

Agriculture

Junior High

Grade 9

Teacher Guide

Standards-Based



Papua New Guinea

Department of Education

'FREE ISSUE

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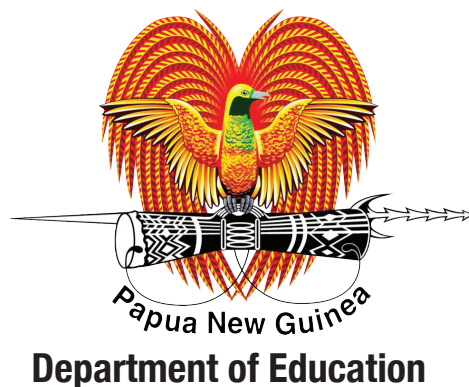
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Issued free to schools by the Department of Education

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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
MIDG	Medium Term Development Goals
NGOs	Non- Government Organizations
PBA s	Performance based Assessments
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 to work, study and live in the 21st century.

Agriculture content will provide learners with a range of competencies important in the world of work and in 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 will equip them to be scenically, technologically and environmentally literate and productive members of the 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.

Agriculture embraces STEAM and provides the students the opportunity to integrate Science, Technology, Engineering, Mathematics and Arts to equip students with the essential values, attitudes, skills and knowledge. The content captures enables students to acquire relevant skills, values, attitudes and knowledge to make and earn a living and lead productive lives as members of the local, national and international community

Agriculture teachers are encouraged to use this teacher guide 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 into consideration at all times.

I commend and approve this Agriculture Teacher Guide for Grade 9 to be used in all Junior High/Secondary Schools throughout Papua New Guinea.



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

Introduction

Nature has endowed Papua New Guinea with a diverse and a unique natural environment. The rugged mountain ranges, deep ocean floor, flourishing and diverse flora and fauna, the winds, and the fast flowing rivers provide a fertile ground for scientific inquiry. But how does one go about inquiring and addressing the problems that nature presents if one is not trained to ask the right questions? This is where the knowledge, skills, values and attitudes of Agriculture become necessary. The 21st Century is a time of rapid change. New knowledge, tools and ways of doing and communicating continue to emerge and evolve and impact our lives in many different ways. Life style diseases have also taken a toll in the lives of many Papua New Guineans.

Student's 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.

The realignment of Agriculture will provide learners with a range of competencies important in the world of work and in a knowledge-based society. It envisions the development of scientifically, technologically, and environmentally literate and productive members of society who are critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers and effective communicators.

This course will further deepen students' understanding of advanced agricultural knowledge in the processes, practices and technologies that occur in the field of Agriculture. Students will study theory and carry out practical sessions in the areas of crops, animals, aquaculture, natural resources and agribusiness. Teachers are encouraged to engage students in learning realistic contexts for increased and better understanding of learning concepts.

Time allocation for Agriculture is 240 minutes per week. Teachers are urged to fully utilise the allocated time.

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 9 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 attitude 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 Physical Education syllabi and teacher guide to plan, teach and assess different Physical Education units and topics, and the KSVAs described in the grade-level benchmarks;
- understand the Physical Education national content standards, grade-level benchmarks, and evidence outcomes;
- effectively make sense of the content (KSVAs) described in the Physical Education 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 Physical Education skills, processes, concepts, ideas, principles, practices, values and attitudes;
- confidently interpret, translate and use Physical Education 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 Physical Education 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 Physical Education 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.

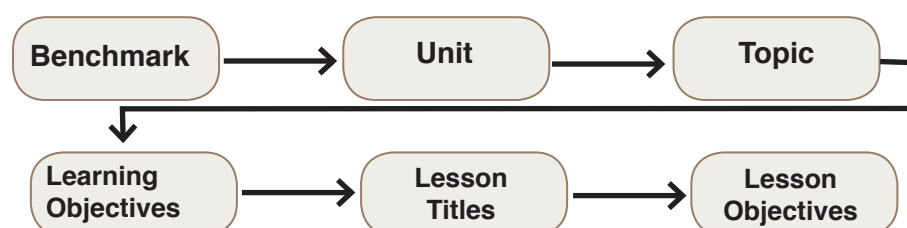
The first thing teachers should do is to read and understand each of the sections of the teacher guide to help them understand the key SBC concepts and ideas, alignment of PNG SBC components, alignment of the syllabus and teacher guide, setting of content standards and grade-level benchmarks, core curriculum, 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 Physical Education 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.

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-centered, 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. 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.

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

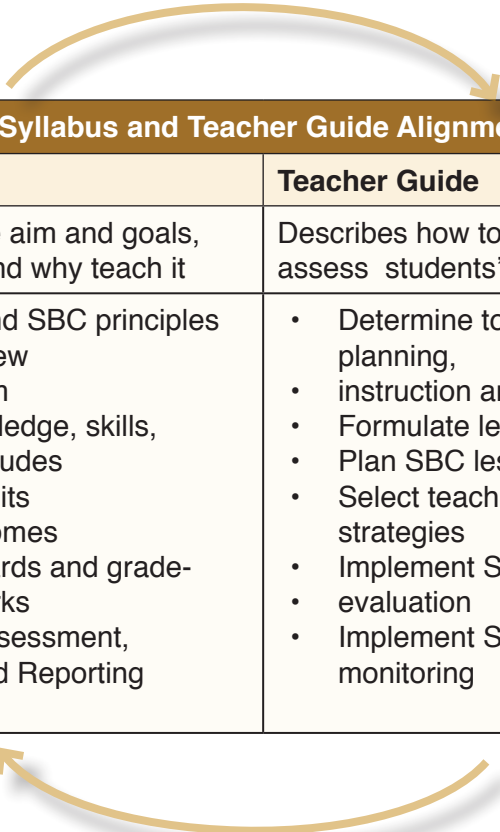
be counterproductive. It will hinder students from achieving the expected proficiency standards and hence, high academic standards and the desired level of education quality. That is, they should not be applied across all contexts and with all students, without considering the educational needs and the characteristics of each context. Teachers must use innovative, creative, culturally relevant, and differentiated or varied the teaching and learning approaches to teach the curriculum to enable their students to achieve the national content standards and grade-level benchmarks. This will enable all students to experience success in learning the curriculum and achieve high academic standards.

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 9 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
<ul style="list-style-type: none"> • Overarching and SBC principles • Content overview • Core curriculum • Essential knowledge, skills, values and attitudes • Strands and units • Evidence outcomes • Content standards and grade-level benchmarks • Overview of assessment, evaluation, and Reporting 	<ul style="list-style-type: none"> • Determine topics for lesson planning, • instruction and assessment • Formulate learning objectives • Plan SBC lesson plans • Select teaching and learning strategies • Implement SBC assessment and evaluation • Implement SBC reporting and monitoring

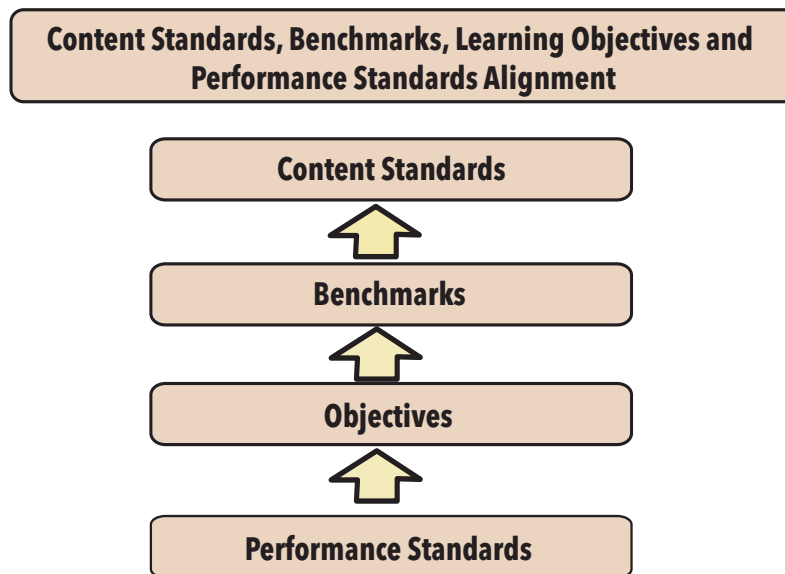
The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what 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 9 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 determine 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 intended 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.

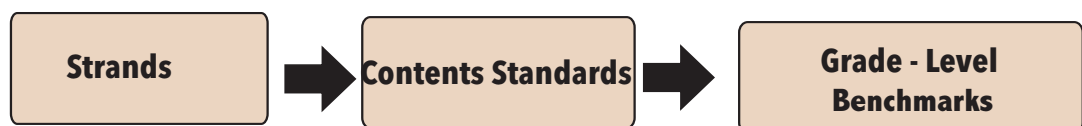
Benchmarks

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

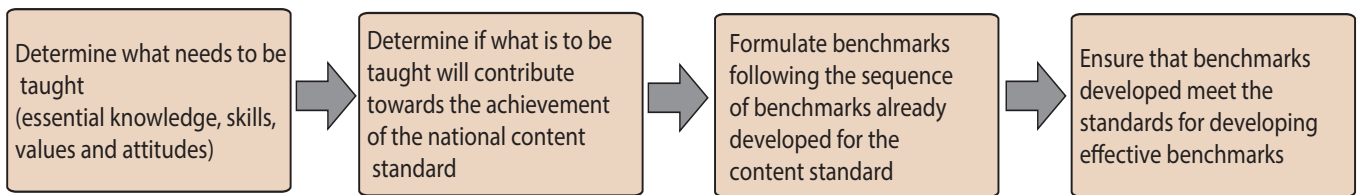


Development of Additional Benchmarks

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

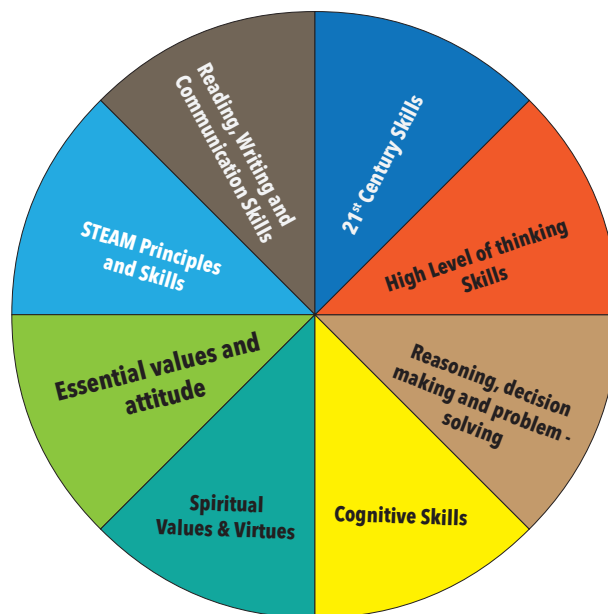
Proficiency standards describe what all students in a particular grade or school level can do” at the end of a strand, or unit. These standards are sometimes called evidence outcomes because they indicate if students can actually apply or use what they have learnt in real life or similar situations. 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 extracurricular programs 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

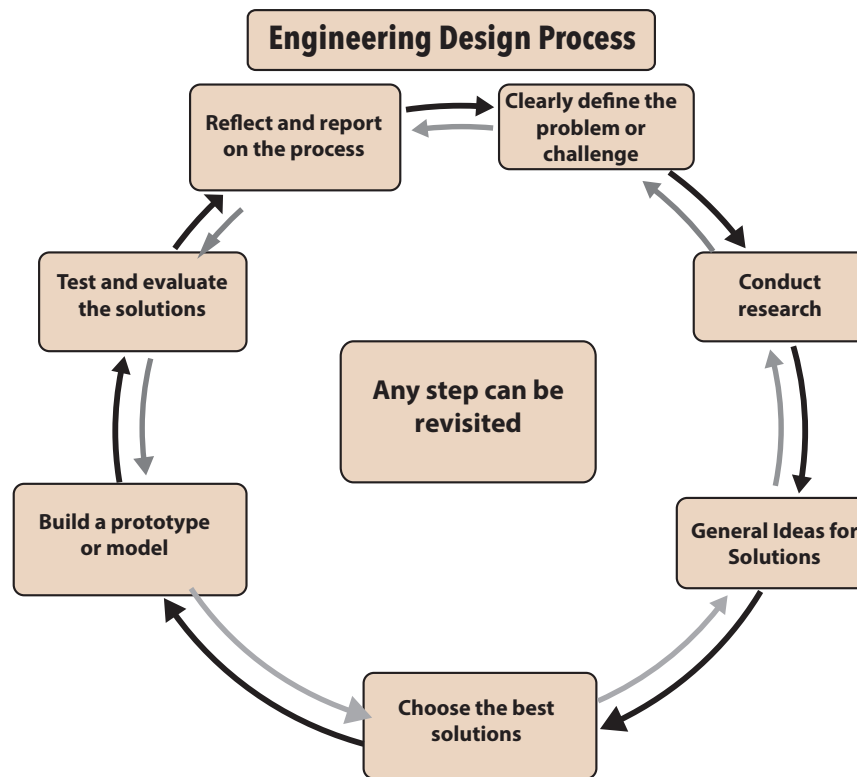
The trial and error method involve trying different approaches until a solution is found. It is often used as a last resort when other methods have been exhausted.

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

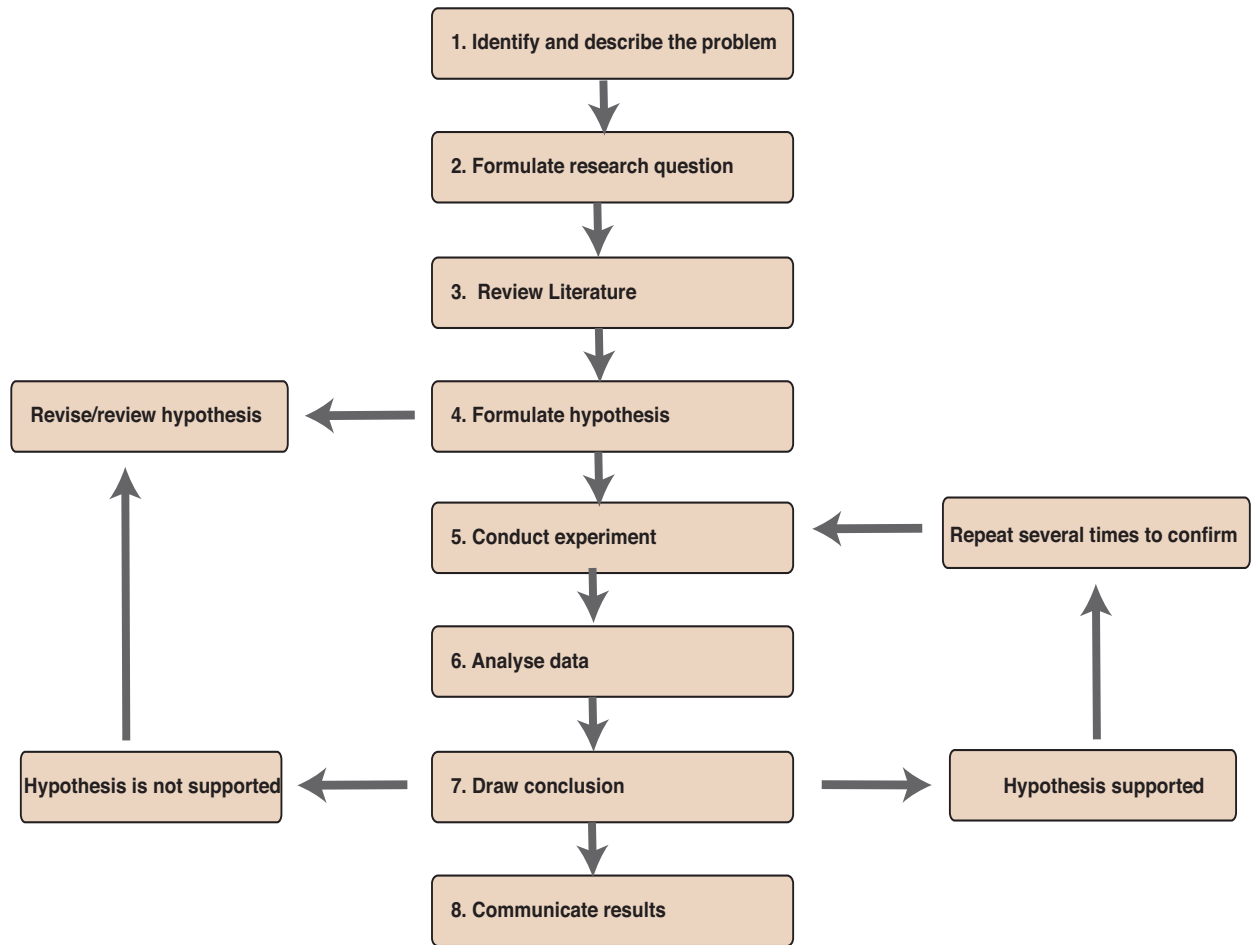
Science uses predominantly the quantitative-scientific inquiry process to investigate, understand, and make informed decisions about problems relating to the natural world. The steps in the process vary, depending on the purpose of the inquiry and the types of questions asked. There are six basic science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

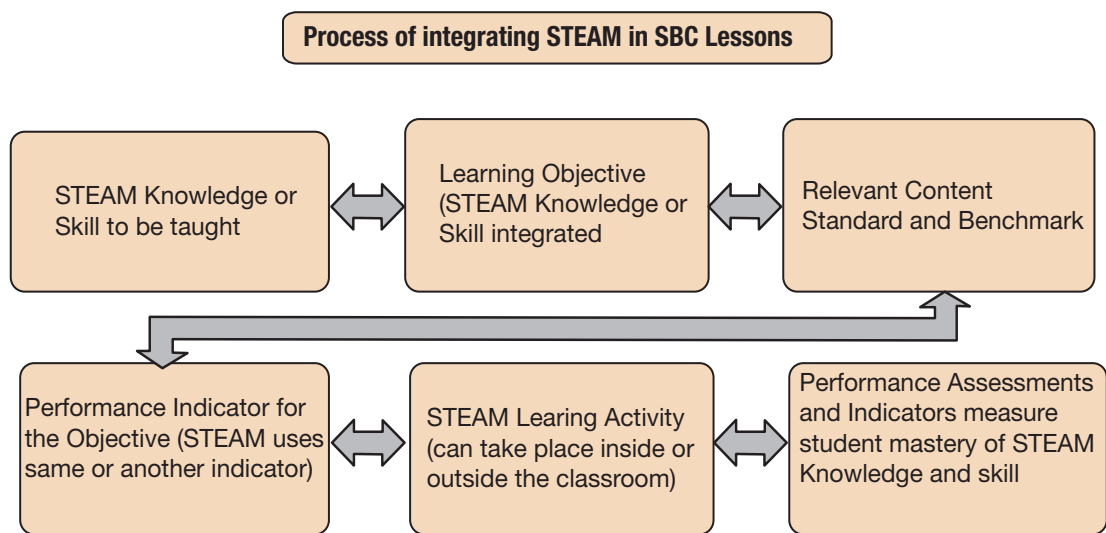
Knowing about how to integrate STEAM problem- solving skills, principles, values and attitudes as well as STEAM teaching, learning, and assessment strategies into standards-based lesson plans is essential for achieving the desired STEAM learning outcomes. When integrating STEAM problem-solving skills 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 inquire 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.

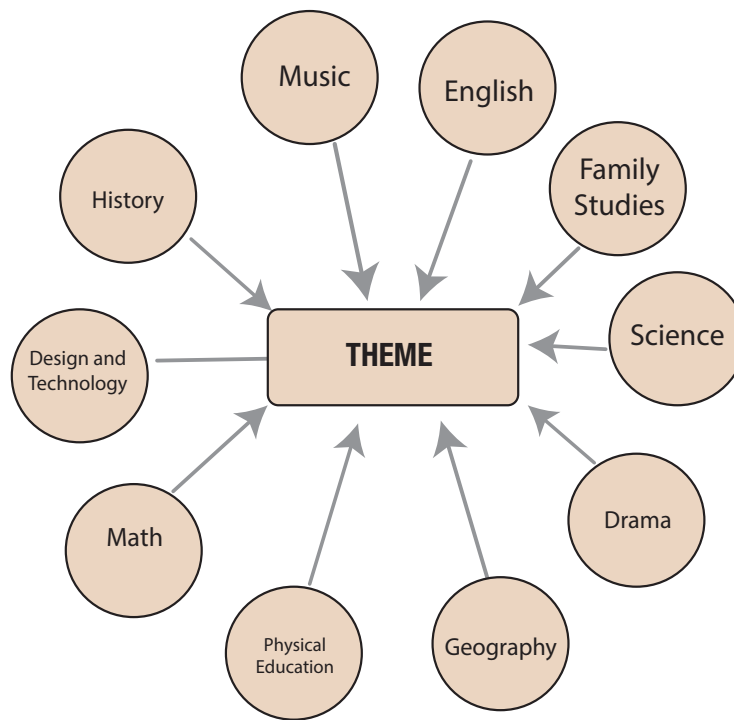
There are three approaches that PNG SBC will engage to foster conducive learning for all its children whereby they all can demonstrate proficiency at any point of exit. Adapting these approaches will have an immense impact on the lives of these children thus they can be able to see themselves as catalyst 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.



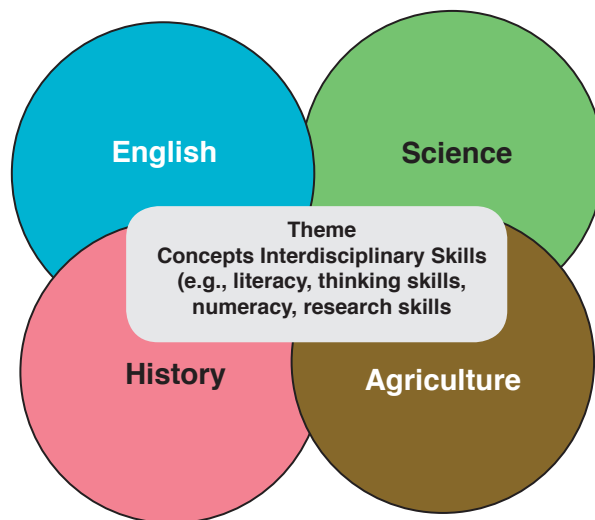
2. Interdisciplinary Approach

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.

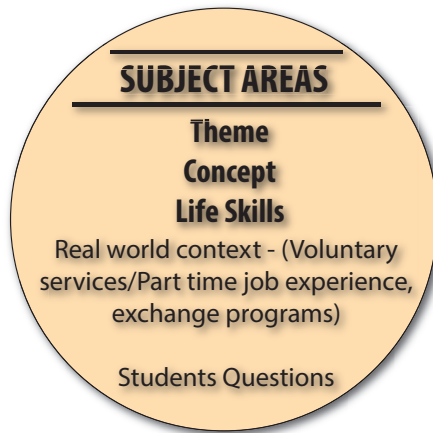
4. Trans disciplinary Approach

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.



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;

- | | |
|--|--|
| <ul style="list-style-type: none"> • Public and private (privileged) knowledge • Specialised knowledge • Good and bad knowledge • Concepts, processes, ideas, skills, values, attitudes • Theory and practice • Fiction and non-fiction • Traditional, modern, and postmodern knowledge | <ul style="list-style-type: none"> • Subject and discipline-based knowledge • Lived experiences • Evidence and assumptions • Ethics and Morales • Belief systems • Facts and opinions • Wisdom • Research evidence and findings • Solutions to problems |
|--|--|

Types of Processes

There are different types of processes. These include;

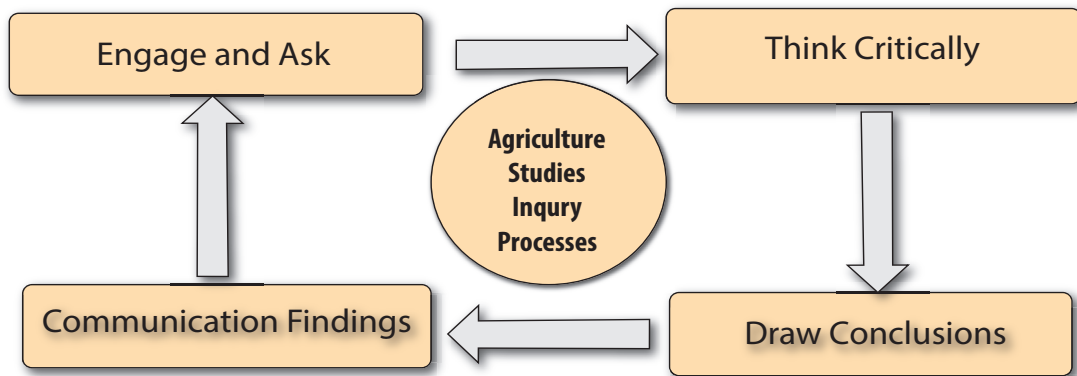
- | | |
|---|--|
| <ul style="list-style-type: none"> • Problem-solving • Logical reasoning • Decision-making • Reflection | <ul style="list-style-type: none"> • Cyclic processes • Mapping (e.g. concept mapping) • Modeling • Simulating |
|---|--|

Inquiry processes include:

- Gathering information
- Analysing information
- Evaluating information
- Making judgements
- Taking actions

Critical Inquiry Processes

<p>Engage and Ask</p>	<p>How will I engage my students in the topic and prompt them to ask questions?</p> <ul style="list-style-type: none"> • Determine the enduring understandings about the topic being studied. • Engage your students with the topic by grabbing their interest with a hook connected to the enduring understandings. • Allow students to generate questions based upon the topic and hook. • Determine what questions will be essential to achieving the enduring understandings. (Student generated or teacher determined) • With students, determine what other information is needed in order to fully answer the questions.
<p>Think Critically</p>	<p>How will students access and analyse information about this topic?</p> <ul style="list-style-type: none"> • Have students think about where they can find answers to the questions posed about the topic. • Gather and organize multiple primary and secondary sources. • Ensure that sources used expose students to different perspectives and viewpoints about the topic. • Students should use sources to collect, analyse, and interpret data. • Ensure students are analysing sources for credibility, bias, and perspective in order to identify gaps in the research.
<p>Draw Conclusion</p>	<p>How will students synthesize ideas to answer the questions posed based on sources used?</p> <ul style="list-style-type: none"> • Students should engage in civic discussion to answer the questions posed while respecting diverse opinions. • Engage students in evaluating possible courses of action and their consequences. • Students should make and justify an informed decision or choice and/or design an action plan supported by evidence from sources. • Have students evaluate the consequences of a decision or choice. • Allow students to make revisions based on feedback and further study.
<p>Communicate Findings</p>	<p>How will students demonstrate what they have learned and take action on that learning?</p> <ul style="list-style-type: none"> • Determine how students will apply what they have learned and share their findings with others. • Explore appropriate audiences for students to present conclusions. • Determine if there is an opportunity for students to take action and influence others to make more informed decisions. • Have students develop strategies to persuade others, including policy makers when applicable. • 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;

- | | |
|---|---|
| <ul style="list-style-type: none"> • Attributing • Comparing and contrasting • Grouping and classifying • Sequencing • Prioritising • Analysing | <ul style="list-style-type: none"> • Detecting bias • Evaluating • Metacognition (Thinking about thinking) • 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;

- | | |
|---|--|
| <ul style="list-style-type: none"> • Generating ideas • Deconstruction and reconstruction • Relating • Making inferences • Predicting • Making generalisations • Visualizing | <ul style="list-style-type: none"> • Synthesising • Making hypothesis • Making analogies • Invention • Transformation • Modeling • 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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Listens, read, write, and speak with comprehension and clarity • Define and apply discipline-based conceptual vocabulary • Describe people, places, and events, and the connections between and among them • Arrange events in chronological sequence • Differentiate fact from opinion • Determine an author’s purpose • Determine and analyse similarities and differences • Analyse cause and effect relationships • Explore complex patterns, interactions and relationships • Differentiate between and among various options | <ul style="list-style-type: none"> • Listens, read, write, and speak with comprehension and clarity • Define and apply discipline-based conceptual vocabulary • Describe people, places, and events, and the connections between and among them • Arrange events in chronological sequence • Differentiate fact from opinion • Determine an author’s purpose • Determine and analyse similarities and differences • Analyse cause and effect relationships • Develop an ability to use and apply abstract principals • 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
<ul style="list-style-type: none"> • Sanctity of life • Truth • Aesthetics • Honesty • Human • Dignity • Rationality • Creativity • Courage • Liberty • Affectivity • Individuality 	<ul style="list-style-type: none"> • Self-esteem • Self-reflection • Self-discipline • Self-cultivation • Principal morality • Self-determination • Openness • Independence • Simplicity • Integrity • Enterprise • Sensitivity • Modesty • Perseverance

2. Social Values

Core values	Sustaining values
<ul style="list-style-type: none"> • Equality • Kindness • Benevolence • Love • Freedom • Common good • Mutuality • Justice • Trust • Interdependence • Sustainability • Betterment of human kind • Empowerment 	<ul style="list-style-type: none"> • Plurality • Due process of law • Democracy • Freedom and liberty • Common will • Patriotism • Tolerance • Gender equity and social inclusion • Equal opportunities • Culture and civilisation • Heritage • Human rights and responsibilities • Rationality • Sense of belonging • Solidarity • Peace and harmony • Safe and peaceful communities

Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
<ul style="list-style-type: none"> • Optimistic • Participatory • Critical • Creative • Appreciative • Empathetic • Caring and concern • Positive • Confident • Cooperative 	<ul style="list-style-type: none"> • Responsible • Adaptable to change • Open-minded • Diligent • With a desire to learn • 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

Strands, Units and Topics

The table below outlines the contents of Grade 9 Agriculture in Strands, Units and suggested Lesson Titles to be taught in an academic year.

Crops	Unit 1: Soil	Soil formation	Soil Composition	
			Types of soil	
	Characteristics of soil	Soil formation process	Physical properties of soil	
			Chemical properties of soil	
	Unit 2: Types of Crops	Types of crops and environments where they are farmed	Types of crops	Environmental requirements of crops
				Characteristics of crops
	Crop Farming practices	Crop Farming practices in different environments	Phenology of different crops	
			Improvement to crop farming systems	Ways of improving crop farming practices
	Crop cultivation and Technology	Crop management systems		
			Technologies used in crop management	Benefits of crop management technologies
	Introduction to Horticulture	Importance of Horticulture Plants		
			Classification of Horticulture Plants	Fruit tree cultivation and processing
	Fruit tree cultivation and processing	Vegetables cultivation and processing		
			Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products
	Vegetables cultivation and processing	Spice Cultivation and processing		
			Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		
			Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products
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	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		
			Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		
Spice Cultivation and processing			Processing, Preserving and Marketing of Plant Products	Cultivation of fruit trees in different environments
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		Fruit tree cultivation techniques
Spice Cultivation and processing			Processing, Preserving and Marketing of Plant Products	Fruit tree planting project
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		Vegetables cultivation techniques
Spice Cultivation and processing			Processing, Preserving and Marketing of Plant Products	How vegetable plants are cultivated in different environments
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		Vegetable garden project
Spice Cultivation and processing			Processing, Preserving and Marketing of Plant Products	Cultivation practices of spice plants in different environments
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		Spice cultivation and processing techniques
Spice Cultivation and processing			Processing, Preserving and Marketing of Plant Products	Spice cultivation project
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		Processing, Preserving and Marketing of Fruit Tree Products
Spice Cultivation and processing			Processing, Preserving and Marketing of Plant Products	Processing, Preserving and Marketing of Vegetable Products
	Spice Cultivation and processing	Processing, Preserving and Marketing of Plant Products		Processing, Preserving and Marketing of Spice Products

Unit 6: Plant Farming Practices and Management Systems	Types of horticulture	Pomology Cultivation Olericulture Cultivation Ornamental plants Arboriculture Cultivation Landscaping horticulture Cultivation
	Horticulture Cultivation and Management Systems	Cultivation practices of pomology and olericulture Processing and preservation methods of pomology and olericulture Marketing, regulation and the use of Pomology and olericulture
	Horticulture Production and processing	Cultivation practices of Ornamental plants Cultivation of Arboriculture and Landscaping horticulture Processing and preservation method Ornamental plants and Arboriculture and Landscaping horticulture Marketing, regulation and Ornamental plants and Arboriculture and Landscaping horticulture.

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 9 Agriculture

Teaching Content

UNITS OF WORK

STRAND 1: CROPS

Content Standard 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 maximize crop production returns in different environments

Units	Benchmarks	Topics	Suggested Lesson Titles
Unit 1: Soil	9.1.1.1. Identify different types of soil and how they are formed	Soil formation	1. Soil Composition 2. Types of soil 3. Soil formation process
	9.1.1.2 Investigate and evaluate the characteristics of different types of soil	Characteristics of soil	1. Physical properties of soil 2. Chemical properties of soil

Content Standard 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 environments and places where they are farmed.

Unit 2: Types of Crops	9.1.2.1 Identify different types of crops and assess the environments where they are farmed	Types of crops and environments where they are farmed	1. Types of crops 2. Environmental requirements of crops
	9.1.2.2 Identify and analyze the characteristics of different crops.	Characteristics of crops	1. Physiology of different crops 2. Phenology of different crops

Content Standard 1.3 Students will be able to investigate and analyze crop farming, processing, marketing, regulation, and management principles, systems and practices used in different contexts, environments and places

Unit 3: Crop Farming Practices and Management Systems	9.1.3.1 Examine and evaluate the effectiveness of crop farming practices use in different contexts and environments	Crop Farming practices	1. Crop farming methods 2. Crop management systems 3. Crop Farming practices in different environments
	9.1.3.2 Research farming practices used in different environments and propose ways of improving these practices.	Improvement to crop farming systems	1. Ways of improving crop farming practices 2. Advantages and disadvantages of improved crop farming practices

Content Standard: 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 analyse their advantages and disadvantages.

