provide supplemental rather than primary income. Many pay lakes are part of diversified farm operations. Few pay lake operators have formal training in aquaculture or business. Consequently, many pay lakes are managed inefficiently. Few operators keep accurate records of costs or income. Keeping accurate records of stocking densities, time of stocking, catch rates and customer needs would give the novice operator a definite marketing advantage over most established operations.

Marketing through fee fishing requires a willingness to deal with the public and to work long hours, often seven days a week. Considerable management ability is required to provide maximum returns. The primary advantage is the premium price received by the operator.

**Channel Catfish Popular**

Many species of fish are marketed through fee fishing; however, the channel catfish is by far the most popular. Channel catfish are usually available throughout the year, can be purchased at desirable sizes, are easily caught, and do not reproduce in open ponds that do not have holes or cavities. The size of fish commonly stocked varies from about 1 to 6 pounds. Some pay lake operators like to have a variety of sizes in the pond, while others prefer consistently small or large fish. Discussions with existing pay lake operators in the area will provide insight into local customer preferences.

It is not reasonable to produce and sell channel catfish from the same pond. Usually, fish are purchased from outside sources or raised in other ponds. Attempting to raise channel catfish in ponds open to fishing results in the ponds being open for only a few months of the year; a large number of small fish that are unacceptable to the customer; and fishermen returning a large number of stressed fish that die or learn hook avoidance.

Stocking densities vary from a few hundred to over 8,000 pounds per acre. Higher stocking densities do not necessarily mean higher catch rates, but are related to potential water quality problems, such as decreased dissolved oxygen. If the weight of channel catfish in a pond exceeds 1,500 pounds per surface acre, aeration equipment should be available. If stocking densities exceed about 3,000 pounds per surface acre, aeration is a necessity.

Catch rates in fee fishing ponds appear to be related to time exposed to angling. In recently opened ponds stocked with fish that have not been exposed to angling, catch rates are very high, often over five fish per angler hour. Typically, within a few days catch rates decline to less than one fish per angler hour. This suggests it may be more desirable in fee fishing ponds to frequently replace fish rather than attempt to carry high densities.

Four replacement programs are commonly used:

- Replacement of fish caught
- Replacement based on number of customers or receipts
- Regular scheduled replacement
- Seasonal (weather or holiday related) replacement.

Individual operators will have to determine the best replacement program for a particular facility. More frequent replacement requires considerable time for scheduling and more meticulous record keeping. The most efficient and profitable fee fishing operations are those that move the maximum pounds of fish in the minimum time with the least obligation of limited resources. Frequent replacement in a relatively small pond containing a moderate density of fish has the potential of the most return on investment.

Channel catfish in fee fishing ponds usually are fed only a maintenance diet. Few operators attempt to promote fish growth in the pond. Fish are fed 1 to 2 percent of the estimated weight of fish in the pond, two or three times per week. A commercial catfish ration is usually fed.

**Marketing Other Species**

Other fish such as rainbow trout or hybrid striped bass are marketed through fee fishing facilities. Rainbow trout require an abundant supply of high quality cool water. Trout fee fishing operations generally are limited to locations at which summer water temperatures do not exceed 70° F. General operating procedures at trout fee fishing facilities are similar to those described for catfish. Because of increasing demands for high quality water and restrictive water use regulations, it is difficult to locate or purchase undeveloped sites appropriate for trout fee fishing operations.

In many areas of the southern United States pond water temperatures are less than 70° F for four to six months of the year. Fee fishing facilities in these areas could sell rainbow trout seasonally. Trout are active and feed well when catfish are sluggish and not biting. Using a combination of catfish and trout could extend the fishing season and improve the cash flow of some fee fishing operations.

Hybrid striped bass recently have become available from commercial producers. Hybrid striped bass are easily caught by hook and line and could be marketed through fee fishing. As hybrid striped bass become more available they undoubtedly will enter the fee fishing market. Striped bass and hybrid striped bass are important game fish throughout the southern United States. In many states there are specific game and fish regulations concerning their production and marketing.

**Live Haulers**


Small-scale producers may sell fishes to live haulers. Live haulers usually buy fishes at the pond bank, then transport and sell them at other outlets such as processing plants, pay lakes, recreational lakes, or retail outlets. Small-scale producers often have difficulty working with live haulers because the producers lack proper equipment and experience. Live haulers need to know exactly how many pounds, what size, and when fishes will be available. Live haulers prefer not to handle small quantities of fish, less than 1,000 to 2,000 pounds, and in some areas not less than 5,000 to 10,000 pounds. Some live haulers may use small trucks to transport fishes within restricted geographic areas, providing an outlet for 500 to 1,000 pounds of fish at a time. They prefer that fish be of a consistent size.

Grading at the pond side is desirable. The producer should have a weighing system so that no doubt exists about how many fish are being sold. Since many small-scale producers do not have extensive holding facilities, fishes are often loaded directly from the pond to the hauling truck. This results in poor quality water in the hauling tank. A supply of fresh, high quality water is desirable to flush out the hauling tank. Live haulers usually do not provide harvesting services. Therefore, the producer has to have the equipment and ability to harvest and load fishes quickly.

Catfish, trout and baitfish are bought by live haulers. Live haulers are an especially attractive market for small-scale baitfish producers because of the difficulty in entering the well established and controlled baitfish distribution system.

### Direct Sales to the Public


Retailers require a constant supply and consistent size product.

Another marketing alternative is direct sales of live, whole or processed fish. This option requires a holding facility but offers the advantage of a premium price with a minimum amount of dealing with the public. Specific hours of operation can be established. Small producers may be open only a few hours one day per week. This allows efficient scheduling of time and reduces time lost waiting for a customer. Orders for fish can be taken prior to pick up with all customers required to pick up fish during a specified time.

If processed fish are sold directly to the public, sanitary processing facilities are required. Local public health officials should be contacted concerning regulations for processing and selling aquaculture products.

### Direct Sales to Restaurants, Grocery Stores, and Other Retail Outlets

Direct sales to restaurants, grocery stores, or other retail outlets often appear to be a viable marketing alternative for small producers. In most cases they are not. Although there may be many retail outlets in the vicinity, they require a constant supply and consistent size product. A small producer probably will have fish available for only a very short time. Even though the producer might be able to deliver a quality product at a reasonable price, the retail outlet manager will usually choose an established distributor or large producer for convenience and dependability.

### Permits and Licenses

Fee fishing operations are regulated by state agencies such as the Department of Natural Resources, Department of Conservation and in some cases the Department of Agriculture. Additionally, local business permits may be required. If fish are processed, the public Health Department may require certain permits be obtained or specific procedures be followed. Prior to selecting a specific marketing option, contact local regulatory agencies such as the Department of Natural Resources or service agencies such as the Cooperative Extension Service concerning local regulations and permit requirements.

### Advertising

**Advertising pays.** Regardless of the marketing alternative chosen, a sound advertising program will increase sales and profits. Small-scale producers seldom consider advertising important or include advertising expenses in budgets. Most small-scale producers assume incorrectly that a few signs and word-of-mouth will provide a profitable enterprise. Traditional advertising outlets such as newspapers, radio and local cable television should be used. In addition, sponsoring special events and working with local outdoor writers can significantly increase profits.

## Strand 3: Aquaculture

## Unit 2: Aqua Farming Practices and Management Systems

**Content Standard 11.3.2** Students will be able to investigate and analyse the different types of aqua farming and management principles, systems and practices used in different environments and places to farm, process, preserve, market, regulate and consume plants, animals and fish.

**Benchmark 11.3.2.3** Examine how aqua farming and consumption of each product are regulated.

**Topic: Aquaculture Regulations**

**Learning Objectives:**

By the end of this topic, students will be able to:
- Investigate and explain the regulations of products on aqua farming and consumption

**Essential Questions:**
1. What products are commonly produced in aqua farming consumption?
2. What are some rules and regulations in aqua farming systems?

| | |
|---|---|
| **Essential Knowledge** | Regulations of products in aqua farming |
| **Essential Skills** | Investigation process, regulation of products in aqua farming |
| **Essential Attitudes and Values** | Caring and concern on aqua farming regulations<br>Dignity towards aqua farming products |

**Assessment:** Regulations in aqua farming systems

**Content Background**

**Basin legislation**

The main pieces of legislation regulating the fisheries and aquaculture sector in Papua New Guinea are the Fisheries Management Act (1998) and the Fisheries Management Regulations (2000). The main objective of these instruments is to promote the management and sustainable development of fisheries and aquaculture in the country.

The Act applies to all fishing activities by both residents and foreigners. It makes provision for fisheries management plans, provides for access agreements, specifies the terms and conditions of fishing licenses and powers of fishery officers. Subsidiary regulations to implement the Act may be made by the Head of State in order to regulate, control and manage aquaculture units licensed under the Act and activities related to or supportive of aquaculture.

The Fisheries Management Regulations is a subsidiary regulation made under the Act. The Regulations provide for the licensing of various fisheries and fish breeding activities, the control of fisheries and regulate the licenses for the export

of fish and aquaculture facility that may be obtained under the Regulations. The national competent body for matters related to fisheries and aquaculture is the National Fisheries Authority (NFA). The NFA is granted corporate status under the Act and comprises the National Fisheries Board and the Authority. The NFA has an Aquaculture Division which is responsible for the management and development of aquaculture and inland fisheries sector. The Authority acts as the secretariat and implementing arm of NFA. It inter alia makes recommendations to the Board on the granting of licence and implements any licensing scheme in accordance with the Act; controls and regulates the storing, processing and export of fish and fish products; and collects data relevant to aquatic resources. The Board shall be responsible for providing general control and guidance over the exercise of the functions of the Authority. The Managing Director of the Authority may appoint Fishery Officers who then are authorised to inspect the aquaculture units by taking samples or by asking the person engaged in aquaculture to produce the licence in conformity with the Act. Any person who contravenes the Act commits an offence punishable by a fine or imprisonment.

NFA's main role is to be the facilitator, policy maker, provider of technical advice and fund applied aquaculture research, targeting mainly commercial aquaculture activities. The role of fostering the development of artisanal aquaculture and performing activities such as research, extension and training is the role of other government departments, namely the National Department of Agriculture and Livestock (NDAL) and the National Agricultural Research Institute (NARI). NFA collaborates with these agencies to implement their respective aquaculture programs and ensure that their programs are consistent with national policies.

In this respect, the 2004 National Aquaculture Development Policy, elaborated under the auspices of NFA, mentions that the policy is based on a vision to foster development of commercial aquaculture by the private sector, using economic profit as the motive, and subsistence aquaculture to enhance food security and provide some alternative income source. The vision of the Policy is:

- To establish aquaculture as a viable business industry by facilitating and supporting the private sector to establish economically, socially and environmentally sustainable aquaculture ventures, with NFA facilitating development when appropriate.

- Food security by producing sufficient fish or fish products to feed the people of Papua New Guinea.
- To ensure that the Papua New Guinean aquaculture industry is protected against harmful diseases.

- To promote information and communication, and educate Papua New Guineans about aquaculture as an alternative means of producing fish and other aquatic products for economic profit and food.

- To integrate aquaculture with agriculture by encouraging farmers to asubsistence/artisanal aquaculture into their existing agriculture options.

- To encourage foreign investment.

- To develop aquaculture on the basis of ultimate self-sufficiency within the sector with decreasing dependence on imports.

**Legal definition**

**Under the Fisheries Management Act, the term "fishing" means:**

*"(a) searching for or taking fish; or*
*(b) the attempted searching for or taking of fish; or*
*(c) engaging in any activity which can reasonably be expected to result in the locating or taking of fish; or*
*(d) placing, searching for or recovering any fish aggregating device or associated equipment including radio beacons; or*
*(e) any operation at sea in support of or in preparation for any activity in relation to a fishing vessel described in Paragraphs (a), (b), (c) or (d) except any related activity as defined in this subsection; or*
*(f) any use of an aircraft which is related to any activity described in Paragraphs (a), (b), (c) or (d), except for flights in emergencies involving the health or safety of a crew member or the safety of a vessel; or*
*(g) aquaculture".*

**The term "fishing" hence encompasses aquaculture.**

**Furthermore, a specific definition of aquaculture is provided.**

**Aquaculture means** "*the cultivation, propagation or farming of fish, whether from eggs, spawn, spat or seed, including rearing fish lawfully taken from the wild or lawfully imported into the country, or by other similar process".*

Fish means *"any water-dwelling aquatic or marine animal or plant, alive or dead, and includes their eggs, spawn, spat and juvenile stages, and any of their parts, but does not include any species of whale".*

**The term "fish" therefore encompasses aquatic animal and plant. Guidelines and codes of conduct**

By virtue of its membership of the Food and Agriculture Organisation (FAO), Papua New Guinea subscribes to the FAO Code of Conduct for Responsible Fisheries (1995). Many of its fishery plans and its National Aquaculture Development Policy is claimed to reflect the principles enshrined in the Code of Conduct for Responsible Fisheries.

**International arrangements**

At an international level, Papua New Guinea acceded to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1975 . The International Trade Fauna and Flora Act (1979) implements Papua New Guinea's obligations as a Party to the CITES.

Papua New Guinea ratified the Convention on Biological Diversity (CBD) in

1993, acceded to the Cartagena Protocol on Biosafety in 2006 and is also a Member of the World Organization for Animal Health (OIE).

At a regional level, Papua New Guinea is a Member of the Secretariat of the Pacific Community (SPC ) which has a Fisheries, Aquaculture and Marine Ecosystems Division.

*Planning*

**Authorization system**

Aquaculture is an activity that may require a licence. The National Aquaculture Development Policy states that:

- All commercial operations with an annual production turnover of ten (10) tonnes or more or utilizing more than one (1) hectare of land or water surface area, whether in sole use for aquaculture or multiple use for other activities must be licensed.
- Small non-commercial or semi-commercial projects with an annual production capacity of less than ten (10) tonnes require no licence.
- All sea cage, pearl shell, oyster, aquarium species and other species not covered in the two-above paragraphs must be licensed regardless of size.
- Aquarium dealers, whether small or large, require license.
- Subject to the Fisheries Management Regulation, an aquaculture facility licence:

"(a) shall be issued for a specified type, class or species of fish; and
(b) shall be issued in respect of a specified area of fisheries waters or a specified place; and
(c) may require a vessel used in conjunction with the aquaculture facility to be–
(i) licensed; or
(ii) subject to such terms and conditions as are specified in the aquaculture licence; and
(d) shall be subject to such further terms and conditions as may be specified in it".

**Access to land and water**

According to the Water Resources Act (1982), water means *"all water in the country, including lakes, rivers, streams, swamps, surface and underground waters, water sources, and coastal waters comprising the internal waters and territorial sea".*

Except for domestic purposes, the right to the use, flow and control of water is vested in the State.

A Water Resources Board is established under the Water Resources Act to perform the following functions:
"(a) to examine problems concerning, and make plans in respect of–
(i) the allocation and quality of water; and
(ii) the control–

(A) of erosion on the banks of rivers and shores of lakes and coastal shores; and
(B) of flow and flooding in and from rivers and lakes; and
(iii) the conservation of water; and
(iv) the needs of fisheries and wildlife and recreational uses of water; and
[...]
(e) to control the damming, diversion, taking and use of water and discharge of anything into water so far as any such acts may affect the quality or availability of water for other purposes; and [...]
(h) to promote the best usage of water resources, including multiple uses, and to allocate water resources between competing demands; and
(i) to consult with government bodies on the maximum utilization of water resources in the national interest".

In order to use water, especially when water may be polluted by contaminants, a water use permit is required. A water permit is needed when the person wishes to: "(a) dam a river or stream; or

(b) divert water; or
(c) release water or contaminants into any water; or
(d) release water containing contaminants onto land or into ground in circumstances that result in –
(i) the contaminants; or
(ii) other contaminants emanating as a result of process from the contaminants,entering the water; or
(e) being the occupier of land, to cause or permit contaminants emanating as a result of processes from matter previously placed on or released on to the land or into the ground, to enter water; or
(f) take or use water; or
(g) knowingly cause any contaminant to enter water".

The Water Resources Act empowers the Director of Water Resources to "authorize a person, by himself or by his assistants, employees, agents, servants or contractors, with or without vehicles and machinery:
(a) to enter on land for the purpose of exercising the rights vested by this

Act in the State to the use, flow and control of water and carrying out investigations into water resources and of taking measures –

(i) for conserving water, regulating the flow of water and preventing the contamination of water; or
(ii) for protecting the bed and banks of any water course or lake or shore and removing obstructions from the bed or banks; or
(iii) for removing or destroying any works affecting the use, flow or control of water not authorized by or under this Act or not authorized, before the commencement date by or under any other Act; and
(b) to enter on land within a water control district and carry out such works relating to the use, flow and control of water, as specified in the instruments".

**Water and wastewater**

The Environmental Contaminants Act (1978) prohibits the discharge of environmental contaminants into the environment, unless the person holds a licence to discharge.

An environmental contaminant is defined as:

*"(a) any substance whether liquid, solid, gaseous or radio-active, or any form of electromagnetic or thermal energy which, when discharged, emitted or deposited into the environment, causes or may cause, by reason of its properties, characteristics, the volume, amount and weight and point of its discharge, or other circumstances, a present or future alteration of the environment so as to affect adversely its beneficial use; and*
*(b) any substance, material or matter prescribed to be an environmental contaminant or a hazardous environmental contaminant".*

**Fish movement**

Under the Animal and Disease Control Act (1952), "(1) the Minister for Agriculture may, by notice in the National Gazette, prohibit or restrict–
(a) the introduction or importation of any animal or kind of animal into the country; or
(b) the movement of any animal or kind of animal within the country.
(2) A notice under Subsection (1) may_
(a) require a permit or consent to be obtained; or
(b) impose, or authorize the imposition of, conditions by a permit or consent, or both.
(3) A person who is concerned in introducing, importing or moving, or in the attempted introduction, importation or movement, of an animal in contravention of a notice under Subsection (1) is guilty of an offence".

According to the Fisheries Management Regulation (2000), any premises exclusively or predominantly used for the commercial storage, processing or export of fish shall be licensed as a fish storage facility or a fish factory or fish export facility.

The owner or occupier of the premises may apply for a fish storage facility, or fish factory, or fish export facility licence in respect of such premises. The licence will be granted only if the facility intended for preparation, processing or storage of fish for human consumption is capable of such preparation, processing or storage to internationally acceptable standards for the type, class or species of fish for which the licence is being sought.

A fish export facility licence:
"(a) shall specify the type, class or species of fish to be processed under the licence; and
(b) shall be subject to the condition that all fish processed in the facility shall be exported in accordance with this Regulation; and
(c) may specify other matters in relation to the processing and export of fish; and

(d) shall be subject to such further terms and conditions as are specified in it".

A fish export facility in which fish intended for human consumption is prepared, processed or stored shall:

"(a) comply with any law relating to food for human consumption; and
(b) be constructed so as to be capable of being maintained, and be maintained, in a clean and hygienic condition; and
(c) be equipped only with equipment and fittings which are capable of being sterilised and are maintained in a clean and hygienic condition".
Moreover, it shall be a condition of any licence issued that a Fishery Officer may, at all reasonable times, enter the premises or facility to which the licence relates, for the purpose of:
"(a) inspection of the condition of the facility; or
(b) examination of any fish held in the facility; or
(c) where he considers it necessary or desirable, taking samples for analysis of any fish in the facility".

**Disease control**

The Minister for Agriculture may declare a disease or pest affecting animals to be a disease for the purposes of the Animal Disease and Control Act (1952).

The Minister may also declare a disease to be a notifiable disease. The owner of an animal, or the occupier of any land on which there is an animal, who knows or suspects; or ought, if he used reasonable diligence, to know or suspect, that the animal is infected by a notifiable disease, and who fails to notify an Inspector immediately, is guilty of an offence. It is also worth mentioning that the National Aquaculture Development Policy encompasses aquatic animal health management through the harmonization and enforcement of appropriate regulatory frameworks; capacity building both at the institutional and farmer levels through awareness, training; the adoption of sensitive diagnostic methods.