Unit 4: Crop Farming and Technology	9.1.4.1 Identify and assess the advantages and disadvantages of technology used for crop cultivation.	Crop cultivation and Technology	1. Technologies used in crop cultivation 2. Advantages of technology used in crop cultivation 3. Disadvantages of technology used in crop cultivation
	9.1.4.2 Examine different types of technology used to manage crops and evaluate their effectiveness.	Technologies used in crop management	1. Crop management technologies 2. Benefits of crop management technologies

Content Standard 1.5 Students will be able to identify and examine the characteristics and physiology of different types of plants, categorise them according to their characteristics, purposes, and benefits, and explore the different context, environments, and places where they are farmed.

Units	Benchmarks	Topics	Lesson Titles	
Unit 5:Types of Plants	9.1.5.1 Identify and examine different types of horticulture plants and evaluate their functions, purposes, and benefits.	Introduction to Horticulture	1. Introduction to Horticulture 2. Types of Horticultural Plants 3. Planning a horticulture project	
		Importance of Horticulture Plants	1. Purpose of horticulture cultivation 2. Benefits of Horticulture Plants	
	9.1.5.2 Research and classify fruit trees, vegetable plants, and spice plants according to their species, functions, purposes, and benefits.	Classification of Horticulture Plants	1. Classification of fruit trees 2. Classification of vegetable plants 3. Classification of Spice Plants 4. Horticulture project(optional)	
		9.1.5.3 Investigate and explain how fruit trees, vegetables, and spices are cultivated and processed in different environments and places.	Fruit tree cultivation and processing	1. Cultivation of fruit trees in different environments 2. Fruit tree cultivation techniques 3. Fruit tree planting project
			Vegetables cultivation and processing	1. Vegetables cultivation techniques 2. How vegetable plants are cultivated in different environments Vegetable garden project
	Spice Cultivation and processing	1. Cultivation practices of spice plants in different environments 2. Spice cultivation and processing techniques 3. Spice cultivation project		
9.1.5.4 Analyze how fruit trees, vegetables and spice products are processed, preserved, and marketed in different contexts and environments.	Processing, Preserving and Marketing of Plant Products	1. Processing, Preserving and Marketing of Fruit Tree Products 2. Processing, Preserving and Marketing of Vegetable Products 3. Processing, Preserving and Marketing of Spice Products		

Content Standard 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.

Units	Benchmarks	Topics	Lesson Titles
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Unit 6: Plant Farming Practices and Management Systems	9.1.6.1 Investigate and explain the differences between Pomology, Olericulture, Ornamental Plants, Arboriculture and Landscaping horticulture.	Types of horticulture	<ol style="list-style-type: none"> 1. Pomology Cultivation 2. Olericulture Cultivation 3. Ornamental plants 4. Arboriculture Cultivation 5. Landscaping horticulture Cultivation
	9.1.6.2 Analyse how to cultivate, process, preserve, market, regulate and use Pomology, Olericulture, Ornamental plants, Arboriculture and Landscaping horticulture.	Horticulture Cultivation and Management Systems	<ol style="list-style-type: none"> 1. Cultivation practices of pomology and olericulture 2. Processing and preservation methods of pomology and olericulture 3. Marketing, regulation and the use of Pomology and olericulture
		Horticulture Production and processing	<ol style="list-style-type: none"> 1. Cultivation practices of Ornamental plants 2. Cultivation of Arboriculture and Landscaping horticulture 3. Processing and preservation method Ornamental plants and Arboriculture and Landscaping horticulture 4. Marketing, regulation and Ornamental plants and Arboriculture and Landscaping horticulture

Content Standard 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.

Units	Benchmarks	Topics	Lesson Titles
Unit 7: Plant Farming and Technology	9.1.7.1 Investigate and explain how technological interventions have improved the cultivation, production, marketing, and regulation of different horticulture plants.	Technology Interventions in Horticulture	<ol style="list-style-type: none"> 1. New and Emerging Technologies in Horticulture cultivation 2. Technology improvements of cultivation and production of horticultural plants 3. Technology improvements in marketing and regulation of horticultural plants
	9.1.7.2 Identify and explain the impact of technology on traditional and modern cultivation and processing of horticulture plant products.	Impact of horticultural technology on plant cultivation and processing	<ol style="list-style-type: none"> 1. Impacts of technology on traditional cultivation and processing of horticultural plant products. 2. Impacts of technology on modern cultivation and processing of horticultural plant products.
	9.1.7.3 Identify and evaluate the advantages and disadvantages of using technology to propagate horticulture plants in order to improve their products.	Benefits horticulture technology in plant propagation	<ol style="list-style-type: none"> 1. Positive and negative effects of horticulture technology on plant propagation. 2. Hydroponics farming 3. Genetic engineering 4. Advantages and disadvantages of horticulture technology on plant products

STRAND 1: UNIT 1: CROPS

Content Standard 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: 9.1.1.1. Identify different types of soil and explain how they are formed.

Topic: Soil Formation

Learning Objectives:

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

- Describe the different types of soil and how it is formed.
- Identify and describe the different components of soil.

Essential Questions

1. How is soil formed?
2. What are the components of soil?
3. What are the different types of soil?

Essential Knowledge, Skills, Attitudes and Values	
Knowledge	<ul style="list-style-type: none"> • Types of soil, • Components of soil, • Processes involved in soil formation.
Skills	<ul style="list-style-type: none"> • Describe different types of soil, explain how soil is formed, identify and describe components of soil.
Attitudes	<ul style="list-style-type: none"> • Appreciate types of soil, its components and the processes involved in its formation.
Values	<ul style="list-style-type: none"> • Value the different types of soil, its components and the processes involved in soil formation.
Assessment tasks	<ul style="list-style-type: none"> • Describe different soil components and how they are formed

Content Background:

There are many different soils in the world. All soils are different because of where and how they are formed. Basically soil is formed by the weathering or breakdown of rock on the upper layers of the solid mass of earth. And this very rock is called the **Parental material**. There are other factors that play a part in how a soil forms. They interact to form different types of soils. These five factors are:

1. Living organisms
2. Climate
3. Type of parental material that
4. Time that the parental material undergoes weathering
5. Topography

Soils are formed when inorganic matter (minerals) and organic matter breaks down into small particles during a weathering process. Weathering can be mechanical, chemical or biological process.

Below are different weathering agents that interacts together to form soil

1. **Moving water** – the streams and rivers, water moves stones about, rubbing them together. Small particles break off and they may eventually become part of the mineral or inorganic particles of the soil
2. **Heat and Cold** – make rocks expand and contract. If they have weak places, they will crack and break up.
3. **Wind** – in desert areas sometimes wears rocks by blowing sand against them.
4. **Carbon dioxide** – in the air forms weak carbonic acid. This can dissolve limestone and chalk rocks. The activities of plants and animals contribute to the formation of soil by adding organic materials.

Physical Composition of the Soil

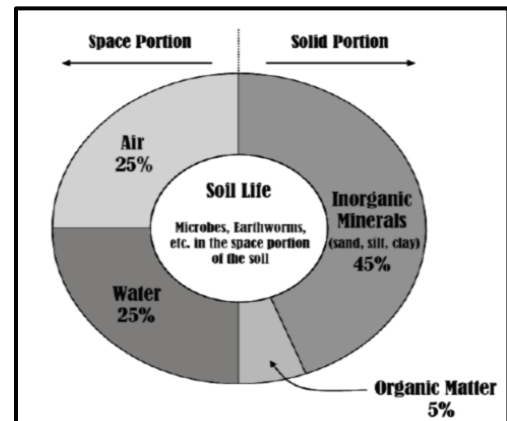
Soil is made up of four main parts:

Water (25% by volume)

Air (25% by volume)

Organic matter (5% by volume)

Mineral matter (45% by volume)



Reference/Sources

Ossom, E, Robertson, B, (2009) Agriculture in Melanesia Grade 9 Student's Book

Benchmark: 9.1.1.2. Investigate and evaluate the characteristics of different types of soil.

Topic:

Learning Objectives:

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

- Identify and describe the physical and chemical characteristics of soil.
- Classify soils based on their physical and chemical characteristics
- Examine and explain characteristics of cultivatable soils

Essential Questions

1. What are the physical properties of soil?
2. What are the chemical properties of soil?

Essential Knowledge, Skills, Attitudes and Values	
Knowledge	Physical and chemical properties of soil.
Skills	Identify and describe the physical and chemical properties of soil.
Attitudes	Appreciate the characteristics of soil. Eager to learn about the characteristics of the soil.
Values	Value the importance of the characteristics of soil.
Assessment Tasks	Classify and describe physical and chemical properties of soil

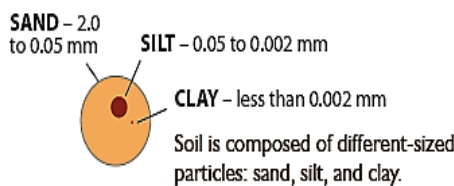
Topic:

**Content Background
Characteristics of soil**

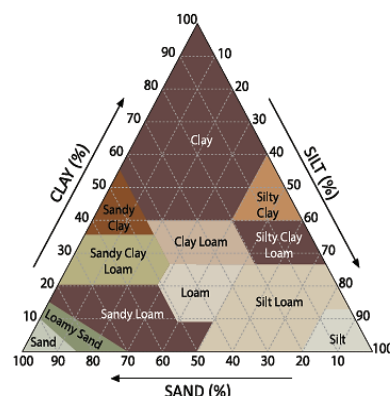
Physical Properties - These are the aspects of the soil that can be seen and touched. This includes the soil texture, soil colour, soil structure, porosity (spaces between particles).

Soil Texture

Soil is made up particles. These particles are categorized into three groups by size: sand, silt and clay. Sand particles are the largest and clay particles are the smallest. Most soils are a combination of the three. The relative percentages of sand, silt and clay are what give soil its texture. A soil triangle can be used to classify different proportions of sand, silt, and clay



Source: [https://www. Soils4teachers.org/physical properties](https://www.Soils4teachers.org/physical-properties)



soil texture triangle helps to identify the soil type. Source A: <https://www. Soil->

Soil Structure

This is the solid category of soil, which consists of individual particles (sand, silt, clay and organic matter) can cement together to form aggregates (also referred to as peds).

Aggregates are groups of soil particles held together by organic matter or chemical forces. **Pores** are the spaces in the soil.

Below are illustrations of how soil aggregates to form its characteristics 'structure'

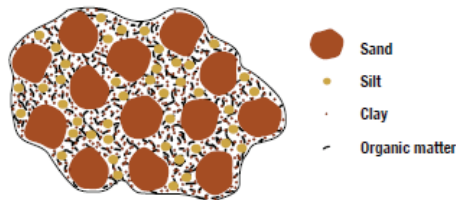


Fig a. Soil aggregates, Source: Abstracted from Baxter, N.M. Know Your Soils- Part 1: Introduction to Soil (1968) pp.07 (fig a& b)

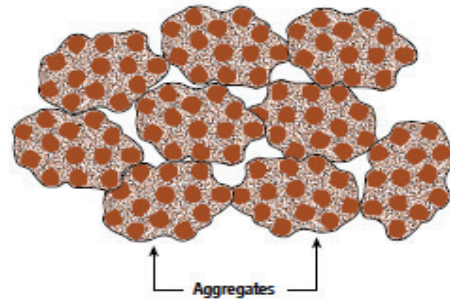
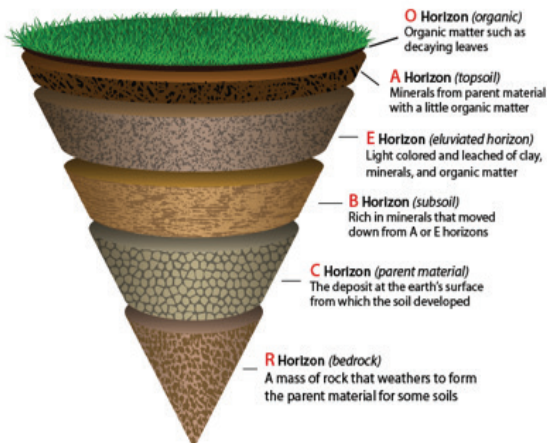


Fig b. Aggregates joined together to give the soil its characteristics 'structure'

Soil Colour

Soil colours are related to chemical properties, aeration or drainage, and organic matter. Soil colour is an important characteristic of the soil as it can provide an indication of the soil's drainage characteristics. Soil colour may also help you determine the different horizons of the soil.



Soil Profile

There are different types of soil, each with its own set of characteristics. Dig down deep into any soil, and you'll see that it is made of layers, or horizons (O, A, E, B, C, R). Put the horizons together, and they form a soil profile. Like a biography, each profile tells a story about the life of a soil. Most soils have three major horizons (A, B, C) and some have an organic horizon (O).

Soil Porosity – This refers to the spaces or pores within and between aggregates. It can be either filled with air or water. The number, size and shape of the pores determine the amount and rate at which water and air can move into and through the soil, and also the amount of water held in the soil. Pores can be divided into two main classes based on the diameter.

Chemical Properties: The chemical properties of the soil affect the ability of the soil to supply plant food (nutrients). They may affect the activity of organisms living in the soil. For example, soil may lose so many nutrients that it becomes lateritic and barren. Lateritic soils contain so much aluminum and iron that they kill plants. Even weeds find it hard to grow.

Reference/Sources

Ossom, E, Robertson, B, (2009) Agriculture in Melanesia Grade 9 Student's Book

Baxter, N.M. Know Your Soils- Part 1: Introduction to Soil (1968), Mulqueens Publishers, Australia

Unit 2: Types of Crops

Content Standard 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 environments and places where they are farmed.

Benchmark: 9.1.2.1. Identify different types of crops and assess the environments where they are farmed.

Topic: Types of Crops and Environments where they are farmed

Learning Objectives:

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

- Identify different types of crops.
- Examine the environmental requirements of different crops.

Essential Questions

1. What are the different types of crops?
2. What are some essential requirements needed by a specific crop to grow in an environment?

Essential Knowledge, Skills, Attitudes and Values	
Knowledge	<ul style="list-style-type: none"> • Different types of crops, environmental requirements of specific type of crops.
Skills	<ul style="list-style-type: none"> • Identify types of crops • Examine the crop's environmental requirements.
Attitudes	<ul style="list-style-type: none"> • Appreciate different types of crops and their respective environments.
Values	<ul style="list-style-type: none"> • Value how different crops are farmed in different environments.
Assessment Task	<ul style="list-style-type: none"> • Classify crops according to the different environments which they are farmed

Content Background:

By use, crops fall under six categories; Food crops, Feed crops, Fibre crops, Oil crops, Ornamental crops, and Industrial crops.

Food crops – for human needs (e.g. wheat, maize, legumes, rice, potatoes, and tomatoes).

Feed crops – for cattle or livestock consumption (e.g. barley, beets, grasses for domestic animals to graze and store as hay or silage).

Fiber crops – for the sake of fibers used in clothes, bedding, industry, and household (hemp, cotton, flax, bamboo).

Oil crops – for oil manufacturing either for machinery fuel (rape) or food industry (sunflower, olives).

Ornamental crops – for home decoration and landscape design (garden or pot flowers and bushes).

Industrial crops – for industrial manufacturing (rubber).

Benchmark: 9.1.2.2. Identify and analyse the characteristics of different crops.

Topic: Characteristics of different crops

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of the topic students will be able to: <ul style="list-style-type: none"> Identify and describe the characteristics of different crops Compare and distinguish a variety of subsistence and commodity crops Examine and categorize crops according to their physical characteristics
Essential Questions	<ol style="list-style-type: none"> What are some characteristics of crops? How does environment affect the characteristics of crops
Knowledge	Describing different characteristics of crops
Skills	Identifying and examining of different characteristics of crops.
Attitudes	Appreciate the different characteristics of crops.
Values	Value the different characteristics of crops.
Assessment Task	Describe the characteristics of different crops and categorise them according to their physical characteristics

Content Background:

Crop plants are characterised and classified into multiple ways that are relevant for crop production and management. They can be further classified as either cool season or warm season, depending on the range of temperatures that are optimum for their growth. Other common features include similar morphology, growth and reproduction and environmental and climatic adaptations.

By life span: Different crops are classified by the number of growing seasons required to complete their life cycle. Generally, these groups are annuals, biennials, and perennials.

Annuals will provide continuous blooms throughout the growing season, while biennials provide blooms during their second year of growth. Perennials will bloom for 2 to 8 weeks or longer, however, bloom time will vary and can occur during the beginning, middle, or end of the growing season.

By temperature requirements: Cool-season crop-prefers cool temperatures (peas, lettuce, Cole crops) Warm-season crop-prefers warm temperatures (tomato, pepper)



Annuals will provide continuous blooms throughout the growing season.

Source: <https://extension.psu.edu/plant-life>

Herbaceous perennials have top growth that completely dies back to the ground during winter; however, roots and crowns remain alive. **Source:** <https://extension.psu.edu/plant-life-cycles>

Unit 3: Crop Farming Practices and Management Systems

Content Standard 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.

Benchmark: 9.1.3.1. Examine and evaluate the effectiveness of crop farming practices used in different contexts and environments.

Topic: Crop Farming Practices

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> Identify and describe types of crop farming practices used in different contexts. Analyse different crop farming practices in different environments.
Essential Questions	<ol style="list-style-type: none"> What are crop growing practices? What are types of crop farming practices? What farming practices are needed for crop production management? What are sustainable agriculture practices?
Knowledge	Types of crop farming practices/methods in different contexts and environments
Skills	Identifying and analyzing of crop farming practices.
Attitudes	Being cooperative in analyzing types of crop farming practices
Values	Value different types of crop farming practices.
Assessment task	Describe types of crop farming practices used in different environments

Content Background:

Crop Farmers work the land to produce high quality and high yielding vegetables, fruits, grains, cotton, nuts, sod, sugar cane, flowers and other necessities that grow from the earth. They must ensure that their fields are well maintained and the soil and plants are healthy. Crop farmers also make plans for crop rotation to make sure that the nutrients in the soil are sufficient to grow appropriate materials. Several farming methods which are practiced worldwide,:

What are crop growing practices?

Crop production involves managing the crop and the soil. **Crop** management includes making decisions on **planting date**, **plant** population, irrigation, and the use of plant growth regulators for managing canopy size and preparing the crop for harvest.

Types of Farming Practiced Across the World

- **Arable Farming:** Arable farming involves growing of crops only in warm climate.
- **Pastoral Farming:** Pastoral farming (also known in some regions as livestock farming or grazing) is farming aimed at producing livestock, rather than growing crops. Examples include dairy farming, raising beef cattle, and raising sheep for wool. In contrast, mixed farming is growing of both crops and livestock on the same farm.
- **Subsistence Farming:** Characterized by farmers having small and scattered land areas, most farmers practicing this method are poor who never use:
- **Mixed farming:** is a type of farming which involves both the growing of crops and the raising of livestock
- **Commercial Farming:** Commercial Farming: farming for a profit, where food is produced by advanced technological means for sale in the market. Often very few workers are employed. (See Subsistence
- Intensive farming is a type of agriculture, arable farming and animal husbandry, with a higher level of input and production per square unit of agricultural land area.
- **Extensive agriculture** is a farming system that uses a small amount of labour and capital relative to the area under cultivation.
- **Nomadic Farming:** Nomadic pastoralism is a form of pastoralism when livestock are herded in order to find fresh pastures on which to graze. True nomads follow an irregular pattern of movement, in contrast with transhumance where seasonal pastures are fixed.
- **Sedentary Farming:** Agriculture as practiced in one place by a settled farmer in which fields are not rotated is called sedentary agriculture. The term was used for primitive agriculturists in tropical Africa who farmed the same piece of land indefinitely in contrast to shifting cultivation.

What farming practices are needed for crop production management?

These include planting method, watering, fertilizing, weeding, and other maintenance measures which farmers can also record into Argive system, into tasks. Every usage of water, fertilizer, pesticide or some other material farmer can record per field, crop and a season.

Sustainable and eco-friendly farming practices

- Permaculture. Permaculture is a food production system which mimics how vegetables and plants grow in natural ecosystems.
- Aquaponics & Hydroponics.
- Using Renewable Energy Resources.
- Crop Rotation & Polycultures.
- Trees Can Increase Crop Yields.
- Wrapping It Up.

References/Sources

<https://www.open.edu.au/your-career/agriculture-forestry-fishing/crop-farmer>

<http://www.farmingsolutions.org/different-farming-methods-you-should-know/>

Benchmark: 9.1.3.2. Research farming practices used in different environments and propose ways of improving these practices

Topic: Crop Farming Improvement Practices

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Identify and discuss improved farming practices • Classify farming practices accordingly • Describe ways of improving crop farming systems practices in different environments.
Essential Questions	<ol style="list-style-type: none"> 1. What are the two ways to increase farm production? 2. What are the three different ways of increasing production on the same piece of land? 3. What is sustainable farming practices? 4. What are poor agricultural practices?
Knowledge	<ul style="list-style-type: none"> • Identifying ways of improving crop farming practices. • Suggest benefits of improved crop farming practices
Skills	<ul style="list-style-type: none"> • Discuss improved crop farming practices and its benefits.
Attitudes	<ul style="list-style-type: none"> • Appreciate the importance of improving crop farming systems.
Values	<ul style="list-style-type: none"> • Value the benefits of improved crop farming systems.
Assessment task	<ul style="list-style-type: none"> • Describe ways of improving crop farming systems and practices in different environments

Content Background:

There are various ways of improving crop farming practices to increase agricultural productivity. Below are examples of some ways to improve crop farming systems;

1. Transport facilities
2. Irrigation Facilities
3. Proper Marketing Facilities
4. Supply of Quality Inputs
5. Agricultural Education

What are the two ways to increase farm production?

Multiple cropping and use of modern farming methods are two different ways of increasing production on the same piece of land. e.g., (i) Multiple Cropping When more than one crop is grown on a piece of land during the year it is known as multiple cropping.

What are the three different ways of increasing production on the same piece of land?

- (i) Multiple cropping can be done.
- (ii) In Palampur farmers grow jowar and bajra during rainy (Kharif) season.
- (iii) They grow potato between October and December.

- (iv) During winter, they grow wheat.
- (v) It is possible due to the self-developed system of irrigation.

What are poor agricultural practices?

The increased use of chemicals, as fertilizer and pesticide, has disturbed the natural composition of nutrients in the soil. Poor agricultural practices are reducing soil porosity, increasing soil salinity and alkalinity, disturbing the natural composition of nutrients in the soil.

What is sustainable farming practices?

Sustainable agriculture is farming in sustainable ways, which means meeting society's present food and textile needs, without compromising the ability for current or future generations to meet their needs. It can be based on an understanding of ecosystem services.

References/Sources

<https://www.economicdiscussion.net/agriculture/productivity/how-to-increase-agricultural-productivity>

Unit 4: Crop Farming and Technology

Content Standard 1.4. Students will be able to examine how technology is used in the cultivation, regulation, and management of crops in different societies and environment, and analyse their advantages and disadvantages.

Benchmark: 9.1.4.1. Identify and assess the advantages and disadvantages of technology used for crop cultivation.

Topic: Crop Cultivation and Technology

1. What are the advantages of technology in crop cultivation?
2. What are the disadvantages of technology in crop cultivation?

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Identify and examine the advantages of crop cultivation and technology. • Identify and examine the disadvantages of crop cultivation and technology.
Essential Questions	<ol style="list-style-type: none"> 1. Identifying advantages of technology in crop cultivation 2. Identifying disadvantages of technology in crop cultivation 3. Examining the advantages and disadvantages of technology in crop cultivation.
Knowledge	<ul style="list-style-type: none"> • Be informed of the advantages and disadvantages of technology used for crop cultivation
Skills	<ul style="list-style-type: none"> • Identifying and examining advantages and disadvantages of technology in crop cultivation.
Attitudes	<ul style="list-style-type: none"> • Wise consumers and decision makers
Values	<ul style="list-style-type: none"> • Proactive and creative thinkers in dealing with challenges
Assessment task	<ul style="list-style-type: none"> • Describe the advantages and disadvantages of crop cultivation technology

Content Background:

Advantages of Technology in Crop cultivation:

- Modern machines can control the efforts of farmers.
- They reduce the time.
- Used supply water to the crops.
- While Machines are useful in sowing the seeds.
- they are used in the transportation.
- Irrigational technology.
- Application of synthetic fertilizers.
- Chemical pest control.
- They increase the price and demand of the products.
- Better marketing and exposure to the price.
- Facilities in online trading and E-Commerce.

- Further, improve the fertility of the soil.
- Decrease the use of water, Fertilizers which keeps the prices down.
- Low run of chemicals and also waste materials into seas and water.
- Reduce impact on the ecosystem.
- Suitable for the campus environment.

Disadvantages of Technology in crop cultivation:

- The excessive use of chemicals by the help of machines reduces the fertility of the land.
- Lack of practical knowledge the farmers can't handle the machines properly.
- While the cost of maintenance is very high.
- Overuse of machines may lead to environmental damage.
- It is efficient but has many side effects and drawbacks.
- Furthermore, Driverless agriculture machine is a liability to access the technology.
- Improve the scouting programs.
- The robotic machine could not change their culture; we have to set their program manually.
- Most of the farmers are illiterates so they are unable to use the modern



Picture 1: Before Technology



Picture 2: After Technology



Irrigation of crops; Technology has helped a lot in farming.

Source: <https://iowaagliteracy.wordpress.com/ways-technology-has-changed-farming>

Source: <https://www.quora.com/What-are-the-advantages-of-technology-in-agriculture>

Benchmark: 9.1.4.2 Examine different types of technology used to manage crops and evaluate their effectiveness.

Topic: Technologies used in Crop Management

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Describe different types of technologies used in crop management. • Analyse the benefits of technology in crop management.
Essential Questions	1. What are the different technologies used in crop management? 2. Explain the benefits of crop managements
Knowledge	<ul style="list-style-type: none"> • Describe types of technologies used in managing crops. • Benefits of technology in crop management.
Skills	<ul style="list-style-type: none"> • Examine and describe types of technology used in crop management • Compare the advantages and disadvantages of using crop farming ecologies • Identify and discuss the benefits of technologies used in crop management
Attitudes	<ul style="list-style-type: none"> • Critical thinkers
Values	<ul style="list-style-type: none"> • Creative thinkers and decision makers
Assessment task	<ul style="list-style-type: none"> • Describe different types of technologies used in crop management

Content Background:

Using Technology to improve Crop Management

Throughout all segments of agriculture, farmers are finding the key to management today and preparing for tomorrow involves the use of technology. This prompted farmers and plantation managers increasingly using information technology to help them improve their decision making capabilities, particularly when trying to manage the inherent variability found within the crop environment.

Precision Farming is a systems approach to managing crops and land selectively, according to their needs. It utilizes expertise from many disciplines and integrates the latest information technology tools and techniques to enable farm managers to get a better understanding and control of their fields. Management is the essential factor to achieve a stated outcome for the farm

Reference/Sources

<https://www.agriculture.com/technology/crop-management/using-technology-to-improve-crop-management>

https://www.researchgate.net/publication/228988522_Using_information_technology_to_improve_crop_management/link

Unit 5: Types of Plants

Content Standard 1.5 Students will be able to identify and examine the characteristics and physiology of different types of plants, categorise them according to their characteristics, purposes, and benefits, and explore the different contexts, environments and places where they are farmed.

Benchmark 9.1.5.1 Identify and examine different types of horticulture plants and evaluate their functions, purposes, and benefits.

Topic 1: Introduction to Horticulture

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Explain and understand what is horticulture and the types of horticultural plants. • Explain the functions, purposes and benefits of horticultural plants.
Essential Questions	<ol style="list-style-type: none"> 1. What is horticulture? 2. What are types of horticultural plants? 3. What are functions, purposes and benefits of horticultural plants?
Knowledge	<ul style="list-style-type: none"> • Types of horticultural plants • Functions, purposes, and benefits of horticultural plants
Skills	<ul style="list-style-type: none"> • Explain and categorize horticulture and the types of horticulture
Attitudes	<ul style="list-style-type: none"> • Appreciate horticulture and types of horticulture
Values	<ul style="list-style-type: none"> • Value the Functions, purposes, and benefits of horticultural plants
Assessment task	<ul style="list-style-type: none"> • Explain the functions, purposes and benefits of horticultural plants

Content Background:

Horticulture is a branch of plant agriculture that deals with garden crops, fruits, vegetables and ornamental plants. Horticultural plants need their seeds to be planted in seedbed and are looked after for some weeks before transplanted on to the field. When planting horticultural crops irrigation and nursery are important, crops cannot be successfully produced where there is insufficient water. Types of plants

1. Fruit trees- a fruit tree is a tree which bears fruits that is consumed by humans and animals.
2. Vegetables – vegetables are part of plants that are consumed by humans or other animals as food or any part of the plant that includes the flower, fruit, stem and leaf which is edible
3. Spices - A spice is seed, fruit, root, bark or other plant substance primarily used for flavoring, coloring or preserving food.

The major areas of horticulture include:

- Arboriculture is the study of and the selection, plant, care and removal of, individual trees, shrubs, vines and other perennial wood plants.
- Floriculture includes the production and marketing of floral crops. The study of flower cultivation.
- Landscape horticulture includes the production, marketing and maintenance of landscape plants.
- Olericulture includes the production and marketing of vegetables.
- Pomology includes the production, processing and marketing of fruits or cultivation of fruits.
- Viticulture includes the production and marketing of grapes.
- Oenology includes all aspects of wine and winemaking.
- Postharvest physiology involves the maintaining the quality of and preventing the spoilage of plants and animals.

References/Sources

1. En.m.wikipedia.org
2. <https://horticulture.ucdavis.edu>

Benchmark: 9.5.1.2 Research and classify fruit trees, vegetable plants, and spice plants according to their species, functions, purposes, and benefits.

Topic 1: Classification of Horticulture Plants

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic, students will be able <ul style="list-style-type: none"> • Investigate and explain the factors that determine the category fruit trees fall under • Distinguish between the different fruits, vegetables, and spices • Compare and classify fruits and vegetables, spices according to their distinguishing characteristics
Essential Questions:	<ol style="list-style-type: none"> 1. How are fruit trees classified? 2. How are vegetable plants classified? 3. How are spice plants classified?
Knowledge	<ul style="list-style-type: none"> • Classification of fruit trees, vegetable plants and spice plants.
Skills	<ul style="list-style-type: none"> • Compare and categorize fruit trees, vegetable plants, and spice plants respectively.
Attitudes	<ul style="list-style-type: none"> • Appreciate classification of fruit trees, vegetable plants and spice plants.
Values	<ul style="list-style-type: none"> • Value the classification of fruit trees, vegetable plants, and spice plants.

Content Background:

Fruit Trees: Fruit Trees may be classified by several determining factors such as genus and family, tree size, fruit development and growth habits.

Vegetable Plants: Vegetables are classified according to which part of the plant is eaten. Some vegetables fit into more than one category when several different parts of the plant are edible, e.g. both the roots and the leaves of beetroot can be eaten.

Spice Plants: Spices can be classified depending on the parts of the plant that are to be used. Different plant parts like leaf, root, bulb, fruit, seed, etc. are used as spice.

Spices are primarily used as food flavouring and also used to perfume cosmetics and incense.

References/Sources

www.gardenguides.com

www.vegetables.co.nz

Benchmark 9.1.5.3 Investigate and explain how fruit trees, vegetables, and spices are cultivated and processed in different environments and places.

Topic 1: Cultivation of Plants in Different Environments

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic, students will be able to <ul style="list-style-type: none"> • Describe how fruit trees are cultivated and processed. • Describe how vegetables are cultivated and processed. • Describe how spices are cultivated and processed.
Essential Questions	<ol style="list-style-type: none"> 1. How are fruit trees cultivated and processed in different environments? 2. How are vegetables cultivated and processed in different environments? 3. How are spices cultivated and processed in different environments?
Knowledge	<ul style="list-style-type: none"> • Cultivation and processing of fruit trees, vegetables and spices.
Skills	<ul style="list-style-type: none"> • Explain cultivation of fruit trees, vegetables, and spices • Explain processing of fruit trees, vegetables, and spices
Attitudes	<ul style="list-style-type: none"> • Appreciate how fruit trees, vegetables, and spices are cultivated and processed.
Values	<ul style="list-style-type: none"> • Value the types of cultivation and processing of fruit trees, vegetables and spices.

Content Background:

Fruit tress cultivation

1. Site selection

Select a site that receives full sun light. Fruit trees require 6 – 8 hours of sunlight in a day. Avoid planting at sites shaded by large trees.

2. Land preparation

Land preparation depends on the type of crop. The purpose of land preparation is to provide necessary soil conditions which will make it easier for plants to grow. The land must be ploughed and harrowed depending on the area of the land

3. Common and introduced varieties

When panting fruit trees it is important to know the varieties of fruit trees. Different varieties have different requirements of growing. The introduced varieties have high yield then the common fruit tree.

4. Agronomic requirements

This requires knowledge on growing cycle, environmental requirements, soil condition and the types of nutrients available in the soil.

5. Nursery requirements

the types of nursery can be made depends on the type of tree crop. Most fruit trees use poly bag nursery before being planted on to the field.

6. Plant spacing

Different fruit trees have different plant spacing. Proper spacing prevents plants from competing with nutrients and water. The spacing is used by using the distance between rows and distance between plants.