**Drugs**
The Poisons and Dangerous Substances Act (1952) makes provision for the control, sale and use of poisons, drugs and dangerous substances. "Poison" means a thing specified in Schedule 1, 2 or 3 of the Act, whereas "dangerous substance" means a thing specified in Schedule 4 or 5.

Schedule 5 applies to fish (e.g antibiotic used for the treatment of fish, or growth promotion) and mentions that the substances specified in this Schedule shall be packed, labelled and sold in accordance with Section 12 of the Act.

Section 12 states that:
" 1) Subject to this Act and to any other law, any person may sell to a purchaser who is known to the vendor to be engaged in mining, agriculture, horticulture or the keeping or breeding of animals a thing specified in Schedule 5 that is packed exclusively for the purpose of the industry in

which the purchaser is engaged.
(2) Where a thing referred to in Subsection (1) is labelled and packed as required by this Act and is sold in the quantity set out in Schedule 5, it shall, for the purposes of this Act, be deemed to be specified in that Schedule and not in any other Schedule notwithstanding that it, or some of its component parts, is in fact specified in any other Schedule".

**Feed**

Under the Public Health Act (1973), "the Head of State, acting on advice, may make regulations, not inconsistent with this Act, prescribing all matters that by this Act are required or permitted to be prescribed, or that are necessary or convenient to be prescribed for carrying out or giving effect to this Act, and in particular prescribing matters providing for and in relation to:
[...]
*(i) the licensing, control and inspection of–*
*(i) the preparation, sale, distribution and possession of food and drugs; and*
*(ii) the keeping of animals used for food or for the production of food products, and the food products of those animals [...]".*

**Food safety**

The main Act for securing wholesome, sound and safe food for human consumption is the Food Sanitation Act (1991).

Under this Act, "animal" means "cattle, pigs, rabbit, poultry, bird (other than a game bird), fish *(including crustacean and mollusk), reptile or other animal which is used for human food" and "meat" means "the whole or any edible part of the dead body of an animal that is ordinarily used as food by man, whether fresh, chilled or frozen".*

The Act establishes a Food Sanitation Council responsible for investigating and deliberating on matters relating to the prevention of food poisoning, the preparation, standards and the requirements of food, food additives, apparatus and packages; and investigating and reporting to the Minister of Health on any matter relating to food sanitation or any other matter as the Minister directs. The Minister may appoint food inspectors and food analysts under the Act.

**Benchmark 11.3.3.1** Examine post-harvest technologies and evaluate their advantages and disadvantages.

**Topic: Post-Harvest Technologies of Aquaculture**

**Learning Objectives:**

By the end of this topic, students will be able to:

- Research proper post-harvest technologies of aquaculture and state their advantages and disadvantages
- Distinguish the different methods of assessing freshness of fish

**Essential Questions:**

1. What technologies are used in post-harvesting of aquaculture?
2. What are the advantages and disadvantages of the post-harvest technologies?

| | |
|---|---|
| **Essential Knowledge** | Technologies used in post-harvest of aquaculture |
| **Essential Skills** | Assessing freshness by sensory and chemical methods |
| **Essential Attitudes and Values** | |

**Assessment:** State post–harvesting technologies in aquaculture.

**Content Background**

**Aquaculture**

Aquaculture, the aquatic counterpart of agriculture, has grown rapidly in recent decades. It is the breeding or farming and harvesting of aquatic organisms, including fish, mollusks, crustaceans, aquatic plants and other organisms in all types of water environments.

**Post-Harvest Technology**

Post-harvest describes the systems of harvesting, handling, processing, sorting, storing, packaging, transportation and marketing of aqua produce. In this topic we will cover fish handling after harvest, transportation, processing, and measuring of quality.

**Fish handling after harvest**

Harvest and handling during aquaculture refers to the activities which take place when fish are removed from the pond, cage or other production unit, and before the products are marketed for human consumption as food. What happens to fish during this crucial period has implications for food loss and

waste (FLW) at this stage and in the subsequent stages of the value chain.

Unless harvested quickly with minimal stress and damage, properly handled, and chilled, then spoilage and quality deterioration will be accelerated. This is especially prudent in tropical areas, where ambient temperatures are high and conducive to rapid bacterial growth. For products which are to be marketed live, poor harvesting techniques and improper post-harvest handling will increase the risk of mortality of fish prior to and during marketing

Harvesting is one of the most important activities of fish farming. It is an important step in getting fish out of production facilities in good condition so their survival and quality for other uses are assured. Aquaculture facilities vary considerably in terms of production technique, level of investment, size, and whether production is in pond or cage culture is used.

**Handling**

The quality of fish depends on how it is handled from the time it is taken out from the water until it reaches the kitchen. Fish landed is usually subjected to rough handling treatments.

Consider these three cardinal rules in handling fresh fish;

*1. Cleanliness:*
- Observe cleanliness throughout the fish handling chain.
- Gut the fish immediately after fish is harvested

*2. Care:*
- Work on fish as quickly as and as promptly as possible.
- Sort fish properly before packing.
- When fish have to wait on deck or on the fish landing for some time before working on these, cover these to protect them from heat and other elements.
- Drain fish before icing
- Avoid brushing the fish
- Don't throw, trample or kick the fish

*3. Cooling:* Temperature is the most important single factor affecting the quality of fish.
- Use plenty of ice. Put additional layer of ice it reaches the kitchen. Fish landed is usually subjected to rough handling treatments.
- on top, bottom and side of fish in boxes or shelves.
- Don't over-fill a box or shelf. The next box or shelf on top will smash the fish below.
- Lay the fish belly downward – this prevents entry of dirt water into the fish.
- Don't pack fish so tightly that melted ice cannot flow.
- Fish is cooled more quickly when ice cold water is poured on them. Fish spoils easily when allowed to stay in stagnant water, blood or slime.
- Store fish in ice as quickly as possible. Make sure the fish room is always kept clean.

**Transportation:**

- Fresh fish transported to far distances must be packed with ice to ensure freshness when they reach the consumers.
- Proper packing of fresh fish with ice means arranging the fish and ice alternately in the container to maintain chilling temperature.
- It is attained with the ratio of 1 kg of ice to 2 kg of fish.
- The more sophisticated method of the transportation is the refrigerated truck or Insulated Van.
- When transporting fish within the region, wholesalers pack them in ice. Upon reaching their destination, fish are repacked with ice and sold to retailers and eventually to consumers.
- The latest practice of transporting live marketable fish.

**Processing:**

- Fish spoils very quickly within 12 hours after being harvested.
- This due to the high ambient temperature that is ideal for bacterial growth.
- To prevent contamination of the fish, proper hygiene must be ensured.
- Contamination can come from people, soil, dust, sewage, surface water, manure, or spoiled foods.
- Poorly cleaned equipment
- To prevent spoilage of the harvested fish, either the bacteria present in them must be killed or their growth must be suppressed.

**Measuring Quality of Freshness**

**Quality** is a measurement made by the customer on the suitability of a product (fish) for its purpose or use.

**The assessment of quality**
For the average person purchasing fish for cooking at home, ‘quality’ means that the fish looks good, feels good, smells good, and makes a satisfying meal.

- **Looks good** means that the fish looks alive as if it has just come from the sea. Colours are bright and clear, the flesh is glossy and transparent, and the body is undamaged. It does not look dull or dried-out. Feels good means that the flesh is firm and pliable, rather than soft.

- **Smells good** means that there is either no smell or a very slight ‘sea’ smell. There is no strong ‘fish’ smell or bad odour. The ultimate test comes with the eating of the fish. ‘Quality’ here means that it tastes good and has no ill-effects afterwards.

- **Tastes good** means that it not only has a delicious taste, but also that the texture is right. The flesh is firm, yet tender. Of course, poor cooking can ruin the meal no matter what the quality of the fish. Fish, like other meats, are subject to bacterial contamination, and care must be taken in selection, handling, preservation and cooking.

**Fish quality Assessment**

There are several ways of assessing fish quality and they are categorized as follows;

1. **Sensory method** – this is using your 5 senses to determine freshness like; smell, seeing the gill colours, feel the flesh texture, see the body colours and fish eyes

| | HIGH QUALITY | MEDIUM QUALITY | POOR QUALITY |
|---|---|---|---|
| **Eyes** | Eye clear, black stands out from head, surface of eye convex | Eye about 50% cloudy. Surface of eyes slightly concave. | Eye opaque/brown. Severely sunken |
| **Body colour** | Body colours bright | Body colours dull | Body colours dark-not visisble |
| **Gill colour** | Gills bright pink/red | Gills brown, small or medium amount of slime (clear) | Gills brown/putrid. |
| **Smell** | No 'fish' smell or slight 'seawater' smell | Definite 'fish' smell. | Pronounced putrid odour |
| **Flesh texture** | Firm and elastic (springs back quickly on pressing) | Flesh soft (doesn't spring back fully on pressing). | Flesh falling away from carcass. Very soft texture. |

*Table1: Table categorizing different sensory methods with the degree of freshness.*

**2. Chemical method**

This is use of chemical to test and to see if there is any fish damage chemically to determine the degree of freshness.

**3. Physical method**

This is use of physical means such as use of devices to measure electrical properties to establish freshness or use of pH meter to determine certain level of pH, and or measuring the texture of the fish muscles, and

**4. Microbiological method**

The aim of microbiological examinations of fish products is to evaluate the possible presence of bacteria or organisms in fish that determines the freshness and quality of the fish.

Of all methods, sensory method is commonly used as it is simple and practically can be used by any one.

## Strand 3: Aquaculture Unit 3: Aqua Farming and Technology

**Content Standard 11.3.3** Students will be able to examine how technology is used to aqua farming and processing, preservation, marketing, consumption, regulation and management of plants, animals and fish in different environment and places and evaluate their strengths and weakness.

**Benchmark 11.3.3.2** Research and discuss the processes of using communications technologies in sales and marketing of aqua farming products.

**Topic: Sales and Marketing Technology**

**Learning Objectives:**

By the end of this topic, students will be able to:
- Identify technologies used to market and sell aqua farming products.

**Essential Questions:**
1. How is communication technology used in sales and marketing of aqua products?
2. Why is communication technology important in sales and marketing of aqua products?

| | |
|---|---|
| **Essential Knowledge** | Communication skills for Sales and marketing aqua products |
| **Essential Skills** | Communication Skills |
| **Essential Attitudes and Values** | Taking ownership |

**Assessment:** Conduct a research on marketing technologies applicable to the local area

**Content Background**

**Information Communication Technology in Aquaculture**

The world is undergoing an information Communication Technology (ICT) revolution, a revolution that has enormous socio-economic implications for the developed and developing countries.

The latest innovations of ICTs in fisheries sectors have brought about a tremendous change in the life styles of the fish farmers. Different initiatives in ICTs have been taken up which would also help in expanding and developing technologies to the farmers.

However, the rural people still have difficulties in accessing crucial information in forms they can understand in order to make timely decisions. New information and communication technologies are generating possibilities to solve problems of rural people to promote the agricultural production by providing scientific information.

The introduction of mobile phones has brought about a tremendous change in the fisheries sector. Some notable result is the dramatic improvement in the efficiency and profitability of the fishing industry. As the mobile service spread, it allowed fisherman to land their catches whre there were wholesalers ready to purchase them.

Different communication technologies have been used by the fisherman, entrepreneurs, aquaculturist, extension workers etc.

**Marketing**

Culturing an aquaculture product to market size may be the most difficult task faced by the aqua culturist, but finding a market for the product produced may be the most important task. Marketing must be considered in planning the enterprise. All too often, the product is produced and then a market is sought. Marketing must be considered before the product is grown and not as an afterthought.

As a farmer, the producer has the unique advantage of first knowing what the market wants and then producing it. The farmer can shift away from the strict "production mentality" to a "market" mentality, where the market will drive production decisions, within technological limitations. Adjustments in the production schedule, i.e., time of stocking, stocking density, grow-out period and harvest period, can lead to higher prices and higher profits when the market information is included in production management.

The supply chain includes all links from the point of production (point of catch or farm site in the case of aquaculture) to the end user or final consumer. The supply chain for fish and fishery products can involve a large number of people between the fisher or fish farmer and the final consumer.

The supply side of fish and fishery products is affected by factors such as: market demand, prices, seasonality, climatic conditions, population dynamics, economic situation, fuel prices, policy and legal environment. The perishable nature of fish requires special attention to handling, grading and packing, and the market price is usually dependent upon the quality of fish (although this is not always true when demand does not match supply). Supply chains are concerned with how long it takes to present the good for sale. The main objectives of supply chain management are to reduce the number of links and to reduce bottlenecks, costs incurred, time to market, etc. Good supply chain management is essential to develop a value chain

To take the best advantage of the market, the farmer must develop and keep an up-to-date marketing plan. Due to the uncertainty of yields and prices, planning the market strategy becomes very important. Market planning is not a one-stage process. It must be continuous throughout the year. A successful market plan must be flexible. The market plan must address several critical points including:

- The location of the market
- The completion
- The volume the market requires
- When the market needs the product
- When the harvest will be ready
- The quality necessary to satisfy the market
- The market requirements (size and form)
- Product delivery and handling
- The cost/price relationship
- The market plan should be reviewed and revised often.

Knowing that a market exists is the starting point. Gaining access to the market can often pose a problem. There may be entry barriers that the farmer must overcome before the product can be marketed.

How can a new producer gain access to the market? Some methods require innovation and salesmanship, while others are more direct. A small producer may find direct sales to consumers as the best alternative. A larger producer may be able to contract with an established buyer.

In many situations, the volume, quality and price may be determined by the buyer. Consequently, the producer must be willing to work with the buyer and meet the market requirements. Quality and consistency of the products are key factors in successful marketing, as is the ability to provide good service at competitive prices. Major factors of importance to fish buyers at the time of purchase include:

- Appearance
- Flavor
- Freshness
- Consistent supply
- Quality guarantee
- Price

An understanding of the market requirements and commitment to fulfilling them are fundamental to success.

### *PNG's Fish Collection and Marketing Centers*

During the early 1970s a number of fish collection and marketing centers were established. This led to the Coastal Fisheries Development Program, the biggest publicly funded fisheries development activity ever undertaken in PNG. The program, planned in the late 1970s, envisaged the construction or rehabilitation of 20 coastal fisheries stations separated by distances of about 200 km and each equipped to freeze and store about 1 tonne of fish per day. Fish collection vessels would deliver ice to outlying villages and collect their catches, while a vessel with freezer storage would collect the product and transport it to the major towns for local sale or export. Funding was provided mainly by the National Government, but in some cases Provincial Governments and donors also provided inputs.

Twenty-two coastal fisheries stations were actually established and became operational at one time or another. Up to a dozen collection vessels over 10 m length and numerous smaller collection boats were deployed, but results were disappointing. A review of four stations undertaken in 1984 concluded that they were all over-capitalized, under-utilized and economically non-viable. Three of the most productive stations were refurbished with loan funding from the International Fund for Agricultural Development, and although the best of these (Samarai in Milne Bay Province) produced up to 300 tonnes of fish a year, all of them still operated at a loss. Problems included delays in installing and maintaining equipment (a Government Department's responsibility), poor fish quality and marketing problems, difficulty in recruiting and retaining competent managers, and confusion between commercial and service activities.
Source: Preston (2001)

**Channels of fish markets**

A fish market is a marketplace for selling fish products. It can be dedicated to wholesale trade between fishermen and fish merchants, or to the sale of seafood to individual consumers, or to both. Retail fish markets, a type of wet market, often sell street food as well.

*Koki Fish Market*

Fish can be sold as:

- Fresh Fish Market (after harvest from farm)
- Live Fish Market (while in pond)

**Types of Fish Market**

Fish distribution usually involves three levels.

**1. Primary Markets:**

- Markets located in villages, district headquarters or at a crossroads are considered primary markets.
- They are usually near areas where fish are caught.
- Fishermen bring a variety of fishes (dominated by small fish from both open-water capture and from ponds) to the primary markets.

**2. Secondary Markets:**

- The intermediaries take the fish bought from the fishermen / primary markets / landing points to the nearest port markets by road or river to sell to wholesalers.

- From these secondary markets the fish distributed to urban markets / higher secondary markets through different channels by commissioned agents for wholesalers or other kind of intermediaries.

**3. City or Terminal Markets:**

- Retailers buy fish from wholesaling centres of secondary markets. They sell fish directly to consumers either through fixed stalls

At each market level, wholesalers and retailers may be supplying fish to local consumers. Marketing fish starts with the primary market. Fish are collected and sold at the farm-gate and redistributed to other markets. However, fish farmers may choose to sell their own fish, if transportation can be arranged easily and if they stand to realize higher prices after deducting marketing costs such as charges for transportation, labour, etc. They often sell to hotels, school mess, main markets, hospital mess, and mining mess.

**Price Determination**

Fish can be obtained by money, barter, or through gift exchange. In non-monetized societies the barter equivalents are fairly standardized, although bargaining does occur at the retail level as well as in transactions between traders and wholesalers. The transition from a barter to a money economy has seriously affected existing market patterns. The increase in production as a result of the modernization of the fisheries sector has attracted traders formerly not engaged in fish processing and marketing.

In a free market system, the prices of fish are not fixed and are determined by a complex of factors. These include:

- transport cost,
- production cost,
- supply and demand,
- competition,
- processing technique,
- variety of fish.

## Strand 3: Aquaculture Unit 3: Aqua Farming and Technology

**Content Standard 11.3.3** Students will be able to examine how technology is used to aqua farming and processing, preservation, marketing, consumption, regulation and management of plants, animals and fish in different environment and places and evaluate their strengths and weakness.

**Benchmark 11.3.3.3** Examine and explain the relevance of fisheries policies rules and regulations in monitoring and managing all aspects of aquatic resources.

**Topic: Rules and Regulations**

**Learning Objectives:**
By the end of this topic, students will be able to:
- Interpret the different fisheries policy, regulations and rules.

**Essential Questions:**
1. Who regulates the fishing industry in PNG?

| | |
|---|---|
| **Essential Knowledge** | Fisheries policy and regulations |
| **Essential Skills** | Interpret fisheries policies and regulations |
| **Essential Attitudes and Values** | Appreciate that policies and regulations protect consumers |

**Assessment:** Find out which fishery policy is locally applicable

**Content Background**

**Policy and Regulations**

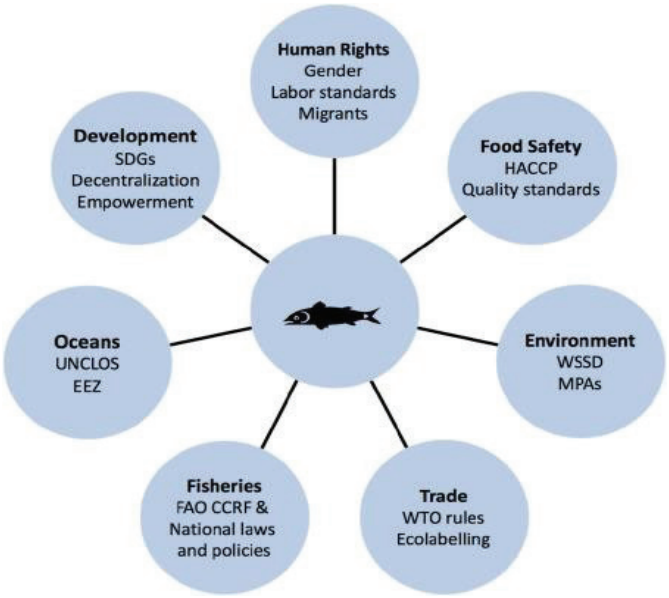
The Papua New Guinea Government as a Fisheries Management Act 1998 that governs all fisheries activities in the country. Fisheries policy, regulations and rules are derived from the Fisheries Management Act (1998). The PNG National Fisheries Authority (NFA) is the primary regulatory and management body for the sector and it provides support and coordinate fishery development in the country. It also facilitates export certification and regulation and manages fisheries resources for sustainable growth.

**Fishery Policy**

Fisheries policy and laws are usually set at national level. Although with decentralization prevalent in many countries, fisheries management has frequently been devolved to local or provincial levels, and fishing communities can be key partners in the management of the resource they depend upon. Fisheries policy does not occur in a vacuum, however, and it interacts with a range of other legal and policy instruments at multiple levels.

Fishing takes place within the broader frame of ocean governance under the UN Convention on the Law of the Sea, under which states have claimed Exclusive Economic Rights (including to fisheries) in the zone encompassing 200 nautical miles from the coast. In addition to national laws and policies

and the UN Law of the Sea, fisheries and aquaculture are governed through a set of policy standards and guidelines such as the FAO Code of Conduct for Responsible Fisheries and the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (Fig 1). These instruments are endorsed by the member states of FAO through the Committee on Fisheries (COFI), which meets biennially. The codes and standards are meant to guide national governments, as well as other fisheries and aquaculture stakeholders.




Global, regional, and national laws and policies from other sectors (e.g., pollution, trade, food safety, environmental conservation, and development) also influence fisheries and aquaculture policies.

**General Legal Framework of PNG Fisheries**

The Fisheries Management Act 1998 defines the role and responsibilities of the National Fisheries Authority. The Act essentially empowers NFA to manage, control and regulate all of PNG's fishery resources, whether these be inland, coastal or offshore. Although the Act recognises and allows for customary uses, rights and traditional resource ownership, it does not in itself empower provincial or lower level governments to manage fisheries in what they may consider to be their areas of jurisdiction. Such powers may be delegated by the Minister for Fisheries through regulation or promulgation, but this is entirely discretionary. The Act is 56 pages in length and consists of nine parts:

- Part i Preliminaries
- Part ii Institutional arrangements
- Part iii Fisheries management, conservation and development
- Part iv Licences
- Part v Enforcement and observer programme
- Part vi Jurisdiction, procedure, offences, penalties and liability
- Part vii Administrative proceedings
- Part viii Evidence
- Part ix Miscellaneous

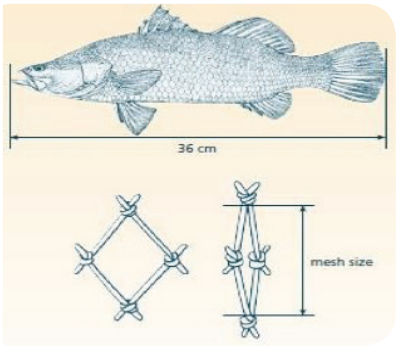
With respect to the details of the Act:

- The provisions of the Act on the functions of the NFA are given in Section 7 of fisheries Act
- The provisions of the Act on the content of fisheries management plans and on the objectives of fisheries management in PNG are given in Section 3.2.5 above

Apart from the Fisheries Act, there are at least 28 other legislative instruments currently in force and relevant to the fisheries sector. Most important of these is the Organic Law on Provincial and Local-level Governments of July 1995, which gives provincial governments the responsibility for fisheries and other development activities and the provision of basic services. The Organic Law requires that national bodies devolve as many of their functions as possible to the Provincial authorities, or carry them out at Provincial level. Other relevant legislation includes the environment, maritime zones, shipping and maritime safety acts and regulations, and laws governing business and company management.

**Some Examples of Papua New Guinea Fisheries Regulations**
Barramundi (Lates calcarifer)

**Gear restrictions:**



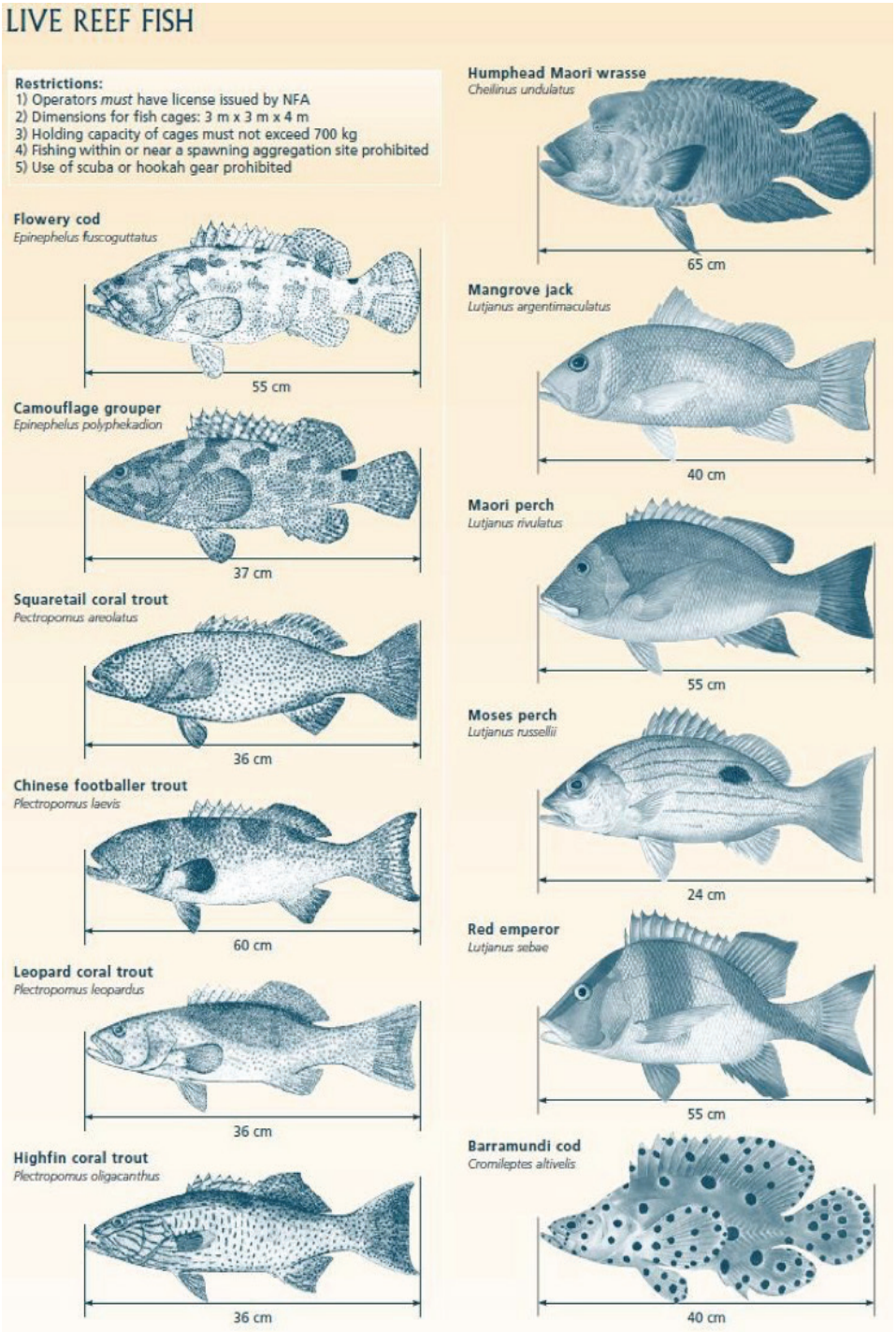

- Prohibited to use seine and gill nets with net mesh size more than 15 cm
- Prohibited to use seine and gill nets with mesh sizes between 6.35 cm and 12.7 cm from 1 March–30 April (peak period of juvenile recruitment) between Sui village and PNG/ Irian Jaya border
- Prohibited to use seine and gill nets with mesh sizes more than 12.7 cm from 1 September–31 October (peak spawning time) between Sui village and Buzi village

**Area closure:**

1. Spawning and breeding grounds closed to commercial fishing 1 October–30 November between Sigabaduru village and PNG/Irian Jaya border

**Other restrictions:**

1. Owners of licensed collector vessels prohibited from catching barramundi
2. Total allowable catch is 260 metric tonnes per year

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## Strand 4: Natural Resource Management

| | | | |
|---|---|---|---|
| **Content Standard 11.4.1** Students will be able to define capture fishery, investigate the different types of fish and other consumable aquatic organisms and plants harvested using this method of fisheries, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they are harvested. | | | |
| **Units** | **Benchmarks** | **Topic/s** | **Lesson Title/s** |
| **1. Types of Capture Fishery** | **11.4.1.1** Investigate and examine the cultivation of capture fishery in different natural environments. | Capture fishery cultivation | Sea ranching<br>Coastal lagoon Farming<br>Stocking of inland lagoons<br>Flood plain fisheries management |
| | **11.4.1.2** Examine the characteristics of capture fishery organisms found in different environments and places. | Capture fishery organisms and environments | Characteristics of capture fishery organisms<br>Capture fishery organisms and habitats |
| **Content Standard 11.4.2** Students will be able to investigate and analyse the different types of capture fishery practices and management systems used in different environments and places to capture**,** process, preserve, market, regulate and consume fish and other aquatic organisms and plants. | | | |
| **2. Capture Fishery harvesting practises and management system** | **11.4.2.1** Investigate and explain the factors affecting the ~~of~~ capture fishery production in different places and environments. | Factors affecting capture fishery production | Factors of capture fishery production |
| | **11.4.2.2** Research and explain the process and ways of processing and marketing capture fishery products. | Capture fishery and marketing processes | The fishery process<br>The Marketing process |
| | **11.4.2.3** Examine how capture fishery and consumption of its products are regulated. | Capture fishery and consumption regulations | Capture fishery regulations<br>Consumption regulations |
| **Content Standard 11.4.3** Students will be able to examine how technology is used in capture fishery and the processing, preservation, marketing, consumption, regulation and management of fish and other aquatic organisms and plants in different environment and places and evaluate their strengths and weakness. | | | |
| **3. Capture fishery and technology** | **11.4.3.1** Examine post-harvest technologies in capture fishery and evaluate their advantages and disadvantages | Post-harvest technology | Post-harvest technology |
| | **11.4.3.2** Research and discuss the processes of using communications technologies in sales and marketing of capture fishery products. | Communication technology processes in capture fishery | Use of Communication technology in capture fishery |

| | | | |
|---|---|---|---|
| | **11.4.3.3** Examine and explain the relevance of fisheries policies, rules and regulations in monitoring and managing all aspects of aquatic resources | Policies and Regulations | Importance of Monitoring aquatic resource policy<br>Managing aquatic resources |
| **Content Standard 11.4.4** Students will be able to define forestry, investigate the different types of forestry and forests, categorize them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they grow and are harvested. | | | |
| **4. Types of forestry and forests** | **11.4.4.1** Identify and examine different types of forest products and analyse their properties, functions, purposes, and benefits. | Identifying forest products | Properties<br>Functions<br>Purposes<br>Benefits |
| | **11.4.4.2** Research and classify forest products according to their species, properties, functions, purposes, and benefits. | Classify forest products | Species<br>Properties<br>Functions<br>Purposes<br>Benefits |
| | **11.4.4.3** Investigate and explain how different forest products are cultivated and processed in different environments and places. | Processing forest products | Cultivation<br>Maintaining<br>Harvesting<br>Processing |
| **Content Standard 11.4.5** Students will be able to investigate and analyze the different types of forestry practices and management systems used in different environments and places to harvest, process, preserve, market, regulate, and consume forests products. | | | |
| **5. Forests harvesting (creation) practises and management systems** | **11.4.5.1** Assess different approaches and practices practiced in producing and preserving forest products. | Producing and preserving forest products | Nursery<br>Plantation<br>Saw mill |
| | **11.4.5.2** Investigate and explain how the cultivation, processing, preservation, sales and marketing, and consumption of forest products are regulated in different places. | Forestry regulations | Forestry Act |
| **Content Standard 11.4.6** Students will be able to examine how technology is used in the harvesting, processing, preservation, marketing, regulation, consumption, and management of forestry. | | | |
| **6. Forestry and Technology** | **11.4.6.1** Investigate and explain how technology could be used to grow timber species in PNG on a large scale. | Technology and growing timber species | Fertiliser application |
| | **11.4.6.2** Investigate and identify a problem related to the establishment, production, and marketing of forest products and develop appropriate solutions to address the problem. | Constrains and solutions | Land tenure<br>Labour intensive<br>Longer harvest time etc…. |

## Strand 4: Natural Resource Management
## Unit 1: Types of Capture Fishery

**Content Standard 11 4.1:** Students will be able to define capture fishery, investigate the different types of fish and other consumable aquatic organisms and plants harvested using this method of fisheries, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they are harvested.

**Benchmark: 11.4.1.1** Investigate and examine the cultivation of capture fishery in different natural environments.

**Topic: Capture fishery cultivation**

**Learning Objective:** Students will be able to;

- Explain what is Capture fishery cultivation
- Identify cultivation of Capture fishery in different environments

**Essential Questions**

1. What is Capture fishery cultivation?
2. What are the different environments in cultivation of capture fishery?

| | |
|---|---|
| **Essential Knowledge** | Capture fishery cultivation |
| **Essential Skills** | Research and analyse Capture fishery cultivation in different environments |
| **Essential Attitudes & Values** | Appreciate and value the capture fishery cultivation |

**Content Background**

**Capture fisheries** is the exploitation of aquatic organisms without stocking the seed. Recruitment of the species occurs naturally. This is carried out in the sea, rivers, reservoirs, etc. Fish yield decreases gradually in capture fisheries due to indiscriminate catching of fish including brooders and juveniles. Overfishing destroys the fish stocks. Pollution and environmental factors influence the fish yield. The catches include both desirable and undesirable varieties.

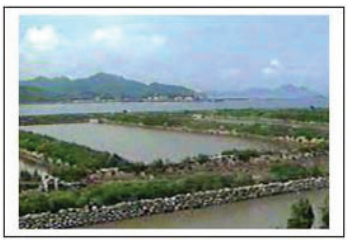
Capture fisheries is intended for catching fishes and also prawns, lobsters, crabs, sea-cucumbers, whales, pearl oysters, edible bivalve and abundant other organisms of other than fishes etc.

## Capture fishery cultivation

*Examples of this type of cultivation*

**1. Sea Ranching** – Is the release of the young of fishery species reared in hatcheries and nurseries into natural bodies of water for subsequent harvest at maturity or the manipulation of fishery habitat, to encourage the growth of the wild stocks. It can occur in two ways;

First, the approach relies on extensive rather than intensive techniques, in other words, growth occurs in the natural habitat and not in cages or nets; and second, the approach is closely integrated into the commercial fishing industry.


***Examples of Sea Ranching Systems***

**2. Inland culture based fisheries** - are essentially a form of extensive, farming practice conducted in small water bodies (generally less than 100 ha). These water bodies would not be able to support a subsistence fishery due to a lack of adequate natural recruitment of suitable species. Artificial water bodies, not built for fishery purposes (such as ponds) but often built for irrigation purposes, can be used.

The stocked fish live and grow in the water body consuming the naturally produced food organisms in it. The fish are harvested at a suitable time or when the water level withdraws.
Culture-based fisheries differ from traditional stock enhancement practices in large inland waters in that the group that manages the small water body will have ownership of the stock: in a large water body the fishery will have open access.


*Examples of Culture-based fisheries*

**Assessment Task**: Students will do a research and present on types of capture fishery cultivation in different environments.
**Source**: http://nptel.ac.in/courses/120108002
Lawinsider.com/dictionary/sea-ranching

## Strand 4: Natural Resource Management
## Unit 1: Types of Capture Fishery

**Content Standard 12. 4.1:** Students will be able to define capture fishery, investigate the different types of fish and other consumable aquatic organisms and plants harvested using this method of fisheries, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they are harvested.

**Benchmark: 11.4.1.2** Examine the characteristics of Capture fishery organisms found in different natural environments

**Topic: Capture fishery organisms and environments**

**Learning Objective:** Students will be able to;

- Explain characteristics of capture fishery organisms.
- Identify capture fishery organisms and their habitats.

**Essential Questions**

1. What are the characteristics of capture fishery organisms?
2. What are capture fishery organisms and their habitats?

| | |
|---|---|
| **Essential Knowledge** | • Characteristics of capture fishery organisms<br>• Capture fishery organisms and habitats |
| **Essential Skills** | • Discuss characteristics of capture fishery organisms and their habitats |
| **Essential Attitudes & Values** | • Appreciate and value the capture fishery organisms and their habitats |

**Content Background**

**Capture fishery organisms and environment**

Capture fishery is conducted in freshwater and sea waters.

The **freshwater habitat** includes the lakes, ponds, streams, springs, and rivers. These water bodies are known for low salt content or low salinity. The animals and plants in freshwater habitat vary from the ones in the estuarine habitat. This is due to the salinity factor.

Examples of capture fishery organisms that live in freshwater are; tilapia, freshwater prawns and freshwater trout.

**Adaptation of Organisms to Fresh Water and Sea Water**

Those features of organisms which structurally, physiologically, and behaviorally fit them for life in their particular habitats and improve their chances of survival are known as adaptations. They are adapted to the environment in the following ways:

***Examples of Fresh Water organisms***

**Tilapia** - live and thrive in warm waters and cannot survive for long in temperatures below 60 degrees Fahrenheit. Indeed, they need tropical-like conditions, with water temperatures between 76 to 84 degrees Fahrenheit. They prefer fresh water, such as lakes and streams, which have low concentrations of salt.

It has fins that help it swim in water. It has gills that help it breath in water. It has specialized eyes for viewing objects in water. It has scales to make its body surface slippery for easy movement in water.

2. **Freshwater prawns** – The freshwater prawn, sometimes called the freshwater shrimp, is a member of a large group of freshwater crustaceans found in many parts of the world.

Like other aquatic organism's prawns **have developed external gills for breathing under water**. They do not have fins like fishes, but by pushing their abdomen they swim in water. By the help of their legs they can walk along the bottom of the water bodies.

**3. Freshwater trout –** Trout are usually found in cool, clear streams and lakes. Trout have fins entirely without spines, and all of them have a small adipose (fatty) fin along the back, near the tail. Trout use fins and their tails also the shape of their body helps them. For defense adaptations they use their scales they also have a different color for camouflage to keep safe from predators. They also flee anytime they sense danger. The shape of their mouth also helps them eat because it is made for them to jump out of the water which is also an adaptation trout have for food.

**The sea water habitat -** A sea habitat is a body of salt water, its coastline and floor, all of which are inhabited by multiple species of marine life. A sea habitat has several zones that serve as homes to different types of creatures. There are the shallow, coastal zones along the sea's border with land, deeper areas past the edge of the continental shelf, and the floor of the sea itself. Sea habitats are affected by factors such as temperature, tides, current, salinity, depth and vegetation.

The wildlife of a sea habitat can be quite diverse, because the creatures that live there have adapted to the varying conditions of the ocean. While the majority of creatures breathe through gills and cannot survive outside of water for long periods.

***Examples of Sea Water organisms***

**1. Tunas** – are elongated, robust and streamlined fishes; they have a rounded body that tapers to a slender tail base and a forked or crescent – shaped tail. In color, tunas are generally dark above and silvery below, often with an iridescent shine.

Tunas swim with their mouths open to help receive oxygen-rich water. This helps to make the water go against their gills so they can receive the oxygen. Another adaptation that they have is a higher blood pressure.

2. **Sea Crabs** – are **arthropods**, they have an **exoskeleton composed mainly by chitin**, which, when being mineralized with **calcium carbonate** becomes hard and resistant, so in most cases it is a carapace (shell) for the crab. When these crabs grow and develop, they need to molt their exoskeleton because they no longer fit in it. For this reason, sea crabs make many molts. This process represents a danger for sea crabs, first of all, because they are vulnerable to the attack of their predators, who await the molting process in order to have easy access to them.