7. Management practices

Management practices are practices carried out from nursery to harvesting of crop, this includes weeding, watering, fertilizer application and pest and diseases management.

8. Harvesting packing and marketing

the proper time to remove fruit is governed by whether the product will be sold and consumed within hours, or stored for weeks months or even a year. Most fruits are harvest as close as possible to the time they are eaten.

Vegetable Processing

1. Land preparation – land preparation depends on the type of crop. The soil must be well drain loamy soil. the land should be plough and incorporated with some manure or compost.
Nursery – there are different types of nurseries that are used to nursed seeds. Seedbeds, seed trays and polybag.
2. Spacing –the distance between plants and distance between rows.
3. Transplanting – transferring of crops from the nursery to the main food garden
4. Management practices –this includes watering, weeding, staking, fertilizer application and disease and pest control.
5. Harvesting – depends on the maturity of the crop.

Vegetable Processing

Processed vegetables include canned, frozen, dehydrated pickled products. Vegetables for canning and freezing usually include small size, high quality and uniformity. most vegetables have different maturity date which is re-quired for constant supply of raw material. The processed vegetable should have a taste, odour and appearance comparable to the fresh product and retain its nutritive value.

CULTIVATION OF SPICES

1. Land preparation
the soil must be well drained sandy or loamy with the pH of 6.5-8 . the land selected must be cleared.
2. Plant propagation
Seed propagation is mostly common with all spices.
3. Management practices
This includes watering, weeding, staking, fertilizer application and dis-ease and pest control.
4. Harvesting
Tools for harvesting can include hand pruners, a sharp knife or scissor and hands for pinching leaves, seeds or fruits.

Processing spices – the following are some processing techniques used.

1. Drying
2. Grading
3. Grinding



Sources

<https://www.britanica.com>
<https://homeguides.sfgate.com>
<En.howtopedia.org>
www.senecah.org

Benchmark 9.1.5.4 Analyse how fruit trees, vegetables and spice products are processed, preserved, and marketed in different contexts and environments.

Topic 1: Processing, Preserving and Marketing of Plant Products

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic, students will be able to <ul style="list-style-type: none"> • Explore and describe how fruit trees are processed, preserved and marketed. • Identify and explain how vegetables are processed, preserved and marketed. • Describe and outline how spice products are processed, preserved and marketed.
Essential Questions:	<ol style="list-style-type: none"> 1. What is the difference between processing and preserving? 2. How are fruit trees processed, preserved and marketed? 3. How are vegetables processed, preserved and marketed? 4. How are spices products processed, preserved and marketed?
Knowledge	<ul style="list-style-type: none"> • Processing, preserving and marketing of fruits trees, vegetable and spice plant products
Skills	<ul style="list-style-type: none"> • Explain how vegetables, fruits and spices plants are processed and preserved
Attitudes	<ul style="list-style-type: none"> • Appreciate the processing, preserving and marketing of fruits trees vegetables and spice products.
Values	<ul style="list-style-type: none"> • Care for plant products • Critical thinkers and decision makers • Sustainability of plants products

Content Background:

To process and preserve fresh produce successfully, the spoilage agents must be destroyed without ruining the nutritional value or palatability of produce itself. Unfortunately fruit, vegetables and root crops are the only natural source of the essential vitamin C in our food. This vitamin is easily destroyed especially where processing makes use of heat. In order to retain the maximum amount of vitamin C in processed food, it:

- Should be used when freshly harvested
- Must not be subjected to long soaking or washing
- Must be processed immediately after preparation
- Should not be treated in copper, iron or chipped pans.

The best methods for small scale processing are

- **Drying:** The aim in drying is to reduce the water content of the produce to level insufficient for enzyme activity. Produce can be dried using solar or artificial heat.
- **Processing using chemicals:** Chemicals used in processing include; preserving with sugar, pickled vegetables, preservation with salt and fermented products.

- **Heat treatments:** for many years fruit and vegetables have been preserved by heat, using canning or bottling methods.

Marketing

There can be many participants in any given marketing systems. The main ones are:

- **Farmers:** Most farmers are mainly concern the growing of crops and their awareness of marketing as a tool to increase income is non-existent or is limited to what they learn from other small farmers. In developing countries very few growers have either sufficient production of sufficient knowledge to take advantage of the marketing choices available.
- **Traders:** The role of traders is essentially to act as the link producer and distributor.
- **Commission Agents:** The role of specialised commission agents is to take produce owned by farmer of a trader and sell it for the best price possible.
- **Retailers:** What the retailer buys reflects the quality and quantity of what he thinks his customers will buy.

References/Sources: www.fao.org

Unit 6: Plant Farming Practices and Management Systems

Content Standard 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 9.1.6.1 Investigate and explain the differences between Pomology, Olericulture, Ornamental Plants, Arboriculture and Landscaping horticulture.

Topic 1: Types of horticulture

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic students will be able to <ul style="list-style-type: none"> Identify, describe and differentiate major areas (Pomology, Olericulture, and Ornamental Horticulture) of horticulture industry.
Essential Questions	<ol style="list-style-type: none"> 1. What is Pomology? 2. What is Olericulture? 3. What is Ornamental Horticulture? 4. What are the two major categories within Ornamental Horticulture? 5. What is Arboriculture? 6. What is Landscaping horticulture? 7. What is the difference between (Pomology, Olericulture and Ornamental Horticulture)
Knowledge	<ul style="list-style-type: none"> Pomology, Olericulture, Ornamental Horticulture, Arboriculture and Landscaping horticulture
Skills	<ul style="list-style-type: none"> Differentiate Pomology, Olericulture, Ornamental Horticulture, , Arboriculture and Landscaping horticulture
Attitudes	<ul style="list-style-type: none"> Appreciate the types and major areas of horticulture.
Values	<ul style="list-style-type: none"> Value the horticulture industry

Content Background:

A direct relationship exists between horticulture and science. The area of science most closely associated with horticulture is botany. **Botany** is the study of plants and plant processes. The field of science that deals with the cultivation of horticultural plants is known as horticulture science.

The horticulture industry is the contribution of scientific, technological and production activities that ensure the satisfaction of the consumer. The horticulture industry can be divided into three areas: pomology, olericulture, and ornamental horticulture. Each area is unique and includes many career opportunities.

Pomology

Pomology is the planting, harvesting, sorting, processing and marketing of fruit and nut crops. Fruit crops include large and small fruits. Examples of large fruits are peaches, apples and pears. Small fruits include strawberries, raspberries and blueberries. Almonds, pecans and walnuts are popular nut crops.



Olericulture

The area of horticulture that involves the production of vegetable food crops is olericulture. Olericulture includes the planting, harvesting, storing, processing and marketing of vegetable crops. Sweet corn, tomatoes, snap beans, and lettuce are examples of vegetable crops.



Ornamental Horticulture

The growth and use of plants for their beauty is the area of horticulture known as **Ornamental horticulture**. Ornamental horticulture is divided into two categories. These are floriculture and landscape horticulture. Both involve the use of flowering and foliage plants. **Foliage plants** are those used for their colourful greenery or leaves. **Floriculture** is the area of ornamental horticulture associated with the production and use of flowers, potted plants and annual bedding plants. It includes the use of floral products in the florist's trade.

The production and use of plants to beautify the outdoor environment is **landscape horticulture**. Landscape horticulture includes designing plans for landscapes, installing landscapes as specified in the plans and maintaining the landscapes.



Arboriculture

Is the cultivation, management and study of individual trees, shrubs, vines and other perennial woody plants. The science of arboriculture study how these plants grow and respond to cultural practices and to their environment.

References/Sources

AgEdLibrary.com

Benchmark: 9.1.6.2 Analyse how to cultivate, process, preserve, market, regulate and use Pomology, Olericulture, Ornamental plants, Arboriculture and Landscaping horticulture.

Topic 1 Management systems of Pomology and Olericulture

Topic 2 Management systems of Ornamental plants and Arboriculture and landscaping horticulture.

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic students will be able to: <ul style="list-style-type: none"> • Identify the different management systems and practices of horticulture • Compare the cultivation and processing of different horticulture plants • Distinguish horticulture plant cultivation practices of Pomology and Olericulture • Identify and explain the management systems and practices of Landscaping horticulture
Essential Questions	<ol style="list-style-type: none"> 1. What are the management systems and practices of pomology? 2. How can farmers cultivate, process, and market pomology plant products? 3. How the management systems of Pomology and Oleiriculture are differ from one another? 4. What are management systems and practices of Arboriculture? 5. What are management systems and practices of Landscaping horticulture?
Knowledge	<ul style="list-style-type: none"> • Management system and practices of pomology. • Management systems and practices of olericulture. • Management systems and practices of ornamental plants. • Management systems and practices of Arboriculture. • Management systems and practices of Landscaping horticulture.
Skills	<ul style="list-style-type: none"> • Examine the management system and practices of pomology • Describe and evaluate the management system and practices of olericulture • Describe and evaluate the management system and practices of ornamental plants. • Describe and evaluate the management system and practices of arboriculture
Attitudes	<ul style="list-style-type: none"> • Appreciate the management systems and practices of pomology, olericulture and ornamental plants, arboriculture landscaping horticulture
Values	<ul style="list-style-type: none"> • Wise in decision making • Critical thinkers and decision makers in dealing with horticulture plant production
Assessment Task	<ul style="list-style-type: none"> • Compare and describe the cultivation of different horticulture plants

Content Background:

Management systems and practices of pomology

1. Cultivation -Site selection, planting and spacing, pruning
2. Soil management – irrigation and fertilization
3. Crop enhancement – pollination, thinning
4. Harvesting and packing

Management systems and practices of olericulture

1. Cultivar selection
2. Seedbed preparation
3. Fertilizer application
4. Pest and disease management

Management systems and practices of arboriculture

Tree pruning

1. Pruning techniques
2. Management of young trees
3. Management of mature trees

Management systems and practices of landscaping horticulture

1. Maintain healthy plants by meeting their cultural requirements with the goal of using less pesticides
2. Avoid planting invasive species, instead choose plants that minimize maintenance and increase habitat
3. Select plants whose mature size will fit the scale and size of the landscape
4. Fertilizer application
5. Pest and disease control

Unit 7: Plant Farming and Technology

Content Standard 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.

Benchmark 9.1.7.1 Investigate and explain how technological interventions have improved the cultivation, production, marketing, and regulation of different horticulture plants.

Topic: Technology Interventions in Horticulture

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic students will be able to: <ul style="list-style-type: none"> Identify and evaluate the technological interventions that improved cultivation, production, marketing and regulation of different horticulture plants.
Essential Questions	<ol style="list-style-type: none"> How can horticulture be improved? What technology is required to increase the crop yield? How does technology help farming? What technology is used in farming?
Knowledge	<ul style="list-style-type: none"> Technological interventions that improved the cultivation, production, marketing and regulation of different horticulture plants?
Skills	<ul style="list-style-type: none"> Identify and evaluate the technological interventions that improved cultivation, production, marketing and regulation of different horticulture plants.
Attitudes	<ul style="list-style-type: none"> Appreciate the technological interventions that improved the cultivation, production, marketing and regulation of different horticulture plants?
Values	<ul style="list-style-type: none"> Value the use of technology in horticulture production

Content Background:

How can horticulture be improved?

Increase the availability of high quality and safe horticultural produce by developing improved crop management practices (e.g. good agricultural practices, integrated production and pest management, integrated soil health management, organic farming) for sustainable and environmentally friendly horticultural crop

Nitrogen-use efficiency could increase rice crop yields by 22 percent, but irrigation increased the yields by another 21 percent. Heat-tolerant varieties of wheat could increase crop yields from a 17 percent increase to a 23 percent increase with irrigation

Contribution of Innovative Technologies to New Developments in Horticulture

In greenhouse horticulture the production process and control are still often done manually. A lot of labour is used in processes like crop sensing, crop maintenance, harvesting and packaging of food, flowers and pot plants. Human intelligence for repetitive tasks at a high capacity level is required for these processes. Tasks in the greenhouse are often performed by foreigners since they are more cost effective.

Transporting and accommodating low cost labour to a high level production site turns out to be more effective than transporting a high level production site to an area where low cost labour is available, especially when the volume per unit is large compared to the price and consumption is local. This evolution is changing the idea that growing systems, sensors, mechanization and robotics should only replace labour in highly developed areas. New technologies should also improve the reproducibility of quality, reliability to delivering the requested amount, reducing the time to market and reducing costs in the entire production chain.

Continuous improvement is difficult to realise when manpower is replaced, frequently resulting in a continuous management effort to acquire human resources of the appropriate quality and productivity at the right moment. New technologies should add value to the product and open ways to continuous improvement. New technologies that reduce human interference will stimulate a process of continuous improvement.

New technologies that can replace and improve the human sensors and actuators and can support human interpretation and decision-making will change greenhouse horticulture in the future.

Sources

<https://www.researchgate.net>

Benchmark 9.1.7.2 Identify and explain the impact of technology on traditional and modern cultivation and processing of horticulture plant products.

Topic: Impact of horticultural technology on plant cultivation and processing

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic students will be able to <ul style="list-style-type: none"> Identify and explain the impact of technology on traditional and modern cultivation and processing of horticulture plant products.
Essential Questions	<ol style="list-style-type: none"> 1. What are traditional cultivation of horticultural plants 2. What are modern cultivation of horticultural plants 3. What are some impacts of technology on cultivation practices of traditional and modern cultivation and processing of horticulture plants?
Knowledge	<ul style="list-style-type: none"> Impact of technology on traditional and modern cultivation and processing of horticulture plant products.
Skills	<ul style="list-style-type: none"> Identify and explain the impact of technology on traditional and modern cultivation and processing of horticulture plant products.
Attitudes	<ul style="list-style-type: none"> Appreciate the impact of technology on traditional and modern cultivation and processing of horticulture plant product
Values	<ul style="list-style-type: none"> Value and be open minded about the Impact of technology on traditional and modern cultivation and processing of horticulture plant products.

Content Background

Most traditional cultivation was done by using natural resources. Horticulture is done by using shifting pattern of field use. Production drops when there is an over use of soil and depleting of nutrients. Traditionally the land is left to fallow and farmers move to a new land. They clear the wild vegetation with a slash and burn technique.

Modern cultivation technology is used to improve the wide types of production practices employed by farmers. It makes use of hybrid seeds of selected variety of a single crop, technologically advanced equipment and lots of energy subsidies in the form of irrigation water, fertilizers and pesticides.

Modern agriculture uses advanced technology, it is less labor intensive than traditional agriculture, and the yield quantity is larger because there is a focus on maximizing production and maintaining a consistent quality. Modern agriculture uses advanced technology, such as plant breeding techniques and pesticides. Seeds that are hybrids may be used and other gene editing techniques applied.

Modern agriculture is less labor intensive than traditional agriculture because there is a greater reliance on machinery. This is in terms of both harvesting and growing the plants but also in cases where one is applying fertilizers and pesticides. Some equipment used in modern agriculture:



Sources

<https://www.longdom.org>

<https://socratic.org/>

<https://www.kullabs.com/>

Benchmark 9.1.7.3 Identify and evaluate the advantages and disadvantages of using technology to propagate horticulture plants in order to improve their products.

Topic: Benefits of Horticulture technology in plant propagation

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of the topic, students will be able <ul style="list-style-type: none"> • identify the benefits of using technology in horticulture propagation • describe the advantages and disadvantages of using technology in to propagate horticulture
Essential Questions	<ol style="list-style-type: none"> 1. What are the advantages of using technology to propagate horticulture plants in order to improve their products? 2. What are the disadvantages of using technology to propagate horticulture plants in order to improve their products?
Knowledge	<ul style="list-style-type: none"> • Advantages and disadvantages of using technology to propagate horticulture plants in order to improve their products?
Skills	<ul style="list-style-type: none"> • Identify and evaluate the advantages and disadvantages of using technology to propagate horticulture plants in order to improve their products?
Attitudes	<ul style="list-style-type: none"> • Appreciate the advantages and disadvantages of using technology to propagate horticulture plants in order to improve their products?
Values	<ul style="list-style-type: none"> • Be open minded • Be creative and critical thinkers
Assessment Tasks	<ul style="list-style-type: none"> • Describe types of horticulture technology and its benefits in horticulture propagation

Content Background

Vegetative plant propagation "Advantages & Disadvantages, Natural & Artificial Methods

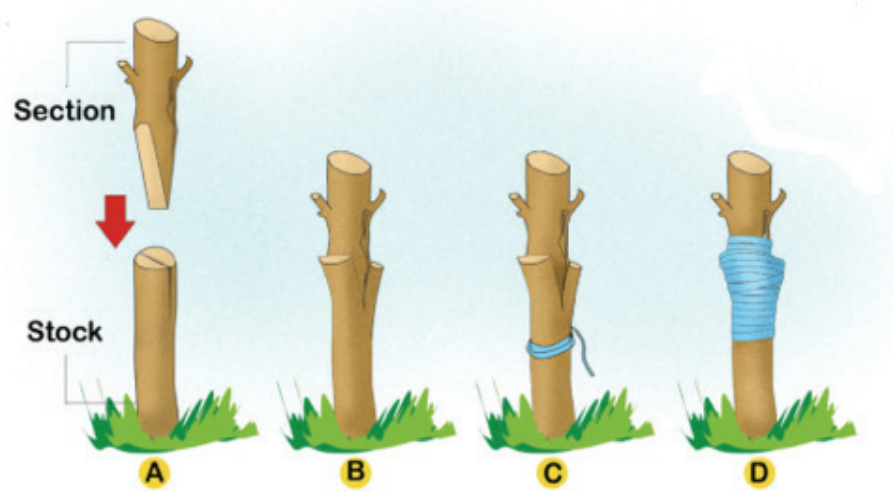
Plant propagation is the process of increasing the number of plants of a particular species or cultivar. Propagation can be via sexual or asexual means. Over the years, horticulturalists have developed asexual propagation methods that use vegetative plant parts. This allows plants to be created in ways that nature cannot duplicate.

Asexual or vegetative plant propagation

Asexual plant propagation methods produce new plants from vegetative parts of the original plant, such as the leaves, stems and roots. These methods are generally referred to as vegetative propagation. Many plants can reproduce this way naturally, but vegetative propagation can also be artificially induced.

Sexual reproduction of fruit trees is a rarely used method in horticulture. Mainly applied in research stations to conserve the richness of the gene pool and develop new varieties. On the production side, this method cannot satisfy the requirements for production quality and quantity. The new specimen, resulted from the sexual reproduction, carries unpredictable characteristics of its own, which includes the tendency to revert to a wild-like state of the specie.

However, some of the known fruits keep intact their specific characteristics of the variety independently from the way, which was used for propagation. It can be sexual or asexual reproduction these fruits inherit the characteristics of the variety. The chestnut is a typical representative of this group. Plant can be asexually reproduced either by using part of two or more plants in a union or parts of the same plant. In the first case we call it grafts age and in the second case we call it rooting. All asexual propagation techniques belong one of the two categories



(a) Grafting fruit plants and tress



(b) Bud grafting on Guava tree before and after

Source: (a & b):https://www.google.com.pg/search?q=budding+and+grafting+plants&tbm=isch&ved=2ahUKEwiYw--am43oAhUiWHwKHdN-nAs0Q2-cCegQIABAA&oq=budding+and+grafting+plants&gs_l=img.3..0.2993.24271..27172...0.0..0.604.10500.0j5j13j6j7j2.....0....1..gwsimg.....0i30j0i5i30j0i8i30j0i24.XchJJWh8YJQ&ei=RB5mX-piRK6Kw8QPTz4noDA&bih=657&biw=1366#imgrc=IFgeebv15gTW0M

Advantages of vegetative propagation

The main advantage of vegetative propagation methods is that the new plants contain the genetic material of only one parent, so they are essentially clones of the parent plant. This means that, once you have a plant with desirable traits, you can reproduce the same traits indefinitely, as long as the growing conditions remain similar. This is especially important for commercial growers who want to reproduce the highest-quality plants and ensure consistency of a variety of plant or crop for sale. This can also help to maintain consistent quality and taste in products made from plants or crops. For example, in Zealand's tea plantation, they propagate new tea plants using cuttings to ensure consistency in the taste and quality of their tea.

With vegetative propagation, plants also bypass the immature seedling phase and therefore reach the mature phase sooner. This can save a lot of time and money for commercial plant production. For example, it takes 3–4 years for a tea plant to grow big enough (from a cutting) to be ready for harvesting and processing into tea. Growing from seed would take even longer.

Disadvantages of vegetative propagation

The main disadvantage is the potential to impact on biodiversity of a species. Also, if a particular plant clone is susceptible to certain diseases, there is potential to lose entire crops, such as the impact of kiwifruit disease Psa. One way to protect against these problems is to establish a genetic bank of seeds or plants (a germplasm collection), which is common practice in various cropal sectors.

UNIT OF WORK

STRAND 2: ANIMALS

Content Standard 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 system, purposes and their benefits and investigate the different context, environments, and places where they are farmed.

Units	Benchmarks	Topics	Lesson Titles
Unit 1:Types of Animals	9.2.1.1 Analyse the relationship between domesticated and farmed monogastric and polygastric animals and discuss environments which they are domesticated or farmed.	Domesticated and farmed animals	<ol style="list-style-type: none"> 1. Domesticated monogastric and polygastric animals 2. Farmed monogastric and polygastric animals 3. Environmental requirements for Monogastric and polygastric animals
	9.2.1.2 Research and categorize monogastric and polygastric animals according to their feeding systems, functions, purposes, and benefits.	Characteristics of monogastric and polygastric animals	<ol style="list-style-type: none"> 1. Characteristics of Monogastric animals 2. Characteristics of Polygastric animals 3. Purpose and benefits of monogastric and polygastric animals
	9.2.1.3 Investigate and explain the anatomy of monogastric and polygastric domesticated and farmed animals.	Anatomy of Monogastric and Polygastric animals	<ol style="list-style-type: none"> 1. Monogastric animal Anatomy 2. Polygastric animal anatomy

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.

Units	Benchmarks	Topics	Lesson Titles
Unit 2:Animal Farming Practices and Management Systems	9.2.2.1 Research and explain the purposes and benefits of different animals.	Purpose and benefits of animals	<ol style="list-style-type: none"> 1. Purpose and benefits of domesticated animals 2. Benefits to the farmers 3. Socio-economic benefits
	9.2.2.2 Investigate and classify animals according to their species, breeds, and products.	Animal species, breeds and products	<ol style="list-style-type: none"> 1. Pig species and breeds 2. Goat species and breeds 3. Sheep species and breeds 4. Cattle species and breeds

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 analyze their advantages and disadvantages.

Units	Benchmarks	Topics	Lesson Titles
Unit 3: Animal Farming and Technology	9.2.3.1 Analyse and discuss the impact of technology in animal farming.	Impacts of technology in animal farming	<ol style="list-style-type: none"> Existing farm technology Benefits of technology in animal farming Disadvantages of technology in animals farming
	9.2.3.2 Investigate the use of current animal farming technology, explain its associated problems, and develop solutions of improving it.	Problems of using Technologies in animal farming	<ol style="list-style-type: none"> Field trip –(optional) Ways of improving problems associated with the use of animal farming technology
	9.2.3.3 Discuss the current and emerging trends in animal farming and justify how it is used to improve farming, production, and marketing of animal products.	Current and emerging trends in animal farming	<ol style="list-style-type: none"> Current and emerging trends in animal Farming Methods to improve farming production Marketing of animal products (project)

Content Standard 2.4 Students will be able to identify and evaluate the characteristics of different types of domesticated and farmed Birds, categorize them according their characteristics, functions, and benefits, and investigate the different contexts, environments, and places where they are farmed.

Units	Benchmarks	Topics	Lesson Titles
Unit 4: Types of Birds	9.2.4.1 Investigate and explain the importance of Poultry production.	Poultry	<ol style="list-style-type: none"> Introduction to poultry Importance of poultry production
	9.2.4.2 Differentiate between domesticated and farmed birds, and examine these animals in each of these two categories.	Types of domesticated and farmed birds	<ol style="list-style-type: none"> Domesticated Birds Farmed Birds Differences in domesticated and farmed birds
	9.2.4.3 Examine and evaluate the characteristics of domesticated and farmed birds.	Domesticated and farmed birds	<ol style="list-style-type: none"> Characteristics of domesticated birds Characteristics of farmed birds What is an anatomy External anatomy of domesticated and farmed birds

Content Standard 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.

Units	Benchmarks	Topics	Lesson Titles
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Unit 5: Bird Farming Practices and Management Systems	9.2.5.1 Investigate and appraise the poultry farming principles, systems, and practices used in different environments.	Poultry farming principles, systems and practices	<ol style="list-style-type: none"> 1. Poultry Production systems 2. Extensive farming systems 3. Semi intensive farming systems 4. Intensive farming system
	9.2.5.2 Examine systems and practices used to farm birds in different climatic conditions and critically reflect on the challenges.	Bird farming systems for different climatic conditions	<ol style="list-style-type: none"> 1.Challenges of bird farming in the highland areas 2.Challenges of bird farming in the lowland areas
Content Standard 2.6 Students will be able to investigate how technology is used for bird farming, processing, preservation, marketing, consumption, regulation, and management in different contents and analyze their strengths and weakness.			
Units	Benchmarks	Topics	Lesson Titles
Unit 6: Bird Farming and Technology	9.2.6.1 Identify and explain the different technologies used in the poultry farming.	Technologies used poultry production systems	<ol style="list-style-type: none"> 1. Technologies used in small scale poultry Farming 2. Technologies used in large scale poultry Farming
	9.2.6.2 Analyze the advantages and disadvantages of technologies used in poultry production systems in different environments.	Advantages and Disadvantages of the use of technology	<ol style="list-style-type: none"> 1. Advantages of the use of poultry farming technology 2. Disadvantages of the use of poultry farming technology

Strand 2: Animals**Unit 1: Types of Animals**

Content Standard 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 system, purposes and their benefits and investigate the different context, environments, and places where they are farmed.

Benchmark 9.2.1.1 Analyse the relationship between domesticated and farmed monogastric and polygastric animals and discuss environments which they are domesticated or farmed.

Topic: Domesticated and Farmed Birds

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to: <ul style="list-style-type: none"> • Define domestic and farmed animals and class them according to characteristics, feeding systems, purposes and benefits. • Discuss about the environment in which domesticated and farmed animals live
Essential Questions	<ol style="list-style-type: none"> 1. What is the difference between domesticated and farmed animals 2. What is the purpose of looking after animals? 3. Why are domesticated animals different from farmed animals? 4. What kind of environment are these animals domesticated and farmed?
Knowledge	Domesticated and farmed animals characteristics
Skills	Distinguish, categorize, classify domestic and farmed animals
Attitudes	Being creative and responsible farmers
Values	Appreciate the importance of domesticated and farmed animals

Content Background

There are five (5) major livestock species farmed throughout Papua New Guinea currently as well as other emerging animal farming such as insect farming (apiculture). Goats, sheep and cattle are major widely farmed in Papua New Guinea.

Description of domesticated, monogastric and polygastric animals

Domesticated animals are animals that have been selectively bred and genetically adapted over generations to live alongside humans. They are genetically distinct from their wild ancestors or cousins. Example

- dogs and cats – for companionship
- sheep, cow, pigs, goat, turkeys – farmed for food
- horse, donkey and camels – working animals sanctity

Monogastric animals are animals that have one stomach and many are omnivorous in their feeding behaviour; Example

- Pigs – eat both plant matter and animal matter
- Rabbits – eat mainly plant matter



Polygastric animals are animals that have two stomachs and are herbaceous in their feeding behaviour; Example

- Cow – farmed for meat and milk
- Goat – farmed for meat and milk
- Sheep – farmed for meat



Environment in which domesticated, monogastric and polygastric animals live.

Domesticated companion animals live with human beings in their houses for reasons

Example:

- Dog is a very good friend and companion of humans and provides security to its owner
- Cats are kept in the house to control the number of rats and may deter snakes away from the house

Monogastric and Polygastric animals

Monogastric and polygastric animals are farmed animals and live in farms. They can be kept in open farms or enclosed farms such as:

- Pigs can be kept in an extensive or semi-intensive farm where they are fed with some fed and may look for some them. On the other hand in intensive farms the pigs are provided with all it requirements
- Cattle usually is kept in an open farm but may be housed as in a fed lot system

Many farmed animals are usually kept in herds unlike domesticated companion animals that live with human beings.

Benchmark: 9.2.1.2 Research and categorize monogastric and polygastric animals according to their feeding systems, functions, purposes, and benefits.

Topic: CHARACTERISTICS OF MONOGASTRIC AND POLYGASTRIC ANIMALS

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • differentiate between monogastric and polygastric animals and classify them according to their differentiating characteristics • discuss the purposes and benefits of farming monogastric and polygastric animals.
Essential Questions	<ol style="list-style-type: none"> 1. What is a monogastric animal and how is it different from a polygastric animal? 2. What is the main characteristic that distinguishes a monogastric animal from a polygastric and discuss how are they related?
Knowledge	Characteristics of monogastric and polygastric animals
Skills	Distinguish and categorize animals into monogastric and polygastric
Attitudes	Caring and concerned for animals welfare
Values	Appreciate the importance of animals to humans and environment

Content Background:

Feeding Systems

Feeding systems of monogastric and polygastric animals depends on the type of farming system used. In a monogastric livestock, For example, A pig can be kept in a pan and fed with manufactured feed such as the feed meal, protein concentrates and other vegetable waste. In an extensive system the pig has the choice to feed on what they are able to find. They make choices. The pigs are omnivores and so dig for worms under this system of farming.

Polygastric animal

In a free range system the animal is allowed to make choices and pick the type of feed it requires. For example the goats will accept a wide variety of feeds. Goats usually refuse anything which has been soiled by other animals. Goats value browse than feedlot feeding.

Cattle go browsing and need more grass than what a goat can take and require larger feeding area than smaller animals like goats and sheep. Different monogastric animals have their own choice of feed but the feeding system depends on either;

- Intensive system of farming
- Semi-intensive
- Extensive systems

The purpose of farming monogastric and polygastric animals is for;

- Providing meat(protein)
- Providing milk
- Companionship
- Wealth generation

The benefits of monogastric and polygastric animal farm differ according to the farmer and the consumers/users.

- Income
- The main benefit is for income generation. Farming has become a business and is a source of earning income to pay for other goods and services that the farmer requires.
- Some animals are used as draft animals for working and transportation
- Providing protein, milk and other edible products
- Reducing unemployment

Benchmark 9.2.1.3 Investigate and explain the anatomy of monogastric and polygastric domesticated and farmed animals.

Topic: Anatomy of Monogastric and Polygastric animals

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to: <ul style="list-style-type: none"> • identify and discuss the external anatomy of monogastrics and polygastrics • Identify organs that make up the digestive systems of monogastric and polygastric farmed animals
Essential Questions	<ol style="list-style-type: none"> 1. Why are animals different from each other? 2. How do we distinguish an animal from another? 3. Do all animals feed on the same food consume the same amount? Explain....
Knowledge	External and internal anatomy and functions of domestic and farmed animals
Skills	Identifying, explaining and classification of parts and functions of animal body parts
Attitudes	Being creative and responsible farmers
Values	Acknowledge and develop a sense of responsibility animal contributions to farmers and society

Content Background:

The term "anatomy" refers to the science concerned with the form, structure and spatial relationships of living organisms. Since body structure is closely related to body function, knowledge of structure and function of an animal's body will help farmers to understand clearly how each structure works to produce a particular livestock product e.g. meat, milk, eggs.

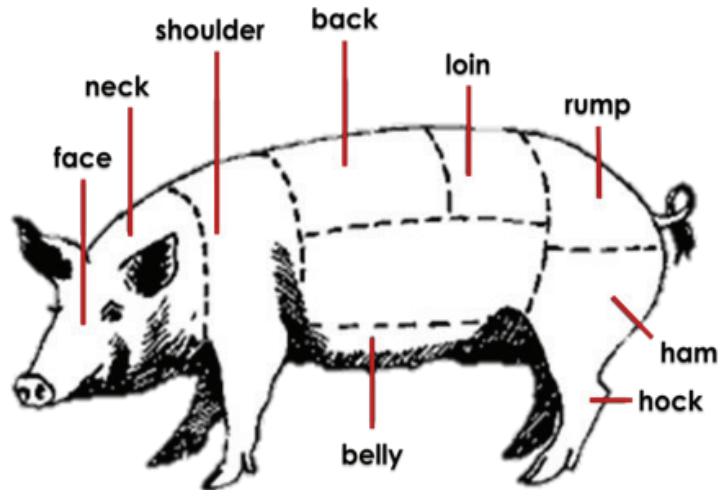
Functions and uses of body parts

There many parts of animals and each have a specific function or a part to play each day for the animals' survival. Many of the parts in both monogastric and polygastric animals have the same functions.