Another important aspect is that if the molt is not carried out properly, the crabs can get trapped in their old shell and die. Before the molting the crab ingests a large amount of water, to increase the size of its old shell, and once it feels that it has loosened, it begins to slowly withdraw its body. Once it has completely left the old shell, it is again filled with water, in order to expand the new one a little more, so that it allows it to continue growing comfortably.

This molting process can last several hours; for this reason, the crabs hide to be safe from their predators, until the new shell is hard enough.

**Assessment Task**
Students will construct models of different habitats and include capture fishery organisms that are found in those habitats.

**Source:** https://stoplearn.com/fresh-water-habitat-2/
https://whoatwherewhy.com/what-are-the-adaptive-features-of-prawn/
https://www.allthingsnature.org/what-is-a-sea-habitat.htm

## Strand 4: Natural Resource Management

## Unit 2: Capture fishery harvesting practices and management system.

**Content Standard 11.4.2** Students will be able to investigate and analyse the different types of capture fishery practices and management systems used in different environments and places to **capture,** process, preserve, market, regulate and consume fish and other aquatic organisms and plants.

**Benchmark 11.4.2.1**. Investigate and explain the factors affecting the capture fishery production in different places and environments.

**Topic: Factors affecting capture fishery production.**

**Learning Objectives**

Students will be able to:

- Explore, identify and explain the factors affecting capture fishery production.

**Essential questions**

1. What is capture fishery production?
2. What are some of the factors affecting the capture fishery production in different environments?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Factors affecting the capture fishery production in different environments. |
| **Skills** | Discover and list factors affecting capture fishery. |
| **Attitudes** | Show open minded to learn. |
| **Values** | Appreciation of the knowledge and skills learnt. |

**Content Background:**

**Survey Conducted and published online**

**Assessment of Factors Affecting Fish Production and Marketing in Gambella Region, Ethiopia**

Fish production has been practiced since ancient Egypt and China. It has become a fast-growing agricultural sector that provides animal protein for most people globally.

This review is undertaken to assess the main factors affecting fish production and the marketing chain in Gambella region. Despite the known water and fish potential of the region, fish production is very low. Major factors contributing to a reduction in fish production in the region include inefficient fishing gears, poor transportation access, poor postharvest handling, low price at the landing site, and improper market place.

The survey conducted by interviewing fishers about the existing production constraints and ranked them according to their importance: inefficient fishing gear, lack of motorized boat service, poor transportation access, lack of value adding facilities, lack of fish handling facilities (like refrigerator), poor postharvest handling, crocodile attack, and gear theft problem. The fishers also added that they have faced marketing constraints like low price at the landing site, poor road access, high transportation cost, improper market place, lack of cold storage, and poor power supply.

Moreover, the majority of the surveyed fishery cooperatives responded that they do not have good prices for their products at the market. The price of the product is determined by its quality and preference by the customers. While local fishers are utilizing the traditional fishing system, the fish produced in this system is of low quality and results in low prices at the markets.

**Assessment Task**

Research, identify and explain the factors affecting capture fishery production.

**Source:** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7315307/

## Strand 4: Natural Resource Management
## Unit 2: Capture fishery harvesting practices and management system.

**Content Standard 11.4.2** Students will be able to investigate and analyse the different types of capture fishery practices and management systems used in different environments and places to **capture,** process, preserve, market, regulate and consume fish and other aquatic organisms and plants.

**Benchmark 11.4.2.2** Research and explain the process and ways of processing and marketing capture fishery products.

### Topic 1: Processing and marketing of Capture fishery products.

**Learning Objectives**
By the end of this topic, students will be able to:

- Investigate, identify and explain the processes and ways of marketing capture fishery products.

**Essential questions**
1. What are the basic procedures used in the final processing of fish products?
2. Why marketing of fish products is important?
3. What are the features of marketing of fish products?
4. What are elements of marketing fish products and why these components are important?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | Basic procedures used in the final processing of fish products, features and elements of marketing fish products. |
| **Skills** | Analyse, compare and explain |
| **Attitudes** | Open minded with desire to learn. |
| **Values** | Appreciate learning knowledge and skills. |

**Content Background:**

**Fish processing**

What is fish and fishery processing? The term fish processing refers to the processes associated with fish and fish products between the time fish are caught or harvested and the time final product is delivered to the customer. Pre-processing of fish prepares the raw material for final processing. It is often performed on shipboard or in a shore-based plant and includes such operations as inspection, washing, sorting, grading, and butchering of the harvested fish.

The four basic procedures used in the final processing of fish products are heating, freezing, controlling water activity (by drying or adding chemicals), and irradiating. All these procedures increase the shelf life of the fish

by inhibiting the mechanisms that promote spoilage and degradation. Each of these procedures also has an effect on the nutritional properties of the final product.

1. **Heating:** Heat treatment can significantly alter the quality and nutritional value of fish. Fish is exposed to heat during both the cooking process and the canning process.

2. **Freezing:** Of the many processing methods used to preserve fish, only freezing can maintain the flavour and quality of fresh fish. The three steps for freezing fish include immediate cooling and holding, rapid freezing, and cold storage.

3. **Controlling water activity**: Reducing the water activity of fish inhibits the growth of microorganisms and slows the chemical reactions that may be detrimental to the quality of the fish product. The control of water activity in fish is accomplished by drying, adding chemicals, or a combination of both methods.

4. **Irradiating:** Radurization is the irradiation process for extension of shelf life of fresh fishery products in ice or under refrigeration by reducing the number of spoilages causing bacteria. Two factors are most significant in determining the optimum radiation dose for radurization. These arise from qualitative and quantitative changes in the microbial growth and radiation dose responses of tissues constituents that govern the organoleptic attributes of fishery products. Radiation sensitive gram-negative bacteria are mostly responsible for spoilage of fishery products. Therefore, the reduction of spoilage causing microorganisms by low level of radiation leads to an extension of shelf life of fishery products.

**Marketing of fish products**

***Importance of marketing fish products***

The marketing of fish is important in the following ways:

1. It helps in determination of price for the fish products.
2. It is a means of earning income for the farmer
3. Marketing of fish prevents glut by locating and transporting them from area of surplus to the area of shortage.
4. It makes the taste of the consumers known to the farmers or marketers about the fish to produce or purchase for sale.
5. Marketing determines the forms in which fish should be processed, stored, sorted, graded and sold to consumers.
6. Through packaging, it makes fish attractive and appetizing to consumer to enhance sale.
7. Marketing of fish creates employment opportunities for the many peo-

ple.

***Features of marketing of fish products***

These refer to the characteristics that are common with the marketing of fish products. The main features of marketing of fish products include the following:

1. It begins at the level of individual farmers who are the producers. The farmers rear and/or harvest fish from the water bodies and process them to certain level before they make it available to the market.
2. It ends with the consumers. They are the end user of fish products.
3. Producers (Fish farmers) are widely dispersed. Initially, fish farmers are found at the riverine areas but these days, they are widely scattered in the society because of rise in fish pond, tanks, cage and other means of producing fish.
4. Fish products are perishable and seasonal in supply.
5. Institutional supports are limited. The level at which institutions can support in the supply of fish products to the market is very small to make a significant increase in the market.

***Element of marketing fish products***

These are important components without which marketing of fish may not be successful. Apart from processing, the major elements of marketing fish include storage, sorting, grading, packaging, transportation and buying and selling.

1. **Assemblage**: This is the process by which a farmer or marketer gathers his fish products from different sources together. Assemblage enables the farmer or marketer to take accurate record of his total fish products.

2. **Storage**: This is the manner in which processed fish is kept and the accommodation of such fish before sale.

3. **Sorting:** This is the process of categorizing fish products into groups using certain characteristics such as size, colour, specie, weight and so on.

4. **Grading:** This could be synonymous with fixing prices. It is the act of allocating prices to the fish products especially sorted fish.

5. **Packaging:** This is the process of putting and wrapping of fish products in a certain materials or containers such as bag, cans, nylons, cartons and so on. It is the loading of fish products into any of the containers in readiness for storage or sale.

6. **Labeling:** This is the act of attaching a piece of paper, fabric or plastic to a bag, cans, nylons or cartons containing preserved fish to identify, describe or give instructions about the content. The paper, fabric or plastic is known as the label. Some label contains the price of the fish in the can, bag or container.

8. **Storage:** This is the act of keeping processed fish products especially dry fish in a room or warehouse for some time before supplying them for sale.

9. **Transportation:** This entails moving processed fish from farm or warehouse to the middle men or consumers who may be at the farm gate or market.

10. **Advertisement:** This is the act of publicizing or making fish products supplied to the market known to the public.

11. **Selling and buying:** This is the process by which farmers or middle men exchange their fish products with money and middle men acquiring fish products from farmers by the marketers or consumers through payment. The farmers give out their fish products to the farmers through the process of selling while the middle men obtain fish products from the farmers through the process of buying. Therefore, selling and buying are interwoven and go together for fish products to move from one person or place to another. The buying and selling of fish products begin with the farmers while the chain ends with the consumers.

**Assessment Task:** Identify and explain the processes and ways of marketing capture fishery products.

**Source:** https://medcraveonline.com/JAMB/JAMB-08-00243.pdf

## Strand 4: Natural Resource Management

## Unit 2: Capture fishery harvesting practices and management system.

**Content Standard 11.4.2** Students will be able to investigate and analyse the different types of capture fishery practices and management systems used in different environments and places to capture**,** process, preserve, market, regulate and consume fish and other aquatic organisms and plants.

**Benchmark 11.4.2.3** Examine how capture fishery and consumption of its products are regulated.

### Topic 1: Capture fishery and consumption regulations

### Learning Objectives

By the end of this topic, students will be able to:

- Discuss principles and international standards of behaviour for responsible practices for capture fishery and consumption regulations.
- Identify and differentiate between code of fishing activities and Fishing gear selectivity.

### Essential questions

1. Why are there principles and international standards of behaviour practices set for capture fishery and consumption regulations?
2. What are some of the fishing activities regulations?
3. What are some of the fishing gear selectivity regulations?

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | International standards of behaviour practices set for capture fishery and consumption regulations. |
| **Skills** | Analyse, compare, differentiate and explain the principles and international standards of behaviour practices set for capture fishery and consumption regulations. |
| **Attitudes** | Open minded with desire to learn. |
| **Values** | Appreciate learning knowledge and skills. |

### Content Background:

Fisheries, including aquaculture, provide a vital source of food, employment, recreation, trade and economic wellbeing for people throughout the world, both for present and future generations and should therefore be conducted in a responsible manner. This Code sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The Code recognises the nutritional, economic, social, environmental and cultural importance of

fisheries, and the interests of all those concerned with the fishery sector. The Code takes into account the biological characteristics of the resources and their environment and the interests of consumers and other users. States and all those involved in fisheries are encouraged to apply the Code and give effect to it.

**Fishing activities**

1. States should ensure that fishing is conducted with due regard to the safety of human life and the International Maritime Organization International Regulations for Preventing Collisions at Sea, as well as International Maritime Organization requirements relating to the organization of marine traffic, protection of the marine environment and the prevention of damage to or loss of fishing gear.

2. States should prohibit dynamiting, poisoning and other comparable destructive fishing practices.

3. States should make every effort to ensure that documentation with regard to fishing operations, retained catch of fish and non-fish species and, as regards discards, the information required for stock assessment as decided by relevant management bodies, is collected and forwarded systematically to those bodies. States should, as far as possible, establish programmes, such as observer and inspection schemes, in order to promote compliance with applicable measures.

4. States should promote the adoption of appropriate technology, taking into account economic conditions, for the best use and care of the retained catch.

5. States, with relevant groups from industry, should encourage the development and implementation of technologies and operational methods that reduce discards. The use of fishing gear and practices that lead to the discarding of catch should be discouraged and the use of fishing gear and practices that increase survival rates of escaping fish should be promoted.

6. States should cooperate to develop and apply technologies, materials and operational methods that minimize the loss of fishing gear and the ghost fishing effects of lost or abandoned fishing gear.

7. States should ensure that assessments of the implications of habitat disturbance are carried out prior to the introduction on a commercial scale of new fishing gear, methods and operations to an area.

8. Research on the environmental and social impacts of fishing gear and, in particular, on the impact of such gear on biodiversity and coastal fishing communities should be promoted.

**Fishing gear selectivity**

1. States should require that fishing gear, methods and practices, to the extent practicable, are sufficiently selective so as to minimize waste, discards, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species and that the intent of related regulations is not circumvented by technical devices. In this regard, fishers should cooperate in the development of selective fishing gear and methods. States should ensure that information on new developments and requirements is made available to all fishers.

2. In order to improve selectivity, States should, when drawing up their laws and regulations, take into account the range of selective fishing gear, methods and strategies available to the industry.

3. States and relevant institutions should collaborate in developing standard methodologies for research into fishing gear selectivity, fishing methods and strategies.

4. International cooperation should be encouraged with respect to research programmes for fishing gear selectivity, and fishing methods and strategies, dissemination of the results of such research programmes and the transfer of technology.

**Assessment Task:**

- Analyse principles and international standards of behaviour for capture fishery and consumption regulations.
- Identify and differentiate between code of fishing activities and Fishing gear selectivity and list them.

**Source:** https://www.fao.org/3/v9878e/v9878e00.htm

## Strand 4: Natural Resource Management Unit 3: Capture fishery and technology

**Content Standard 11.4.3:** Students will be able to examine how technology is used in capture fishery and the processing, preservation, marketing, consumption, regulation and management of fish and other aquatic organisms and plants in different environment and places and evaluate their strengths and weakness.

**Benchmark: 11.4.3.1** Examine post-harvest technologies in capture fishery and evaluate their advantages and disadvantages.

**Topic: Post-harvest technology**

**Learning Objective:** Students will be able to;
- Explain post-harvest technologies in capture fishery.
- Identify their advantages and disadvantages in post-harvest technology.

**Essential Questions**
1. What are post-harvest technologies in capture fishery?
2. What are the advantages and disadvantages in post-harvest technology?

| | |
|---|---|
| **Essential Knowledge** | Post-harvest technology |
| **Essential Skills** | Describe advantages and disadvantages in post-harvesting technology |
| **Essential Attitudes & Values** | Appreciate and value post-harvest technology |

**Content Background**

Post-harvest technology in capture fishery is define as what culminates into activities, processes and steps in harvesting, handling, storage, processing, packaging, transportation and marketing.

**1. Post- harvest -** Half of the world's sea food is caught or otherwise collected by small-scale fishermen operating millions of fishing crafts. Over the years, traditional fishing gears have been upgraded and newer more efficient fishing systems have been introduced. Most important among them are fish harvesting systems like trawls, seines, lines, gill nets and entangling nets, drone technology and using a fish detector to find school of fish.

*Trawling*

*Drone technology*

*Fish detector*

2. **Post- harvest handling – T**he need for proper handling and processing of fish is important both for the fishing industry and for the consumers. After fish are caught, bacteria, biochemical changes, and chemical actions will deteriorate the quality of the fish, generally through physical and temperature damage. Controlling temperatures, handling fish carefully, and preventing contamination can slow these processes.

*Handling of fish and shell fish*

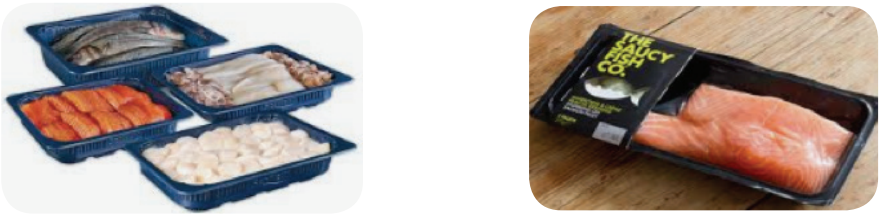
4. **Post- harvest Storage** – implies a strict control of environmental temperature and humidity in the storage chamber. The cost-effective postharvest technologies for proper handling and preservation of fresh fish and processed seafood should be explored to ensure product safety and maintenance of quality throughout the supply chain from production to table of the consumers.

5. **Post- harvest Processing –** The four basic procedures used in the final processing of fish products are heating, freezing, controlling water activity these (by drying or adding chemicals) and irradiating. All these procedures increase the shelf life of the fish by inhibiting the mechanisms that promote spoilage and degradation.

*High-Tech Freezing Technology*

*Drying or adding chemicals*

5. **Post- harvest Packaging –** Fish and seafood have a high nutritional value but are at the same time sensitive, perishable foods. Packing protects the products from harm and contributes towards reducing losses during transport, storage or the retailers.




*Packaging of fish and seafood*

6. **Post- harvest transportation–** Fish are transported by sea, air or land. Once fish have been placed in their transport container, they are brought to their destination by the quickest possible means that will provide a relatively smooth and direct route.

7. **Post- harvest marketing -** The end of the production process in is marketing. Marketing is the act of gathering in a public place for buying and selling merchandise or farm products such as fish and fish products. Farmers frequently consider marketing of fish products as one of their major challenges in fish farming. This is because while the farmers are able to identify poor prices, lack of transport, lack of ready market, and high post-harvest losses as the challenges, they are often poorly equipped to identify potential solutions. Successful marketing requires learning new skills, new techniques and new ways of obtaining and using the information appropriately. Marketing is the point in which the farmer's products such as fish leave him with a return called income.

*Fish and seafood sold in shops*

**Assessment Task**

Students will classify post-harvest technologies used with its advantages and disadvantages

**Source:**

https://agritech.tnau.ac.in/fishery/fish_fishharvesttechnology.html
https://www.fao.org/fishery/en/technology
https://medcraveonline.com/JAMB/JAMB-08-00243.pdf

## Strand 4: Natural Resource Management
## Unit 3: Capture fishery and technology

**Content Standard 11.4.3:** Students will be able to examine how technology is used in capture fishery and the processing, preservation, marketing, consumption, regulation and management of fish and other aquatic organisms and plants in different environment and places and evaluate their strengths and weakness.

**Benchmark: 11.4.3.2** Research and discuss the processes of using communications technologies in sales and marketing of capture fishery products.

**Topic: Capture fishery and technology**

**Learning Objective:** Students will be able to;
- Discuss the processes of using communication technologies in sales and marketing of capture fishery products.

**Essential Questions**
1. What are the processes of communication technologies used in sales and marketing of capture fishery products?

| | |
|---|---|
| **Essential Knowledge** | Communication technologies used in sales and marketing of capture fishery products |
| **Essential Skills** | Research on the processes of communication technologies in sales and marketing |
| **Essential Attitudes & Values** | Appreciate and value the processes used in communication technologies in sales and marketing |

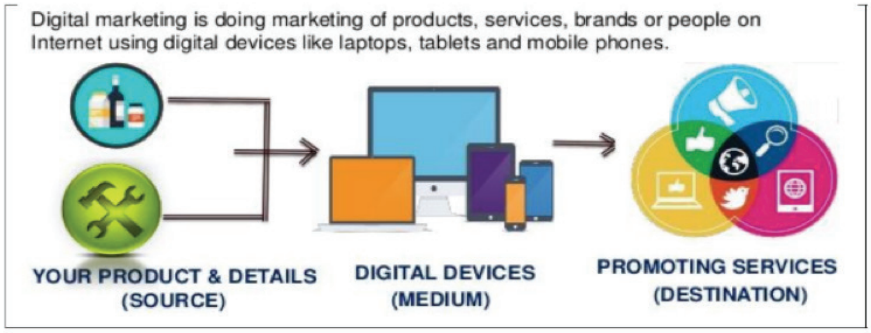
**Content Background**

**E-marketing of fish and fish products**

E-Marketing stands for electronic marketing, is known as Internet marketing. It is different to traditional marketing, E-Marketing takes marketing techniques and concepts and applies them through the electronic medium of internet.

E-marketing threads the technical and graphical aspects of online tools together, allowing for design, advertising, brand development, promotion and sales. Internet marketing offer the possibility to tracking almost every action a visitor or potential customer takes in response to marketing messages and how they navigate through their buying cycle. One of the most desirable aspects of Internet marketing is low barrier to entry. Digital marketing/ e-marketing as the name specifies is marketing over the internet through various digital devices.

***An example of processes used in communication technology***




As technology advanced rapidly over the past two decades, digital media became so widespread that anybody could access information anytime, from anywhere. This helped in promoting products through this all-pervasive media as the marketers could monitor what is trending, what is the selling point of a product.

**Examples of Oneline Marketing**

***1. Email Marketing***

Considered as one of the most important types of digital marketing channels, email marketing can be understood as the bridge between the highest point of a business channel. It is amongst the best types of marketing channels in terms of improving sales by ensuring engagements.

***2. Video Marketing/youtube Marketing***

Youtube is the second biggest search engine on the planet. Videos act as one of the most interactive types of online marketing.

***3. Blog Marketing***

A blog is only a channel. It can have have recordings, podcasts, content articles, new subjects, offer affiliate marketings, give guidline or knowledge and incorporates content that fills the channel. Blogging makes to the list of different types of online marketing channels on the grounds that dealing with that channel is truly an expertise all alone.

***4. Social Media Marketing***

Amongst different types of online marketing, Social Media is youngest and as appealing as innovative and powerful. Most onlinefish and fish products sellers have grasped the utilizastion of social stages to advance their brand image.. It is the cheapest and best platform to advance ones business without spending a bomb on cosly websites and advertisments. In the these types of marketing channels like, facebook, goggle, twitter and instagram, one would look for target audiences and give careful consideration to dialect messages they're sharing.

**5. Web Marketing**

In this modern era, customers and companies are on the inernet for information. Most online fish sellers have a well developed and established website. Having a website will be more convenient for customers and leads.

It makes it easier for customers to purchase fish products. Many will be more likely to visit your website, rather than visiting your physical location and browsing for your products. They  can just find what they're looking for on your online site.

**Assessment Task**

Students will develop a digital marketing on any sea product using laptops, tablets and mobile phone.

**Source**

https://www.researchgate.net/publication/329237865_E-marketing_of_fish_and_fish_products

## Strand 4: Natural Resource Management

## Unit 3: Capture fishery and technology

**Content Standard 11.4.3:** Students will be able to examine how technology is used in capture fishery and the processing, preservation, marketing, consumption, regulation and management of fish and other aquatic organisms and plants in different environment and places and evaluate their strengths and weakness.

**Benchmark: 11.4.3.3** Examine and explain the relevance of fisheries policies, rules and regulations in monitoring and managing all aspects of aquatic resources.

**Topic: Policies and regulations**

**Learning Objective:** Students will be able to;
- Explain the relevance of fisheries policies, rules and regulations in monitoring and managing all aspects of aquatic resources.

**Essential Questions**
1. What are the policies, rules and regulations in monitoring and managing aquatic resources?

| | |
|---|---|
| **Essential Knowledge** | Policies, rules and regulations |
| **Essential Skills** | Investigate fisheries policies, rules and regulations |
| **Essential Attitudes & Values** | Appreciate and value the policies, rules and regulations in monitoring and managing aquatic resources |

**Content Background**

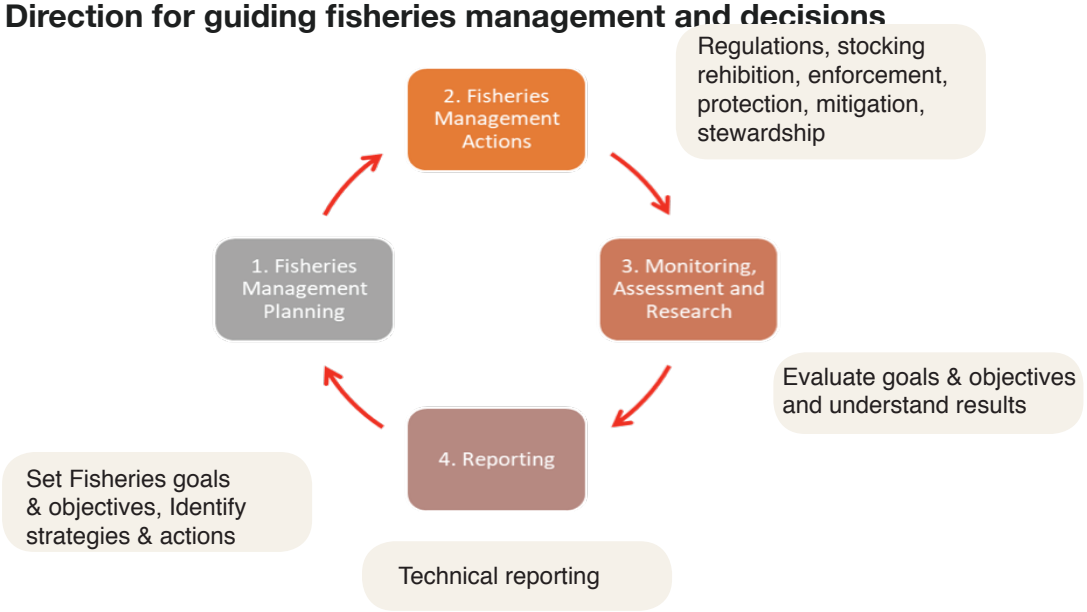
Enforcing fishery regulations, including bans, minimum catch sizes, the type of fishing gear allowed and monitoring to avoid activities such as poaching in restricted areas or catching threatened species, are the issues that require attention to reduce the impacts on biodiversity arising from overfishing, by-catch and degradation of habitat.

Fisheries management consists of three administratively and logically distinct activities:

1. Fisheries management system
2. Monitoring control and surveillance
3. Fishery Judicial system.

Together these three components form the fisheries management rule. Fisheries policy and laws are usually set at national level.
The goal of **fisheries management** is to produce sustainable biological, environmental and socioeconomic benefits from renewable aquatic resources. Fisheries management face many different conditions, however, (1) resource sustainability must be a central issue; (2) those having or having been given the privilege of exploitation must also have responsibility for the management and maintenance of the stock; (3) long-term access to marine resources may be combined with an obligation to sharing, for example, in times of need investments outside the fisheries sector may be drawn upon to cover shortfall in incomes.

**Direction for guiding fisheries management and decisions**




The laws on fisheries provides for:
- The regulation and management of fisheries
- The development of the fishing industry
- Sustainable exploitation of the fishery

**Assessment Task**
Students will compile a booklet enforcing fishery polices and regulations and identify monitoring and control surveillance used on a type of capture fishery organism.

**Source**
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/fishery-regulation
https://www.fisheries.noaa.gov/topic/laws-policies

## Strand 4: Natural Resource Management
## Unit 4: Types of forestry and forests

**Content Standard 11.4.4**
Students will be able to define forestry, investigate the different types of forestry and forests, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they grow and are harvested.

**Benchmarks 11.4.4.1**
Identify and examine different types of forest products and analyse their properties, functions, purposes, and benefits.

**Topic:** Forest Products

**Learning Objective: Students will be able to;**
- Identify the different types of forest product
- Analyse the properties, functions, purposes and the benefits of the different types of forest products.

**Essential Questions**

1. What are the different types of forest products?
2. What is the function and purpose of these forest products?
3. How do we/ community/ province/ country and the world benefit from these forest products?
4. Knowledge, Skills, Attitudes and Values

| Essential Knowledge, Skills, Attitudes and Values | |
|---|---|
| **Knowledge** | • types of forest products, its properties, functions, purposes and benefits |
| **Skills** | • Identifying and investigating |
| **Attitudes** | • Be conscious in the ways forest products are used |
| **Values** | • Appreciated the importance of forest products in the lives of people |

**Content Background**

**Forest Products**

Forests are important in today's world. Much of the things we use in our home either come indirectly or directly from the forests.

Forest products are any material derived from the forestry for direct consumptions or commercial use.

Solid wood as raw is by far the dominant forest product used for many purposes. It is used as wood fuel in the form of firewood and charcoal, finished structural materials used for constructing buildings or wood pulp which is used in the production of paper.

Food products derived from the forest are honey, wild meat, fruits, mushrooms as well as medicinal and dietary supplements which are considered to be nutritional valuable.

Due to the ban on plastic bags, baskets are alternatives which are processed from reeds, fiber, canes, bamboos and grass. Other products that are made from the raw material are mats, traps, and small traps.

Baskets made from reeds

Armlet made from plant fiber, rattan and shell.

Table shows some examples of forest products.

| **Types of Forest Products** | | |
|---|---|---|
| Food Products from the Forests | Wood and Timber products | Other Forest Products and their Uses |
| Honey, Wild meat, Fruits, Mushroom, Palm wine, Palm oil, Cola nuts | Wood raw material, Swan softwood, Swan hardwood, Wood based panels, Paperboard, Paper and Wood Pulp, Rubber, Balsa Wood | Medical and dietary supplements, Rattan, Cane and Raffia, Fuel Wood |

**Assessment task**

- Research types of forest products obtained from the forest that are used direct or indirectly and how these are used by or for the people in their local areas in PNG.

**Source**

- https://www.environmentbuddy.com/plants-and-trees/15-forest-products-and-their-uses/
- https://www.jstage.jst.go.jp/article/jsta1957/31/1/31_1_16/_pdf
- https://webcache.googleusercontent.com/search?q=cache:5V9E6Xu-VRqIJ:https://www.catawiki.com/en/l/26786237-armlet-3-plant-fibre-rattan-shells-papua-new-guinea&cd=14&hl=en&ct=clnk&gl=pg

## Strand 4: Natural Resource Management
## Unit 4: Types of forestry and forests

**Content Standard 11.4.4**
Students will be able to define forestry, investigate the different types of forestry and forests, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they grow and are harvested.

**Benchmark: 11.4.4.2** Research and classify forest products according to their species, properties, functions, purposes, and benefits.

**Topic: Classification of forest products**

**Learning Objective:** Students will be able to

- Research the types species of forest products in PNG and their properties, functions, purposes and benefits
- Classify the forest products according their species, properties, functions and purposes and their benefits

**Essential Questions**
1. How are forest products classified?

| **Essential Knowledge, skills, attitudes and values** | |
|---|---|
| **Knowledge** | Classification of Species, properties, functions, purposes and benefits of forest products |
| **Skills** | Researching and classifying forest products |
| **Attitudes** | Passion to learn more about the various groups of forest products. |
| **Values** | Appreciate the various groups of species and purpose, functions and the benefits |

**Content Background**

**Classification of forest products**

Forest products can be divided into several categories when looking at the point of how it is being used. Basically, these forest products can be grouped as; Timber, Non-timber and minor minerals or Wood Forest Products (WFP)and Non-Wood Forest Products (NWFP) or Timber forest products (TFP) and Non-Timber forest products (NTFP)

The terms Non-Timber Forest Products or Non-Wood Forest Products or Minor Forest Products (MFP) are used synonymously generally to mainly indicate forest products that does no include timber.

**Timber Forest Products (TFP)**

**Table:** Classification of Non-Timber Forest Products

| Plant products | | Animals and animal products | |
|---|---|---|---|
| **Categories** | **Descriptions** | **Categories** | **Description** |
| **Food** | Vegetal foodstuff and beverages provided by fruits, nuts, seeds, roots | Living animals | Mainly vertebrates such as mammals, birds, reptiles |
| **Fodder** | Animal and bee fodder provided by leaves, fruits etc. | Honey, beeswax | Products provided by bees. |
| **medicine** | Medicinal plants (e.g. leaves, bark, roots) used in traditional medicine and/or by pharmaceutical companies | Bushmeat | Meat provided by vertebrates, mainly mammals |
| **Perfume and cosmetics** | Aromatic plants providing essential (volatile) oils and other products used for cosmetic purposes | Other edible animal products | Mainly edible invertebrates such as insects (e.g. caterpillars), crabs and other "secondary" products of animals (e.g. eggs) |
| **Dying and tanning** | Plant material (mainly bark and leaves) providing tannins and other plant parts (especially leaves and fruits) used as color-ants | Hides, skins | Hide and skin of animals used for various purpose |
| **Utensils, handicrafts** | Heterogeneous group of products including thatch, bamboo, rattan, wrapping leaves, fibers (e.g. Arouma, Bwa Flo, Silk cotton floss, Screw pine | Medicine | Entire animals or parts of animals such as various organs used for medicinal purposes (e.g. caterpillars, crab legs, snake) |
| **Constructions materials** | thatch, bamboo, fibers | Colorants | Entire animals or parts of animals such as various organs used as colorants |
| **Ornamentals** | Entire plants (e.g. orchids, ferns, philodendron) and parts of the plants (e.g. pots made from roots) used for ornamental purposes | Other nonedible animal products | e.g. bones used as tools, feathers, teeth/ task etc. |
| **Exudates** | Substances such as gums (water soluble), resins (water insoluble) and latex (milky or clear juice), released from plants by exudation | | |

**Assessment Task**

Research and classify Timber forest products (TFP)and Non-Timber forest products (NTFP) in their Provinces according to their species, properties, functions, purposes and benefits

**Source**

https://sites.google.com/site/myblogbhutan/home/forestry/study-on-definition-and-classification-of-non-timber-forest-products
https://www.intechopen.com/chapters/18520
Table 1. Adapted from FAO, 1995; Shiva & Verma,2002Classification of Non Timber Forest Products

## Strand 4: Natural Resource Management Unit 4: Types of forestry and forests

**Content Standard 11.4.4**
Students will be able to define forestry, investigate the different types of forestry and forests, categorise them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they grow and are harvested.

**Benchmark 11.4.4.3**
Investigate and explain how different forest products are cultivated and processed in different environments and places.

**Topic: Processing of Forest Products**

**Learning Objective**

- Investigate ways or methods used to cultivate different forest products of different environments and places.
- Explain the method and steps in processing different forest products in various environments and places.

**Essential Questions**
How are different forest products cultivated in the different environment and places?
How are different forest products processed in their respective environment and places?

| Essential Knowledge, Skills, Attitude and Values | |
|---|---|
| **Knowledge** | methods of cultivating different forest products<br>methods of processing the cultivated forest product in different environments |
| **Skills** | Investigating and describing |
| **Attitudes** | Develop cautiousness and confidence to know about methods of cultivating and processing forest products. |
| **values** | Have sense of responsibility towards health and safety preparation methods in all tasks. |

**Content Background**

Cultivating and Processing forest products

The cultivation and processing of different forest products depend entirely on the Producers of forest products who heavily depend on the forest types and ownership. As woods are the dominant product of the forest product, the processes involved in producing wood products are important. Generally, the processes for commercial land can include seedling production, site preparation, planting, applying fertilizers and herbicides, thinning (pre-commercial or commercial), and logging. These processes may vary for different species and for spatial locations. The products category may include logs, lumbers, residues, etc.

**Pulp and Paper manufacturing process**


**Pulp and Paper industry**

Paper plays a vital role in our daily lives and it has been used for many years till now. Paper is an eco-friendly product which is made with the pulp of wood.

**Paper is made through the following processes:**

1. Pulping procedure will be done to separate and clean the fibers
2. Refining procedure will be followed after pulping processes
3. Dilution process to form a thin fiber mixture
4. Formation of fibbers on a thin screened
5. Pressurization to enhance the materials density
6. Drying to eliminate the density of materials
7. Finishing procedure to provide a suitable surface for usage

The processes for non-timber forest products can have a large variety; for example,' wild meat harvested from the forest is processed in various ways before it can be consumed directly or smoked for preservation for later or commercial purpose at local markets. Forest products from plants are also processed before direct consumption and or processed for storage.

**Assessment task**

Investigate and describe the methods of cultivating and processing different forest products -Use an example for Wood forest product or Non-wood forest product explain the method cultivation and processing of the forest product

**Source:**

- https://commons.wikimedia.org/wiki/File:Global_Forest_Resources_Assessment_2020_%E2%80%93_Key_findings.pdf
- https://www.pulpandpaper-technology.com/articles/pulp-and-paper-manufacturing-process-in-the-paper-industry

## Strand 4: Natural Resource Management
## Unit 4: Types of forestry and forests

**Content Standard 11.4.5**
Students will be able to investigate and analyze the different types of forestry practices and management systems used in different environments and places to harvest, process, preserve, market, regulate, and consume forests products.

**Benchmark 11.4.5.1** Assess different approaches and practices practiced in producing and preserving forest products.

**Topic: Producing and preserving forest products**

**Learning Objectives:**

By the end of this topic, students will be able to:
- Evaluate different approaches and practices applied in producing forest products
- Evaluate different approaches and practices applied in preserving forest products

**Essential Questions:**

1. How are forest products preserved?
2. What products are produced from the forest?
3. What are the approaches of preserving forest products?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Knowledge** | Production and preservation of forest products |
| **Skills** | Differentiating, evaluating |
| **Values** | Common good, Betterment |
| **Attitudes** | Critical, Appreciative |

**Content Background:**
Forests and trees outside forests provide many different products, ranging from timber and fuelwood to food (berries, mushrooms etc.), fodder, and other non-wood forest products.

**Forest products and services**
Forests are recognised as an integral part of national economies, providing a wide range of production inputs, environmental goods, food, fuel, medicines, household equipment, building material and raw materials for industrial processing.

**What products are produced from forest?**

1 . Wood products – Timber, Sandalwood, Plywood.
2. Non-wood forest product - Kendu leaves, Bamboo, Sal seed, Honey,
3. Medicinal plants. – Rubber, Pickle and squash, Cashew and spice.
4. Minerals. - Biodiesel plant.

**Some of the steps we can take to preserve our forest resources are as follows:**

- Regulated and Planned Cutting of Trees
- Control over Forest Fire
- Reforestation and Afforestation
- Check over Forest Clearance for Agricultural and Habitation Purposes
- Protection of Forests
- Proper Utilisation of Forest and Forests Products

**Sources:**

https://www.en.wikipediaorg
https://www.environmentalpollution.in
https://www.fao.org
https://www.greenfacts.org

**Assessment Task:**

- Create a chart on the different approaches and practices applied in producing forest products
- Create a chart on the different approaches and practices applied in preserving forest products

## Strand 4: Natural Reasource Management
## Unit 4: Types of forestry and forests

**Content Standard 11.4.5**
Students will be able to investigate and analyse the different types of forestry practices and management systems used in different environments and places to harvest, process, preserve, market, regulate, and consume forests products.

**Benchmark 11.4.5.2** Investigate and explain how the cultivation, processing, preservation, sales and marketing, and consumption of forest products are regulated in different places.

**Topic: Forestry regulations**

**Learning Objectives:**
By the end of this topic, students will be able to:
- Explain how the forestry industry in Papua New Guinea is regulated.

**Essential Questions:**
1. Are there any forestry regulations in PNG?
2. What is the focus of PNG's forestry regulations?
3. Which government entity regulates these policies in PNG?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Knowledge** | Forestry Regulation |
| **Skills** | Investigate, Explain |
| **Values** | Sustainability, Betterment of human kind, Empowerment |
| **Attitudes** | Optimistic, Confident, Participatory, Care and Caring |

**Content Background:**

What are the main forestry policies in PNG?

Forest policy imperatives in PNG reflect those expressed in the literature. These include the level of rent capture, consideration of market based pricing mechanisms, the economic costs of promoting domestic processing, and investment in forest management consistent with sustainable forest development.6 Nov 2018

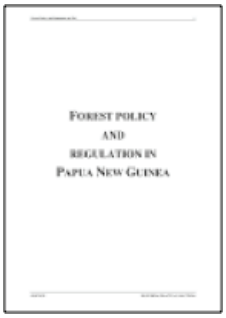
What is the purpose of forestry Act 1991?