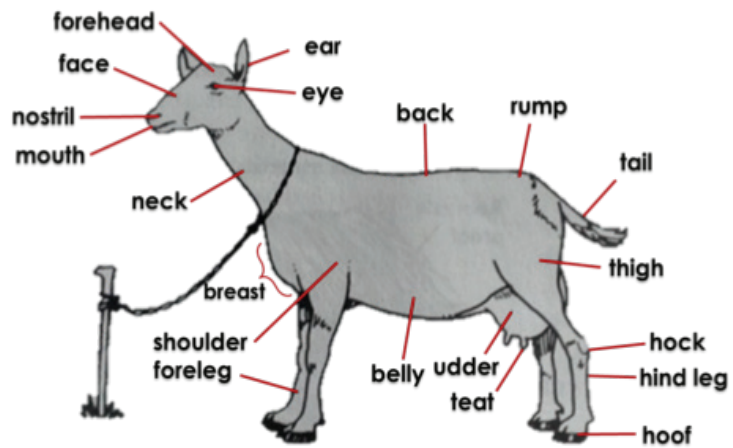
Example of body parts of a pig is given below

Part	Functions/use
Legs <ul style="list-style-type: none"> • Forelegs • Hind legs 	Used for movement in search for food and escaping predators
Mouth	<ul style="list-style-type: none"> • Eating and drinking water • Collecting food
Eyes	<ul style="list-style-type: none"> • Used for seeing
Snout	<ul style="list-style-type: none"> • Nose drills found and used for smelling and digging for worms
Ear	<ul style="list-style-type: none"> • Used for listening

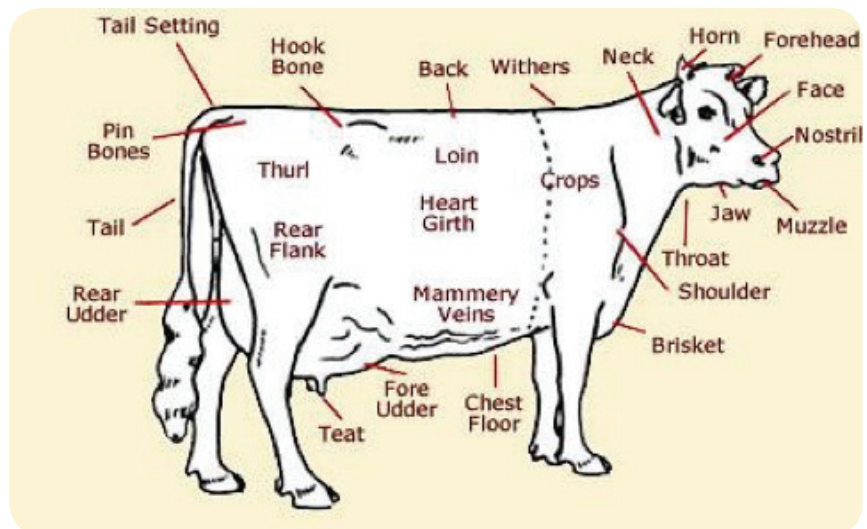
An example of a monogastric animal



An example of polygastric animal
Parts of a Goat



Parts of a Cow



Recommended Resources

Newspapers, magazines, posters

Kapari, Michal, W, 1958, Second edition 2000, Longman publishers, Pearson Education Australia, Melbourne, Australia

Strand 2**Unit 2 : Animal Farming Systems and Practices**

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: 9.2.2.1 Research and explain the purposes and benefits of different animals

Topic: PURPOSE AND BENEFITS OF ANIMALS

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to identify and explain the benefits and purposes of different animals to the farmer and society
Essential Questions	<ol style="list-style-type: none"> 1. How do farmers and society depend on animals? 2. What do we call animals that are kept in enclosures and cultivated? 3. What do farmers do to cultivate animals to add value to their products?
Knowledge	Purpose and benefits of livestock farming
Skills	Research and report on the benefits of domesticated and farmed animals
Attitudes	Being responsible and opened minded farmers
Values	Appreciate the importance of animals to humans and society

Content Background:

Livestock are used by humans for a variety of purposes, many of which have an economic value. The main purpose of livestock is for subsistence and commercial benefits. Livestock products include: meat, dairy products, clothing and adornment, fertilizer, labour and land. Management. Meat- the production of useful form of dietary protein and energy. Mammalian livestock can be used as a source of milk, which can in turn easily be processed into other dairy products, such as yogurt, cheese, butter, and ice-cream.

Livestock produce arrange of fibre textiles. For example, sheep and goats produce wool and mohair; cows, deer, and sheep skins can be made into leather, livestock bones, hooves and horns can be used to fabricate jewellery, pendants, or head gear. Manure can be spread on fields to increase crop yields. Manure is also used to make plaster for walls and floors, and can be used as a fuel for fibres. The blood and bone of livestock can be used as fertilizers

Purpose for raising different animals

The purpose for raising animals may vary, but the most important one is to provide protein. The type of protein available depends on the choice of the farmer. Some examples and their purposes;

Pig

- Supply of meat for protein
- Form of wealth
- Manure applied to vegetable gardens

**Goat**

- Supply of meat for protein
- Supply of milk
- Manure applied to vegetable gardens
- Form of wealth

Cattle

- Supply of meat for protein
- Supply of milk
- Skin used for making leather products
- Offal's used for stock feed for other animals such pigs
- Manure can be used for fertilizing plants
- Used as draught animal to pull ploughs and carts

**Sheep**

- Supply meat for protein
- Wool used for blankets, clothes and other products

**Benefits of raising different animals**

There are many benefits of farming animals but the main ones would include

Income generation

- Income generation opportunities are very high. The money earned can be used to pay for goods and services that others provide.
- Animals such as buffalos and horses are strong and when trained ease the problem of paying for transport. They can be used for transportation and ploughing

In Papua New Guinea pigs are looked after for two reasons: as a commercial business and because they have a high value in traditional society. In a commercial business farmers look after their pigs and sell them for money. Farmers get more money if their pigs are well fed. Looking after pigs in a traditional village has far more traditional importance than commercial value. For instance, pigs raised in the village are important in marriage, settling family, clan and land disputes, or paying for someone's death.

Benchmark 9:2.2.2 Investigate and classify animals according to their species, breeds, and products

Topic: ANIMAL SPECIES, BREEDS AND PRODUCTS

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • examine and classify domesticated and farmed animals according to their species breeds, and products which they produce
Essential Questions	<ol style="list-style-type: none"> 1. How do farmers select animals for farming purposes? 2. Do all animal species have the same characteristics? 3. How do farmers determine which animal breeds are best for farming?
Knowledge	Farmed animal species characteristics
Skills	Classification of farmed animal species
Attitudes	Being optimistic and judgmental in selecting animal species
Values	Appreciative of animal importance to humans and environment

Content Background:

Species is a category used in the taxonomic classification of living organisms which is subordinate to a genus; it is generally the final category and is composed of individuals having common characteristics which distinguish them from other categories. They are given scientific names to differentiate them from other species

Example

Animal	Scientific Name
Cattle	<ul style="list-style-type: none"> • Bos taurus – temperate type cattle • Bos indicus – Zebu-type cattle
Pig	<ul style="list-style-type: none"> • Sus scrofa
Goat	<ul style="list-style-type: none"> • Capra hircus
Horse	<ul style="list-style-type: none"> • Equus caballus.
Sheep	<ul style="list-style-type: none"> • Ovis aries

Breeds of animals

A breed is a group of individuals having a common origin and possessing certain distinguishing characteristics not common to other members of the same species.

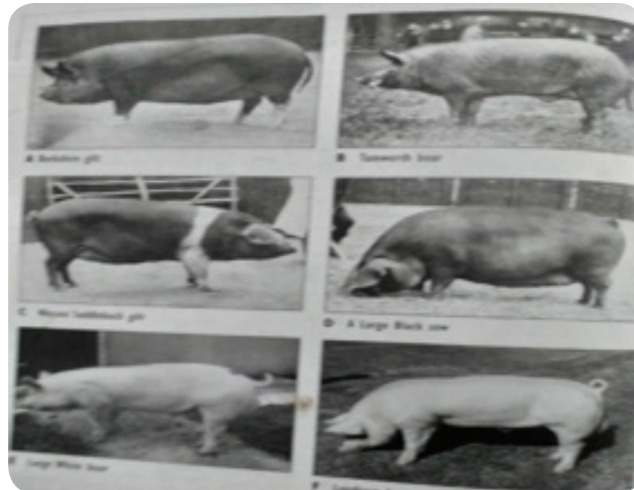
Examples of pig breeds	
Breeds	Characteristics
Native	Very common breed found in PNG. Its short dummy and smooth walker, the body length is short and the animal makes very little noise as it walks. It has short erect ears, long narrow, broad shoulders and light hindquarters. It is a slow growing animal but can grow faster if fed an improved diet. The sow is a very good mother and can produce a litter every twelve or eighteen months. An average litter size is about five. The piglets are small at birth. The sow usually loses much of her physical condition during lactation and normally needs a period of fattening before mating again.
Berkshire	Berkshire is an introduced British pig with erect ears and white hair on the legs, tail and face, the rest being black. This pig walks with a stilted walk when compared with the native pig. Unlike the native pig its forequarters are not fully developed, but its hindquarters are bigger with a lot of meat. Under good management conditions, sows produce large litters of nine or ten. The sow is a good mother producing large and healthy piglets. Berkshires survive well under normal village conditions.
Tamworth	Tamworth is an introduced pig with erect ears. It is red colored with a long, narrow snort and long, straight face. It is betted adapted for grazing because it can root and dig up ground for itself. The sow is a reasonably good mother and can regularly produce a large litter of up to eight.
Large white	The large white is an introduced pig. It is a large, pure white animal with a straight snort. The ears are erect and its body is long with good depth of size. This animal is very easily sunburnt and not suitable for farming at lower altitudes. Large white perform well where there are high management levels. The average litter size for sows is ten.
Large black	The large is an introduced pig. It is large and black with floppy ears which fall over its eyes. The large black performs well where there are high management levels. The average litter size sows is usually nine to ten.
Landrace	The landrace is an introduced pig. It is white in colour and easily identified by its large floppy ears which fall over its eyes. It is easily sunburnt. As with the large whit, it requires a level of high management skills. The sow produce about the same litter size as the large white.
Wessex saddleback	The wessex saddleback is an introduced pig and it is easily recognized by the distinctive whit saddle across its shoulders with the rest of its body being black. It has large floppy ears and the body length is shorter than that of white breeds. The sows are very mothers with a good litter size. These breeds is well adapted to the PNG climate.
Durock	This breed is also known as Duroc-Jersey. Durocs have a solid color hair-coat ranging from a very light golden to a dark mahogany red. The durocs perform better than other pig breeds in the quality of its muscle. It also has a low incidence of disease if properly managed. Other desirable characteristic include its ability to adapt to various environment conditions, and ability to grow well even on village farm waste; low mortality rate if well looked after and high efficiency in converting feed to meat. Many tropical farmers the duroc to all other breeds. The major problem with the duroc is that its front legs are usually not very strong. Careful selection is needed to ensure that this undesirable characteristics is prevented from being introduced into a new herd of cross breeds

Crossbreeds

Many cross breeds found in PNG are obtain from cross- breeding between introduced breeds (for example, large black crossed with landrace) or between a introduced breed and a native breed and a native breed (for example, wessex saddle back crossed with a native pig). Cross breeds are introduced as a way of combining the desirable characteristics

PIG BREEDS

Although there are many breeds of pig only one or more is suited to a particular climate. Three types of pig breeds are found in PNG; the native bush pig, the introduced pig and crossbreeds. The common introduced pigs found in PNG are Berkshire, Tamworth, Large white, Landrace, Wessex saddleback and large Black. These breeds have their own characteristics. If farmer wants to have good breed then he will mate a sow and boar to get an offspring. This can be done either by mating one introduced breed with another introduced breed or a native pig with and introduced pig. The offspring is called a crossbreed. These features are summarised in the table below- (Refer to diagram of pig breeds)

**Cattle breeds****Simmental Cow**

Hereford cows



French meat breed Salers



Goat and Sheep breeds

Fine wool ewes (Rambouillet)



Long woolled rams (Romney and Lincoln)



Primitive breed
(Old Norwegian Sheep)
Photo courtesy of Hilde Buer



Medium wool ewes (Texel)



Fat-rumped rams (Turki)
Photo courtesy of Fardeen Omidwar



Hair sheep (Pelibüey)



Recommended Resources: Newspapers, magazines, posters

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 9.2.3.1 Analyse and discuss the impact of technology in animal farming.

Topic: Impacts of technology in animal farming

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • identify and discuss types of farm technology which enhances animal farming • identify the advantages and disadvantages of technology in animal farming
Essential Questions	<ol style="list-style-type: none"> 1. What is technology? 2. What are some of the technologies used in animal farming? 3. How does farm technology benefit farmers and society? 4. How do farmers and society benefit from animal rearing technology? 5. What are the advantages and disadvantages in of technology in farming animals in different environments?
Knowledge	Uses of technology in animal farming
Skills	Investigating impacts of technology in animal farming
Attitudes	Show interest in the use of technology in animal farming
Values	Appreciate the use of technology in animal farming

Content Background

Daily work on livestock farming is simple in and standard application routinely. Data monitoring in the modern animal farm enables the ongoing control of production, animal health, and welfare. However, as the number of animals increases, error burden and work load increase. Successful livestock farmers will be capable of rapidly adapting their infrastructures to exploit changes in technology for better production. Mechanism and automation systems offer options in front of the user in intense competition for convenience.

Currently, most data is extracted manually, yet manual observation is gradually being replaced by many milking systems by automated recording (milk yield, milk conductivity, activity recording and body weight measurements) leading to better data, both in quantity and quality. The number of farms automation systems has increased rapidly since 1980. Almost any medium- to large-sized farmers can benefit from enhanced automation. There are many opportunities for facilities in automation technologies and systems

Unit 3: Animal Farming and Technology

Benchmark 9.2.3.2 Investigate the use of current animal farming technology, explain its associated problems, and develop solutions of improving it

Topic: PROBLEMS OF USING TECHNOLOGIES IN ANIMAL FARMING

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • examine and outline the current animal farming technology • discuss its advantages and disadvantages and suggest possible solutions to problems associated with its application
Essential Questions	<ol style="list-style-type: none"> 1. What are the current animal farming technologies and explain its problems? 2. What type of technology is used in a pig farm for the actual care and management of pigs? 3. What are the common types of technology that are used by most sheep and goat farmers in goat and sheep rearing? 4. What are the main technologies that are visible in most cattle farms?
Knowledge	<ul style="list-style-type: none"> • Use of technology in monogastric and polygastric animal farms
Skills	<ul style="list-style-type: none"> • Investigate and report on the type of technology in use in current animal farms
Attitudes	<ul style="list-style-type: none"> • Be optimistic in finding solutions to the problems arising from the use of technology in animal farming.
Values	<ul style="list-style-type: none"> • Appreciate the advantages and disadvantages of using technology in animal farming

Content Background

Today livestock farmers increasingly use robots on production or algorithms to optimize their farm management decisions. Technological developments are creating a new automation system in which smarter and more flexible work possibilities in livestock production. The automation of animal husbandry and integration of on-farm systems and processes have a key role to play in facilitating the process of meeting each of important challenges for competitive market.

The main technology is electronic recording, milking, heat detection auto-weighting, auto-drafting, genetic improvement, feeding, barn optimization, and health monitoring, livestock housing and equipment designs. These technologies provide to dairyman many opportunities to make easier and more convenient their decisions about dairy future plans

Benchmark 9.2.3.3 Discuss the current and emerging trends in animal farming and justify how it is used to improve farming, production, and marketing of animal products.

Topic: CURRENT AND EMERGING TRENDS IN ANIMAL FARMING

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able: <ul style="list-style-type: none"> to explore and discuss the current and emerging technology trends in animal farming Substantiate how current and emerging trends improve farming, production and marketing of animal products.
Essential Questions	<ol style="list-style-type: none"> 1. What are emerging technologies to improve farming, production and marketing of animal products? 2. How can they minimize human labor? 3. Explain how farming technology can be used to increase, yield and improve animal health?
Knowledge	<ul style="list-style-type: none"> Farming techniques and emerging technology to minimize human involvement, increase yield and improve animal health.
Skills	<ul style="list-style-type: none"> Explore and list types of animal rearing technology
Attitudes	<ul style="list-style-type: none"> Being appreciative of the use of technology in animal farming.
Values	<ul style="list-style-type: none"> Value the importance of using animal rearing technology in animal farming, processing, and marketing.

Content Background:

Today livestock farmers increasingly use robots on production or algorithms to optimize their farm management decisions. Technological developments are creating a new automation system in which smarter and more flexible work possibilities in livestock production. The automation of animal husbandry and integration of on-farm systems and processes have a key role to play in facilitating the process of meeting each of important challenges for competitive market. The main technology is electronic.

Unit 4: Types of Birds

Content Standard 2.4 Students will be able to identify and evaluate the characteristics of different types of domesticated and farmed Birds, categorise them according their characteristics, functions, and benefits, and investigate the different contexts, environments, and places where they are farmed.

Benchmark: 9.2.4.1. Investigate and explain the importance of Poultry production.

Topic: POULTRY

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Discover the important aspects of poultry production and • Explain their functions, purpose and benefits to the lives of people. • demonstrate experiences with benefits of poultry farming and production in their own contexts
Essential Questions	<ol style="list-style-type: none"> 1. What is poultry Farming? 2. What is poultry production and why is it important to the lives of people? 3. How does it benefit people? 4. What is supply and demand in poultry production?
Knowledge	<ul style="list-style-type: none"> • Importance of poultry farming and production; good food source and revenue making source
Skills	<ul style="list-style-type: none"> • Explain the importance of poultry and poultry production and discuss how it benefits the lives of people.
Attitudes	<ul style="list-style-type: none"> • Show interest on how people prefer poultry production of meat and eggs add value to their livelihoods in terms of food and revenue/investment.
Values	<ul style="list-style-type: none"> • Being concerned about the Importance of poultry farming and production

Content Background

What is poultry farming?

- Poultry farming is an animal husbandry that raises domesticated birds such as chicken, ducks, turkey and geese etc. to produce eggs and meat. The eggs as layers and birds as meat from broilers.
- The socio-economic Importance of Family Poultry Family poultry using small-scale poultry keeping by households using family labor and locally available feed resources. The poultry may range freely in the household compound and find much of their own food, getting supplementary amounts from the householder.
- Family poultry managed by individual farm families in order to obtain food security, income and gainful employment for women and children” (Brancaert, as cited in Sonaiya, 1990c). Family poultry is quite distinct from medium to large-scale commercial poultry farming. Family poultry is rarely the sole means of livelihood for the family but is one of a number of integrated and complementary farming activities contributing to the overall

well-being of the household.

- Poultry provide a major income-generating activity from the sale of birds and eggs. Occasional consumption provides a valuable source of protein in the diet. Poultry also play an important socio-cultural role in many societies. Poultry keeping uses family labour, and women (who often own as well as look after the family flock) are major beneficiaries. Women often have an important role in the development of family poultry production as extension workers and in vaccination programmers. For smallholder farmers in developing countries (especially in low income, food-deficient countries [LIFDC]), family poultry represents one of the few opportunities for saving, investment and security against risk.
- In some of these countries, family poultry accounts for approximately 90 percent of the total poultry production (Branckaert, 1999). In Bangladesh for example, family poultry represents more than 80 percent of the total poultry production, and 90 percent of the 18 million rural households keep poultry. Landless families in Bangladesh form 20 percent of the population (Fattah, 1999, citing the Bangladesh Bureau of Statistics, 1998) and they keep between five and seven chickens per household. In LIFDC countries, family poultry-produced meat and eggs are estimated to contribute 20 to 30 percent of the total animal protein supply (Alam, 1997, and Branckaert, 1999), taking second place to milk products (38 percent), which are mostly imported. Similarly, in Nigeria, family poultry represents approximately 94 percent of total poultry keeping, and accounts for nearly four percent of the total estimated value of the livestock resources in the country. Family poultry represents 83 percent of the estimated 82 million adult chickens in Nigeria. In Ethiopia, rural poultry accounts for 99 percent of the national total production of poultry meat and eggs (Tadelle et al., 2000).
- Poultry are the smallest livestock investment a village household can make. Yet the poverty stricken farmer needs credit assistance even to manage this first investment step on the ladder out of poverty. Poultry keeping is traditionally the role of women in many developing countries. Female-headed households represent 20 to 30 percent of all rural households in Bangladesh (Saleque, 1999), and women are more disadvantaged in terms of options for income generation. In sub-Saharan Africa, 85 percent of all households keep poultry, with women owning 70 percent of the poultry. (Guéye, 1998 and Branckaert, 1999, citing World Poultry 14).
- Income generation is the primary goal of family poultry keeping. Eggs can provide a regular, albeit small, income while the sale of live birds provides a more flexible source of cash as required. For example, in the Dominican Republic, family poultry contributes 13 percent of the income from animal production (Rauen et al., 1990). The importance of poultry to rural households is illustrated by the example below from the United Republic of Tanzania (see Table 1.1). Assuming an indigenous hen lays 30 eggs per year, of which 50 percent are consumed and the remainder has a hatchability of 80 percent, then each hen will produce 12 chicks per year.

Importance of Poultry farming

- Most important aspect of agriculture in producing meat and egg as part of health and diet. Commercial farming feeds the large population in the world.
- Is an animal husbandry that raises domesticated birds such as chickens, ducks, turkey and geese to produce meat or eggs for consumption and marketing
- Provides research areas in poultry science to deal with egg and meat production systems, production development, egg and meat quality and economics.

Importance of Poultry Production

- Production of eggs , meat and generates high revenue
- Good source of food from eggs and meat

Benefits of poultry production

- 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.
- Poultry farming is a continuous source of revenue and food.

Supply and demand in poultry production

The expectations by consumer population on poultry production of meat and eggs;

1. Increased Health perceptions: healthier protein to consume
2. Increased in convenience vs. whole bird sales

Examples

1. 1980's: a shift in the type of meat products people could purchase at the market
2. Consumer preferred further processed and already cut-up meat compared to doing it themselves at home
 - New products: chicken tenders and other ready –to eat frozen foods
 - Convenience items: rotisserie chickens also become a big hit
3. Low cost- the price of chicken compared to other meat is lower because of efficiencies in productions.
4. Fast food outlets: many meals at fast food restaurants now have chicken options or are solely chicken.
5. Designer Eggs;
 - Contributes to making eggs more appealing to health-conscious consumers, increasing sales.
 - Designer Eggs: eggs which have higher concentrations of: Vitamin E, - Omega – 3 fatty acids (good for the heart)

Ref: History of Poultry Production “not just feet and feathers” (file:///G:/Agriculture%20Poultry/HistoryofPoultryProductionver3Pres.pdf)

Benchmark: 9.2.4.2. Differentiate between domesticated and farmed birds, and examine these animals in each of these two categories

Topic: TYPES OF DOMESTICATED AND FARMED BIRDS

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • identify and describe the different types of domesticated and farmed birds, • Observe and describe the differences of domesticated and farmed birds.
Essential Questions	<ol style="list-style-type: none"> 1. What are the types of farmed birds? 2. What are the types of domesticated birds? 3. Distinguish between domesticated and farmed birds?
Knowledge	Types of farmed and domesticated birds
Skills	Analyse and describe the types of farmed and domesticated birds
Attitudes	Show enthusiasm in the types of farmed and domesticated birds
Values	Care and love for birds

Content Background:

Types of domesticated birds

Domestic bird is neither wild caught nor bred in another country and imported. For example, Cockatoo originates from Australia but is a domestic bird in the United States of America. When the parent bird bred has its baby hatched within the country that makes the bird to be a domestic bird. They offer great companionship, food and fibre to humans. People raise them as pets and to provide fresh eggs every day. Large commercial chicken industry farms them to produce egg and meat in large quantities to meet consumer needs and wants.

There are 8 common types of pet birds

1. Budgerigar
2. Cockatiel
3. Cockatoo
4. Hyacinth Macaw
5. Parrotlet
6. Green Cheeked conure
7. Hahn's Macaw

Ref: *Wikipedia*

Types of farmed birds

There are 6 farmed birds according to research by Kristen Lie-Nielsen (Aug.14, 2017)

- **Chicken** – can be domestic and farmed for its delicious eggs and meat, has beautiful feathers and make as great pets. Eat bugs and eats 1\4 pound in a day and easy to grow. Adult hen can lay 4 to 6 eggs in a week. Can feed family for several days.
- **Geese** – friendly and very useful, easy to keep and can bring variety of rewards. Lays 20 to 40 eggs in a year and known for its delicious dark meat. It is a weedier of flat leafy weeds and an excellent guard animal – honking loudly when predators or intruders are around. Feeds on ½ pound a day and needs water to swallow its food.
- **Ducks** – farmed for thousands of years- different types such as skinny runners, meat-faced, unique muscovy plumber swimming breeds which have their own needs. Use water to bath and swallow their food and eat. Need space of 4 sq feet per bird, sleeps on the ground and eats ¼ pounds of feed a day.
- **Guinea Fowl** – African bird has blue bald heads and speckled. Lays 30 eggs a year and during summer does not feed. Has better flavor than chicken – use for pest control and has good fresh eggs.
- **Quail** - great birds and require space of 1sq feet per bird. Does not require nest boxes- lays eggs in private corners – skittish, runs and hides, 200 eggs/year – tiny and speckled and delicacy. Eats 1.5 grains per day – should be kept away from large predators such as rats and cats.
- **Turkey** – Striking addition to your farm. Male bird, when its happy will show off its plumage and has bright blue head. Originally from Mexico and Central America. Lays 2 to 3 eggs per week, has good meat and can be kept as a pet- very affectionate but notorious.

Benchmark: 9.2.4.3. Examine and evaluate the characteristics of domesticated and farmed birds.

Topic: DOMESTICATED AND FARMED BIRDS

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Describe the characteristics and behaviors of domesticated birds • Describe the characteristics and behaviors of farmed birds • Explain their understanding of the birds through their experiences in their contexts
Essential Questions	<ol style="list-style-type: none"> 1. What are the characteristics and behaviors of domesticated birds? 2. What are the characteristics and behaviors of farmed birds?
Knowledge	<ul style="list-style-type: none"> • Characteristics and behaviors of domesticated birds 2. Characteristics and behaviors of farmed birds
Skills	<ul style="list-style-type: none"> • Examine, observe and describe the characteristics and behaviors of domesticated birds and Characteristics and behaviors of farmed birds.
Attitudes	<ul style="list-style-type: none"> • Care and love for birds
Values	<ul style="list-style-type: none"> • Appreciate and be considerate about the characteristics and behaviors of domesticated birds and Characteristics and behaviors of farmed birds.

Content Background:

Birds can be carnivores, herbivores or omnivores. Adult birds find food for their babies. There are five (5) major characteristics of birds by Michelle Ullman

1. Feathers

All birds have Feathers as the definite characteristic of Aves, found on every living species of bird and no other class of animal. Feathers are made of keratin, the same substance that forms hair and nails in other animals and are highly modified scales. Feathers are critical not only for flight but also for warmth and protection against the elements -- and in many species, for males to attract mates. Soft, fluffy downy feathers help keep birds warm, contour feathers streamline birds' bodies and aid in flying, and flight feathers on wings and tail give the bird loft. Birds shed, or molt, old feathers once or twice each year, depending on the species.

2. Wings

All birds have wings, although not all birds fly. Nor are wings confined to Aves; bats are flying mammals and most insects have wings. Birds' bodies are beautifully designed for flight, with strong chest muscles and just enough curve to their wings to provide lift. Differences in wing shape provide different advantages to the various bird species. The narrow, sharp-tipped wings of the falcon provide speed; albatrosses soar high on wings much longer than they

are wide. Most songbirds have elliptical, evenly shaped wings that facilitate quick, small movements in the tight spaces of their tree homes. Swimming birds, such as penguins and puffins, have flipper-shaped wings that propel them rapidly and gracefully through water.

3. Beak

All birds have beaks, or bills, made of a bony core surrounded by a thin layer of keratin. Birds do not have true teeth, but many species have tomia -- sharp ridges along the edges of their beaks. Birds do not chew food but grind or rip it into pieces small enough to swallow. The shape of a bird's beak indicates the bird's general diet. Meat-eaters like hawks and owls have sharp, hooked beaks for ripping and tearing. Strong, cone-shaped beaks help seed eaters break through shells. Ducks and geese have broad, flat beaks for straining food out of the water.

4. Eggs

All birds lay eggs, some very colorful or covered with spots. Eggs are not unique to birds, of course, as fish, reptiles, amphibians and insects also lay eggs. A bird egg has a hard shell made mostly of calcium and a layer of hardened mucus. Inside the egg, the developing embryo receives nutrition from the yolk and the albumin, the egg white. Most birds construct nests to protect their eggs, and then care for the eggs and the hatchlings. The majority of bird species are devoted parents; in most cases, both male and female care for young.

5. Skeleton

Most birds have lightweight skeletons with hollow bones. This keeps them light enough for flight. Many fused bones, including the collarbones or wish-bones, make birds' skeletons rigid in comparison to mammals'. This helps brace the birds' wings during flight. Their sternums, or breastbones, are large, providing sturdy attachment points for powerful wing muscles. Flightless penguins have heavy bones filled with marrow, helping them to survive in their freezing home range. Ostriches have heavy, solid bones in their legs, helping the birds run and defend themselves with powerful kicks.

Bird behaviours

Refer to the actions of birds in response to environmental situations. Some display instinctive behaviours, while others display learned behaviours. This means that they care for themselves by feeding and interacting with other birds, humans and other animals. The birds view people as part of their flock therefore act accordingly.

Dominant birds are birds that display their behaviours when they believe that they are the head of a pecking order. They can develop bad behaviours by biting or screeching at people and other animals to defend their territory. Following are the interpretation of the behaviours that birds display;

- Tongue clicking – invitation to interact with other birds etc.
- Grinding of the beak – at ease and contentment
- Panting – overheated or uncomfortable
- Sharp flick of the wing – demonstration of annoyance

- Preening – to keep the feathers in good condition, the bird smooths its feathers by stroking them with its beak, the garden birds do dust baths and splash around in the water.
- Feeding behavior – changes according to temperature, season and time of the day, in winter they bobble their heads when they are hungry or excited for being fed. Some birds feed at certain time of the day – some species are very messy when they feed with enthusiasm.

Common Behaviours & Tips by Brian Mertins “Easy Guide to Understanding Bird Behaviour”

1. Feeding Behaviour – various ways of feeding by different species of birds

- Ground Feeding
- Canopy Feeding
- Bark Feeding
- Aerial Feeding
- “Hawking” Behavior
- Predatory Feeding (Hunting) - A heron hunting voles in the tall grass

2. Territorial Behaviour – showing its dominance or arrogance behavior

3. Courtship Behaviour – showing its courtship with a male or female bird of the same species

4. Nest Building – different birds build their own nests by nature and species

- Cup Nests
- Cavity Nests
- Other Nest Types

5. Mating Behaviour – between a male and female bird

6. Mobbing & Predator Evasion - Parent birds intensely chase, scream & mob, sometimes directed towards animals that threaten their lives by animals such as rats, jays, squirrels, raccoons, snakes, etc. when birds are calling and giving an alarm because of the threats from the predators.

7. Fledgling Behaviour – behavior shown by the young birds due to new environment or climatic changes; when the juveniles have now left their comfortable nest and they seem groggy and clumsy as they test their wings. They can land on humans and will find it hard to avoid predators if they don't understand their bird languages. They follow their parents begging for food.

8. Flocking Behaviours – moving in flocks instead of isolation- the juveniles are now self-sufficient, but remain with the group for safety.

9. Migration & Seasonal Movement – flight of birds from one location to another depending on the change of seasons.

Strand 2 Unit 5: Bird Farming Practices and Management Systems

Content Standard 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.

Benchmark: 9.2.5.1 Investigate and appraise the poultry farming principles, systems, and practices used in different environments.

Topic: POULTRY FARMING PRINCIPLES, SYSTEMS AND PRACTICES

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • explore types of production systems used in poultry farming and • explain how they are practiced used in different environments
Essential Questions	<ol style="list-style-type: none"> 1. What are the production systems used in poultry farming? 2. What is the purpose of small production system and explain how it is practiced in different environments? 3. What production systems do the large scale or commercial farming use and for what purpose?
Knowledge	<ul style="list-style-type: none"> • Production systems used in Poultry Farming
Skills	<ul style="list-style-type: none"> • Investigate and study the production methods and systems and explain how they used in poultry farming
Attitudes	<ul style="list-style-type: none"> • Acceptance of the production systems used in poultry farming
Values	<ul style="list-style-type: none"> • Appreciate the production systems used in poultry farming

Content Background:

Production systems of Poultry farming

Small scale production systems are used by family farming to meet their everyday needs for the following reasons;

- home consumption only;
- home consumption and cultural reasons
- income and home consumption and
- income only

Family poultry are kept under a wide range of conditions, which can be classified into one of four broad production systems (Bessei, 1987):

- free-range extensive ,
- backyard extensive
- semi-intensive
- Intensive.

Free-Range Extensive Systems

The birds are kept under free-range conditions, where they are not confined and can scavenge for food over a wide area. The two Free-Range Extensive Systems can be the;

1. **Rudimentary shelters** made to for birds to roost - may or may not be used. The birds may roost outside, usually in trees, and nest in the bush. These flocks of birds consist of different species with varying ages.
2. **Backyard Extensive Systems** where Poultry are housed at night but allowed free-range during the day. They are usually fed a handful of grain in the morning and evening to supplement scavenging.