This Act makes provision for the management, development and protection of the forest resources of Papua New Guinea and for related matters.

What does PNG forest Authority do?

The Papua New Guinea Forest Authority (PNGFA) is the government body responsible for monitoring and controlling the wood and forest-based industries and the management of PNG's forest resources.

**Sources:**




**Assessment Task:**

Research and report on the policies that regulate forestry in Papua New Guinea**.**

## Strand 4. Natural Resource Management
## Unit 4: Types of forestry and forests

**Content Standards 11.4.6** Students will be able to examine how technology is used in the harvesting, processing, preservation, marketing, regulation, consumption, and management of forestry.

**Benchmark 11.4.6.1** Investigate and explain how technology could be used to grow timber species in PNG on a large scale.

**Topic: Technology and growing timber species**

**Learning Objectives:**

By the end of this topic, students will be able to:
- Identify appropriate technologies involve in growing timber species

**Essential Questions:**

1. What technologies are used in growing timber species?
2. How are these technologies useful in growing timber?
3. Why are these technologies useful in growing timber?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Knowledge** | Technology used in growing timber |
| **Skills** | Investigate, examine |
| **Values** | Appreciate, |
| **Attitudes** | Care, Empowerment |

**Content Background:**

These technologies used in forestry include:

- Drones.
- Lasers.
- Scanners.
- Infra-red sensors.
- 3D sensing and imaging.
- Advances in tree-breeding

**The Technology Behind Growing Trees**

The wood products industry has implemented technological advances into each step of the process, from growing seedlings to monitoring tree health, and from milling to creating finished boards.

With forestry, technology is amazing because it's always changing. "We are always trying to figure out the best way to do things, whether it's the technology that helps rivers thrive or technology that helps foresters do their jobs."

**Seeds**

Learning how to best grow trees from seed onward is a constant endeavor sourcing seeds locally to ensure planting seedlings in the places they originated.

The technology of nurseries has improved, so now they are more consistent and they grow a healthy little tree that meets the specifications of each landowner.

Previously seedlings were grown in a field, but with better understanding of the seeds' biology, seedlings can be grown in green houses with controlled environments so each tree gets enough water, sunlight and room to grow. Researchers do not alter the genetics of the trees, but test them to find which the heartiest growers of the bunch are.

Growing seedlings with higher chances of vitality allows foresters to grow fewer trees and space them out with enough room, as they do not have to account for as much mortality as in the past.
Start thinking about forest density at the seed level, and that practice has improved and changed over the decades, healthy seedlings helps reforestation efforts to minimize the need for herbicide applications.

Herbicides are used to suppress competing vegetation and give seedlings a better chance of survival. Starting with healthier seedlings allows them to succeed faster with less herbicide use.

**Aerial views**

With aerial drones, radar technology and helicopters, foresters are able to map their trees from the sky with enough detail to determine which areas need to be addressed, thus improving their ability to manage the land.

**The use of aerial drones and radar technology to map timberlands**

Studying the aerial images can also ensure the foresters' safety. From the sky, foresters can detect trees with snapped tops and others leaning over from damage, so they know what they are dealing with before they go in to clean up those areas.

Knowing the location of the damaged trees can lead to a faster clean up, which helps prevent the spread of infestation into healthy standing trees and the build up of fuel during fire season.

The drones help find sites where landslides, lightning strikes or diseases cast may have affected the trees. In addition to inventory plots from the ground, the drones are used to fly over reforested harvest units and count the new young trees using a program called Drone2Map.

**Lidar**

Lidar, also called ladar, is another innovation used. A combination of light and radar, lidar shoots laser lights down from the sky that bounce back up to create a digital image of the slopes and steepness of the ground surface, as well as the shape, height and density of trees. It's extremely precise and you can actually tell all the land forms down to the matter of an inch.

Lidar, drones and GIS allows the foresters to analyze data quickly. The foresters also have programs on their phones so they can track where they are in the field in relation to the data in real time. It's a whole new world out there with technology.

**Digital monitoring**

Lone Rock Timber monitors the growth and vitality of its forests by physically going out to the field and collecting data.

Technology is used to take that data and information and put it into computer programs to monitor those forests with virtual reality, and see how those forests are going to grow over time.

Foresters do not have to revisit each site every year because the programs have enough information to track how the forests will grow.
Although growth and yield models have been around for decades, they continue to improve with each passing year.
"Information is more and more available to our foresters in the field. As technology in all of our lives changes and improves, it is being implemented in forestry as well. It's very contemporary and exciting and constantly changing."

**Source:** The News Review

**Assessment Task**
Investigate, Identify and Explain how technology can be used to grow timber species.
**Performance Indicator**
Identify the name and state the uses of the ten different technologies used in growing timber species

**Rubric**

| Criteria | Advanced | Satisfactory | Not Yet |
|---|---|---|---|
| Show evidence of research on the topic | Strong indication of research supported by evidence | Some indication of research supported by evidence | Little indication of research and no evidence to support |
| Correctly name the required number of technologies as expected | Names ten technologies used in growing timber species | Names up to six technologies used in growing timber species | Names up to two technologies used in growing timber species |
| Explains the uses of the individual technologies correctly | Explains the uses of ten technologies used in growing timber species | Explains the uses of up to six technologies used in growing timber species | Explains the uses of up to two technologies used in growing timber species |

## Strand 4: Natural Resource Management
## Unit 4: Types of forestry and forests

**Content Standard 11.4.6** Students will be able to examine how technology is used in the harvesting, processing, preservation, marketing, regulation, consumption, and management of forestry.

**Benchmark 11.4.6.2** Investigate and identify a problem related to the establishment, production, and marketing of forest products and develop appropriate solutions to address the problem.

**Topic: Constrains and Solutions**

**Learning Objectives:**

By the end of this topic, students will be able to:

- Identify a problem related to the establishment, production and marketing of forest products.
- Investigate and develop appropriate solutions to problems related to establishment, production and marketing of forest products.

**Essential Questions:**

1. What are some constrains related to the establishment, production and marketing of forest products?
2. What are some solutions in addressing problems related to the establishment, production and marketing of forest products?

## Essential Knowledge, Skills, Attitudes and Values

| | |
|---|---|
| **Knowledge** | Constrains and Solutions to establishing, producing and marketing of forest products |
| **Skills** | Identify, investigate, research |
| **Values** | Rationality, Empowerment |
| **Attitudes** | Participatory, Cooperative |

## Content Background:

### What is the main problem facing the forestry industry?

As mentioned, **deforestation and climate change** has devastating effects on the forest industry. In particular, deforestation can lead to the extinction of tree species. This can then lead to the extinction of animals who depend on those specific tree species for food and habitat.

What are some solutions in addressing problems in forestry?

- Government Regulations.
- Banning Clear-Cutting of Forests.
- Reforestation and Afforestation.
- Reduce Consumption of Paper.
- Educate Others.
- Eat Less Meat.
- Purchase from Sustainable, Forest-Friendly Companies.
- Reduce Consumption of Deforestation Prone Products.

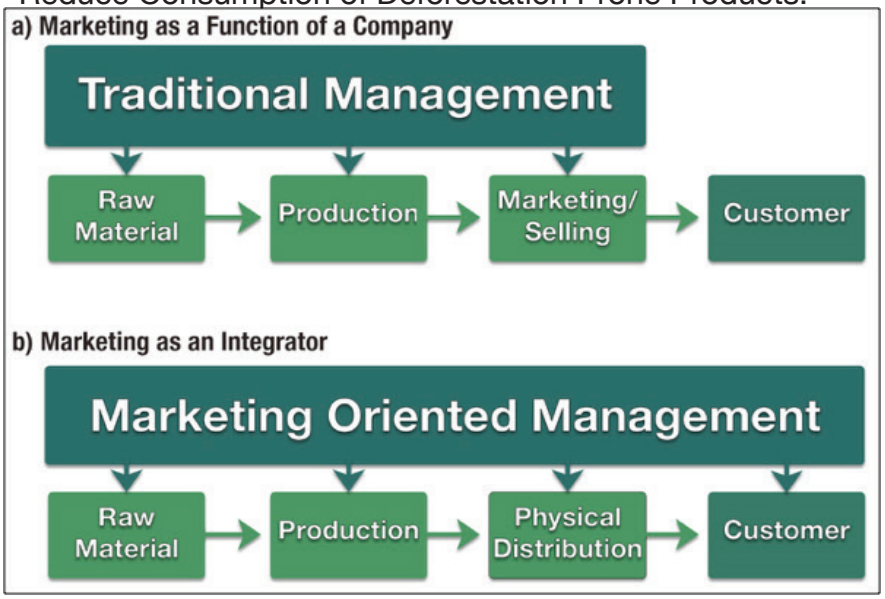



***Figure 2-2:*** *Marketing as a Function of the Company and as an Integrator*

### Assessment Task

Research and evaluate a problem related to the establishment, production and marketing of forest products and indicate solutions to addressing this problem.

## STRAND 5 : AGRIBUSINESS
## Content Overview

| **Content Standard 11.5.1 Content Standard 5.1** Students will be able to examine the different principles, practices, characteristics, enablers and contexts of business, and explore how agriculture businesses are started and managed in different contexts. | | | |
|---|---|---|---|
| **Unit** | **Benchmarks** | **Topic** | **Lesson Titles** |
| **Starting Up and Managing an Agribusiness** | **11.5.1.1** Examine different business records and explain how these are used to manage businesses and for decision-making. | Business Records | Managing finances.<br>Record keeping |
| | **11.5.1.2** Identify and analyse the major sources of funding for a business. | Major Funding Sources | Formal credit organizations<br>Informal credit sources |
| | **11.5.1.3** Compare and contrast debt and equity financing and explain the impact on financial statements. | Equity Financing | Debt and equity financing<br>Impact of debt and equity financing. |
| | **11.5.1.4** Discuss the importance of analysing financial statements to determine the financial health, cash flow, and worth of a business. | Financial statements | Importance of financial statements |
| | **11.5.1.5** Analyse cash flow from operating activities to assess profitability and liquidity. | Cash Flow | Preparing cash flow statements<br>Understanding Profitability and Liquidity |

## Strand 5 : Agribusiness Unit 1 : Agriculture and Marketing

**Content Standard 11.5.1** Students will be able to examine the different principles, practices, characteristics, enablers and contexts of business, and explore how agriculture businesses are started and managed in different contexts.

**Benchmark 11.5.1.1** Examine different business records and explain how these are used to manage businesses and for decision-making.

**Topic: Business Records**

**Learning Objectives :**

By the end of this topic, students will be able to:
- Discuss and explain the principles of managing finances in agribusiness.
- Examine the importance of book keeping.

**Essential questions:**
1. What are the different financial records?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Essential Knowledge** | Financial Management Principles, Financial statements for book keeping. |
| **Essential Skills** | Discuss and explain the principles of managing finances, examine the importance of book keeping |
| **Essential Attitudes & Values** | Appreciate the value of financial management. |

**Assessment:** Collect samples of business records and present to class

**Content Background:**

**Financial management principles.**

Probably no term is used more often among managers than the word profit, or –the bottom line.‖ For any business, the bottom line on the income statement is crucial. This figure represents a composite of how the firm, and its management, has performed over the past year.

It is a guideline to measure the relative success or failure of the firm over this period of time. Profit, the amount remaining from a sale after cost of the product and operating expenses have been paid, is often used as a historical benchmark to provide evidence of the skill and ability demonstrated by decision-makers within the organization. The firm's CEO (chief executive officer), corporate board members, and management team are all familiar with this word -profit.‖ The importance of this figure over time can be related to the ability of the firm to grow, enter new markets, and introduce new products. Although the bottom line is of great importance in itself, other types of financial data are also needed to properly evaluate a firm's performance. The successful

agribusiness manager must understand what the firm did (or did not do) that led to the resulting bottom line, and the successful manager uses this understanding to improve the bottom line in the future. This is what the study of financial management is all about. The successful manager understands the financial operations of the firm well enough to use this information as a tool for improving firm performance. Although the bottom line provides a benchmark for comparison, successful agribusiness managers must understand the interrelationships of other accounts on the balance sheet and the income statement to properly manage the business.

**The importance of financial statements**

Financial management requires a working knowledge of how to interpret financial information from a firm's records. Such information is used to satisfy two distinct needs of the agribusiness fi rm. First, and perhaps more importantly, is the need for information that can be used internally by managers in decision-making. Second, information is also needed for financial reporting, such as reporting financial performance to stockholders, entities outside the firm such as lenders, and others who have interests in the firm.

Without financial information, agribusiness managers at any level find it difficult to successfully pursue the goals and objectives of the organization. Each agribusiness enterprise therefore must accumulate historical records of financial information that are vital for its continued success. The importance of financial information and records is evidenced by the tons of paper, the billions of forms, the millions of computers, and the hundreds of thousands of people who are employed in recording business activities throughout thecountry.

Modern financial record keeping had its beginning some six centuries ago in Italy. The growth of commerce in Venice and Genoa, which were great commercial centers, created an accompanying need for business records. As a response to this need, a system of records and bookkeeping was developed that is still widely used throughout the world today. This system summarizes the records of a firm by dividing them into two basic documents.

These documents are called the balance sheet and the income statement. Together, they make up the primary financial statements of the firm.

## Strand 5 : Agribusiness

## Unit 1: Starting up and managing an AgribusinessAgriculture and Marketing

**Content Standard 11.5.1** Students will be able to examine the different principles, practices, characteristics, enablers and contexts of business, and explore how agriculture businesses are started and managed in different contexts.

**Benchmark 11.5.1.2.** Identify and analyse the major sources of funding for a business.

**Topic : Major Funding Sources**

**Learning Objectives :**
By the end of this topic, students will be able to:
- Identify and classify formal and informal credit organisations.

**Essential questions:**
1. What are formal and informal credit organisations?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Essential Knowledge** | Formal credit organisations and informal credit sources |
| **Essential Skills** | identify and classify formal and informal credit organisations |
| **Essential Attitudes & Values** | Appreciate the value the major credit organisations. |

**Assessment:** Research formal and informal credit organisations

**Content Background:**

Formal and Informal Credit Markets and Rural Credit markets are an essential economic institution. In developing countries, particularly in countries undergoing rapid social and economic transition, it is important to identify emerging credit demand and institute credit supply in a timely manner to facilitate economic transformation. There is no lending without financial resources. Loans to agriculture can be financed by different sources of funds such as farmer household savings, capital markets, equity; budget allocations of the government, central bank refinance facilities and international borrowing. All these various funds, some of which are highly political, have different implications on the fund management, performance and autonomy of financial institutions. Public funds increase the vulnerability of financial institutions to government interference in their daily management and operations. Savings deposits and other short-term funds require highly sophisticated fund management when they are used for agricultural lending with its specific seasonal or long-term patterns. Capital market funds are costly to raise and only available for well performing financial institutions.

In the last decade there has been a sharp decline in the availability of public funds for agricultural lending. This prompts a fundamental question: what sources of funds can fill the gap? Moreover, what are the impacts of using other financial instruments and new funding sources?

The change of the funding sources will impact the financial institutions. On one hand, autonomy may increase and the governance structure may improve. On the other hand, costs and risks may rise. Doubtless, it is much easier to channel subsidized public resources than to obtain savers' confidence or to mobilize capital market funds.

**The most relevant aspects are the following:**

- What is the impact of the various sources of funds on the performance of financial institutions?
- What are the specific risks of using certain funding sources for agricultural lending?
- What is the impact of the liability structure on the governance and autonomy of financial institutions?

Suggestions are also made on how to improve the access to less explored sources and how to manage funds effectively with the goal of providing the necessary financial resources for agricultural investments.

## Strand 5 : Agribusiness
## Unit 1: Starting up and Managing an Agribusiness

**Content Standard 11.5.1** Students will be able to examine the different principles, practices, characteristics, enablers and contexts of business, and explore how agriculture businesses are started and managed in different contexts.

**Benchmark 11.5.1.3** Compare and contrast debt and equity financing and explain the impact on financial statements.

**Topic : Equity Financing**

**Learning Objectives :**
By the end of this topic, students will be able to:
- Identify and differentiate between debt and equity financing.

**Essential questions:**
1. What is debt and equity financing?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Essential Knowledge** | Principles of debt and equity finance |
| **Essential Skills** | identify and differentiate between debt and equity financing |
| **Essential Attitudes & Values** | Value the impact of debt and equity finance |

**Assessment:** Differentiate between debt and equity financing

**Content Background:**

Most companies use a combination of debt and equity financing, but there are some distinct advantages of equity financing over debt financing. Principal among them is that equity financing carries no repayment obligation and provides extra working capital that can be used to grow a business.

Companies usually have a choice as to whether to seek debt or equity financing. The choice often depends upon which source of funding is most easily accessible for the company, its cash flow, and how important maintaining control of the company is to its principal owners. The debt to equity ratio shows how much of a company's financing is proportionately provided by debt and equity.

**Equity Financing**

The main advantage of equity financing is that there is no obligation to repay the money acquired through it. Of course, a company's owners want it to be successful and provide equity investors a good return on their investment, but without required payments or interest charges as is the case with debt financing.

Equity financing places no additional financial burden on the company. Since there are no required monthly payments associated with equity financing, the company has more capital available to invest in growing the business. But that doesn't mean there's no downside to equity financing.

In fact, the downside is quite large. In order to gain funding, you will have to give the investor a percentage of your company. You will have to share your profits and consult with your new partners any time you make decisions affecting the company. The only way to remove investors is to buy them out, but that will likely be more expensive than the money they originally gave you.

**Debt Financing**

Debt financing sometimes comes with restrictions on the company's activities that may prevent it from taking advantage of opportunities outside the realm of its core business. Creditors look favorably upon a relatively low debt-to-equity ratio, which benefits the company if it needs to access additional debt financing in the future.

The advantages of debt financing are numerous. First, the lender has no control over your business. Once you pay the loan back, your relationship with the financier ends. Next, the interest you pay is tax deductible. Finally, it is easy to forecast expenses because loan payments do not fluctuate.
The downside to debt financing is very real to anybody who has debt. Debt is a bet on your future ability to pay back the loan.

What if your company hits hard times or the economy, once again, experiences a meltdown? What if your business does not grow as fast or as well as you expected? Debt is an expense and you have to pay expenses on a regular schedule. This could put a damper on your company's ability to grow.

Finally, although you may be an LLC or other business entity that provides some separation between company and personal funds, the lender may still require you to guarantee the loan with your family's financial assets. If you think debt financing is right for you, the U.S. Small Business Administration works with select banks to offer a guaranteed loan program that makes it easier for small businesses to secure funding. (For related reading, see "Should a Company Issue Debt or Equity?"

**Key Facts**

- The main advantage of equity financing is that there is no obligation to repay the money acquired through it.
- Equity financing places no additional financial burden on the company, however, the downside is quite large.
- Creditors look favourably upon a relatively low debt-to-equity ratio, which benefits the company if it needs to access additional debt financing in the future.

## Strand 5 : Agribusiness
## Unit 1 : Starting up and Managing an Agribusiness

**Content Standard 11.5.1** Students will be able to examine the different principles, practices, characteristics, enablers and contexts of business, and explore how agriculture businesses are started and managed in different contexts.

**Benchmark 11.5.1.4** Discuss the importance of analysing financial statements to determine the financial health, cash flow, and worth of a business.

**Topic :** Financial statements

**Learning Objectives**
By the end of this topic, students will be able to:
- Demonstrate preparing a cash flow statement for an agricultural based enterprise.

**Essential Questions**
1. What are the different types of financial statements?

**Essential Knowledge, Skills, Attitudes and Values**

| | |
|---|---|
| **Essential Knowledge** | Importance of financial statements |
| **Essential Skills** | identify and analyse the importance of different types of financial statements |
| **Essential Attitudes & Values** | Value the importance of financial statements |

**Assessment:**
Determine the worth of business using its financial statements.

**Content Background:**
Financial Statements represent a formal record of the financial activities of an entity. These are written reports that quantify the financial strength, performance and liquidity of a company.