Semi-Intensive Systems

These are a combination of the extensive and intensive systems where birds are confined to a certain area with access to shelter. They are commonly found in urban and peri-urban as well as rural situations. In the “run” system, the birds are confined in an enclosed area outside during the day and housed at night. Feed and water are available in the house to avoid wastage by rain, wind and wild animals. In the European system of free-range poultry keeping, there are two other types of housing. The first of these is the “ark” system, where the poultry are confined overnight (for security against predators) in a building mounted on two rails or skids (usually wooden), which enable it to be moved from place to place with draught power. A typical size is 2 × 2.5 m to hold about 40 birds. The second type of housing is the “fold” unit, with a space allowance (stock density) for adult birds of typically 3 to 4 birds per square metre (birds/m²), both inside and (at least this) outside. The fold unit is usually small enough to be moved by one person. Neither of these two systems is commonly found in developing countries

Intensive Systems

These systems are used by medium to large-scale commercial enterprises, and are also used at the household level. Birds are fully confined either in houses or cages. Capital outlay is higher and the birds are totally dependent on their owners for all their requirements; production however is higher. There are three types of intensive systems;

- **Deep litter system:**
Where birds are fully confined (with floor space allowance of 3 to 4 birds/m² within a house, but can move around freely. The floor is covered with a deep litter (a 5 to 10 cm deep layer) of grain husks (maize or rice), straw, wood shavings or a similarly absorbent (but non-toxic) material. The fully enclosed system protects the birds from thieves and predators and is suitable for specially selected commercial breeds of egg or meat producing poultry (layers, breeder flocks and broilers).
- **Slatted floor system:**
This is where wire or wooden slatted floors are used instead of deep litter, which allows stocking rates to be increased to five birds/m² of floor space. Birds have reduced contact with faeces and are allowed some

freedom of movement.

- Battery cage system:

-

This is usually used for laying birds, which are kept throughout their productive life in cages. There is a high initial capital investment, and the system is mostly confined to large-scale commercial egg layer operations. An intensive system of rearing indigenous chickens commercially is uncommon, a notable rare exception being in Malaysia, where the industry developed in response to the heavy demand for indigenous chickens in urban areas (Subramanian, 1988). However, this accounts for only two in every 100 000 (0.002 percent) of that country's indigenous chicken.

Benchmark: 9.2.5.2 Examine systems and practices used to farm birds in different climatic conditions and critically reflect on the challenges.

Topic: BIRD FARMING SYSTEMS FOR DIFFERENT CLIMATIC CONDITIONS

Essential Knowledge, Skills, Attitude and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> Identify the different systems and practices in bird farming in different climatic conditions Describe the challenges faced in different climatic conditions using the different systems and practices of bird farming.
Essential Questions:	<ol style="list-style-type: none"> 1. What systems and practices of bird farming are used at different climatic conditions? 2. What are the challenges faced with the use of these systems and practices?
Knowledge	<ul style="list-style-type: none"> Advantages and disadvantages of poultry and production systems
Skills	<ul style="list-style-type: none"> Identifying, evaluating and communicating
Attitudes	<ul style="list-style-type: none"> Be considerate about the advantages and disadvantages of poultry and production systems.
Values	<ul style="list-style-type: none"> Appreciate and consider the advantages and disadvantages of poultry and production systems.

Content Background:

Advantages of poultry production systems

In intensive poultry farming;

- Breeds are high yielding and each hen can produce up to 300 eggs per year with use of battery cage systems;
- Higher yield of poultry in egg production activity, triple over other systems
- Allows for higher density of population with greater number of eggs laid per hen
- Resources are more efficient.
- When sanitary control is increased then it is easy to tell the unhealthy fowl
- Shows significance savings in time and labour cost
- Complimentary cages and distribution of food, drinking fountains, storage and filling, egg collection, manure removal and drying chicken manure for example automated systems work very well in this system.

Disadvantages of production systems: In intensive poultry farming;

- birds can be very stressful and may allow for diseases to incur
- Therefore, require or demand a healthy balanced diet and a comfortable environment.
- May be too costly to manage.

With use of battery cage systems;

- Reduction of animal welfare which usually leads to possible effects of health of the birds
- Stressed birds may lead to infertility

Unit 6: Bird Farming and Technology

Content Standard 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.

Benchmark: 9.2.6.1 Identify and explain the different technologies used in the poultry farming

Topic: TECHNOLOGIES USED IN POULTRY PRODUCTION SYSTEMS

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> Identify and describe how different technologies are used in poultry management practices such as processing, preservation etc Explain the strengths and weakness of how this technology is used in each of the specific stages of practice of poultry farming.
Essential Questions:	1. What are the different technologies and how are they used in poultry farming?
Knowledge	Different technologies used in the poultry farming
Skills	Recognize and explain the different technologies used in the poultry farming
Attitudes	Acknowledge and appreciate the technologies used in poultry farming.
Values	Appreciate the different technologies used in bird farming

Content Background

Technologies used in Poultry production systems in Bird Farming
Generally, technologies are used both in small scale and large scale production systems to meet the needs and demands of consumption and market of poultry egg and meat. This includes the appropriate technologies and expertise and specialties of labour and equipment's and materials to structure and build housing, brooding, feeding systems, water troughs and collecting eggs processes for the production to be of expected quality output.

Feed storage silos	Laying nests
<ul style="list-style-type: none"> Watering lines Ventilation and monitoring systems Cooling systems Heating systems 	<ul style="list-style-type: none"> Incinerators Processing of manure and composter systems Hatcheries Transport of eggs, chicks and feed.

The different Technologies used in production systems

- Large scale production systems

The requirements for poultry farms and creating optimal conditions have fundamentally changed in the past couple of years. Without new technologies

and modern approaches you cannot guarantee the high efficiency of farms. Modern farm poultry breeding is a complex of top technologies. In order to function as a balanced unit, it is necessary to have not only the appropriate technology, but the experience of a team of top-class specialists - architects, builders, livestock specialists, feed and genetic specialists, electrical engineers and others.

To maintain the high efficiency and quality of production the large scale production systems must provide the technologies, structures, and building components for the following poultry production systems;

- Feed storage - silos
- Spiral conveyors
- Feeding lines and chain conveyors
- Weighing systems for feed and animals
- Watering lines
- Ventilation and monitoring systems
- Cooling systems
- Heating systems
- Control systems
- Surveillance systems
- Lighting systems
- Laying nests
- Cages and alternative systems
- Egg collection
- Building constructions
- Incinerators
- Processing of manure and composter systems
- Hatcheries
- Transport of eggs, chicks and feed
- Feed mills
- Large-capacity grain storages

Benchmark: 9.2.6.2 Explore the advantages and disadvantages of technologies used in the production systems in different environments.

Topic: ADVANTAGES AND DISADVANTAGES OF THE USE OF TECHNOLOGY

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> Describe the advantages and disadvantages of technologies used in the production systems and where they are used in different environments.
Essential Questions	<ol style="list-style-type: none"> 1. What are the advantages and disadvantages of technologies used in the production systems? 2. Where are the technologies used in different environments?
Knowledge	Advantages and disadvantages of technologies used in the production systems
Skills	Explore and discover the advantages and disadvantages of technologies used in the production systems.
Attitudes	Aware of and appreciate the advantages and disadvantages of technologies used in the production systems.
Values	Value the importance of the advantages and disadvantages of technologies used in the production systems.

Content Background:

Advantages of the technologies used in the production systems

- Increases the efficiency of the poultry systems
- Streamline relationships with suppliers and customers
- Increase the speed , flexibility and efficiency of the production process
- Expand the range of what can be produced from meat and eggs.

Disadvantages of the technologies used in the production systems

- May be very costly – you need to have the capital to start up a poultry farm and its production system
- To be successful, you need adequate feed for the birds
- You require the presence of non-acidic clean water- colourless, odorless, clear and tasteless for birds to drink.
- Environment to be conducive for bird species to survive
- Have to control the avian flu that can transmit from bird to human
- Also loose a batch of chicks with poultry disease.

Technologies used in different environments

Technologies used in different environments vary to suit their conditions and wellbeing of poultry, and for quality yield of meat and eggs.

- Savannah dry and wet climate
- Highlands cold and wet climate
- Coastal temperatures –islands and coastal villages

Strand 3:

Content Overview

Content Standard 3.1 Students will be able to define aquaculture, investigate the different types of plants, animals and fish cultivated using this method of farming, categorize 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
Unit 1: Types of Aqua farming Plants, Animals, and Fish	9.3.1.1 Investigate and make sense of the historical background of aqua farming and rationalize its importance	Introduction to Aqua Culture	1. Historical background of aqua farming 2. Importance of aquaculture
	9.3.1.2 Distinguish and explain the attributes of freshwater, brackish water, and salt water environment.	Aquatic farming environments	1. Attributes of freshwater environments 2. Attributes of brackish environment 3. Attributes of saltwater environments.
	9.3.1.3 Investigate and discuss the cultivation of different fresh, brackish and salt water plants in different environments.	Cultivation of aquatic plants	1. Fresh water plants cultivation 2. Brackish plants cultivation 3. Saltwater plants cultivation

Content Standard 3.2 Students will be able to investigate and analyze 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.

Units	Benchmarks	Topics	Lesson Titles
Unit 2: Aqua farming Practices and Management Systems	9.3.2.1 Examine the principles of aqua farming and explain their importance in understanding aqua farming practices	Principles of aqua farming	1. Aqua farming principles 2. Importance of Aqua farming
	9.3.2.2 Investigate and explain aqua farming systems and practices used in different places and environments.	Aqua Farming Systems And Practices	1. Importance of Aqua farming 2. Fresh water farming systems and practices 3. Brackish water farming systems and practices 4. Salt water farming systems and practices`

Content Standard 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.

Units	Benchmarks	Topics	Lesson Titles
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Unit 3: Aqua farming and Technology	9.3.3.1 Identify and discuss the tools, equipment and other devices used in aqua farming.	Gears and devices used in aqua farming	<ol style="list-style-type: none">1. Aqua farming gears and equipment.2. Devices used in Aqua farming
	9.3.3.2 Analyze technologies used in aqua farming, identify their problems, and develop appropriate solutions.	Challenges faced with the use of technology	<ol style="list-style-type: none">1. Aqua farming technologies2. Problems associated with the use of aqua farming technology3. Solutions and appropriate actions

Content Standard 3.1 Students will be able to define aquaculture, investigate the different types of plants; animals and fish cultivated using this method of farming, categorize them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they are farmed.

Benchmark: 9.3.1.1 Investigate and make sense of the historical background of aqua farming and rationalise its importance.

Topic: Introduction to Aquaculture

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of the topic; students will be able to; <ul style="list-style-type: none"> • Define the meaning of aqua farming • Explain the history of aqua farming and its importance • Distinguish between domestic and commercial aqua culture farming practices
Essential Questions	<ol style="list-style-type: none"> 1. What is Aquaculture? 2. Which environment enables aquaculture farming? 3. What is the main aquaculture farming practice use informally? 4. What is domestic aquaculture? 5. What is commercial aquaculture?
Knowledge	<ul style="list-style-type: none"> • Meaning of Aqua farming • Historical background of Aqua farming/ also in PNG • Importance of Aqua farming/also in PNG
Skills	<ul style="list-style-type: none"> • Explain the meaning of aquaculture and aqua farming • Draw timeline on Aqua farming • Explore historical background of Aqua farming in PNG and its importance
Attitudes	<ul style="list-style-type: none"> • Be committed , diligent and acknowledge the History of Aqua farming in other countries and even in Papua New Guinea
Values	<ul style="list-style-type: none"> • Value the usefulness and the importance of Aqua farming and its meaning also in Papua New Guinea.

Content Background:

Aquaculture is breeding, raising, and harvesting fish, shellfish, and aquatic plants. Basically, it's farming in water. Aquaculture (less commonly spelled aquiculture), also known as aqua farming, is the farming of fish, crustaceans, molluscs, aquatic plants, algae, and other organisms. Mariculture refers to aquaculture practiced in marine environments and in underwater habitats. What are aquatic plants give two examples?

Many small aquatic animals use plants such as duckweed for a home, or for protection from predators. Some other familiar examples of aquatic plants might include floating heart, water lily, lotus, and water hyacinth.

All **crocodiles** are semiaquatic and tend to congregate in freshwater habitats such as rivers, lakes, wetlands and sometimes in brackish water and saltwater.

Hydrophytes

Aquatic plants are plants that have adapted to living in aquatic environments (saltwater or freshwater). They are also referred to as hydrophytes or macrophytes.

Characteristics of aquatic environments

Abiotic characteristics

An ecosystem is composed of biotic communities that are structured by biological interactions and abiotic environmental factors. Some of the important abiotic environmental factors of aquatic ecosystems include substrate type, water depth, nutrient levels, temperature, salinity, and flow.

What three criteria do we use to classify aquatic biomes?

Aquatic biomes are distinguished by the availability of sunlight and the concentration of dissolved oxygen and nutrients in the water.

- The photic zone extends to a maximum depth of 200 meters, while the aphotic zone is deeper than 200 meters.
- Aquatic biomes in the ocean are called marine biomes.

The History of Aquaculture

Aquaculture consists in farming aquatic organisms. Around 500 BCE, the Romans farmed oysters and fish in Mediterranean lagoons, whereas freshwater **aquaculture** developed empirically some 1000 years earlier in China. The earliest form of **aquaculture** practiced consisted of trapping wild aquatic animals in lagoons, ponds or small shallow lakes, so that they would be available at all times. This method dates back to the Neolithic age, when man started to act on natural resources, namely around 4000 B.C. in Europe.

Benchmark: 9.3.1.2 Distinguish and explain the attributes of freshwater, brackish water, and salt water environment.

Topic: Aquatic Farming Environments

Essential Knowledge. Skills, Values and Attitudes	
Learning Objectives	By the end of the topic; students will be able to; <ul style="list-style-type: none"> • Identify different types of aqua farming based on the environment. • Differentiate between a variety of aquatic environments • Compare and classify aquatic organisms according to the type of aquatic environment that is conducive for its survival
	<ol style="list-style-type: none"> 1. What does aquatic environment mean? 2. Where do we farm aquatic organisms? 3. What are the characteristics of aquatic environment?
Knowledge	<ul style="list-style-type: none"> • Types of Aqua farming • Quality, characteristics and features of aqua farming in marine, fresh and brackish water environments
Skills	<ul style="list-style-type: none"> • Identify different types of aqua farming based on the environment • Explain the characteristics of different types of aqua farming in different environment
Attitudes	<ul style="list-style-type: none"> • Appreciate the attributes of aqua farming
Values	<ul style="list-style-type: none"> • Value the attributes of aqua farming

Content Background

The physical-chemical characteristics of any aquatic ecosystem include pH, conductivity, and temperature, water transparency, nutrient and the chlorophyll-levels. Aquatic means relating to water; living in or near water or taking place in water; does not include groundwater, as "aquatic" implies an environment where plants and animals live. Aquatic ecosystem, environmental system located in a body of water.

There are four types of aquatic biomes

- Freshwater Biome. It is naturally occurring water on Earth's surface. ...
- Freshwater wetlands Biome.
- Marine Biome.
- Coral reef Biome.

In addition to water breathing animals, e.g. fish, most mollusks etc., the term "aquatic animal" can be applied to air-breathing aquatic or sea mammals such as those in the orders Cetacea (whales) and Sirenia (sea cows), which cannot survive on land, as well as the pinnipeds (true seals, eared seals, and the walrus).

There are two main types of aquaculture—marine and freshwater. NOAA efforts primarily focus on marine aquaculture, which refers to farming species that live in the ocean and estuaries

1. Mariculture

Mariculture is aquaculture that involves the use of sea water. It can either be done next to an ocean, with a sectioned off part of the ocean or in ponds separate from the ocean, but containing sea water all the same. The organisms bred here range from molluscs to sea food options like prawn and other shellfish, and even seaweed.

Growing plants like seaweed are also part of mariculture. These sea plant and animal species find many uses in manufacturing industries such as in cosmetic and jewellery where collagen from seaweed is used to make facial creams. Pearls are picked from mollusc and made into fashion items.

2. Fish farming

Fish farming is the most common type of aquaculture. It involves the selective breeding of fish, either in fresh water or sea water, with the purpose of producing a food source for consumption. Fish farming is highly exploited as it allows for the production of cheap source of protein.

Furthermore, fish farming is easier to do than other kinds of farming as fish are not care intensive, only requiring food and proper water conditions as well temperatures. The process is also less land intensive as the size of ponds required to grow some fish species such as tilapia is much smaller than the space required growing the same amount of protein from beef cattle.

3. Alga culture

Alga culture is a type of aquaculture involving the cultivation of algae. Algae are microbial organisms that share animal and plant characteristics in that they are motile sometimes like other microbes but they also contain chloroplasts that make them green and allow them to photosynthesize just like green plants. However, for economic feasibility, they have to be grown and harvested in large numbers. Algae are finding many applications in today's markets. Exxon Mobile has been making strides in developing them as a new source of energy.

4. Integrated multitrophic aquaculture

IMTA is an advanced system of aquaculture where different trophic levels are mixed into the system to provide different nutritional needs for each other. Notably, it is an efficient system.

1. Different types of aqua farming based on the environment

Based on different sources available and involved in farming activity, aquaculture is categorized as mentioned below.

1) Based on temperature of water

- Warm water farms
- Cold water farms

2) Based on water replacement

- Running water farms
- Stagnant water farms

3) Based on physiographical zone

- Inland fish farms
- Coastal fish farms
- Marine fish farms

4) Based on water source

- Rain fed farms
- Tide fed farms
- Ground water fed farms
- River/Canal fed farms
- Spring water/Artesian fed farms
- Sewage fed farms
- Seepage water farms

5) Based on material used for pond construction

- Earthen ponds
- Cement ponds
- Lined earthen ponds
- Plastic tanks

6) Based on species cultured

- Carp farming
- Shrimp farming
- Tilapia farming
- Cat fish farming
- Mullet farming

7) Based on organism cultured

- Fish farm
- Prawn farm
- Crab farm
- Oyster farm
- Mussel farm
- Seaweed farm

8) Based on development stage

- Breeding farm/Hatchery
- Nursery farm
- Seed rearing farm
- Grow out farm

9) Based on sex

- Monosex culture farms
- Mixedsex culture farms

10) Based on stocking

- Single size stocking
- Multiple sizes stocking

11) Based on harvesting

- Single harvesting
- Multiple harvesting
- Rotational harvesting

12) Based on levels of input intensity

Level 1 – Without management either for stocking fish seeds or for fish food supply.

Level 2 – Seeds are stocked. These are supported by the fish food organisms produced only by natural soil productivity. Only stocking of seed is prevalent.

Level 3 – Seeds are stocked and are supported by the fish food organisms produced by natural soil productivity and increased productivity by organic manure and inorganic fertilizer application. Stocking of seed and manure fertilizer application is prevalent.

Level 4 – Stocked fishes are supported by natural soil based productivity, increased productivity due to manure fertilizer application and supplementary feeding.

Level 5 – Hatchery produced seeds are supported only by formulated feed

Resources/Sources

Aquaculture: Characters, types and qualities article shared by Sanchita Kadam

Benchmark: 9.3.1.3 Investigate and discuss the cultivation of different freshwater, brackish water and salt water in different environment.

Topic: Cultivation of Aquatic Plants

Essential Knowledge, Skills, Attitudes and values	
Learning Objectives	<p>Students will be able to;</p> <ul style="list-style-type: none"> • Examine and explain the cultivation of different fresh water plants • Identify different types of aqua farming based on the environment. • Explain the attributes of freshwater, brackish water and saltwater environment • Explain characteristics of aqua farming in different environment • Examine and explain the cultivation of different brackish water plants • Examine and explain the cultivation of different salt water plants • Purpose and benefits of aqua farming
Essential Questions	<ol style="list-style-type: none"> 1. What is the fastest growing aquatic plant? 2. What is the cultivation of plants in water called? 3. Do aquatic plants need sunlight? 4. What are the two main types of aquaculture? 5. How are different fresh water plants cultivated? 6. How are different brackish water plants cultivated? 7. How are different salt water plants cultivated?
Knowledge	<ul style="list-style-type: none"> • Examine the cultivation of different aqua farming plants • Explain the cultivation of aqua farming plants
Skills	<ul style="list-style-type: none"> • Examine the cultivation of different aqua farming plants • Explain the cultivation of aqua farming plants
Attitudes	<ul style="list-style-type: none"> • Collaborate with others, commit and assist in the observation of aqua farming plants and diligently discuss and explain the findings on their cultivation processes.
Values	<ul style="list-style-type: none"> • Value the cultivation, purpose and benefits of aqua farming plants

Content Background:

Aquatic plants are among the easiest plants to grow. Many aquatic plants are actually weeds in their native habitat. In cultivation, these plants are grown in containers. Some popular containers are dish pans, plastic nursery pots or specially made plastic containers for aquatic gardens.



Types of environment

A number of aquaculture practices are used world-wide in three types of environment (freshwater, brackish water, and marine) for a great variety of culture organisms. One of the most popular carpeting plants is java moss because it grows quickly and is easy to take care of. That said, it has been known to grow too fast and may require a lot of pruning to keep it manageable. This is a great choice for anyone who is trying to breed fish

Hydroponics is a type of horticulture and a subset of hydro culture, which is a method of growing plants, usually crops, without soil, by using mineral nutrient solutions in an aqueous solvent. Some plant species need more intense light to thrive, and because light does not penetrate water very well, a stronger light source is needed for taller aquariums. Aquatic plants do best under full spectrum light with a Kelvin rating or “color temperature” between 6,500K and 8,000K.

There are two main types of aquaculture—marine and freshwater. NOAA efforts primarily focus on marine aquaculture, which refers to farming species that live in the ocean and estuaries

1. Mariculture

Mariculture is aquaculture that involves the use of sea water. It can either be done next to an ocean, with a sectioned off part of the ocean or in ponds separate from the ocean, but containing sea water all the same. The organisms bred here range from mollusks to sea food options like prawn and other shellfish, and even seaweed. Growing plants like seaweed are also part of mariculture. These sea plant and animal species find many uses in manufacturing industries such as in cosmetic and jewellery where collagen from seaweed is used to make facial creams. Pearls are picked from mollusk and made into fashion items.

2. Fish farming

Fish farming is the most common type of aquaculture. It involves the selective breeding of fish, either in fresh water or sea water, with the purpose of producing a food source for consumption. Fish farming is highly exploited as it allows for the production of cheap source of protein.

Furthermore, fish farming is easier to do than other kinds of farming as fish are not care intensive, only requiring food and proper water conditions as well temperatures. The process is also less land intensive as the size of ponds required to grow some fish species such as tilapia is much smaller than the space required growing the same amount of protein from beef cattle.

3. Alga culture

Alga culture is a type of aquaculture involving the cultivation of algae. Algae are microbial organisms that share animal and plant characteristics in that they are motile sometimes like other microbes but they also contain chloroplasts that make them green and allow them to photosynthesise just like

green plants. However, for economic feasibility, they have to be grown and harvested in large numbers. Algae are finding many applications in today's markets. Exxon mobile has been making strides in developing them as a new source of energy.

4. Integrated multitrophic aquaculture

IMTA is an advanced system of aquaculture where different trophic levels are mixed into the system to provide different nutritional needs for each other. Notably, it is an efficient system

Benefits of Aquaculture

(a) Economic Benefits

1. Alternative food source

Fish and other seafood are good sources of protein. They also have more nutritional value like the addition of natural oils into the diet such as omega 3 fatty acids. Also since it offers white meat, it is better for the blood in reducing cholesterol levels as opposed to beef's red meat. Fish is also easier to keep compared to other meat producing animals as they are able to convert more feed into protein. Therefore, its overall conversion of pound of food to pound of protein makes it cheaper to rear fish as they use the food more efficiently.

2. Alternative fuel source

Algae are slowly being developed into alternative fuel sources by having them produce fuels that can replace the contemporary fossil fuels. Algae produce lipids that if harvested can be burn as an alternative fuel source whose only by products would be water when burnt.

Such a breakthrough could ease the dependency of the world on drilled fossil fuels as well as reduce the price of energy by having it grown instead of drilling petroleum. Moreover, algae fuel is cleaner and farmable source of energy, which means it can revolutionize the energy sector and create a more stable economy that avoids the boom-bust nature of oil and replaces it with a more abundant fuel source.

3. Increase Jobs in the market

Aquaculture increases the number of possible jobs in the market as it provides both new products for a market and creates job opportunities because of the labour required to maintain the pools and harvest the organisms grown. The increase in jobs is mostly realized in third world countries as aquaculture provides both a food source and an extra source of income to supplement those who live in these regions. Aquaculture also saves fishermen time as they do not have to spend their days at sea fishing. It allows them free time to pursue other economic activities like engaging in alternative businesses. This increase in entrepreneurship provides more hiring possibilities and more jobs.

4. Reduce Sea Food Trade Deficit

The sea food trade in America is mainly based on trade from Asia and Europe, with most of it being imported. The resultant balance places a trade deficit on the nation. Aquaculture would provide a means for the reduction

of this deficit at a lower opportunity cost as local production would mean that the sea food would be fresher. It would also be cheaper due to reduce transport costs.

(b) Environmental Benefits

1. Creates Barrier against pollution with mollusc and sea weed

Molluscs are filter feeders while seaweed acts a lot like the grass of the sea. Both these organisms sift the water that flows through them as brought in by the current and clean the water. This provides a buffer region that protects the rest of the sea from pollution from the land, specifically from activities that disturb the sea bed and raise dust.

Also, the economic benefits of molluscs and sea weed can create more pressure from governments to protect their habitats as they serve an economic importance. The financial benefits realised provides incentive for the government to protect the seas in order to protect sea food revenue.

2. Reduces fishing pressure on wild stock

The practice of aquaculture allow for alternative sources of food instead of fishing the same species in their natural habitats. Population numbers of some wild stocks of some species are in danger of being depleted due to overfishing.

Aquaculture provides an alternative by allowing farmers to breed those same species in captivity and allow the wild populations to revitalize. The incentive of less labor for more gains pushes fishers to convert to fish farmers and make even more profit that before. It also allows them control of the supply of the fish in the market giving them the ability to create surplus stock or reduce their production to reap the best profits available.

It serves different purposes including; food production, restoration of threatened and endangered species populations, wild stock population enhancement, building of aquariums, and fish cultures and habitat restoration.

(c) Health Benefit

All over the world, the demand for seafood has increased because people have learned that seafood's part of regular diets are healthier and help fight cardiovascular disease, cancer, Alzheimer's and many other major illnesses. Aquaculture is currently estimated to account for approximately 13 percent (10.2 million t) of world fish production. Aquaculture will add to wild seafood, and make it cheaper and accessible to all, especially in regions where there depend on imported seafood products.

Unit 2: Aqua farming Practices and Management Systems

Content Standard 3.2 Students will be able to investigate and analyze 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: 9.3.2.1 Examine the principles of aqua farming and explain their importance in understanding aqua farming practices

Topic 2: Principles of Aqua Farming

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Explain the management principles of different types of aqua farming • Emphasis their importance to understand aqua farming practices
Essential Questions	<ol style="list-style-type: none"> 1. What are principles? 2. Why are principles important in farming practices? 3. Why does Aqua farming have principles and policies?
Knowledge	<ul style="list-style-type: none"> • Management principles of different types of aqua farming • Importance of understanding aqua farming practices
Skills	<ul style="list-style-type: none"> • Explain the management principles of different types of aqua farming • Discuss their importance to understand aqua farming practices in different places and environment
Attitudes	<ul style="list-style-type: none"> • Appreciate the importance of understanding aqua farming practices and the Importance of aqua farming
Values	<ul style="list-style-type: none"> • Sustainability of aquatic environments

Content Background:

Aquaculture is the farming of aquatic organisms such as fish, crustaceans, mollusks, and aquatic plants. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish.

Successful **aquaculture** takes into consideration the biology of the aquatic species such as feeding, water flow and temperature needs, and disease prevention and engineering design like water source and water quality study, pond and tank containment systems, water filtration and aeration. Common products of aquaculture are catfish, tilapia, trout, crawfish, oysters, shrimp, and salmon, and tropical fish for aquariums.

The E- course on Principles of Aquaculture gives outline about the basics and history of aquaculture. A wide range of aspects such as Systems of aquaculture, aquaculture in different types of water bodies, Principles of organic aquaculture, Pond management, study of Monoculture, polyculture and integrated culture systems, Water and soil quality in relation to fish production and estimation of productivity, factors affecting productivity of

ponds, Nutrition, health management and economics were portray detailed

Principles of Freshwater Aquaculture Fish

- Principles of organic aquaculture.
- Pre-stocking and post stocking pond management.
- Criteria for selection of candidate species for aquaculture.
- Major candidate species for aquaculture: freshwater, brackish-water and marine.
- Water and soil quality in relation to fish production and estimation of productivity.

Reference/sources

Benchmark: 9.3.2.2 Investigate and explain aqua farming systems and practices used in different places and environments.

Topic: Aqua Farming Systems and Practices

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Different types of aqua farming management systems. • Discuss aqua farming practices used in different places and environment
Essential Questions	<ol style="list-style-type: none"> 1. What are the different systems of aqua culture? 2. What are some factors that farmers consider when establishing aqua domestic culture? 3. What are the main environments which aqua farming can be established? 4. Which aqua culture environment deals with domestic aqua culture? 5. Why is fresh water farming different from marine water farming?
Knowledge	<ul style="list-style-type: none"> • Types of aqua farming management systems • Aqua farming practices in different places and environment
Skills	<ul style="list-style-type: none"> • Explain different types of aqua farming management systems • Discuss aqua farming practices in different places and environment
Attitudes	<ul style="list-style-type: none"> • Appreciate benefits of domestic aqua farming
Values	<ul style="list-style-type: none"> • Sustainability of aqua farming

Content Background:

Aquaculture practices are classified in several ways, depending upon the different aspects and situations involved in the culture practice. Some major and important classifications are given below based on the different factors involved in aquaculture. On the basis of salinity

- Freshwater farming
- Brackish water farming
- Marine water farming

Aquaculture makes use of local photosynthetic production (extensive) or fish that are fed with external food supply (intensive).

- Extensive aquaculture.
- Intensive aquaculture.
- Cage system.
- Irrigation ditch or pond systems.
- Integrated recycling systems.
- Classic fry farming.
- Labeling.
- Inhumane methods.

Freshwater Farming

Farming of aquatic animals and plants in zero saline water, mostly fresh water farming is inland based. Catla, Rohu, Mrigal, Silver carp, Grass carp, Common carp and Fresh water prawn are mainly farmed in fresh water.

Marine water farming

Farming of aquatic animals and plants in sea water is commonly known as marine water farming or mariculture. In mariculture rearing of commercially important fishes and shell fishes are done in open sea by installing cages. On the basis of intensity

- Extensive fish farming system
- Semi-intensive fish farming system
- Intensive fish farming system
- Extensive fish farming system

Extensive fish farming system is the least managed form of fish farming, in which little care is taken. This system involves large ponds measuring 1 to 5 ha in area with stocking density limited to only less than 5000 fishes/ha. No supplemental feeding or fertilization is provided. Fish depends only on natural foods. Yield is poor (500 to 2 ton/ha) and survival is low. The labour and investment costs are low and this system results in minimum income.

Semi-intensive fish farming system

Semi-intensive fish culture system is more prevalent and involves rather small ponds (0.5 to 1 hectare in area) with higher stocking density (10000 to 15000 fish/ha). In this system care is taken to develop natural foods by fertilization with/without supplemental feeding. However, major food source is natural food. Yield is moderate (3 to 10 ton/ha) and survival is high.

Intensive fish farming system

Intensive fish farming system is the well-managed form of fish farming, in which all attempts are made to achieve maximum production of fish from a minimum quantity of water. This system involves small ponds/tanks/raceways with very high stocking density (10-50 fish/m³ of water). Fish are fed completely formulated feed. Good management is undertaken to control water quality by use of aerators and nutrition by use of highly nutritious feed. The yield obtained ranges from 15 to 100 ton/ha or more. Although the cost of investment is high, the return from the yield of fish exceeds to ensure profit.

On the basis of fish species (number of species stocked for farming)

- Monoculture
- Polyculture
- Monoculture

Monoculture is a fish production system in which only one fish species is reared in a culture system. The major fish varieties reared in monoculture system are trout, tilapia, catfishes, carps, shrimp etc. Monoculture of high-value, market-

oriented fish species in intensive system is a common practice throughout the world. Supplementary feeding is compulsory to ensure production.

Polyculture

Polyculture is a 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. In this system of culture species with different habitats and different food preferences are stocked together in such densities that there will be almost no competition for food or space. Polyculture practices give higher yield than monoculture under the same conditions for freshwater carp farming.

Biological basis of polyculture

Common fish species in Indian polyculture are catla, rohu, mrigal, silver carp, grass carp and common carp, and this system is sometimes called as composite fish culture. The biological basis of polyculture is different fish species grow together in a pond with difference in feeding and living behaviour.

The principal requirements of the different species in combination for polyculture are:

-
- They must be different in feeding habits
- They should occupy different columns in a pond system
- They should attain marketable size at the same time
- They should be non-predatory in behaviour

On the basis of enclosure (enclosure used for culture)

- Pond culture
- Cage culture
- Pen culture
- Race-way culture

Pond culture

It is the most common method of fish culture. In this case water is maintained in an enclosed area by artificial construction of dike/bund, where aquatic animals are stocked and grown. Ponds are usually filled by rain, canal water and by man-made bores. They differ widely in shape, size, topography, water and soil qualities.

Cage culture

Cage culture is rearing of fish from juvenile stage to commercial size in a volume of water enclosed on all sides including bottom, while permitting the free circulation of water. Cage culture is readily adapted to water areas which cannot be drained. Fish culture in cage is an innovative concept to exploit the potential of lakes, reservoirs and riverine pools. Cage culture of fish and other aquatic organisms is popular in many countries. Japan, South Korea, China, Philippines, Thailand, Malaysia, Germany, Norway, USA are some of the countries where cage culture is well developed. In principle, almost every

cultivable species of fish can be cultured in cages, such as carps, tilapia, trout, catfishes, etc. depending on socioeconomic, ecological and technical suitability.