Financial Statements reflect the financial effects of business transactions and events on the entity.Four Types of Financial Statements

The four main types of financial statements are:

**1. Statement of Financial Position**
Statement of Financial Position, also known as the Balance Sheet, presents the financial position of an entity at a given date. It is comprised of the following three elements:

**2. Income Statement**
Income Statement, also known as the Profit and Loss Statement, reports the company's financial performance in terms of net profit or loss over a specified period. Income Statement is composed of the following two elements:

Income: What the business has earned over a period (e.g. sales revenue, dividend income, etc)

Expense: The cost incurred by the business over a period (e.g. salaries and wages, depreciation, rental charges, etc. Net profit or loss is arrived by deducting expenses from income.

**3. Cash Flow Statement**

Cash Flow Statement, presents the movement in cash and bank balances over a period. T

**4. Statement of Changes in Equity**

Statement of Changes in Equity, also known as the Statement of Retained Earnings, details the movement in owners' equity over a period.

## Strand 5 : Agribusiness Unit 1: Starting up and Managing an Agribusiness

**Content Standard 11.5.1** Students will be able to examine the different principles, practices, characteristics, enablers and contexts of business, and explore how agriculture businesses are started and managed in different contexts.

**Benchmark 11.5.1.5** Analyse cash flow from operating activities to assess profitability and liquidity.

**Topic: Cash flow**

**Learning Objectives :**
By the end of this topic, students will be able to:
- Demonstrate preparing a cash flow statement for an agricultural based enterprise

**Essential questions :**
1. What is a cash flow statement?

| | |
|---|---|
| **Essential Knowledge** | Cash flow statements |
| **Essential Skills** | demonstrate preparing a cash flow statement |
| **Essential Attitudes & Values** | Appreciate the use of cash flow statements |

**Assessment:** Create a cash flow statement using for a business using previous financial records

**Content Background:**

A cash flow statement is a financial statement that provides aggregate data regarding all cash inflows a company receives from its ongoing operations and external investment sources. It also includes all cash outflows that pay for business activities and investments during a given period.

A company's financial statements offer investors and analysts a portrait of all the transactions that go through the business, where every transaction contributes to its success. The cash flow statement is believed to be the most intuitive of all the financial statements because it follows the cash made by the business in three main ways—through operations, investment, and financing. The sum of these three segments is called net cash flow.

These three different sections of the cash flow statement can help investors determine the value of a company's stock or the company as a whole.

## How Cash Flow Statements Work

Every company that sells and offers its stock to the public must file financial reports and statements. The three main financial statements are the balance sheet and income statement. The cash flow statement is an important document that helps open a wind interested parties insight into all the transactions that go through a company.

There are two different branches of accounting—accrual and cash. Most public companies use accrual accounting, which means the income statement is not the same as the company's cash position. The cash flow statement, though, is focused on cash accounting.

Profitable companies can fail to adequately manage cash flow, which is why the cash flow statement is a critical tool for companies, analysts, and investors. The cash flow statement is broken down into three different business activities: operations, investing, and financing.

Let's consider a company that sells a product and extends credit for the sale to its customer. Even though It recognizes that sale as revenue, the company may not receive cash until a later date. The company earns a profit on the income statement and pays income taxes on it, but the business may bring in more or less cash than the sales or income figures.

## Cash Flows from Operations

This is the first section of the cash flow statement and includes transactions from all operational business activities. The cash flows from operations section begins with net income, then reconciles all noncash items to cash items involving operational activities. So, in other words, it is the company's net income, but in a cash version.

This section reports cash flows and outflows that stem directly from a company's main business activities. These activities may include buying and selling inventory and supplies, along with paying its employees their salaries. Any other forms of in and outflows such as investments, debts, and dividends are not included.

Companies are able to generate sufficient positive cash flow for operational growth. If there is not enough generated, they may need to secure financing for external growth in order to expand.

For example, accounts receivable is a noncash account. If accounts receivable go up during a period, it means sales are up, but no cash was received at the time of sale. The cash flow statement deducts receivables from net income because it is not cash. The cash flows from the operations section can also include accounts payable, depreciation, amortization, and numerous prepaid items booked as revenue or expenses, but with no associated cash flow.

**Key Takeaways**

- A cash flow statement provides data regarding all cash inflows a company receives from its ongoing operations and external investment sources.
- The cash flow statement includes cash made by the business through operations, investment, and financing—the sum of which is called net cash flow.

- The first section of the cash flow statement is cash flow from operations, which includes transactions from all operational business activities.

- Cash flow from investment is the second section of the cash flow statement, and is the result of investment gains and losses.
- Cash flow from financing is the final section, which provides an overview of cash used from debt.

**Difference Between Profitability and Liquidity**

In any company analysis, the two major parameters for analysis are profitability and liquidity, which are the two important criteria for a company to have creditworthiness and have an increasing market capital and market share. Profitability vs Liquidity needs to be analyzed in detail. In this Profitability vs Liquidity article, we will try and understand the difference and the characteristics of the two in detail and why these two parameters are important for financial analysis.

Profitability refers to the company's improvement in margins; margins refer to revenue – cost the more the margins are increasing; it reflects enhanced profitability in the company for that financial year. Profitability enhances the equity reserves and growth prospects of the company. On the other hand, liquidity refers to the ability of the firm to meet short-term and long-term obligations which the business needs to pay in the long run and the short-run the current portion of liabilities

One of the key differences is that it is not necessary always that the profitable company is also liquid in nature that is because the company has invested heavily In the future projects of the company from which the receivables are due after a considerable period of time. This is a major difference that needs to be understood when making financial projections for any company. A company that is not liquid in nature can also go bankrupt in the short run because it does not have enough liquidity in its hands that is why the company needs working capital to meet short-term obligations

Profitability is a measure of business success; that is how well the company is performing over a period of time; it is not an indication of how cash-rich the company is. It cannot tell the analyst the cash position of the company. Liquidity, on the other hand, tells us the cash position of the company, too much cash on the balance sheet also indicates poor working capital management of the company as the company is bearing the opportunity cost of cash which is lying idle on the balance sheet

Profitability is the financial performance measure of the company, which is indicated in the income statement and is reported as Net profit in the profit and loss account. If the net profit is negative, it indicates that the company is bearing losses in that period. Liquidity is present in the balance sheet on the current assets section of any balance sheet of the company which includes marketable securities, prepaid expenses, and inventories apart from cash.

Both Profitability against Liquidity is important for a business as it is a vital aspect for a company. If the company does not have enough cash on its hands, the working capital management will go for a toss, and the company needs to look for a working capital loan which in turn will increase the interest cost of any business. Profitability is also a vital aspect as the company needs to analyze the reason for low-profit growth and also focus on cost reduction.

# Standards-Based Lesson Planning

**TOPIC: Manual Husbandry of Aromatic Plants**

**Lesson Topic: How to harvest Aloe Vera**

**Grade:** 11

**Length of Lesson:** 40 minutes

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**National Content Standard: Content Standard 11.1.7** Students will be able to examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption and management of plants in different types of environments and analyse their advantages and disadvantages.

**Grade-Level Benchmark**
Benchmark 11.1.7.1 Investigate and explain how technology could be used to mass produce and commercialise herbal, aromatic, spice, and ornamental plants in PNG at a large scale.

**Essential Knowledge, Skills, Values, and Attitudes**
**Knowledge:** Manual Husbandry of Aromatic Plants
**Skills:** Research and analyse manual husbandry of ale vera
**Values:** Value manual husbandry of aloe vera
**Attitudes:** Appreciate manual husbandry of aloe vera
**STEAM Knowledge and Skill**
**Knowledge:** Manual husbandry of aloe vera
**Skill:** Processes in manual husbandry
**Performance Indicator:**
Correctly harvest aloe vera
**STEAM Performance Indicator:**
Correctly harvest aloe vera

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**Materials:** handouts, aloe vera,

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**Lesson Objective:**
Identify and describe the manual husbandry of aloe vera
**Essential Questions:**
How technology is applied in manual husbandry of aloe vera?

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## Sample Lesson Procedure
## Lesson Procedure

| Teacher Activities | Student Activities |
|---|---|
| **Introduction** | |
| What is manual husbandry?<br><br>Outline objectives and standards for this lesson | Refer to handouts and explain manual husbandry in their own words. |
| **Body** | |
| **Modelling** | |
| Explain how technology is applied in manual husbandry. | Take note of the specific steps in manual husbandry<br><br>Identify how technology can be applied in manual husbandry of aloe vera. |
| **Guided Practice** | |
| Outline the processes of how a technology can be useful and applied to manual husbandry of aromatic plants. | Make a similar plan on how technology can be applied in aromatic plants |
| **Independent Practice** | |
| Ask students to apply technology in manual husbandry of aloe vera | Do up a plan on how a specific technology can be applied in manual husbandry of aloe vera. |
| **Conclusion** | |
| Assess students understanding of their plan on how to apply technology in manual husbandry of aloe vera. | Present their plan to the class of what the group has come up with in applying technology to manual husbandry of aloe vera |

## Performance Assessment and Standards

**National Content Standard: 11.1.7** Students will be able to examine how technology is used in the cultivation, processing, preserving, marketing, regulation, consumption, and management of plants in different types of environments, and analyze their advantages and disadvantages.

| Lesson Topic | Topic | Benchmark | Performance Assessment | |
|---|---|---|---|---|
| **How to harvest Aloe Vera** | How to harvest Aloe Vera | **Benchmark 11.1.7.1** Investigate and explain how technology could be used to mass produce and commercialise herbal, aromatic, spice, and ornamental plants in PNG at a large scale.. | Correctly harvest aloe vera | |
| | **PROFICIENCY RUBRIC** | | | |
| | **Advanced** | **Proficient** | **Partially Proficient** | **Novice** |
| | Analyse all types of cultivation processes and techniques utilised in horticulture practices in different environment, contexts and places to harvest aloe vera. | Analyse some cultivation processes and techniques utilised in horticulture practices in different environment, contexts and places to harvest aloe vera. | Analyse a cultivation processes and techniques utilised in horticulture practices in different environment, contexts and places to harvest aloe vera. | Difficulty in analysing cultivation processes and techniques utilised in horticulture practices in different environment, contexts and places to harvest aloe vera. |

### STEAM Activity

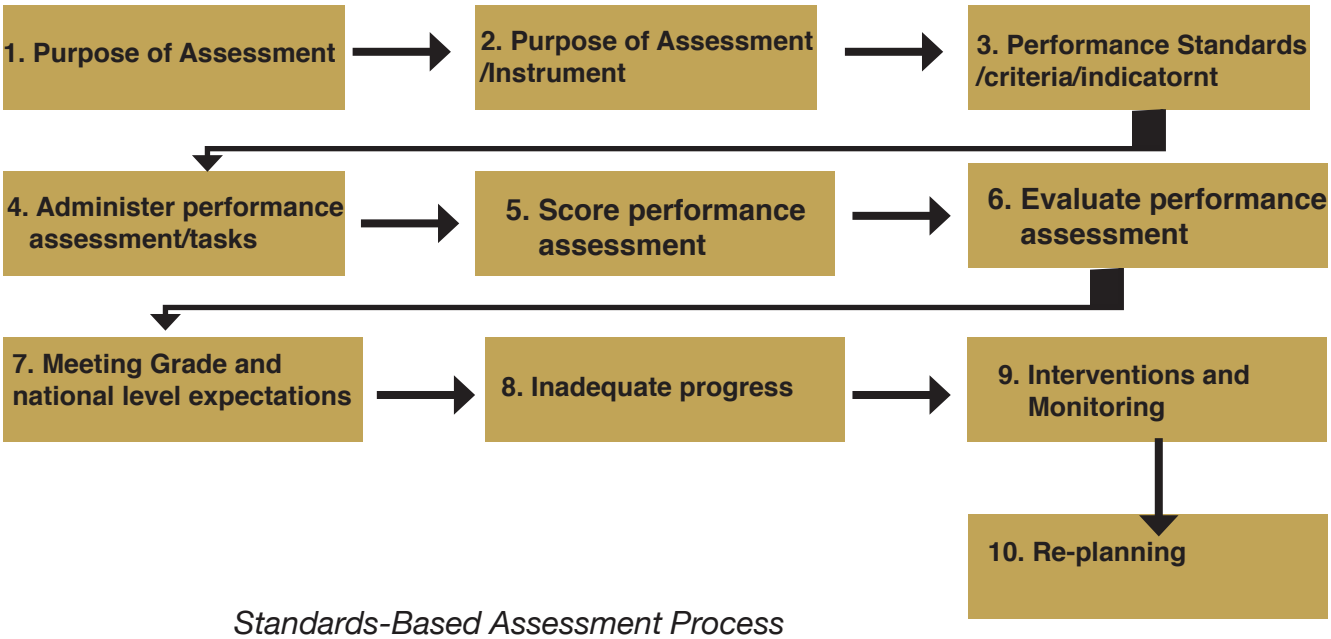
Draw up a plan on how to incorporate technology in enhancing the conduction of manual husbandry to harvest aloe vera.

# Assessment, Monitoring and Reporting

## What is Standards-Based Assessment (SBA)?

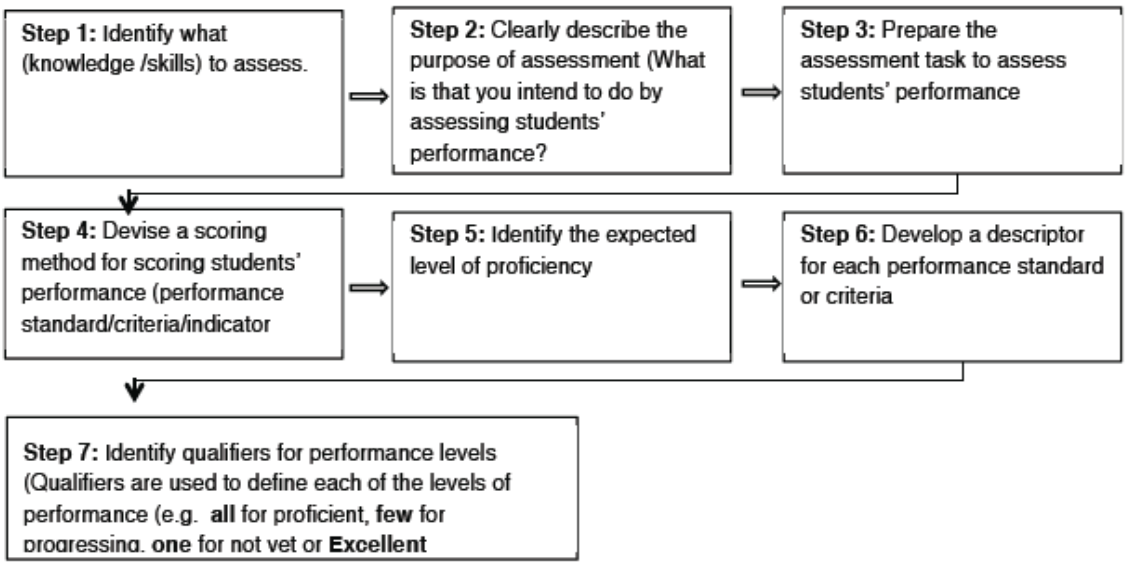
Assessment and reporting is an integral part of the delivery of any curriculum used in the schools. In Standard Based Curriculum (SBC) assessment encourages the use of benchmarks and commended types of assessment that promote standards for a rangeof purposes.

*Standards-Based Assessment Cycle*




*Standards-Based Assessment Process*

Teachers are required to use the steps outlined below when planning assessment. These steps will guide you to develop effective assessments to improve student's learning as well as evaluating their progress towards meeting national and grade –level expectations.



## Purpose of Standards-Based Assessment

Standards-Based Assessment (SBA) serves different purposes. These include instruction and learning purposes. The primary purpose of SBA is to improve student learning so that all students can attain the expected level of proficiency or quality of learning.

Enabling purposes of SBA is to:

- Measure students' proficiency on well-defined content standards, benchmarks andlearning objectives
- Ascertain students' attainment or progress towards the attainment of specificcomponent of a content standard
- Ascertain what each student knows and can do and what each student needs tolearn to reach the expected level of proficiency
- Enable teachers to make informed decisions and plans about how and what they would do to assist weak students to make adequate progress towards meeting the expected level of proficiency
- Enable students to know what they can do and help them to develop and implement strategies to improve their learning and proficiency level
- Communicate to parents, guardians, and relevant stakeholders the performance andprogress towards the attainment of content standards or its components
- Compare students' performances and the performances of other students

## Principles of Standards-Based Assessment

The principle of SBA is for assessment to be;

- emphasise on tasks that should encourage deeper learning,
- be an integral component of a course, unit or topic and not something to add onafterward,
- a good assessment requires clarity of purpose, goals, standards and criteria ofpractices that should use a range of measures allowing students to demonstratewhat they know and can do,
- based on an understanding of how students learn of practices that promotedeeper understanding of learning processes by developing their capacity for self-assessment,
- for improving performance that involves feedback and reflection,
- on-going rather than episodic,
- given the required attention to outcomes and processes, and
- be closely aligned and linked to learning objectives, benchmarks and content standards

## Standards-Based Assessment Types

In standards-Based Assessment, there are three broad assessments types.

### 1. Formative Assessment

Formative assessment includes 'assessment *for* and *as Learning'* and is conductedduring the teaching and learning of activities of a topic.

*Purposes of assessment for Learning*

- On-going assessment that allows teachers to monitor students on a day-to-daybasis.
- Provide continuous feedback and evidence to the teachers that should enable themto identify gaps and issues with their teaching, and improve their classroom teachingpractice.
- Helps students to continuously evaluate, reflect on, and improve their learning.

*Purposes of assessment as Learning*

- Occurs when students reflect on and monitor their progress to inform their futurelearning goals.
- Helps students to continuously evaluate, reflect, and improve their own learning.
- Helps students to understand the purpose of their learning and clarify learninggoals.

### 2. Summative Assessment

Summative assessment focuses on 'assessment *of learning'* and is cconducted afteror at the conclusion of teaching and learning of activities or a topic.

*Purposes of assessment of Learning*

- Help teachers to determine what each student has achieved and how much progresshe/she has made towards meeting national and grade-level expectations.
- Help teachers to determine what each student has achieved at the end of a learningsequence or a unit.
- Enable teachers to ascertain each student's development against the unit or topicobjectives and to set future directions for learning.
- Help students to evaluate, reflect on, and prepare for next stage of learning.

### 3. Authentic Assessment

- Is performed in a real life context that approximates as much as possible, the useof a skill or concept in the real world.
- Is based on the development of a meaningful product, performance or process

- Students develop and demonstrate the application of their knowledge, skills, values and attitudes in real life situations which promote and support the development of deeper levels of understanding.
- Uses either summative or formative assessment methods in real life context.

Authentic assessment refers to assessment that:

- Looks at students actively engaged in completing a task that represents theachievement of a learning objective or standard.
- Takes place in real life situations.
- Asks students to apply their knowledge, skills, values and attitudes in real lifesituations.
- Students are given the criteria against which they are being assessed.

## Performance Assessment

Performance assessment is a form of testing that requires students to perform a task rather than select an answer from a ready-made list. For example, a student maybe asked to explain historical events, generate scientific hypotheses, solve math problems, converse in a foreign language, or conduct research on an assigned topic. Teachers, then judge the quality of the student's work based on an agreed-upon set of criteria. It is an assessment which requires students to demonstrate that they havemastered specific skills and competencies by performing or producing something.

## Types of performance assessment

### *i Products*

This refers to concrete tangible items that students create through either the visual,written or auditory media such as:

- Creating a health/physical activity poster.
- Video a class game or performance and write a broadcast commentary.
- Write a speech to be given at a school council meeting advocating for increasedtime for health and Agriculture in the curriculum.
- Write the skill cues for a series of skill photo's.
- Create a brochure to be handed out to parents during education week.
- Develop an interview for a favourite sportsperson.
- Write a review of a dance performance.
- Essays.
- Projects.

### *ii Process Focused Tasks*

It shows the thinking processes and learning strategies students use as they worksuch as:

- Survival scenarios.
- Problem solving initiative/adventure/ activities.
-

- Decision making such as scenario's related to health issues.
- Event tasks such as creating a game, choreographing a dance/ gymnastics routine,creating an obstacle course.
- Game play analysis.
- Peer assessment of skills or performances.
- Self-assessment activities.
- Goal setting, deciding a strategy and monitoring progress towards achievement.

*iii Portfolio*

This refers to a collection of student work and additional information gathered over aperiod of time that demonstrates learning progress.

*iv. Performances*

It deals with observable affective or psycho-motor behaviours put into action such as:

- Skills check during game play.
- Role plays.
- Officiating a game.
- Debates.
- Performing dance/gymnastics routines.
- Teaching a skill/game/dance to peers.

## Assessment Strategies

It is important for teachers to know that, assessment is administered in different ways.Assessment does not mean a test only. There are many different ways to find out about student's strengths and weaknesses. Relying on only one method of assessing will not reflect student's achievement.

Provided in the table below is a list of suggested strategies you can use to assess student's performances. These strategies are applicable in all the standards-based assessment types.

## Assessment Strategies

| STRATEGY | DESCRIPTION |
|---|---|
| **ANALOGIES** | Students create an analogy between something they are familiar with andthe new information they have learned. When asking students to explain the analogy, it will show the depth of their understanding of a topic. |
| **CLASSROOM PRESENTATIONS** | A classroom presentation is an assessment strategy that requires studentsto verbalize their knowledge, select and present samples of finished work, and organize their thoughts about a topic in order to present a summary oftheir learning. It may provide the basis for assessment upon completion of a student's project or essay. |
| **CONFERENCES** | A conference is a formal or informal meeting between the teacher and a student for the purpose of exchanging information or sharing ideas. Aconference might be held to explore the student's thinking and suggest next steps; assess the student's level of understanding of a particular concept or procedure; and review, clarify, and extend what the student hasalready completed |
| **DISCUSSIONS** | Having a class discussion on a unit of study provides teachers with valuable information about what the students know about the subject. Focus the discussions on higher level thinking skills and allow students toreflect their learning before the discussion commences. |
| **ESSAYS** | An essay is a writing sample in which a student constructs a responseto a question, topic, or brief statement, and supplies supporting detailsor arguments. The essay allows the teacher to assess the student's understanding and/or ability to analyse and synthesize information. |
| **EXHIBITIONS/ DEMONSTRATIONS** | An exhibition/demonstration is a performance in a public setting, during which a student explains and applies a process, procedure, etc., in concrete ways to show individual achievement of specific skills and knowledge. |
| **INTERVIEWS** | An interview is a face-to-face conversation in which teacher and student use inquiry to share their knowledge and understanding of a topic or problem, and can be used by the teacher to explore the student's thinking; assess the student's level of understanding of a concept or procedure and gather information, obtain clarification, determine positions, and probe for motivations. |
| **LEARNING LOGS** | A learning log is an ongoing, visible record kept by a student and recording what he or she is doing or thinking while working on a particular task or assignment. It can be used to assess student progress and growth over time. |
| **OBSERVATION** | Observation is a process of systematically viewing and recording students while they work, for the purpose of making programming and instruction decisions. Observation can take place at any time and in any setting. It provides information on students' strengths and weaknesses, learning styles, interests, and attitudes. |

| | |
|---|---|
| **PEER ASSESSMENT** | Assessment by peers is a powerful way to gather information about students and their understanding. Students can use set criteria to assess the work of their classmates. |
| **PERFORMANCE TASKS** | During a performance task, students create, produce, perform, or present works on “real world” issues. The performance task may be used to assess a skill or proficiency, and provides useful information on the process as well as the product. |
| **PORTFOLIOS** | A portfolio is a collection of samples of a student’s work, and is focused, selective, reflective, and collaborative. It offers a visual demonstration of a student’s achievement, capabilities, strengths, weaknesses, knowledge, and specific skills, over time and in a variety of contexts. |
| **QUESTIONS AND ANSWERS (ORAL)** | In the question–and-answer strategy, the teacher poses a question and the student answers verbally, rather than in writing. This strategy helps the teacher to determine whether students understand what is being, or has been, presented, and helps students to extend their thinking, generate ideas, or solve problems. |
| **QUIZZES, TESTS, EXAMINATIONS** | A quiz, test, or examination requires students to respond to prompts in order to demonstrate their knowledge (orally or in writing) or their skills (e.g., through performance). Quizzes are usually short; examinations are usually longer. Quizzes, tests, or examinations can be adapted for exceptional students and for re- teaching and retesting. |
| **QUESTIONNAIRES** | Questionnaires can be used for a variety of purposes. When used as a formative assessment strategy, they provide teachers with information on student learning that they can use to plan further instruction. |
| **RESPONSE JOURNALS** | A response journal is a student’s personal record containing written, reflective responses to material he or she is reading, viewing, listening to, or discussing. The response journal can be used as an assessment tool in all subject areas. |
| **SELECTED RESPONSES** | Strictly speaking a part of quizzes, tests, and examinations, selected responses require students to identify the one correct answer. The strategy can take the form of multiple-choice or true/ false formats. Selected response is a commonly used formal procedure for gathering objective evidence about student learning, specifically in memory, recall, and comprehension. |
| **STUDENT SELF-ASSESSMENTS** | Self-assessment is a process by which the student gathers information about, and reflects on, his or her own learning. It is the student’s own assessment of personal progress in terms of knowledge, skills, processes, or attitudes. Self-assessment leads students to a greater awareness and understanding of themselves as learners. |

## Project Rubric

| Category | | Satisfactory | Partial Credit | Unacceptable |
|---|---|---|---|---|
| | 9 -10 points | 7- 8 points | 1 - 6 points | 0 points |
| **Quality/ Workmanship** | Maximum effort was put forth to complete the project in a professional manner. Project demonstrates a high degree of quality and attention to detail. Workmanship is excellent. | Some effort was made to complete the project to a level that was sufficient for grading, but does not meet a professional level of quality or appearance. Workmanship is of acceptable quality. | Minimal effort was made to complete the project and the quality and workmanship is sub-par, but still meets the minimal standard. | Little or no effort was made to produce a quality project. Project obviously does not meet minimal standards. |
| **Creativity/ Design** | Project reflects many fundamental elements of design and creativity. Project demonstrates an advanced understanding of creative thinking and attention to aesthetics and presentation. | Project reflects some of the elements of design and creativity, but lacks attention to aesthetics and presentation. | Project was completed, but does not reflect the acceptable levels of design and creativity. Effort was minimal and project is mediocre at best. | Project was not completed on time or reflects little or no effort to complete assignment at an acceptable level. |
| **Functionality** | Project meets or exceeds the design requirements of purpose and functionality. All elements of the design have been met and the project does what it was designed to do. | Project meets some of the design requirements of purpose and functionality. Not all elements of the design have been met, but the project does what it was designed to do. | Project is somewhat functional, but reflects minimal effort. It is intermittent and doesn't always do what it was designed to do. | Project does not work and demonstrates a lack of effort or understanding of the basic elements of functionality and purpose. |
| **Design Process** | Project reflects a clear understanding and application of design process including evidence of research, brainstorming, design and problem solving, prototyping and testing. | Project reflects some understanding and application of accepted design loop principles and sequence including evidence of research, brainstorming, design and problem solving, prototyping and testing. | Project reflects minimal understanding and application of design process. | Project does not show evidence that design process was used. Project does not meet accepted levels of design criteria. |

| | | | | |
|---|---|---|---|---|
| **Criteria/ Constraints** | Project was completed with all constraints and criteria met or exceeded. Reflects attention to detail and quality. | Project was completed with some of the constraints and criteria met. Reflects some attention to detail, but quality is minimal. | Project was completed with a few of the constraints and criteria met. Reflects minimal effort and lacks detail or quality. | Project was not completed and does not reflect the adherence to the constraints or criteria. |
| **Time Management** | Project completed andturned in on time. Student worked diligently when project time was available. Student was on task most of the time. | Project was completed, but hadnotable errors. Student utilized project time somewhat efficiently, but spent time socializing. Student was on task 70% - 80% of the time. | Project was not turned in on time and/or complete. The student was ontask less than 60% of the time. | Project was not turned in on timeand was not completed. Student wasted project time and at times was disruptive to others. |
| **Resource Management** | Always takes responsibility for use and care of all buildingcomponents and resources. Always returns buildingcomponents and materials to proper storage compartments. | Consistently takes responsibility for use and care of building components and resources. Somewhat consistent in returning building components to proper storage compartments. | Sometimes takes responsibility for use and care of building components and resources. Inconsistent in returning building components to proper storage compartments. | Does not take responsibility for the proper use and care of building components and resources. Is careless and does not practice proper storage and safety practices. |
| **Teamwork** | Notable teamwork shown with a determination to participate/ contributeto team success. Completed required individual tasks that contributed to the success of the team. | Teamwork was noted,but was sometimes off task or working on non-related tasks.Contributed to the success of the team,but could have been more engaged to complete tasks sooner. | Notable time off-task with minimal effort given for team success, or did the project alone withoutrelying on others to do their share of the project. | Was not a team player. Either took over project completely, or did not engage in team direction orplans. |
| **Writing/ Reflection** | Writing/reflection is very well organized and explained. Studentincludes all details in design process. Document has almost no grammatical errors. | Writing/reflection is somewhat organized and explained. Student includes most de-tails in design process.Document has very few grammatical errors. | Writing/reflection isnot organized and explained. Studentincludes only a fewdetails in design process. Document has manygrammatical errors. | Writing/reflection is incomplete or not turned in. Student includes no details in design process. Document has many grammatical errors. |
| **Presentation** | Presentation was well organized and presented in a logical sequence. Presentation reflects a full knowledge of the topic with clear answers and explanations to questions asked. | Presentation was fairly organized and most information presented in a logical sequence. Answers to questions were vague or lacked clarity or accuracy. | Presentation was unorganized and lacked a logical sequence. Presentation reflected little attention to detail. Answers to questions were inaccurate and confusing. | Presentation was not acceptable and reflects a lack of organization or knowledge of the topic. Presentation shows little effort to meet expectations. |

# GLOSSARY

| WORDS | DEFINITION |
|---|---|
| **Agri silvicultural system** | It is a combination of crops and trees |
| **Agroforestry** | Is a term used to describe a system where through some kind of special arrangement or temporal sequence trees, shrubs etc. are grown in the same land management units such as agricultural crops and animals |
| **Agronomy** | The science of crop and soil management for crop production. |
| **Agrosylvopastoral system** | It is a combination of trees, animals and crops. |
| **Animal Husbandry** | The science of looking after and breeding farm animals. |
| **Animal NUtrition** | needed or found in animal food |
| **Annual crop** | Crop that grows, reproduces and dies within one year, eg corn,<br>beans, rice, cabbages, etc |
| **Aqua Plant Organisms** | Microalgae, phytoplankton, microphysics or planktonic algae; Gelidium, Pterocladia, Porphyry, and Luminaire – produce agar and carrageenan products. |
| **Aquaculture** | Water farming of all aquatic forms like fish, prawns, molluscs and sea weeds in fresh, brackish as well as in marine waters |
| **Aquaponics** | The integration of recirculating aquaculture and hydroponics in one production system. |
| **Aviculture** | Looking after and breeding birds |
| **Biennial Crop** | Crop that requires two years to reach maturity. In the first year, it<br>produces leaves and in the second it flowers and produces seeds and then dies, eg cabbages, onions, leeks |
| **Biofilter** | Filter used to filter water for the fish |
| **Biofuel** | fuel derived from living matter |
| **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 |
| **Business plan** | A detailed plan setting out the objectives of a business over a stated period, often three, five or ten years. For new business it is an essential document for raising capital or loans, for a group of companies the business plan is written is often called a cooperate plan |
| **Cash flow** | The total amount of cash being received and paid out by a business |
| **Commercial Farming** | Large-scale farming in which many hectares of land are cultivated, usually using machines |
| **Contour Farming** | Making ridges and planting beds across hill slopes |
| **Cropping System** | Pattern of growing crops in garden, eg mixed cropping or intercropping |
| **Cultivation** | Shallow tillage or digging of the soil to loosen it so that water can<br>soak into the soil. It is also for removing weeds |
| **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 |

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| **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 |
| **Enteprenuer** | An individual who undertakes to supply a good or service to the market |
| **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 |
| **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 |
| **Financial report** | A document giving a formal account of the revenue and expenses of a business |
| **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 |
| **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.<br>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 |
| **Hydrophytic plants** | Aquatic plants that have adapted to living in aquatic environments |
| **Industrial crops** | Crops which are not sold directly for consumption because they need to be industrially processed. |
| **Inorganic fertilizer** | Plant food made up of artificial substances, not from plant and animal matter |
| **Macronutrients** | Nutrients that your body needs in large ammounts, which include fat, carbohydrates, and protein |
| **Market** | A place where people meet to buy and sell goods (Merchandise) |
| **Marketing concept** | The process of anticipating the needs of targeted customers and finding ways to meet those needs profitably |
| **Micronutrients** | Vuatmins and minerals needed by the body in very small amounts. |
| **Micro-organisms** | An organism of microscopic size which may exist in its single -celled form or as a colony of cells. |
| **Monoculture** | Fish production system in which only one fish species is reared in a culture system |
| **Monogastric Animals** | Animals that have one stomach and many are omnivorous in their feeding behavior, like pigs. They eat both plant matter and animal matter. |

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|---|---|
| **Mortgage** | A loan with security taken to purchase a house, building or shares, etc, |
| **Natural Resource** | Any materials provided by nature, eg forest trees and animals, land, rivers, fish, minerals, petroleum |
| **Net profit** | Amount of money remaining when all working expenses in a farm enterprise or other projects have been removed |
| **Nutrition** | Study of the amounts and proportions of substances that can be used as food |
| **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 fertilizer** | 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 |
| **Ornamental crop** | Plants or garden plants that are grown for decorative purposes. |
| **Pastoral farming** | Methods of farming in which herdsmen or shepherds keep and care for domestic animals |
| **Perennial crop** | Crop that grows for many years, eg cocoa trees, coffee trees, oil palm, coconut trees, mangoes and orange trees |
| **Polyculture** | Fish production system in which two or more different fish species are farmed or culture of fish along with some other aquatic animals like shrimp or prawn. |
| **Polygastric Animals** | Animals that have two more storage compartment stomachs and are herbaceous in their feeding behaviour like cows and sheep. |
| **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. |
| **Silage crops** | Any crop that is harvested green and preserved in a succulent condition by partial fermentation in a more or less airtight container sauch as a silo. |
| **Silvopastoral system** | It is a combination of domesticated animals and forestry. |
| **System cycling** | Term used to describe the initial process of building a bacterial colony when first starting any aquaponic unit |

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# Appendices

## Appendix 1: Bloom's Taxonomy

| LEVEL OF UNDERSTANDING | KEY VERBS |
|---|---|
| CREATING<br>Can the student create a new productor point of view? | Construct, design, and develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan,produce, assemble, formulate, |
| **EVALUATING**<br>Can the student justify a stand or decision? | Appraise, argue, assess, choose, conclude, critique, decide,defend, evaluate, judge, justify, predict, prioritize, provoke, rank, rate, select, support, monitor, |
| ANALYZING<br>Can the student distinguish betweenthe different parts? | Analyzing, characterize, classify, compare, contrast, debate,criticise, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, experiment, question, test, |
| **APPLYING**<br>Can the student use the information ina new way | Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer,use, demonstrate, illustrate, interpret, operate, sketch, solve, write, |
| UNDERSTANDING<br>Can the student comprehend ideas orconcepts? | Classify, compare, exemplify, conclude, demonstrate, discuss,explain, identify, illustrate, interpret, paraphrase, predict, report, translate, describe, classify, |
| REMEMBERING<br>Can the student recall or rememberthe information? | Define, describe, draw, find, identify, label, list, match, name,quote, recall, recite, tell, write, duplicate, memorise, recall, repeat, reproduce, state, |

## Appendix 2: 21st Century Skills

| | |
|---|---|
| **WAYS OF THINKING** | Creativity and innovationThink creatively<br>Work creatively with othersImplement innovations<br>Critical thinking, problem solving and decision making<br>Reason effectively and evaluate evidence<br>Solve problems Articulate findings<br>Learning to learn and meta-cognitionSelf-motivation<br>Positive appreciation of learningAdaptability and flexibility |
| **WAYS OF WORKING** | Communication<br>Competency in written and oral languageOpen minded and preparedness to listenSensitivity to cultural differences<br>Collaboration and teamwork<br>Interact effectively with others Work effectively in diverse teams<br>Prioritise, plan and manage projects |
| **TOOLS FOR WORKING** | **Information literacy**<br>Access and evaluate informationUse and manage information Apply technology effectively<br>ICT literacy<br>Open to new ideas, information, tools and ways of thinking<br>Use ICT accurately, creatively, ethically and legally<br>Be aware of cultural and social differences Apply technology appropriately and effectively |
| **LIVING IN THE WORLD** | Citizenship – global and local<br>Awareness and understanding of rights and responsibilities as a global citizenPreparedness to participate in community activities<br>Respect the values and privacy of othersPersonal and social responsibility<br>Communicate constructively in different social situations<br>Understand different viewpoints and perspectives<br>Life and career Adapt to change<br>Manage goals and time Be a self-directed learner<br>Interact effectively with others |

## Appendix 3: Standards-Based Lesson Plan Template

**Standards-Based Lesson Plan**

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**Topic: Lesson Topic: Grade:**

**Length of Lesson:**

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**National Content Standard**

**Grade Level Benchmark**

**Essential Knowledge, Skills, Values, and Attitudes**
Knowledge:
Skills:
Values:
Attitudes:

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Materials:

- Lesson Objective:

**Essential Questions:**

## Lesson Procedure

## Performance Assessment and Standards

| National Content Standard : | | | | |
|---|---|---|---|---|
| Lesson Topic | Topic | Benchmark | Performance Assessment | |
| | | | | |
| | | | | |
| | Advanced | Proficient | Partially Proficient | Novice |
| | | | | |

## Appendix 4: Standards-Based Lesson Plan Template-Integrating STEAM

### Standards-Based Lesson Plan (Integrating STEAM)

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**Topic:**
**Lesson Topic:**
**Grade:**
**Length of Lesson:**

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**National Content Standard**

**Grade Level Benchmark**
**Essential Knowledge, Skills, Values, and Attitudes**

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**Knowledge:**
**Skills:**
**Values:**
**Attitudes:**

**STEAM Knowledge and Skill**
**Knowledge:**

**Skill:**

**Performance Indicator:**
**STEAM Performance Indicator:**

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**Materials:**

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**Lesson Objective:**
**Essential Questions:**

| Teacher Activities | Student Activities |
|---|---|
| **Introduction** | |
| | |
| **Body** | |
| **Modelling** | |
| | |
| **Guided Practice** | |
| | |
| **Independent Practice** | |
| | |
| **Conclusion** | |
| | |

## Performance Assessment and Standards

| National Content Standard : | | | | |
|---|---|---|---|---|
| **Lesson Topic** | **Topic** | **Benchmark** | **Performance Assessment** | |
| | | | | |
| | | | | |
| | **Advanced** | **Proficient** | **Satisfactory** | **Poor** |
| | | | | |

**STEAM Activity**_____

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