Advantages of Cage Culture

- Use existing water bodies
- Technical simplicity with which farms can be established or expanded
- Lower capital cost compared with land-based farms
- Easier stock management and monitoring compared with pond culture

Disadvantages of Cage Culture

- Stock is vulnerable to external water quality problems e.g. Algal blooms, low oxygen
- Stock is more vulnerable to fish eating predators such as water rats and birds
- Growth rates are significantly influenced by ambient water temperatures

Pen culture: is defined as raising of fish in a volume of water enclosed on all sides except bottom, permitting the free circulation of water at least from one side. This system can be considered a hybrid between pond culture and cage culture. Mostly shallow regions along shores and banks of the lakes and reservoirs are used in making pen/enclosure using net/wooden materials where fish can be raised. In a fish pen, the bottom of the lake forms the bottom of the pen. Pen has the advantage of containing a benthic fauna which serves as food for the fish and polyculture can be practiced in pens as it is in ponds. The environment in fish pen is characterized by a free exchange of water with the enclosing water body and high dissolved oxygen concentrations.

Advantages:

- Intensive utilization of available space: Stocking density can be increased compared to that of a pond culture system
- Safety from predators: Within the enclosure the predators can be excluded. In the larger pens this would be more difficult, but in smaller pens this can be done as efficiently.
- Suitability for culturing many varied species: Due availability of more space and the natural water system
- Ease of harvest: In the large pens the harvest may not be as easy as in cage rearing but it more controllable and easier than in the natural waters.
- The flexibility of size and economy: When compared with the cage, pens can be made much larger and construction costs will be cheaper than that of the cages.
- Availability of natural food and exchange of materials with the bottom: Since, the bottom of the pen is the natural bottom; the pen cultured organisms are at an advantage that they can procure food/exchange materials from the natural bottom.

Disadvantages:

- High demand for oxygen and water flow
- Dependence on artificial feed
- Food losses: Part of the feed is likely to be lost uneaten, and drifted away in the current, but the loss here would be less than in floating cages.
- Pollution : Since a large biomass of fish are cultured intensively a large quantity of excrements accumulate in the area and cause a high BOD - also substances such as ammonia and other excreted materials, if not immediately removed/ recycled. They pollute the water and cause damages.
- Rapid spread of diseases: For the same reason of high stocking density in an enclosed area, any disease beginning will spread very quickly and can cause immense mortality of stock and production decline.
- Risk of theft: Since the fish are kept in an enclosed area, 'poaching' and thefts can take place more frequently than in natural waters, but perhaps less than those from cages.
- Conflict with multiple uses of natural waters: In locations where a pen is constructed, if the water is used for multipurpose like irrigation and recreational activities, such as swimming, boating etc. may lead to conflicts.

Raceway culture: is defined as raising of fish in running water. It is a high production system in which fishes are grown in higher stocking density. Raceways are designed to provide a flow-through system to enable rearing of much denser population of fishes.

Raceway ponds are basically of two types:

Linear type: Ponds arranged in sequence. In a linear type, the volume of water entering each pond is larger and as the same water is used repeatedly from pond to pond, occurrence of disease in initial ponds may directly affect the other connected ponds

Lateral type: Ponds lay out in parallel. In a lateral or parallel type the volume of water entering each pond is smaller but a fresh supply of water is always ensured, and no transfer of disease from one pond to another.

Recirculating Aquaculture System (RAS)

A Recirculating Aquaculture System (RAS) can be defined as an aquaculture system that incorporates the treatment and reuse of water with less than 10% of total water volume replaced per day. The concept of RAS is to reuse a volume of water through continual treatment and delivery to the organisms being cultured. Water treatment components used in RAS need to accommodate the input of high amounts of feed required to sustain high rates of growth and stocking densities typically required to meet financial outcomes. Generally, RAS consist of mechanical and biological filtration components, pumps and holding tanks and may include a number of additional water treatment elements that improve water quality and provide disease control within the system

On the basis of integration

- Agriculture cum fish farming
- Animal husbandry cum fish farming

Fish farming with agriculture

In the fish integrated agriculture system, fish culture is integrated with agricultural crops such as rice, banana and coconut, thereby producing fish and agricultural crops. Agriculture based integrated systems include rice-fish integration, horticulture-fish system, mushroom-fish system, seri-fish system.

Unit 3: Aqua Farming and Technology

Content Standard 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.

Benchmark: 9.3.3.1 Identify and discuss the tools, equipment and other devices used in aqua farming.

Topic: Gears and Devices used in Aqua Farming

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to: Identify different types of gears used for aqua farming Discuss various types of devices and innovative ideas used in aqua farming
Essential Questions	What are the tools used in aquaculture? What are the equipment needed for fish farming?
Knowledge	Different types of gears used for aqua farming Devices and innovative ideas used in aqua farming Strengths and weakness of gears and devices used in aqua farming
Skills	Identify different types of gears used for aqua farming Discuss the types of devices and innovative ideas used in aqua farming Evaluate their strengths and weakness
Attitudes	Appreciate its benefits and purpose
Values	Value its usefulness in aqua farming in improving the living standards

Content Background:

Coastal fishponds require some essential **equipment** and facilities which are **used** for varied purposes. **Nets and traps**

- Fingerling seine.
- Fingerling suspension net.
- Gillnet seine
- Screens on water control structures
- Harvesting bag net on gates
- Cast net.

List of Catfish farming Equipment

- Pond.
- Handling and grading equipment.
- Water quality tester.
- Fish transporter.
- Dip nets.
- Seine reels.
- Water pumps.

- Automatic feeder.

All types of fishing gear, regardless of how it might be used, are designed to lure and capture fish. Fishing gears are defined as tools used to capture marine/aquatic resources, whereas how the gear is used is the fishing method. Additionally, a single type of gear may also be used in multiple ways. Different target species require different fishing gear to effectively catch the target species.

Fishing gears fall under two general categories, active gear and passive gear. Active gears are designed to chase and capture target species, while passive gears generally sit in one place allowing the target species to approach the capture device. There are many types of nets and line fishing hence this unit discusses mainly on gillnet fishing and handline fishing.

Gillnets

Gillnet is a fishing net which is hung vertically so that fish get trapped in it by their gills. Gillnets are strings of single, double or triple netting walls, vertical, near by the surface, in midwater or on the bottom, in which fish will gill, entangle or enmesh. Gillnets nets have floats on the upper line (head rope) and, in general, weights on the ground-line (footrope) that keeps the net upright.

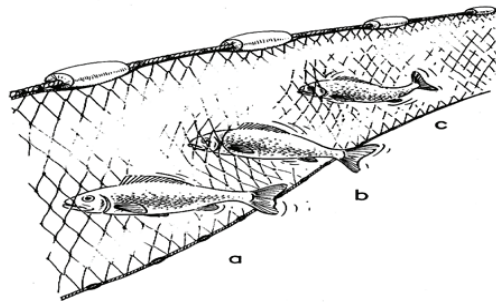


Figure 1. A gillnet Handline

A handline is cheap and simple to construct, but making and using it, like all fishing techniques, requires skill and knowledge to achieve the best results. These operations include selecting a suitable line, hook and sinker and rigging them together in a way that will not distract a fish from taking suitably chosen bait. Once a handline has been suitably rigged, fishing is not simply a matter of throwing the line in the water anywhere and waiting. Other factors must be taken into account. Again, these are variables that change from case to case. They involve where and when to fish, how to encourage the fish to take the bait and once the bait is taken, how to ensure that the hook is embedded in the fish's mouth and the fish prevented from escaping.

A fish is only caught when it has been brought ashore or into a boat and cannot get back into the water. This last aspect deserves just as much attention as the basic equipment, as justified by the numerous tales of fish that “got away”. Attention to all these points will help make you a more effective fisherman in hand lining.

In many parts of the world hand lining is the most readily available and affordable method of fishing, and it should not be regarded as an out-of-date practice. On the contrary it is not only cheap, it is also a fuel efficient and effective form of fishing, particularly when used to catch fish that are commercially important to artisanal fishermen, such as snapper and bonefish at sea and tilapia and catfish in lakes and rivers. In conjunction with a paddled or sailed dugout canoe, this form of fishing provides a relatively cheap method of entering the fishing business. The use of a canoe makes it possible to explore a larger area, to discover new places where fish are concentrated, with the chance of getting bigger catches.



Figure 2. Fish hook anatomy and parts of handling

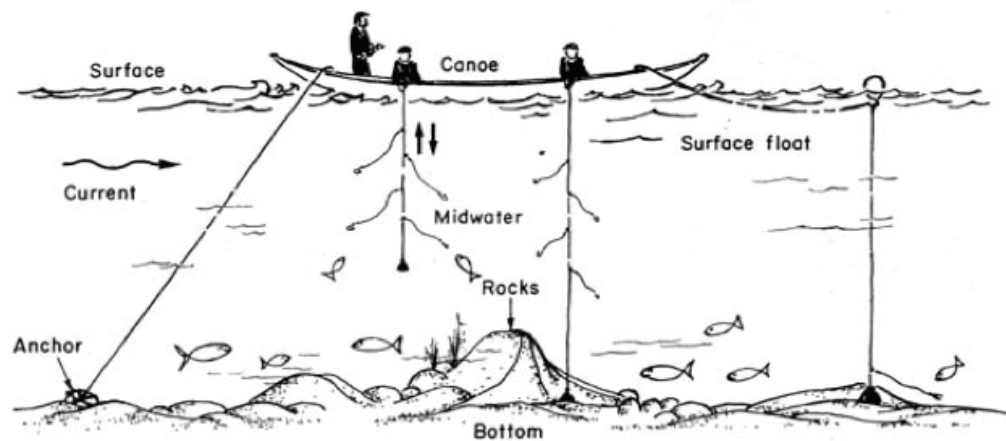


Figure 3. Fishermen fishing using handling

Fish traps

A fish trap is a trap used for fishing. Traps are simple, passive fishing gear that allow fish to enter and then make it hard for them to escape. This is often achieved by:

- putting chambers in the trap or pot that can be closed once the fish enters;
- having a funnel that makes it difficult for the fish to escape .

Smaller traps are generally fully covered except for the entrance or entrances; while larger traps that extend above the water level are often left open at the top.

Types of traps and pots

People in different parts of the world are not always referring to exactly the same things when they use the words "trap" and "pot". In general, traps are large structures fixed to the shore. Pots are smaller, movable traps, enclosed baskets or boxes that are set from a boat or by hand. General types of traps and pots include:

- traps that form barriers to fish movement, including walls or dams, fences, fyke nets, gratings and watched chambers that can be closed by the fisher after the fish enters ;
- traps that make hiding places (habitat traps), including brush traps and octopus pots
- tubular traps, which are narrow funnels or hoses that stop the fish from getting out backwards; eel tubes fall into this category traps that are mechanically closed by the fish, including gravity traps or box traps, bent-rod traps (whipping bough traps), torsion traps and snares;
- baskets, which are enclosed traps and pots usually with a structure to make escape difficult; they include pots made of wood, wire or plastic, conical and drum-like traps made of netting with hoops and frames (e.g. drum nets) and box-like traps made with strong frames
- large open traps or corrals with a part or mechanism to stop fish from escaping, which can be fixed on sticks or anchors, set or floating

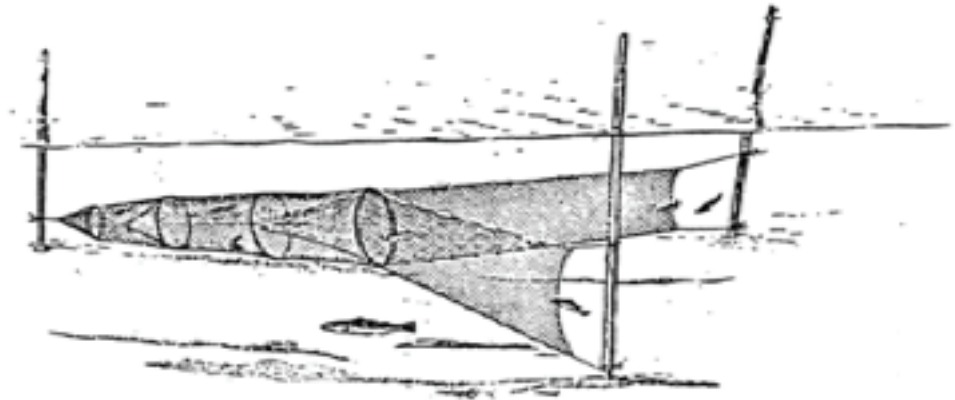


Figure 4. A Trap net set

Benchmark: 9.3.3.2. Analyse technologies used in aqua farming, identify their problems, and develop appropriate solutions.

Topic: Challenges faced with technologies used in aqua farming

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Identify and discuss the disadvantages of the use of domestic consumption aqua farming technologies. • Explain the problems faced with the use of domestic consumption aqua farming technologies • Identify and outline appropriate solutions to problems encountered with the use of aqua farming technologies
Essential Questions:	<ol style="list-style-type: none"> 1. What are the advantages and disadvantages of technologies used in small scale aqua farming? 2. What are the associated problems faced by farmers? 3. How can farmers deal with the aqua farming technology problems?
Knowledge	<ul style="list-style-type: none"> • Technologies used in aqua farming • Complications encountered with the use of aqua farming technologies • appropriate solutions to complications faced with the use aqua farming technology
Essential Skills	<ul style="list-style-type: none"> • Identify and explain technologies used in aqua farming • Explain the complications of technologies used in aqua farming • State appropriate solutions to the technology complications used in aqua farming
Attitudes	<ul style="list-style-type: none"> • Appreciate the benefits of aqua farming technology • Proactive in dealing with difficult situations • Wise decision makers
Values	Value the use of aqua farming technologies

Content Background

The systems and technology used in aquaculture has developed rapidly in the last fifty years. They vary from very simple facilities (e.g. family ponds for domestic consumption in tropical countries) to high technology systems (e.g. intensive closed systems for export production). Much of the technology used in aquaculture is relatively simple, often based on small modifications that improve the growth and survival rates of the target species, e.g. improving food, seeds, oxygen levels and protection from predators. Simple systems of small freshwater ponds, used for raising herbivorous and filter feeding fish, account for about half of global aquaculture production.

A greater understanding of complex interactions between nutrients, bacteria and cultured organisms, together with advances in hydrodynamics applied to pond and tank design, have enabled the development of closed systems. These have the advantage of isolating the aquaculture systems from natural aquatic systems, thus minimizing the risk of disease or genetic impacts on the external systems.

New developments

Developments in engineering, some adapted from offshore oil rig construction, increase the possibilities for a progressive offshore expansion of aquaculture using robust cages. Culture-based capture fisheries involving the release of young fish into the wild to improve harvest (an operation also referred to as restocking, stock enhancement or ranching) have existed for a long time for freshwater and anadromous species (e.g. salmon). Sea ranching, however, has just made a start but its long-term viability is being assessed. Advances have also been made in capture-based aquaculture involving the growing/fattening of young fish (e.g. tuna) captured from the wild. Potential conflicts with capture fisheries are being assessed. Major progress have also being made in the aqua feeds technology, combining a large number of ingredients into very small pellets.

The selection of the aquaculture system or approach to adopt in a particular development is determined by several factors including the following:

- development goals/objectives and target beneficiaries
- acceptability/marketability of culture species
- availability and level of technology
- availability of production inputs and support facilities and services
- investment requirements
- environmental considerations
- Problems of Aquaculture

Environmental

In food systems, nothing comes for free. All attempts at increasing human food supplies inevitably produce environmental consequences elsewhere. With aquaculture, those consequences are only now starting to be understood. Reporters looking to cover the aquaculture sector should be well versed in the environmental factors of aquaculture. Some of the key environmental factors are as follows:

Forage fish impacts:

Though some aquaculture species are raised on vegetarian feed, many, particularly more recently domesticated species like salmon, require wild fish rendered as fish meal and fish oil for their food. What this means is that most of the time, it takes more than a kilogram of wild fish to create a kilogram of farmed fish. This finding was most famously publicized in a 2000 paper in the journal Nature. In their report,

References

Strand 4: Natural Resource Management Content Overview

Content Standard 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, categorize them according to their characteristics, purposes and benefits, and investigate the different contexts, environments, and places where they are harvested.

Units	Benchmarks	Topics	Lesson Titles
Unit 1: Types of Capture Fishery	9.4.1.1 Investigate and make sense of the historical background of capture fisheries and rationalize its importance.	History of Capture Fishery	<ol style="list-style-type: none"> 1. Historical background of capture fishery 2. Importance of capture fishery
	9.4.1.2 Distinguish and explain the attributes of freshwater and marine water environments.	Fresh and marine water environments	<ol style="list-style-type: none"> 1. Attributes of freshwater environments 2. Attributes of marine environments.
	9.4.1.3 Investigate and discuss the capture of different fish and other consumable aquatic organisms and plants in different environments.	Consumable aquatic organisms and plants	<ol style="list-style-type: none"> 1. Capture of fish 2. Capture of aquatic organisms 3. Capture of aquatic plants

Content Standard 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.

Unit 2: Capture Fishery Harvesting Practices and Management Systems	9.4.2.1. Examine the principles of capture fishery and explain their importance in understanding capture fishery practices.	Principles of Capture Fishery	<ol style="list-style-type: none"> 1. Principles of Capture fishery 2. Capture Fishery principles and harvesting practices
	9.4.2.2 Investigate and explain capture fishery harvesting practices used in different places and environments.	Capture Fishery Harvesting practices	<ol style="list-style-type: none"> 1. Capture fishery harvesting practices of fresh water fish 2. Capture fishery harvesting practices of salt water fish 3. Capture fishery harvesting practices of brackish water fish

Content Standard 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 environments and places, and evaluate their strengths and weakness.

Unit 3: Capture Fishery and Technology	9.4.3.1 Identify and discuss the tools, equipment, and other devices used in capture fishery.	Tools and equipment used in Capture Fishery.	<ol style="list-style-type: none"> 1. Tools used in capture fishery 2. Equipment used in capture fishery 3. Devices used in capture fishery
	9.4.3.2 Analyze technologies used in capture fishery, identify their problems, and develop appropriate solutions.	Trends and effects of capture fishery technology	<ol style="list-style-type: none"> 1. Traditional technology used in capture fishery 2. Modern technology used in capture fishery 3. Challenges associated with the use of capture fishery technology
Content Standard 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.			
Unit 4: Types of Forestry and Forests	9.4.4.1 Investigate and explain the importance of different types of forestry and forests.	Introduction to Forestry	<ol style="list-style-type: none"> 1. The role of trees 2. Types of forestry and forests 3. Forest resources 4. Importance of forestry and forest 5. How forests contribute to the global ecosystem
	9.4.4.2 Distinguish and explain the attributes of different types of forestry and forests in different environments.	Attributes of forestry and forests	<ol style="list-style-type: none"> 1. Characteristics of different Forests and forestry 2. Facts about tropical rainforests 3. Layers of rainforests 4. Largest forests on Earth 5. Trees, woodland, and climate change 6. Carbon storage in forests and wood products
	9.4.4.3 Investigate and evaluate the impact of harvesting forests in different environments.	Trends and effects of forest production technology	<ol style="list-style-type: none"> 1. Introduction to forest harvesting 2. Advantages and disadvantages of forest harvesting 3. The role of forests in environmental protection, 4. Forests restoration after logging
Content Standard 4.5 Students will be able to investigate and analyze the different types of forest harvesting practices and management systems used in different environments and places to harvest, process, preserve, market, regulate, and consume forests.			

Unit 5: Forest Harvesting Practices and Management Systems	9.4.5.1 Examine the principles of forest and explain their importance in understanding forest harvest practices.	Forest management systems and practices	<ol style="list-style-type: none"> 1. Forests Principles 2. Importance of forest harvest practices 3. Conservation effort to protect Biomes
	9.4.5.2 Investigate and explain forest harvesting practices used in different places and environments.	Forest harvesting practices	<ol style="list-style-type: none"> 1. Timber harvests practices 2. Timber harvesting 3. Methods of harvesting forests 4. Timber harvesting Methods that encourage Forest regeneration
Content Standard 4.6 Students will be able to examine how technology is used in the harvesting, processing, preservation, marketing, regulation, consumption, and management of forestry in different environments and places, and evaluate their strengths and weaknesses.			
Unit 6: Forestry and Technology	9.4.6.1 Identify and discuss the tools, equipment, and other devices used in the harvesting of forests.	Tools and equipment used in harvesting of forests.	<ol style="list-style-type: none"> 1. Tools used in forest harvesting 2. Equipment and machines used in forest harvesting 3. Devices used in forest harvesting
	9.4.6.2. Research and analyze technologies used in forestry, identify their problems, and develop appropriate solutions.	Challenges faced with the use of technology in forest production	<ol style="list-style-type: none"> 1. Technologies used in forestry 2. Advantages and disadvantages of the use of technologies 3. Solutions to problems associated with the use of technology in forestry

Strand 4: Natural Resource Management

Unit 1: Types of Capture Fishery

Content Standard: 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, categorize them according to their characteristics, purposes and benefits, and investigate the different context, environments and places where they are harvested.

Benchmark: 9.4.1.1. Investigate and make sense of historical background of capture fisheries and rationalise its importance.

Topic: History of Capture Fishery

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Explain what Capture Fishery is • Identify the importance of Capture Fishery
Essential Questions	<ol style="list-style-type: none"> 1. What is Capture fishery? 2. Why is Capture fishery important?
Knowledge	<ul style="list-style-type: none"> • Capture fishery • Importance of Capture fishery
Skills	<ul style="list-style-type: none"> • Define Capture fishery • Discuss the importance of Capture fishery
Attitudes	<ul style="list-style-type: none"> • Appreciate the environment that provides food
Values	<ul style="list-style-type: none"> • Sustainability in capture fishery

Content Background

Capture fishery refers to all kinds of harvesting of naturally occurring living resources in both marine and freshwater environments. Fisheries that are caught from nature are called captured fisheries. Fisheries are not all about fishes but also refer to other consumable aquatic plants and animals such as prawns, lobsters, crabs and molluscs. There are two types of fisheries: In land fisheries and marine fisheries. Capture fisheries are sometimes called wild fisheries. The aquatic life they support is not controlled in any meaningful way and needs to be “captured” or fished. Wild fisheries exist in primarily in the oceans, and particularly around coasts and continental shelves. They also exist in lakes and rivers.



Inland fishery in freshwater environment



Marine fishery in marine environment

Harvesting of consumable aquatic plants and animals



Prawns



Sea weed



Crab



Shell fish

Importance of Capture fishery

Capture fisheries provide a crucial source of animal protein and contribute to development in the areas of employment.

Sources: [S//www.green.org](http://www.green.org)

Benchmark: 9.4.1.2. Distinguish and explain the attributes of freshwater and marine water environments.

Topic: Freshwater and marine environments

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Explain the attributes of freshwater and marine water environments • Differentiate between freshwater and marine water environments
Essential Questions	<ol style="list-style-type: none"> 1. What are the attributes of freshwater environments? 2. What are the attributes of marine water environments?
Knowledge	<ul style="list-style-type: none"> • Attributes of freshwater environments • Attributes of marine water environments
Skills	<ul style="list-style-type: none"> • Discuss the attributes of freshwater and marine water environments
Attitudes	Appreciate the environment that provides water to sustain life
Values	Value the environment for a common good

Content Background

Characteristics of fresh water environments

The freshwater environment 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 environment vary from the ones in the estuarine habitat. This is due to the salinity factor.

The following characteristics are associated with freshwater environments:

1. Low salinity – Freshwater environment normally contain very low level of salts. It has about 0.5% of salt compared to about 3.5% for sea water
2. Relatively small body of water – Freshwater environment is usually very small compared to the ocean water which is about 75% of the earth surface.
3. Variation in temperature – The temperature of freshwater environment usually varies with season and depth. The temperature at the surface of the water varies slightly with that at the bottom of the water.
4. High concentration of oxygen content – Oxygen is usually available in all parts of the fresh water especially in the surface of the water.
5. Seasonal variation – Most freshwater environment like streams and rivers normally dry up during dry season while others have their volume reduced. The volume of water in river also increases during the raining season.
6. Shallowness of water – Most freshwater environments are shallow hence sunlight can easily penetrate through the water to the bottom

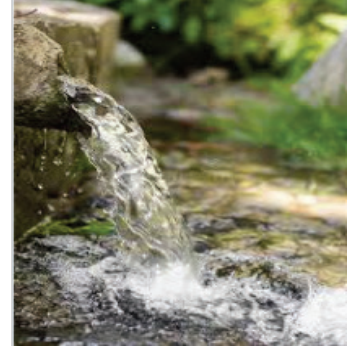
Examples of freshwater environments



River



Lake



Spring

Characteristics of marine water environments

The marine water environment is an environment characterized by the presence of salt water. Marine water is generally composed of about 96.5% pure water and 3.5% percent dissolved compounds. Salinity refers to the saltiness of water.

Sources: <https://classhall.com>>Lessons, ,<https://unsplash.com>>photo>river

Unit 1: Types of Captured Fishery

Benchmark: 9.4.1.3. Investigate and discuss the capture of different fish and other consumable aquatic organisms and plants in different environments.

Topic: Capture of consumable aquatic organisms.

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to describe the capture of different fish and other consumable aquatic organisms in different environments
Essential Questions	<ol style="list-style-type: none"> 1. What type of fish and aquatic organisms are captured in different environments? 2. What are consumable aquatic organisms?
Knowledge	<ul style="list-style-type: none"> • Capture of different fish in different environments • Capture of consumable aquatic organisms in different environments
Skills	<ul style="list-style-type: none"> • Compare types of environment used to capture fish and consumable aquatic organisms
Attitudes	<ul style="list-style-type: none"> • Be responsible and wise when capturing aquatic organisms
Values	<ul style="list-style-type: none"> • Value the contributions of environment to mankind

Content Background

Capture of different fish and consumable aquatic organisms in different environments

Freshwater environment

A vast number of aquatic species have successfully adapted to live in the freshwater environments. Many are captured to be consumed. These are some examples of the most common species found: Angel fish, cichlids, catfish, trout, freshwater prawns, freshwater mussel, largemouth bass and tilapia.



Freshwater Cichlids



Talapia



Fresh water trout



Freshwater mussel



Mud crabs

2. Marine water environment

Marine fisheries are conducted in all the oceans and seas of the world including bays and estuaries. The capture and culture of aquatic organisms in salt water accounts for the bulk of fishery products that reach world markets. Here are some examples of aquatic organisms that are captured in marine water.



Capturing of tuna



Capturing of crabs



Capturing of salmon



Capturing of sea weed

Unit 2: Capture Fishery harvesting practices and management systems

Content Standard 4.2 Students will be able to investigate and analyze 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.

9.4.2.1. Examine the principles of capture fishery and explain their importance in understanding capture fishery practices.

Topic: Principles of Capture Fishery.

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Study the principles of capture fishery and describe its importance in capture fishery harvesting practices. • Discuss and explain the importance of capture fishery practices
Essential Questions	<ol style="list-style-type: none"> 1. What are the principles of capture fishery? 2. What is the importance of capture fishery practices?
Knowledge	<ul style="list-style-type: none"> • Principles of capture fishery • Importance of capture fishery practices
Skills	<ul style="list-style-type: none"> • Explain the principles of capture fishery. • Rationalize the importance of capture fishery.
Attitudes	<ul style="list-style-type: none"> • Protect our environment and natural resources.
Values	<ul style="list-style-type: none"> • Value the principles of capture fishery.

Content Background

Principles of Capture fishery

Main principles of Capture fishery include the following:

Responsibility for management: Inland waters differ from most marine environments in that in that the primary responsibility for decisions affecting the environment and its living aquatic components rarely lies with the fishery authorities but with some other agency. Fisheries interests are therefore peripheral to the policy making and allocation process in most countries.

The value of aquatic ecosystems lies in the sustained net benefits derived from the many goods and services they supply including various ecological functions, products for direct and indirect human consumption, energy, aesthetic and recreational benefits, and assimilative capacity of residues of human activities. Frequently, fisheries have been accorded lower priority because of the perception that alternative uses contribute more to society's welfare.

Conservation of the aquatic ecosystem: Conservation of inland aquatic resources should be viewed within the multi-purpose use of river and lake basins. In most inland waters the principle constraints on the system and its living components come from human activities other than fishing. Government,

at all levels from central to local authorities should set up mechanisms to conserve living aquatic resources compatible with the sustainable use of the basin, the aquatic ecosystem and the water for the whole range of economic and social purposes.

Importance of capture fishery practices

Sustainable, productive fisheries and aquaculture improve food and nutrition security, increase income and improve livelihoods, promote economic growth and protect our environment and natural resources.

Sources: www.worldfishcenter.org > why-fish

Benchmark: 9.4.2.2 Investigate and explain capture fishery harvesting practices used in different places and environments.

Topic: Harvesting Practices

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to: <ul style="list-style-type: none"> Examine and explain capture fishery harvesting practices used in different places and environments.
Essential Questions	1. What are the capture fishery harvesting practices used in different places and environments?
Knowledge	<ul style="list-style-type: none"> Capture harvesting practices used in different places and environments.
Skills	<ul style="list-style-type: none"> Identify and describe the capture fishery practices used in different places and environments.
Attitudes	<ul style="list-style-type: none"> Appreciate the capture fishery practices.
Values	<ul style="list-style-type: none"> Sustainability of Capture Fishery environments Wise farmers and consumers

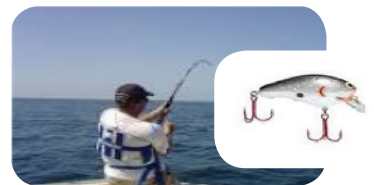
Content Background

The five basic methods of angling are bait fishing, fly-fishing, bait casting, spinning and trolling. All are used in both freshwater and saltwater angling.

1. Bait fishing- Also called still fishing or bottom fishing, is certainly the oldest and most universally used method. Fishing bait is used to attract and catch fish. Traditionally, insects, worms and smaller bait fish have been used for its purpose.



2. Bait casting – bait is impaled on the hook, which is set by the angler raising the tip of the rod when the fish swallows it. Common baits in fishing include night crawlers, worms, maggots, small fish, bread paste and small pieces of vegetables and grains.



3. Fly-fishing – Is a method of that uses a light-weight lure called an artificial fly to catch fish. The fly is cast using a flying rod, reel, and specialized weighted line.



4. Bait casting – Is used when casting a fishing rod using a bait cast reel.



5. Trolling – Involves the use of live bait or artificial lures that are drawn through the water behind a slow-moving boat, originally rowed but now generally motor-powered.



Sources:

<https://www.britannica.com>fishing methods>

<https://vanisalemarine.com>bait cast>

Unit 3: Capture Fishery and Technology

Content Standard 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 environments and places, and evaluate their strengths and weakness.

Benchmark: 9.4.3.1 Identify and discuss the tools, equipment, and other devices used in capture fishery.

Topic: Tools, equipment and devices used in Capture Fishery

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> Recognize and describe the tools, equipment and devices used in Capture Fishery. Distinguish the types of Capture Fishery gears according to the types of environments which they are used Compare and classify capture fishery gear into tools, equipment and devices
Essential Questions	1. What are the tools, equipment and devices used in Capture Fishery?
Knowledge	<ul style="list-style-type: none"> Tools, equipment and devices used in Capture Fishery.
Skills	<ul style="list-style-type: none"> Identify the tools, equipment and devices used in Capture Fishery.
Attitudes	<ul style="list-style-type: none"> Appreciate the tools, equipment and devices used in Capture Fishery.
Values	<ul style="list-style-type: none"> Value the tools, equipment and devices used in Capture Fishery.

Content Background

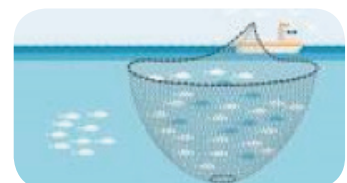
Fish capture technology encompasses the process of catching any aquatic animal, using any kind of fishing methods, often operated from a vessel. Use of fishing methods varies, depending on the types of fisheries, and can range from a simple and small hook attached to a line to large and sophisticated mid water trawls or purse seines operated by large fishing vessels. The targets of capture fisheries can include aquatic organisms from small invertebrates to large tunas and whales, which might be found anywhere from the ocean surface to 2 000 meters deep.

Fishing tools/ gears and equipment

There are many fishing tools and equipment. Below are only a few.

1. Surrounding nets

The net is roughly rectangular in shape without a distinct bag. It is set vertically in water to surround the school of fish, generally of pelagic nature. The nets are subdivided into three categories: one-boat



seine, two-boat seine; and surrounding net without purse line. The one-boat purse seine is commonly used in Brunei Darussalam waters.

2. Hook and Line

The gear generally consists of line(s) and hook(s) to which artificial or edible baits are attached to lure and catch fishes or other aquatic animals



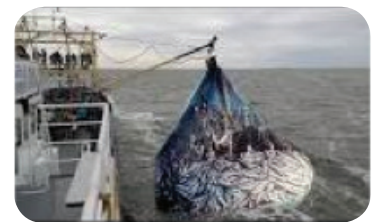
3. Gill nets

Gill nets are curtain-like net that are fitted with sinkers on the lower end and floats on the upper end and are set transversely to the path of migrating fish. Fish trying to make their way through the net wall are entangled, gilled or enmeshed in the mesh



4. Trawl

A conical bag-shaped net with two or more wings, pulled by one or two boats for a period, to catch mainly demersal fish or other aquatic animals that live directly on, or stay near the seabed. The trawl is subdivided into three major types: bottom trawl, pair trawl and beam trawl.



5. Traps

The gear is set or stationed in the water for a certain period to trap moving fish in the water. Trapping is made with the use of a non-return valve fitted in the entrance of the gear. The gear may or may not include a netting material.



Devices

Non-collaborative tools include optical or radar satellites. New data processing technologies in fisheries include: big data, block chain, smart weighing at sea, Radio-frequency identification (RFID), and smartphones for monitoring, artificial intelligence, drones, and on-board cameras.



Source:

<http://www.fao.org/fishery/technology>

<http://www.ilovefishing.fun>

www.oecd.org/green/growth/GGSD_2017_Issue

Benchmark: 9.4.3.2 Analyse technologies used in capture fishery, identify their problems, and develop appropriate solutions.

Topic: Problems and solutions of technology in capture fishery.

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to; <ul style="list-style-type: none"> • Examine the technologies used in capture fishery. • Recognize and explain the problems of technologies used in capture fishery and solutions to the problems
Essential Questions	<ol style="list-style-type: none"> 1. What are the technologies used in capture fishery? 2. What are the problems caused by technologies used in capture fishery? 3. How are problems solved when using technologies in capture fishery?
Knowledge	<ul style="list-style-type: none"> • Technologies used in capture fishery • Problems caused by using technologies in capture fishery • Ways of solving problems when using technologies in capture fishery.
Skills	<ul style="list-style-type: none"> • Identify the technologies used in capture fishery. • Explain the problems of technologies used in capture fishery and solutions to the problems.
Attitudes	<ul style="list-style-type: none"> • Cooperate and participate in identify problems and solutions of using technology in capture fishery.
Values	<ul style="list-style-type: none"> • Openness of solving problems.

Content Background

Technologies used in Capture fishery has caused an imminent and global collapsed of our fisheries. But there, are few key tried- and – tested solutions to overfishing that have been successfully implemented around the world. The trick to scale these solutions is up to global scale, encouraging countries that have originally been resistant to helping and get them on board, and supporting countries that don't have the means to update their fishing policies themselves.

Problems

1. Decreases in availability of land, water and assimilative capacity of the environment
2. Multidisciplinary management actions
3. Marine species have a low reproductive rate.

Solutions

1. Stop trawling
2. Make smart consumer choices
3. Evaluating performances of proposed management actions and test management practices
4. Create more marine protected areas

Sources: <https://www.eubios.info>, <https://www.researchgate.net>, <https://therevolutionmove.com>>sol

Unit 4: Types of Forestry and Forests

Content Standard 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: 9.4.4.1. Investigate and explain the importance of different types of forestry and forests.

Topic: Types of Forests

Knowledge, Skills, Attitudes and Values	
Learning Objectives:	Students will be able to: <ul style="list-style-type: none"> • Explain what forestry is and its importance. • Explore and discuss the different types of forests. • Examine and explain the importance of different types of forests
Essential Questions	<ol style="list-style-type: none"> 1. What is a forest? 2. What are the different types of forests? 3. What is the importance of forests? 4. How do forests contribute to the global ecosystem? 5. What is forestry? 6. What is the importance of forestry?
Knowledge	<ul style="list-style-type: none"> • Different types of forests and forestry • Importance of different types of forests and forestry
Skills	<ul style="list-style-type: none"> • Identify the different types of forests. • Rationalize the importance of forests and forestry.
Attitudes	<ul style="list-style-type: none"> • Appreciate the benefits of forests
Values	<ul style="list-style-type: none"> • Value the importance of forests and forestry

Content Back ground

Trees

Tree is a woody plant that regularly renews its growth (perennial). Most plants classified as trees have a single self-supporting trunk containing woody tissues, and in most species the trunk produces secondary limbs, called branches.

Trees absorb carbon dioxide as they grow and the carbon that they store in their wood helps slow the rate of global warming.

They reduce wind speeds and cool the air as they lose moisture and reflect heat upwards from their leaves. It's estimated that trees can reduce the temperature in a city by up to 7°C.



Trees also help prevent flooding and soil erosion, absorbing thousands of litres of storm water.

The canopies of trees act as a physical filter, trapping dust and absorbing pollutants from the air. Each individual tree removes up to 1.7 kilos every year. They also provide shade from solar radiation and reduce noise.

Forests

A forest ecosystem is a community of organisms that lives within a forest. A forest is usually defined as a large group of trees. Forests cover 1/3 of the earth's surface and contain an estimated 3 trillion trees. The trees help create a special environment which, in turn, affects the kinds of animals and plants that can exist in the forest. Trees are an important component of the environment. They produce large quantities of oxygen and take in carbon dioxide. Transpiration from the forests affects the relative humidity and precipitation in a place. Forests exist in dry, wet, bitterly cold, and swelteringly hot climates.

Types of forests

Different types of forest are found in different parts of the world. Some of the forests are named after locations, for example, tropical forests in the tropics and montane forests on mountains. Forests can be classified according to a wide number of characteristics, with distinct forest types occurring within each broad category. However, by latitude, the three main types of forests are tropical, temperate, and boreal.

Tropical forest



Most tropical forests receive large amounts of rain annually (up to 100 inches), which is spread evenly throughout the year. However, there are some tropical forests that receive seasonal rainfall and experience both a wet and dry season. While tropical forests have many layers, most of the nutrients are held in the vegetation within the canopy; therefore, the soils are typically low in both mineral and nutrient content.

Temperate forest

Temperate forests are common throughout North America, Eurasia, and Japan and are primarily deciduous, characterised by tall, broad-leafed, hardwood trees that shed brilliantly colored leaves each fall. These forests experience varied temperatures and 4 seasons, with winter often bringing below freezing temperatures and summer bringing higher heat and humidity. Rainfall also varies, averaging 30 to 60 inches annually, allowing for soils that are well developed and rich in organic matter.



Boreal forests



Boreal forests (also known as taiga) are located just south of the tundra and stretch across large areas of North America and Eurasia. They are one of the world's largest biomes, encompassing about 11 percent of Earth's land area, but have very short growing seasons with little precipitation and represent relatively few tree species. The forest is dominated by coniferous trees, which have needle-shaped leaves

with minimal surface area to prevent excessive water loss.

Importance of forests and forestry

Forests are of great importance to mankind. Following are some points illustrating the importance of forests:

Forests help in maintaining the water cycle on earth. Plants absorb water from the soil through their roots. The process of releasing excess water by plants into the atmosphere in the form of water vapour is known as transpiration.

- Forests help in maintaining the temperature and oxygen level of the atmosphere. Plants release oxygen during photosynthesis and consume carbon dioxide. Forests being a huge reserve of plants and trees, they play a significant role in balancing oxygen level in the atmosphere.
- Forests help in preventing global warming. The increased amount of carbon dioxide (greenhouse gas) in the atmosphere results in the greenhouse effect and thus causes global warming.
- Forests prevent soil erosion. Trees present in the forests hold the soil particles strongly with the roots and prevent them from erosion.
- Forests also supply a variety of valuable products ranging from pharmaceuticals and greenery to lumber and paper products.
- Forestry is the branch of science that deals with the general care and management of forest lands for wool, water, wildlife, forage and recreation. Forestry is an important supplier of raw materials to a large number of sectors in the economy. Currently, the manufacturing industry is one of the key generators of economic growth and wealth. It is this industry that should be the generator of economic growth, new job opportunities and wealth. Without the supply of timber, a large number of sectors in the manufacturing industry will not be able to fulfill this role.

Forestry is an important sector in the PNG economy, contributing on average 5.1% of GDP in the 1990s. Forestry is the third largest source of foreign exchange. To PNG society the benefits derived from the forest sector fall in three components:

- i) government revenue
- ii) rural jobs and payments
- iii) the provision of infrastructure and services

Reference/Sources

en.wikipedia.org > wiki > Forest
 Britannica All New Kids Encyclopedia

Benchmark: 9.4.4.2. Distinguish and explain the attributes of different types of forestry and forests in different environments.

Topic: Attributes of different types of forestry and forests

Knowledge, Skills, Attitudes and Values	
Learning Objectives:	Students will be able to: <ul style="list-style-type: none"> • Differentiate and explain the attributes of different types of forests and forestry in different environments.
Essential Questions	<ol style="list-style-type: none"> 1. What are the attributes of different types of forests and forestry in different environments? 2. Differentiate between forests and forestry
Knowledge	<ul style="list-style-type: none"> • Attributes of different types of forests • Forestry in different environments.
Skills	<ul style="list-style-type: none"> • Compare and contrast the attributes of different types of forests and forestry.
Attitudes	<ul style="list-style-type: none"> • Being optimistic in identifying the attributes of types of forests and forestry.
Values	<ul style="list-style-type: none"> • Value the attribute of forests.

Content Back ground

The term “forest” encompasses a variety of different kinds of forests, both in terms of species composition, structure and degree of modification caused by humans, animals, diseases and natural disasters.

For FRA 2005, countries were asked to characterize their forests and other wooded land according to five classes: primary, modified natural, semi-natural, protective plantation and productive plantation.

1. Primary- Forest / Other wooded land of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.
2. Modified natural- Forest / Other wooded land of naturally regenerated native species where there are clearly visible indications of human activities.

3. Semi- natural- Forest / Other wooded land of native species, established through planting, seeding or assisted natural regeneration.
4. Productive plantation- Forest / Other wooded land of introduced species, and in some cases native species, established through planting or seeding mainly for production of wood or non-wood goods.
5. Protective plantation- Forest / Other wooded land of native or introduced species, established through planting or seeding mainly for provision of services.

Reference/Sources

(www.fao.org/forestry/site/24815/en)

Global Forest Resources Assessment (FRA) - Wikipedia

[en.wikipedia.org › wiki › Global_Forest_Resources_Assessment_\(FRA\)](http://en.wikipedia.org/wiki/Global_Forest_Resources_Assessment_(FRA))

Benchmark: 9.4.4.3. Investigate and evaluate the impact of harvesting forests in different environments.

Topic: Impact of harvesting forests in different environments.

Knowledge, Skills, Attitudes and Values	
Learning Objectives:	Students will be able to: <ul style="list-style-type: none"> • examine and assess the impacts of harvesting forests in different environments.
Essential Questions:	<ol style="list-style-type: none"> 1. What are the impacts of harvesting forests in different environments? 2. How can forest be restored after harvesting?
Knowledge	<ul style="list-style-type: none"> • Impacts of harvesting forests in different environments.
Skills	<ul style="list-style-type: none"> • Justify the impacts of harvesting forests in different environments.
Attitudes	<ul style="list-style-type: none"> • Caring and concern of the environment
Values	<ul style="list-style-type: none"> • Openness about the impact of harvesting forest.

Content Back ground

Impact of harvesting forests

The impact from human activities on forest health and on natural forest growth and regeneration raises widespread concern. Many forest resources are threatened by overexploitation, fragmentation, degradation of environmental quality and conversion to other types of land use. The main pressures result from human activities, including agriculture expansion, transport infrastructure development, unsustainable forestry, air pollution and intentional burning of forests.

Deforestation is the greatest impact of harvesting forests

Deforestation refers to the decrease in forest areas across the world that is lost for other uses such as agricultural croplands, urbanization, or mining activities. Greatly accelerated by human activities since 1960, deforestation has been negatively affecting natural ecosystems, biodiversity, and the climate.

The most known consequence of deforestation is its threat to biodiversity. In fact, forests represent some of the most veritable hubs of biodiversity. From mammals to birds, insects, amphibians or plants, the forest is home to many rare and fragile species.

80% of the Earth's land animals and plants live in forests.

By destroying the forests, human activities are putting entire ecosystems in danger, creating natural imbalances, and putting Life at threat. The natural world is complex, interconnected, and made of thousands of inter-dependencies and among other functions, trees provide shade and colder temperatures for animals and smaller trees or vegetation which may not survive with the heat of direct sunlight. Besides, trees also feeding animals with their fruits while providing them with food and shelter they need to survive.

Countries Most Impacted By Deforestation

Around the world, deforestation occurs mostly in the tropics where there are different types of forests: from wet and hot rainforests to others that lose their leaves in the dry season and become woodlands. Some parts of the world have managed to protect their forests from deforestation while others have seen their forestal area decline.

According to FAO's report, 6 million hectares of land were lost from forest to agriculture since 1990 in the tropical domain. These changes significantly differ but there are 3 important worldwide examples of deforestation: the Amazon rainforest, Indonesia and Borneo, and Africa.

Sustainable use of the forest means that we harvest the forest at the rate it can regenerate (the process of growing back what has been lost) so that there always will be a forest to harvest for lumber, pulp or other use. Therefore, logging companies must be careful when deciding which harvesting or logging method they will use so that they don't harvest all the trees at once.

Reference/Sources

<http://www.fao.org/3/a-i5588e.pdf>

Unit 5: Forest Creation Practices and Management Systems

Content Standard 4.5: Students will be able to investigate and analyse the different types of forest harvesting practices and management systems used in different environments and places to harvest, process, preserve, market, regulate, and consume forests.

Benchmark: 9.4.5.1. Examine the principles of forest and explain their importance in understanding forest harvest practices.

Topic: Principles of forests

Knowledge, Skills, Attitudes and Values	
Learning Objectives	Students will be able to: <ul style="list-style-type: none"> • Explain the principles of forests. • Discuss the importance of forest harvesting practices.
Essential Questions	<ol style="list-style-type: none"> 1. What are the principles of forests? 2. What is the importance of forest harvesting practices
Knowledge	<ul style="list-style-type: none"> • Principles of forest • Importance of forest harvest practices
Skills	<ul style="list-style-type: none"> • Examine the principles of forests. • Rationalize the importance of forest harvesting practices
Attitudes	<ul style="list-style-type: none"> • Appreciate the principles of forests • Open- minded about the importance of forest harvesting practices
Values	<ul style="list-style-type: none"> • Value the importance of forest harvesting practices

Content Back ground

Principles of forest

One of the key agreements reached at the 1992 Rio Earth Summit was the Principles of Forest Management. The Principles of Forest Management stated that forests, with their complex ecology, are essential to sustainable development economy and the maintenance of all forms of life. Forests provide wood, food, and medicine and contain a biological diversity as yet not fully uncovered. They also act as reservoirs (sinks) for carbon dioxide, a greenhouse gas released into the atmosphere by human processes, which may be contributing towards global warming.

As well as the scientific benefits of forests, they also provide a home to wildlife and fulfill our cultural and spiritual needs.

The Principles of Forest Management assert the right of nations to profit from their own forest resources, but recommend that this should occur within a framework of forest protection, management and conservation. The principles

are not legally binding but provide recommendations on sustainable practice.

The Principles of Forest Management include a number of points:

All nations should take part in “the greening of the world” through planting and conserving forests.

Forests should be managed in order to meet the social, economic, ecological, cultural and spiritual needs of present and future generations.

Unique examples of forest should be protected, for example ancient forests and forests with cultural, historical, spiritual and religious importance.

Pollutants that harm forests should be controlled.

Forestry plans should consider the non-economic values of forests and the environmental consequences of their management. Forest degradation should be avoided.

Sources

FAO. 1993. Yearbook of Forest Products 1991. Rome.

Benchmark: 9.4.5.2. Investigate and explain forest harvesting practices used in different places and environments.

Topic: Forest Harvesting Practices

Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of the topic students will be able to: <ul style="list-style-type: none"> Identify forests harvesting practices used in different places and environments Describe and explain types of forests harvesting practices
Essential Questions	<ol style="list-style-type: none"> What is forest harvesting practice? What are the forest harvesting practices used in different environments?
Knowledge	<ul style="list-style-type: none"> Forest harvesting practices used in different place and environments
Skills	<ul style="list-style-type: none"> Describe and explain the types of harvesting practices in different environments.
Attitudes	<ul style="list-style-type: none"> Appreciate the types of harvesting practices.
Values	<ul style="list-style-type: none"> Value the types of harvesting practices.

Content Back ground

Types of forest harvesting practices

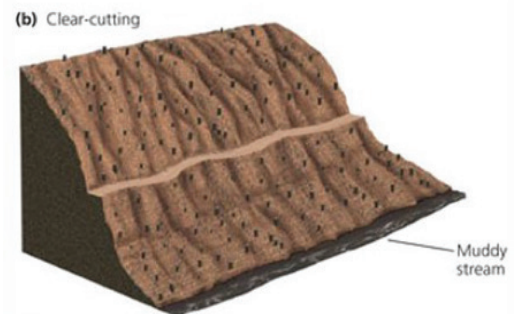
Forest harvesting practices involves cutting trees and delivering them to sawmills, pulp mills and other wood-processing plants. Its practical components include road construction, logging and log transportation.

There are 3 major Harvesting practices:

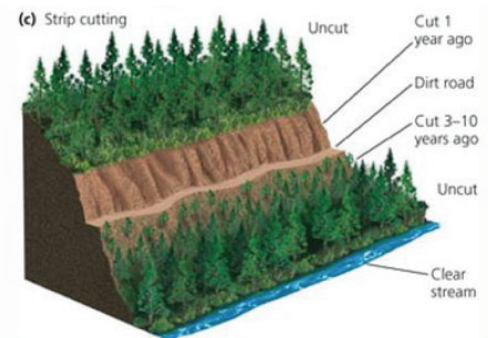
1. **Selective Cutting** and harvest only a limited amount of trees that meet a certain criteria. This usually happens in multi-species forests. Some examples of criteria are maturity, height, age, diseased, etc. One or two operators use chainsaws to cut down the trees on own property, reducing the scarring of the land.



2. **Clear Cutting** Clear cutting means to cut down every tree in a selected area in an efficient and quick manner. Large machines cut the trees, remove branches, cut the logs into lengths and load them onto large trucks in the area. This can create considerable damage such as the destruction of entire areas and soil erosion.



3. **Strip Cutting**
Strip cutting means to harvest trees in narrow strips to minimize damage and try to allow for natural forest regeneration. Heavy machinery is used, leaving sections between the strips uncut, especially among lakes and rivers to reduce soil and limit wind erosion.



References/Sources

www.sciencedirect.com/science/article/pii/0961953492900...

Strand 4: Natural Resource Management
Unit 6: Forestry and Technology

Content Standard 4.6: Students will be able to examine how technology is used in the harvesting, processing, preservation, marketing, regulation, consumption, and management of forestry in different environments and places, and evaluate their strengths and weaknesses

Benchmark: 9.4.6.1. Identify and discuss the tools, equipment, and other devices used in the harvesting of forests.

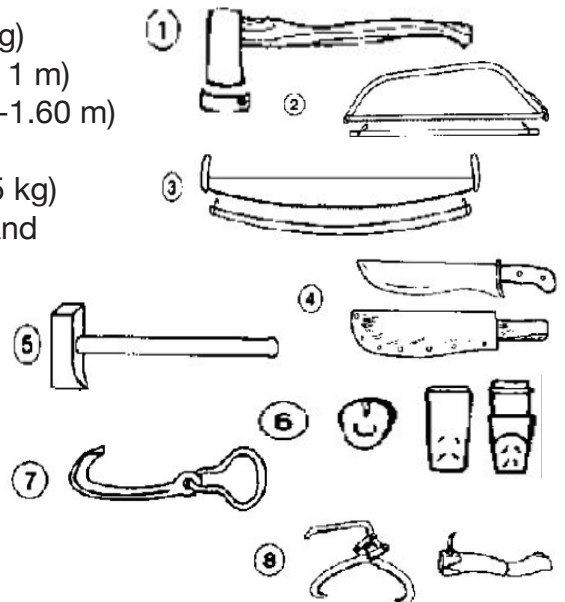
Topic: Basic tools, equipment, and other devices used in the harvesting of forests.

Knowledge, Skills, Attitudes and Values	
Learning Objectives:	Students will be able to: <ul style="list-style-type: none"> Recognise and describe the tools, equipment, and other devices used in the harvesting of forests.
Essential Questions	<ol style="list-style-type: none"> What are the tools and equipment used in harvesting of forests? What are the tools needed for manual wood harvesting?
Knowledge	<ul style="list-style-type: none"> Tools, equipment, and other devices used in the harvesting of forests.
Skills	<ul style="list-style-type: none"> Identify the tools and equipment used in harvesting of forests.
Attitudes	<ul style="list-style-type: none"> Cooperate and participate in discussions
Values	<ul style="list-style-type: none"> Appreciate and value the tools, equipment and devices

Content Back ground

Tools The following tools are needed for efficient manual wood harvesting:

- (1) Axe (weight between 0.8 and 1.5 kg)
- (2) One-man bow saw (length approx. 1 m)
- (3) Cross-cut saw (length usually 1.20-1.60 m)
- (4) Machete
- (5) Splitting hammer (weight about 2.5 kg)
- (6) Wedges (for felling, cross-cutting and splitting)
- (7) Turning hook
- (8) Timber tong and timber pick
- (9) Measuring stick or tape measure
- (10) Caliper (to measure diameter)
- (11) Debarking spade



Equipment and machinery

Common types of machinery are:

Feller-bunchers

Wheeled or track mounted machines designed fell and bunch trees to be skidded, forwarded, or processed. Some felling heads are capable of handling trees of up to 75 cm. There is two general types. (1) Those with a hydraulically powered articulated swivel boom that sever, lift and swing the trees to the desired direction.

(2) Short wheel base machines with close coupled holding arms and shear heads, and depend on moving and swinging the entire machine to perform the bunching function.



Processors and harvesters



A processor delimits trees and crosscuts them into logs. A harvester is a machine that fells, delimits and cross cuts trees at the stump. There are wheeled as well as tracked carriages. Boom reach is typically about 10 m.

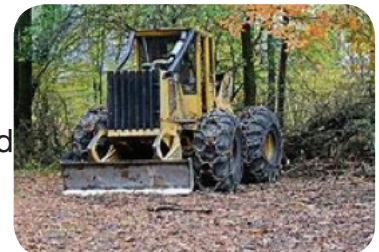
Draught animals and agricultural tractors

Draught animals can be used for smaller logs from final felling operations and from thinnings in manmade forests. Animals used include mules, oxen, water buffaloes and elephants. The farm tractor can be equipped both skidding and forwarding, and also as a base machine for processors and simple harvesters. Farm tractors are common in plantation forestry.



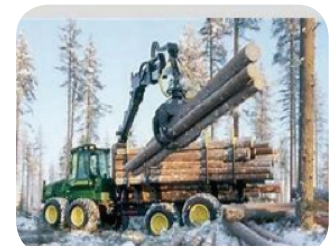
Skidders

Skidders are self-propelled machines for dragging trees or logs by means of winch rope, chokers, grapples or clambunks. Skidders can be rubber tired or tracked. Tracked skidders are either rigid track skidders (crawler tractors/bulldozers) or flexi track skidders.



Forwarders

These are machines that transport trees or logs by carrying them on the chassis completely off the ground. Logs/trees are typically loaded and unloaded using hydraulic or mechanical cranes.



Machinery for log loading and shovel logging

Logs might be loaded on to trucks by truck mounted cranes (self-loading trucks) or by a separate loading machine. This can be a front end loader, a wheeled or tracked machine with forks, lifts or grapples attached to lifting arms at the front end, or a hydraulic loader. Logs may also be loaded manually or by means of simple winch systems. In shovel logging log loaders are used to swing logs to the forest road. The loader moves across the harvest area, grabbing logs/trees within reach, and swinging them around to drop them closer to the road until they are at roadside equipment used in harvesting.

Other Devices

The forestry sector can move forward at a faster rate due to technological advances. From flying drones to do reconnaissance, creating maps using the latest GIS software, to LiDAR calibration plots to increase the accuracy of laser technology. Each piece plays an important role in the progress of allowing timber to come into the mills. By using the technology, it allows for technicians and supervisors to cover more ground and retrieve more data more efficiently.



Sources

International Labour Office Geneva. (1987), Wood Harvesting with Hand Tools, Switzerland

Conway, S. 1973. Timber cutting practices. Miller - Freeman San Francisco, USA.

Enters, T., Durst, P.B., Applegate, G.B., Kho, P.C.S. & Man, G. 2002. Applying reduced impact logging to advance sustainable forest management. FAO, Regional Office for Asia and the Pacific, Bangkok, Thailand.

Benchmark: 9.4.6.2. Research and analyze technologies used in forestry, identify their problems, and develop appropriate solutions.

Topic: Technologies used in forestry, and its associated problems

Knowledge, Skills, Attitudes and Values	
Learning Objectives:	Students will be able to: <ul style="list-style-type: none"> • Examine the technologies used in forestry. • Recognize and explain the problems of technologies used in forestry and solutions to the problems.
Essential Questions	<ol style="list-style-type: none"> 1. What are the technologies used in forestry? 2. What are the problems caused by technologies used in forestry? 3. How are problems solved when using technologies in forestry?
Knowledge	<ul style="list-style-type: none"> • Technologies used in forestry • Problems caused by using technologies in forestry • Ways of solving problems when using technologies in forestry.
Skills	<ul style="list-style-type: none"> • Identify the technologies used in forestry. • Explain the problems of technologies used in forestry • Identify and suggest solutions to the problems.
Attitudes	<ul style="list-style-type: none"> • Cooperate and participate in identify problems and solutions of using technology in forestry.
Values	<ul style="list-style-type: none"> • Creative thinkers and problem solvers.

Content Back ground

The forestry sector has advanced with the use of technology. A number of popular technologies are currently being used in the field, but Geographic Information Systems (GIS) and Global Positioning System (GPS) rank at the top, large pieces of mobile machinery, highly specialized mill equipment, and a multitude of different technologies that have been developed specifically to improve efficiencies for the modern forest products industry.

Problems

Using technologies in forestry can cause many problems. Deforestation is a major problem for the world. Forests are home to 70 percent of the world's animal and plant species. Many cannot survive this loss of habitat, leading to species extinction. Forests also serve people who live in rural communities. Without them, these people have nowhere to hunt and no plants to gather for food or medicinal use.



Climate change is also an effect of deforestation. Trees absorb the harmful greenhouse gases that destroy the ozone layer and contribute to global warming. As more forests are cleared, global warming is increased. Deforestation makes up about 15 percent of all greenhouse gas emissions. Killing trees actually releases carbon dioxide, the most prevalent greenhouse gas. That means nearly a billion tons of carbon are released into the air every year because of deforestation. The more trees humans cut down, the faster climate change will occur.

Solutions

It's tough to simply stop cutting down trees, as they're a major way of human life. However, scientists are encouraging a few solutions to deforestation:

- Eliminate clear-cutting
- Plant new trees in areas where old ones are cut down
- Create protected areas
- Promote sustainable bioenergy



Reference/Source

Dykstra, D.P.; Heinrich, R. Proceedings of the XI World Forestry Congress 13-22 October 1997, Antalya, Turkey 3, D: productive functions of forests, Publication year, 1997

UNIT OF WORK**STRAND 5: AGRIBUSINESS**

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.

Units	Benchmarks	Topics	Lesson Titles
Starting Up and Managing an Agribusiness	9.5.1.1 Identify and examine the economic systems, practices, and factors of starting-up and managing agribusiness.	Economic Principles and systems in Agribusinesses	<ol style="list-style-type: none"> 1. Introduction to agribusinesses 2. Microeconomic principles 3. Macroeconomic principles in Agribusinesses 4. Managing an Agribusiness
	9.5.1.2 Describe the importance of agricultural imports and exports and its impact on agribusiness	Agricultural imports and exports	<ol style="list-style-type: none"> 1. Global economic systems in Agribusinesses 2. Processes and Procedures 3. Impact of Export and Import in Agribusinesses
	9.5.1.3 Research and develop a business plan for starting and operating an agribusiness or enterprise.	Planning and managing an Agribusiness or Enterprise	<ol style="list-style-type: none"> 1. Entrepreneurship 2. Types of ownership 3. Components of an Agribusiness plan.

Unit 1: Agriculture and Marketing

Content Standard 9.5.1.1 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 9.5.1.1. Identify and examine the economic systems, practices, and factors of starting-up and managing agribusiness.

Topic : Economic Principles and systems in Agribusinesses

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Identify and examine the principles and concepts of microeconomics. • Identify and choose the different types of markets involving agricultural products to conduct a market research. • examine and discuss the importance of micro and macroeconomics before starting an agribusiness.
Essential Questions	<ol style="list-style-type: none"> 1. What is Agribusiness? 2. How are microeconomic principles applied in an agribusiness? 3. Why is it necessary to understand macroeconomic principles?
Essential Knowledge	<ul style="list-style-type: none"> • Agribusiness • Microeconomic principles • Macroeconomic principles.
Essential Skills	<ul style="list-style-type: none"> • Identify and examine the principles and concepts of microeconomics • Examine and discuss the principles and concepts of macroeconomics.
Attitudes & Values	<ul style="list-style-type: none"> • Value the importance of basic economic principles in an agribusiness.

Content Background:

What is Agribusiness? Agri-business is a concept of economics which includes total sum of all activities involved in the manufacturing and distribution of farm supplies production operations on the farm and the storage processing and distribution of farm commodities and items made from them.

Agri-Business includes all either a product, commodities or services and encompasses items such as

- 1) productive resources (feed, seed, fertilizers, equipment, energy, machinery etc.
- 2) Agricultural commodities (all food and fiber).
- 3) Facilitative services (credit, insurance, marketing, storages, processing, transportation, packing, distribution).

Agriculture has evolved into agri-business and has become a vast and complex system that reaches far beyond the farm to include all those who are involved in bringing food and fiber to consumers. Agri-business include not only those that farm the land but also the people and firms that provide the inputs (example; Seed, chemicals, credit etc), process the output (example; Milk, grain, meat, etc), manufacture the food products (example; Ice cream, bread, breakfast cereals, etc.), and transport and sell the food products to consumers (example; Restaurants, super markets).

A business can be defined as an organization that provides goods and services to others who want or need them.

Agriculture: Art of cultivating various categories of crops including animal husbandry , finishing and other related activities.

Business: An economic unit that aims to sell goods and services to customers at prices that will provide an adequate return to its owner.

Management: A set of activities (planning and decision making, organizations, leading/directing and controlling), directed at an organizations resources (human, financial, physical, information) with the aim of achieving the organizations goals in efficient and effective manners.

Distinctive features or the principle characteristics of agribusiness are as follows;

- 1) Management varies from business to business depending on the kind and type of business. It varies from basic producer to brokers, wholesalers, processors, packagers, manufacturers, storage proprietors, transporters, retailers, etc.
- 2) Agri-business is very large and evolved to handle the products through various marketing channels from producers to consumers.
- 3) Management varies with several million of farmers who produce hundreds of food and livestock products.
- 4) There is very large variation in the size of agri-business; some are very large, while many others are one person or one family organization.
- 5) Most of the Agri-business units are conservative and subsistence in nature and family-oriented and deal with business that is run by family members.
- 6) The production of Agriculture produce is seasonal and depends on farm production. They deal with unexpected changes of nature.
- 7) Agri-busniess is always market oriented.

- 8) There is direct impact of government programmes on the production and performance of Agribusiness.

Micro-economics

Micro-economics is the application of basic economic principles to decisions within an individual firm or business. Every agribusiness faces tough questions when it comes to allocating its limited resources. Farmers and managers must decide the best way to use physical, human, and financial resources in the production and marketing of goods and services to meet customers' needs and generate a profit. Tools of economic analysis are essential in an agribusiness to make daily business decisions.

The successful agribusiness owner or manager must assemble a variety of different types of information, and then use that information effectively to make the best possible decisions for the short- and long-run financial health of the business. If a business made less profit, it might mean the management had used poor judgment. In today's extremely competitive marketplace, a poor decision may lead to failure of the business.

Thus, economics studies how individuals, businesses, and society choose to combine scarce resources (land, labor, capital, and management) to satisfy unlimited wants and best meet consumer needs. These four scarce resources are often referred to as the factors of production, each of which must receive a payment or return. For example, labor is paid a wage, while management typically receives a salary. Likewise, returns to land are often referred to as rent and returns to capital are represented by interest payments. The way market forces work to allocate returns to these factors is at the heart of a capitalistic economy.

For a successful agribusiness, one should understand and use economic concepts to interpret information, both to assess the broader marketplace, and to improve the effectiveness of their decision-making.

Macroeconomics

Macroeconomics focuses on the "big picture" view of the economic system. It is the application of studying the behavior and performance of an economy in general and focuses on changes to the economy such as unemployment, growth rate, gross domestic product and inflation.

Agribusinesses are greatly affected by macroeconomics because global demand for various food and fiber products is constantly changing. General economic conditions are influenced by such factors as weather, government policies, and international developments.

Macroeconomics is concerned with how the different elements of the total economy interact.

An individual business has relatively little impact on the total economy but having necessary skills at anticipating and interpreting the macroeconomic environment is critical to the success of any agribusiness.

For example, Government policies may raise interest rates to fight inflation. Since interest rates have an important impact on purchases of tractors, combines, and other farm machinery, so farm equipment manufacturers pay close attention to interest rates. Food consumption patterns are also affected by the economy's health. In a boom period, more expensive, luxury food items may sell well. However, during a recession, food purchasing habits may shift as incomes fall. Managers of food companies follow such developments very closely.

Economic Principles of Agribusiness include:

- Supply and demand
- The principle of Diminishing returns
- Fixed and Variable costs
- Substitution of Inputs
- Opportunity costs
- Major markets for Price discovery
- Governments and the Economics of Agriculture

Benchmark 9.5.1.1. Identify and examine the economic systems, practices, and factors of starting-up and managing agribusiness.

Topic: Economic Principles and systems in Agribusinesses

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • identify and examine the principles and concepts of microeconomics. • identify and choose the different types of markets involving agricultural products to conduct a market research. • examine and discuss the importance of micro and macroeconomics before starting an agribusiness.
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Knowledge	<ul style="list-style-type: none"> • Agribusiness • Microeconomic principles • Macroeconomic principles.
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Content Background:

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- The principle of Diminishing returns
- Fixed and Variable costs
- Substitution of Inputs
- Opportunity costs
- Major markets for Price discovery
- Governments and the Economics of Agriculture

Benchmark 9.5.1.2 Describe the importance of agricultural imports and exports and its impact on agribusiness.

Topic: Agricultural imports and exports

Learning Objectives:

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

- Identify and discuss the processes and importance of agricultural imports and exports
- Identify methods that food and agriculture product businesses might use to enter international markets.

Essential questions:

1. Why is it important for agribusiness to enter into the international market?
2. How can an agribusiness enter the international market?
3. How does Import and Export affect agribusiness?

Essential Knowledge	<ul style="list-style-type: none"> • Processes and importance of agricultural imports and imports • Processes and importance of agricultural imports and exports • Impacts of imports and exports on agribusiness • International Markets • Imports • Direct Exporting • Indirect Exporting
Essential Skills	<ul style="list-style-type: none"> • Examine the basic concepts of the International Market • Examine and describe the importance of Imports and Exports in Agribusiness. • Evaluate the impact of imports and exports on agribusiness
Essential Attitudes & Values	<ul style="list-style-type: none"> • Value the importance of the International Market in terms of imports and exports in an agribusiness.

Content Background:

Importance of Import/Export in the International Market

There are many reasons for agribusiness to be interested in the international market.

The exporting of agricultural products boosts employment within a country's economy.

Although most of these rural jobs are in the production of agricultural products, others are in more labor-intensive industries such as wholesale and retail trade, services, and food processing and feed processing. International markets are beneficial for a number of reasons.

Some of these reasons are shown in the list below:

- Exports and sales
- Take advantage of scale economies
- Capture benefits of a global brand
- Reduce risk by diversifying across markets
- Lower costs of production
- Access lower-cost raw materials through international sourcing (Imports)
- Broaden access to credit
- Leverage experiences from operating in international markets into domestic markets

While each reason in the list may not be part of a specific international opportunity for an

Agribusiness, one reason to pursue international markets is to expand sales by capitalizing on growth opportunities in other countries.

Small agribusinesses have found opportunities and success in the international marketplace. Their active pursuit of placing and developing products for international markets has in many cases met with great success. While large companies reap the benefits, smaller agribusiness firms are often more flexible, allowing them to adapt to the changing structure and demands of the international food industry. As with all business in the international marketplace, successful global business endeavors by the small firm require an understanding of the unique characteristics and structures of the customer in each given instance.

Although countless factors influence the global marketplace during any business day, a few key factors have helped increase the number of opportunities for small agribusiness firms in the international arena.

Markets are opening up to conduct business with international suppliers, partners, etc. These nations include those in Eastern Europe, other countries of the former USSR, India, Latin America, China, and other Asian countries. Many African countries are moving continually closer to allowing or welcoming business from outside their borders. Another key factor opening doors of world markets for smaller businesses is technology.

Simply put, today's small food and agribusinesses are often "well wired" — connected via the internet by computer, modem, email, telephone, cell phone, and fax — making them very competitive with much larger firms for emerging-market growth potential. Essentially, the world is truly available to creative, innovative businesses. However, unlike the world market of post-World War II when the multinational companies controlled these markets, markets today are often open to the best competitors. Businesses that succeed will be flexible enough to adapt to constant change and adjust to any challenges. Those companies are often the small, agile companies and businesses.

Exporting

There are two general means used to export an agribusiness's products: indirect and direct exporting. Most agribusinesses, especially those with little international marketing experience, initially enter the global market via indirect exporting.

Indirect exporting uses a trading company or an export management company to handle the logistics of exporting. These trading experts manage the exporting and importing procedures and regulations, and they use their established relationships with buyers and distributors to distribute the product. Advantages offered through working with a trading company include the expertise, knowledge, experience, and connections in the market. These trading companies' networks within the distribution channels can be extremely useful to first-time exporters. Although overall, using indirect exporting may reduce profitability, many firms perceive this to be a low-risk strategy that entails substantially lower investment.

Direct exporting is where the agribusiness itself handles the details of exporting their product.

At this point, the firm conducts research, establishes contacts in the country, and sets up its distribution channels. Firms often open an overseas sales office to manage the operations in that country. Direct exporting involves investments and salaries for the items mentioned previously. In turn, the potential for profits are much higher, and the firm can exert more control over product distribution.

Benchmark 9.5.1.3 Research and develop a business plan for starting up and operating an agribusiness or enterprise.

Topic: Planning and managing an Agribusiness Enterprise Agribusiness Enterprise?? (check against the topic in the Grade 10 Content Overview table

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • examine and discuss the meaning of enterprise. • differentiate between sole proprietorship, partnerships and corporations as forms of business ownership. • discuss and explain the process involved in planning and establishing an agribusiness
Essential Questions:	<ol style="list-style-type: none"> 1. What is an enterprise? 2. What are the different forms of business ownerships? 3. What kind of resources should be considered when planning an agriculture business? 4. Is agribusiness or enterprise plan the same as other forms of business plans?
Essential Knowledge	<ul style="list-style-type: none"> • Enterprise • Sole proprietorship. • Partnership • Corporation • Agribusiness Plan good
Essential Skills	<ul style="list-style-type: none"> • Examine the basic concepts of an Enterprise • Examine and describe the different types of ownerships • Discuss, research and develop an agribusiness plan
Essential Attitudes & Values	<ul style="list-style-type: none"> • Value the importance of planning when starting up an agribusiness. • Collaborate with others in devising a business plan.

Content Background:

What is an Enterprise? Enterprise means to plan a business, to start it and run it. It means to bring the factors of production together, assign each its proper task and pay them remuneration when the work is done. It implies not only running of a business but also shouldering the loss, if any. As a

factor of production, it is an alternative name for the entrepreneur. The person who undertakes all this work is called an organizer, or more commonly an entrepreneur. Organizing and risk-taking are the two main functions of the entrepreneur.

Types of Ownership

Of all the decisions you make when starting a business, probably the most important one relating to taxes is the type of legal structure you select for your company. Not only will this decision have an impact on how much you pay in taxes, but it will affect the amount of paperwork your business is required to do, the personal liability you face and your ability to raise money.

The most common forms of business are **sole proprietorship, partnership** and corporation. A more recent development to these forms of business is the limited liability company (LLC) and the limited liability partnership (LLP). Because each business form comes with different tax consequences, you will want to make your selection wisely and choose the structure that most closely matches your business's needs.

If you decide to start your business as a sole proprietorship but later decide to take on partners, you can reorganize as a partnership or other entity. If you do this, be sure you notify the IRS as well as your state tax agency.

Sole Proprietorship

The simplest structure is the sole proprietorship, which usually involves just one individual who owns and operates the enterprise. If you intend to work alone, this structure may be the way to go.

Partnership

If your business will be owned and operated by several individuals, you'll want to take a look at structuring your business as a partnership. Partnerships come in two varieties: general partnerships and limited partnerships. In a general partnership, the partners manage the company and assume responsibility for the partnership's debts and other obligations. A limited partnership has both general and limited partners. The general partners own and operate the business and assume liability for the partnership, while the limited partners serve as investors only; they have no control over the company and are not subject to the same liabilities as the general partners.

Corporation

The corporate structure is more complex and expensive than most other business structures. A corporation is an independent legal entity, separate from its owners, and as such, it requires complying with more regulations and tax requirements

Planning an Agribusiness

Planning is basically a decision-making process in which an organization and its individual members are to take different courses of action over a period of time. It also refers to policy formulation and the establishment of

goals. Planning is also deciding in advance what to do, when to do, how to do and who will do a particular task. In fact, it is the blue print for future action and bridges the gap between the present and future. Perception, foresight and minimizing risk is vital for a good planner.

Planning, therefore, includes (1) the purpose, (2) setting up objectives, (3) laying down policies, (4) preparing strategies (5) rules (6) procedures, (7) programmes (8) budgeting (9) forecasting and (10) decision-making.

1. **Mission or purpose:** The basic purpose of setting up of the business is called its mission. For instance, the purpose of a college or university is teaching and research. The purpose of a firm is production and distribution of goods and services.
2. **Objectives or goals:** These are the goals or the end results towards which all management activities are directed. Objective is the term commonly used to indicate the end point of a management programme. Objective should be specific and set for different period. Well defined goals or clear objectives are essential for the smooth progress and growth of any business organization.
3. **Policies:** Policies are guidelines to action. These are basic statements (in written form) serving as guides to the thinking and action of subordinates in repetitive situations. They provide broad guidelines. In other words, policy is a standing plan which is a guideline to decision-making, where a manager has certain discretion or it is a solution to recurring problems. When all the policies of a concerned are published in the form of a book or diary it is called policy manual. It is a written and definite statement of policy, readily available as a reference or guide for all managers.
4. **Strategies:** It is also regarded as necessary planning. So strategy is a comprehensive and integrated plan designed to assure that business objectives are accomplished.
5. **Rules:** A rule is a guide to action. It is in the nature of a decision made by the management regarding what is to be done and what is not to be done in a given situation. A rule is more rigid. A rule may or may not be a part of a procedure. Rules will not have any scope for discretion, as they are specific and definite. Breach of the rules usually carries a penalty. “No credit facilities beyond 30 days”, „Smoking is strictly prohibited “, are examples of rules.
6. **Procedures:** A procedure guides in detail how work should be performed, thereby providing a definite way. Procedures provide the manner in which a particular work has to be done. They also provide a sequence of steps to be followed in the execution of a plan. So the chronological series of steps constitute a procedure. If a programme indicates what is to be done, a procedure indicates how it should be done. Procedures are basically guides to action and not guides to thinking. Policies can be executed through procedures.

6 Programs: Programs are sets of Objectives/ goals, policies, rules, procedures and other components required to carry out a course of action.

7 Budgets: A budget is the monetary/quantitative expression of physical plans and policies to be implemented in the future period of time. A budget is a basic plan or statement defining the anticipated cost of attaining an objective. It is an appraisal of the expenses expected against the income anticipated for a particular future period of time. A budget is considered as both a planning and a controlling device. It may be expressed in terms of time, materials, money, man-hours, etc. But usually money budgets are the common ones.

Benchmark 9.5.1.2 Describe the importance of agricultural imports and exports and its impact on agribusiness

Topic: Agricultural imports and exports

Essential Knowledge, Skills, Attitudes and Values	
Learning Objectives:	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Identify and discuss the processes and importance of agricultural imports and exports • Identify methods that food and agriculture product businesses might use to enter international markets.
Essential Questions:	<ol style="list-style-type: none"> 1. Why is it important for agribusiness to enter into the international market? 2. How can an agribusiness enter the international market? 3. How does Import and Export affect agribusiness?
Essential Knowledge	<ul style="list-style-type: none"> • Processes and importance of agricultural imports and imports • Processes and importance of agricultural imports and exports • Impacts of imports and exports on agribusiness • International Markets • Imports • Direct Exporting • Indirect Exporting
Essential Skills	<ul style="list-style-type: none"> • Examine the basic concepts of the International Market • Examine and describe the importance of Imports and Exports in Agribusiness. • Evaluate the impact of imports and exports on agribusiness
Essential Attitudes & Values	<ul style="list-style-type: none"> • Value the importance of the International Market in terms of imports and exports in an agribusiness.

Content Background:

There are many reasons for agribusiness to be interested in the international market. The exporting of agricultural products boosts employment within a country's economy. Although most of these rural jobs are in the production of agricultural products, others are in more labor-intensive industries such as wholesale and retail trade, services, and food processing and feed processing.

International markets are beneficial for a number of reasons. Some of these reasons are shown in the list below:

- Exports and sales
- Take advantage of scale economies
- Capture benefits of a global brand
- Reduce risk by diversifying across markets
- Lower costs of production
- Access lower-cost raw materials through international sourcing (Imports)
- Broaden access to credit
- Leverage experiences from operating in international markets into domestic markets

While each reason in the list may not be part of a specific international opportunity for an Agribusiness, one reason to pursue international markets is to expand sales by capitalizing on growth opportunities in other countries.

Small agribusinesses have found opportunities and success in the international marketplace. Their active pursuit of placing and developing products for international markets has in many cases met with great success. While large companies reap the benefits, smaller agribusiness firms are often more flexible, allowing them to adapt to the changing structure and demands of the international food industry. As with all business in the international marketplace, successful global business endeavors by the small firm require an understanding of the unique characteristics and structures of the customer in each given instance.

Although countless factors influence the global marketplace during any business day, a few key factors have helped increase the number of opportunities for small agribusiness firms in the international arena.

Markets are opening up to conduct business with international suppliers, partners, etc. These nations include those in Eastern Europe, other countries of the former USSR, India, Latin America, China, and other Asian countries. Many African countries are moving continually closer to allowing or welcoming business from outside their borders. Another key factor opening doors of world markets for smaller businesses is technology.

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If when the multinational companies controlled these markets, markets today are often open to the best competitors. Businesses that succeed will be flexible enough to adapt to constant change and adjust to any challenges. Those companies are often the small, agile companies and businesses.

Exporting

There are two general means used to export an agribusiness's products: indirect and direct exporting. Most agribusinesses, especially those with little international marketing experience, initially enter the global market via indirect exporting.

Indirect exporting uses a trading company or an export management company to handle the logistics of exporting. These trading experts manage the exporting and importing procedures and regulations, and they use their established relationships with buyers and distributors to distribute the product. Advantages offered through working with a trading company include the expertise, knowledge, experience, and connections in the market. These trading companies' networks within the distribution channels can be extremely useful to first-time exporters. Although overall, using indirect exporting may reduce profitability, many firms perceive this to be a low-risk strategy that entails substantially lower investment.

Direct exporting is where the agribusiness itself handles the details of exporting their product.

At this point, the firm conducts research, establishes contacts in the country, and sets up its distribution channels. Firms often open an overseas sales office to manage the operations in that country. Direct exporting involves investments and salaries for the items mentioned previously. In turn, the potential for profits are much higher, and the firm can exert more control over product distribution.

Agribusiness**Unit: Agriculture and Market**

Benchmark 9.5.1.3 Research and develop a business plan for starting up and operating an agribusiness or enterprise.

Topic: Planning and managing an Agribusiness Enterprise Agribusiness Enterprise?? (check against the topic in the Grade 10 Content Overview table)

Essential Knowledge, Skills, attitudes and Values	
Learning Objectives	By the end of this topic, students will be able to: <ul style="list-style-type: none"> • Examine and discuss the meaning of enterprise. • Differentiate between sole proprietorship, partnerships and corporations as forms of business ownership. • Discuss and explain the process involved in planning an agriculture business.
Essential Questions	<ol style="list-style-type: none"> 1. What is an enterprise? 2. What are the different forms of business ownerships? 3. What kind of resources should be considered when planning an agriculture business? 4. Is agribusiness or enterprise plan the same as other forms of business plans?
Knowledge	<ul style="list-style-type: none"> • Enterprise • Sole proprietorship. • Partnership • Corporation • Agribusiness Plan good
Skills	<ul style="list-style-type: none"> • Examine the basic concepts of an Enterprise • Examine and describe the different types of ownerships • Discuss, research and develop an agribusiness plan
Attitudes & Values	<ul style="list-style-type: none"> • Value the importance of planning when starting up an agribusiness. • Collaborate with others in devising a business plan.

Content Background:**What is an Enterprise?**

Enterprise means to plan a business, to start it and run it. It means to bring the factors of production together, assign each its proper task and pay them remuneration when the work is done. It implies not only running of a business but also shouldering the loss, if any. As a factor of production, it is an alternative name for the entrepreneur. The person who undertakes all this work is called an organizer, or more commonly an entrepreneur. Organizing and risk-taking are the two main functions of the *entrepreneur*.

Types of Ownership

Of all the decisions you make when starting a business, probably the most important one relating to taxes is the type of legal structure you select for your company.

Not only will this decision have an impact on how much you pay in taxes, but it will affect the amount of paperwork your business is required to do, the personal liability you face and your ability to raise money.

The most common forms of business are sole proprietorship, partnership and corporation. A more recent development to these forms of business is the limited liability company (LLC) and the limited liability partnership (LLP). Because each business form comes with different tax consequences, you will want to make your selection wisely and choose the structure that most closely matches your business's needs.

If you decide to start your business as a sole proprietorship but later decide to take on partners, you can reorganize as a partnership or other entity. If you do this, be sure you notify the IRS as well as your state tax agency.

Sole Proprietorship

The simplest structure is the sole proprietorship, which usually involves just one individual who owns and operates the enterprise. If you intend to work alone, this structure may be the way to go.

Partnership

If your business will be owned and operated by several individuals, you'll want to take a look at structuring your business as a partnership. Partnerships come in two varieties: general partnerships and limited partnerships. In a general partnership, the partners manage the company and assume responsibility for the partnership's debts and other obligations. A limited partnership has both general and limited partners. The general partners own and operate the business and assume liability for the partnership, while the limited partners serve as investors only; they have no control over the company and are not subject to the same liabilities as the general partners.

Corporation

The corporate structure is more complex and expensive than most other business structures. A corporation is an independent legal entity, separate from its owners, and as such, it requires complying with more regulations and tax requirements

Planning an Agribusiness

Planning is basically a decision-making process in which an organization and its individual members are to take different courses of action over a period of time. It also refers to policy formulation and the establishment of goals. Planning is also deciding in advance what to do, when to do, how to do and who will do a particular task. In fact, it is the blue print for future action and bridges the gap between the present and future. Perception,

foresight and minimizing risk is vital for a good planner.

Planning, therefore, includes (1) the purpose, (2) setting up objectives, (3) laying down policies, (4) preparing strategies (5) rules (6) procedures, (7) programmes (8) budgeting (9) forecasting and (10) decision-making.

1. **Mission or Purpose:** The basic purpose of setting up of the business is called its mission. For instance, the purpose of a college or university is teaching and research. The purpose of a firm is production and distribution of goods and services.
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7. **Programmes:** Programmes are sets of Objectives/ goals, policies, rules, procedures and other components required to carry out a course of action.

8. Budgets: A budget is the monetary/quantitative expression of physical plans and policies to be implemented in the future period of time. A budget is a basic plan or statement defining the anticipated cost of attaining an objective. It is an appraisal of the expenses expected against the income anticipated for a particular future period of time. A budget is considered as both a planning and a controlling device. It may be expressed in terms of time, materials, money, man-hours, etc. But usually money budgets are the common ones.

Standards-Based Lesson Planning

What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

When planning a standards-based lesson, teacher instructions are very crucial for your lessons. How teachers instruct the students is what really points out an innovative teacher to an ordinary teacher. Teacher must engage and prepare motivating instructional activities that will provide the students with opportunities to demonstrate the benchmarks. For instance, teacher should at least identify 3-5 teaching strategies in a lesson; teacher lectures, ask questions, put students into groups for discussion and role play what was discussed.

Why is Standards-Based Lesson Planning Important?

There are many important benefits of having a clear and organized set of lesson plans. Good planning allows for more effective teaching and learning. The lesson plan is a guide and map for organizing the materials and the teacher for the purpose of helping the students achieve the standards. Lesson plans also provide a record that allows good, reflective teachers to go back, analyze their own teaching (what went well, what didn't), and then improve on it in the future.

Standards-based lesson planning is vital because the content standards and benchmarks must be comparable, rigorous, measurable and of course evidence based and be applicable in real life that we expect students to achieve. Therefore, teachers must plan effective lessons to teach students to meet these standards. As schools implement new standards, there will be much more evidence that teachers will use to support student learning to help them reach the highest levels of cognitive complexity. That is, students will be developing high-level cognitive skills.

Components of a Standards-Based Lesson Plan

An effective lesson plan has three basic components;

- aims and objectives of the course;
- teaching and learning activities;
- assessments to check student understanding of the topic.

Effective teaching demonstrates deep subject knowledge, including key concepts, current and relevant research, methodologies, tools and techniques, and meaningful applications.

Planning for under-achievers NORMA

Who are underachieving students?

Under achievers are students who fail or do not perform as expected. Underachievement may be caused by emotions (low self-esteem) and the environment (cultural influences, unsupportive family)

How can we help underachievement?

Underachievement varies between students. Not all students are in the same category of underachievement.

Given below a suggested strategies teachers may adopt to assist underachievers in the classroom.

- Examine the Problem Individually
It is important that underachieving students are addressed individually by focusing on the student's strengths.
- Create a Teacher-Parent Collaboration

Teachers and parents need to work together and pool their information and experience regarding the child. Teachers and parents begin by asking questions such as;

- In what areas has the child shown exceptional ability?
- What are the child's preferred learning styles?
- What insights do parents and teachers have about the child's strengths and problem areas?
- Help student to plan every activity in the classroom
- Help students set realistic expectations
- Encourage and promote the student's interests and passions.
- Help children set short and long-term academic goals
- Talk with them about possible goals.
- Ensure that all students are challenged (but not frustrated) by classroom activities
- Always reinforce students

Standards-Based Lesson Planning

The following sample lesson can help teachers to plan effective lessons. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern which should not deviate students learning of the concept from the topic.

Sample Standards-Based Lesson Plan (Integrating STEAM)

Topic: Relationship between domesticated and farmed monogastric and polygastric animals

Lesson Topic: Domesticated and farmed animals

Grade: 9

Length of Lesson: 40 minutes

Content Standard 2.1: Students will be able to identify and appraise the characteristics of different types of domestic and farm animals, categorise them according to their characteristics, feeding system, purposes and their benefits and investigate the different context, environments, and places where they are farmed.

Grade-Level Benchmark

Benchmark 9.2.1.1 Analyse the relationship between domesticated and farmed monogastric and polygastric animals and discuss environments which they are domesticated or farmed.

Essential Knowledge, Skills, Values, and Attitudes

Knowledge: Relationship between monogastric and polygastric animals species

Skills: Distinguish, categorize, and classify, domesticated and farmed monogastric and polygastric animals

Values: Creativity and sustainability

Attitudes: Caring and concern of domesticated and farmed monogastric and polygastric animals

Materials:

Materials: Chart papers, Markers, Working groups

Lesson Objective: Examine and identify types of domesticated and farmed monogastric and polygastric animals

Essential Questions:

1. Name types of domesticated monogastric and polygastric animals and state their purpose
2. What is the difference between monogastric and polygastric animals in relation to the type of environment to which they are farmed

Standards-Based Lesson Planning

What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

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Standards-based lesson planning is vital because the content standards and benchmarks must be comparable, rigorous, measurable and of course evidence based and be applicable in real life that we expect students to achieve. Therefore, teachers must plan effective lessons to teach students to meet these standards. As schools implement new standards, there will be much more evidence that teachers will use to support student learning to help them reach the highest levels of cognitive complexity. That is, students will be developing high-level cognitive skills.

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Teachers and parents begin by asking questions such as;

In what areas has the child shown exceptional ability?

What are the child's preferred learning styles?

What insights do parents and teachers have about the child's strengths and problem areas?

Help student to plan every activity in the classroom

Help students set realistic expectations

Encourage and promote the student's interests and passions.

Help children set short and long-term academic goals

Talk with them about possible goals.

Ensure that all students are challenged (but not frustrated) by classroom activities

Always reinforce students

Sample Standards-Based Lesson Plan

The following sample lesson can help teachers to plan effective lessons. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern which should not deviate students learning of the concept from the topic.

TOPIC: Relationship between domesticated and farmed monogastric and polygastric animals

Lesson Topic: Domesticated and farmed animals

Grade: 9

Length of Lesson: 40 minutes

Content Standard 2.1: Students will be able to identify and appraise the characteristics of different types of domestic and farm animals, categorise them according to their characteristics, feeding system, purposes and their benefits and investigate the different context, environments, and places where they are farmed.

Grade-Level Benchmark

Benchmark 9.2.1.1 Analyse the relationship between domesticated and farmed monogastric and polygastric animals and discuss environments which they are domesticated or farmed.

Essential Knowledge, Skills, Values, and Attitudes

Knowledge: Relationship between monogastric and polygastric animals species

Skills: Distinguish, categorize, and classify, domesticated and farmed monogastric and polygastric animals

Values: Creativity and sustainability

Attitudes: Caring and concern of domesticated and farmed monogastric and polygastric animals

Materials:

Lesson Objective: Examine and identify types of domesticated and farmed monogastric and polygastric animals

Essential Questions:

Name types of domesticated monogastric and polygastric animals and state their purpose

What is the difference between monogastric and polygastric animals in relation to the type of environment to which they are farmed

Teacher Activities	Student Activities
Introduction	
Body	
Modelling	
Guided Practice	
Independent Practice	
Conclusion	
Assessment Task: Describe the difference between domesticated and farmed animals	

Performance Assessment and Standards (Formative Assessment)

National Content Standard:				
Lesson Topic	Topic	Benchmark	Performance Assessment/ Indicator	
Communication Skills in Sales and Marketing	Agribusiness Communication skills in Sales and Marketing	Benchmark 10.5.1.1 Explain and practice effective verbal and written communication skills required for agribusiness sales and marketing.	Oral Presentation- Demonstrate effective verbal communication skills to market a product.	
	PROFICIENCY RUBRIC -Holistic			
	Advanced	Proficient	Partially Proficient	Novice
	Demonstrated strong verbal communication skills effectively in marketing an Agribusiness product.	Demonstrated verbal communication skills effectively in marketing an Agribusiness product	Demonstrated few verbal communication skills in marketing an Agribusiness product	Did not demonstrate effective verbal communication skills in marketing.

Performance Assessment and Standards (Authentic-Summative Assessment)

National Content Standard:			
Lesson Topic	Topic	Benchmark	Performance Assessment/Indicator
Communication Skills in Sales and Marketing	Agribusiness Communication skills in Sales and Marketing	Benchmark 10.5.1.1 Explain and practice effective verbal and written communication skills required for agribusiness sales and marketing.	Develop and write up a sales proposal to business houses or companies to market an Agribusiness Product from an existing Agriculture Project in the school.
PROFICIENCY RUBRIC			
<p>Criteria Exemplary Proficient Partially Proficient Novice</p> <p>Effort Students' proposal is outstanding showing creativity, well organized with great effort. Students' proposal met most expectations and with satisfactory effort. Students' proposal shows minimal effort. Has some errors and could have added more. Students' proposal shows no creativity with very little effort.</p> <p>Content Students understood the concepts of marketing their product and did more than what was expected and added more detail to complete the proposal. Student understood the concepts of marketing their product and completed all the requirements for the proposal. Students understood the concepts of marketing their product but did not complete all the requirements for the proposal. Didn't incorporate all the concepts of marketing their product into proposal. Misunderstood the ideas and principles.</p> <p>Context Sales proposal is very applicable in the community or school for an Agribusiness. Sales proposal is satisfactorily applicable in the community or school for an Agribusiness. Sales proposal is less applicable in the community or school for an Agribusiness. Sales proposal is not applicable in the community or school for an Agribusiness.</p>			

TOPIC: Fish Farming Management Practices and Systems

Lesson Topic: Fish Farming Systems in Freshwater

Grade: 10

Length of Lesson: 40 mins (Theory) and 160 mins During Project Period (Practical)

National Content Standard:

Content Standard 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.

Grade-Level Benchmark; 10.3.2.1. Explore and analyse fish farming and management practices and systems used in different places and environments.

Essential Knowledge, Skills, Attitudes & Values:

Knowledge	<ul style="list-style-type: none"> • The four common ways of fish management and production systems. • Pond System • Open Net Pens • Submersible Net Pens • Recirculating Systems • Fish farming management techniques • Fish handling
Skills	<ul style="list-style-type: none"> • Distinguish between the common methods of fish production • Identify key areas of management and apply appropriate measures to maintain quality • Apply correct techniques when handling fish to maintain freshness of fish. • Assess the freshness of fish by sensory or chemical methods • Formulate checklists to check on the different areas
Attitudes	<ul style="list-style-type: none"> • Be responsible and caring for properties • Appreciate the importance of proper fish handling techniques
Values	<ul style="list-style-type: none"> • Affective and concerned about the importance of good management practices • Rational and honest when expressing the importance of proper fish handling techniques

Lesson Knowledge, Skills, Values and Attitudes including STEAM Knowledge and Skills.

Knowledge: Fish farming management systems and practices in different environments such as freshwater, brackish and marine water and their benefits.

Skills: Describe and illustrate freshwater fish farming management systems in different environments.

Values: gratitude for benefits and purposes of freshwater fish farming management systems

Attitudes: Interest and confident in freshwater fish farming using fish farming management systems.

STEAM Knowledge and Skill:

Knowledge: Science, Technology, Engineering, Arts

Skill: Design a Freshwater fish farming system and implement as a project for the school.

Performance Indicator:

Efficiently and effectively designed and implemented a freshwater fish farming system in the school.

STEAM Performance Indicator: (rubrics can be designed to assess the project)

Science:

Technology used:

Design:

Mathematics application:

Materials: Selected materials specific to the project needs.

Lesson Objective: By the end of the lesson, students will be able to:
Design and implement a Semi-intensive freshwater fish farming system in their school e.g. fish pond

Essential questions:

1. What are the benefits and purposes of freshwater fish farming management systems?
2. How are fish farming management practices applied in various environments?

Insert a Grade 9 Sample here

Assessment, Monitoring and Reporting

What is Standards-Based Assessment (SBA)?

Standards-Based Assessment is an on-going and a systematic process of **assessing, evaluating, reporting** and **monitoring** students' performance and progression towards meeting grade and national level expectations. It is the measurement of students' proficiency on a learning objective or a specific component of a content standard and progression towards the attainment of a benchmark and content standard.

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 and learning objectives
- ascertain students' attainment or progress towards the attainment of specific component of a content standard
- ascertain what each student knows and can do and what each student needs to learn 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 and progress 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;

- emphasizing on tasks that should encourage deeper learning
- be an integral component of a course, unit or topic and not something to add on afterwards
- a good assessment requires clarity of purpose, goals, standards and criteria
- of practices that should use a range of measures allowing students to demonstrate what they know and can do
- based on an understanding of how students learn
- of practices that promote deeper understanding of learning processes by developing students' capacity for self-assessment

- improving performance that involves feedback and reflection
 - on-going rather than episodic
 - given the required attention to outcomes and processes
- 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*’ and is conducted during 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-day basis.
- Provide continuous feedback and evidence to the teachers that should enable them to identify gaps and issues with their teaching, and improve their classroom teaching practice.
- 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 future learning goals
- Helps students to continuously evaluate, reflect, and improve their own learning
- Helps students to understand the purpose of their learning and clarify learning goals

2. Summative Assessment

Summative assessment focuses on ‘assessment *of learning*’ and is conducted after or 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 progress he/she has made towards meeting national and grade-level expectations
- Help teachers to determine what each student has achieved at the end of a learning sequence or a unit.
- Enable teachers to ascertain each student’s development against the unit or topic objectives 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 use of 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.

Authentic assessment refers to assessment that:

- Looks at students actively engaged in completing a task that represents the achievement of a learning objective or standard
- Takes place in real life situations
- Asks students to apply their knowledge, skills, values and attitudes in real life situations
- 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 may be 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 have mastered 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 increased time for health and physical education 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 work such 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 a period 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

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” or “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 include explanations of how well students must demonstrate the content, explaining how good is good enough.

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

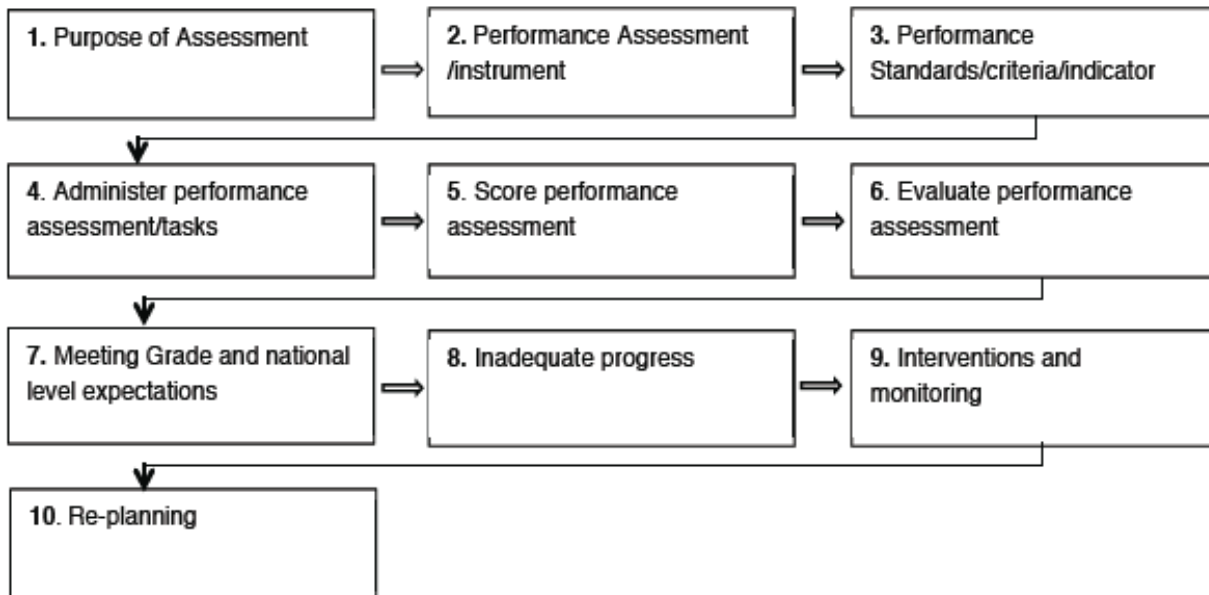
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards

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.

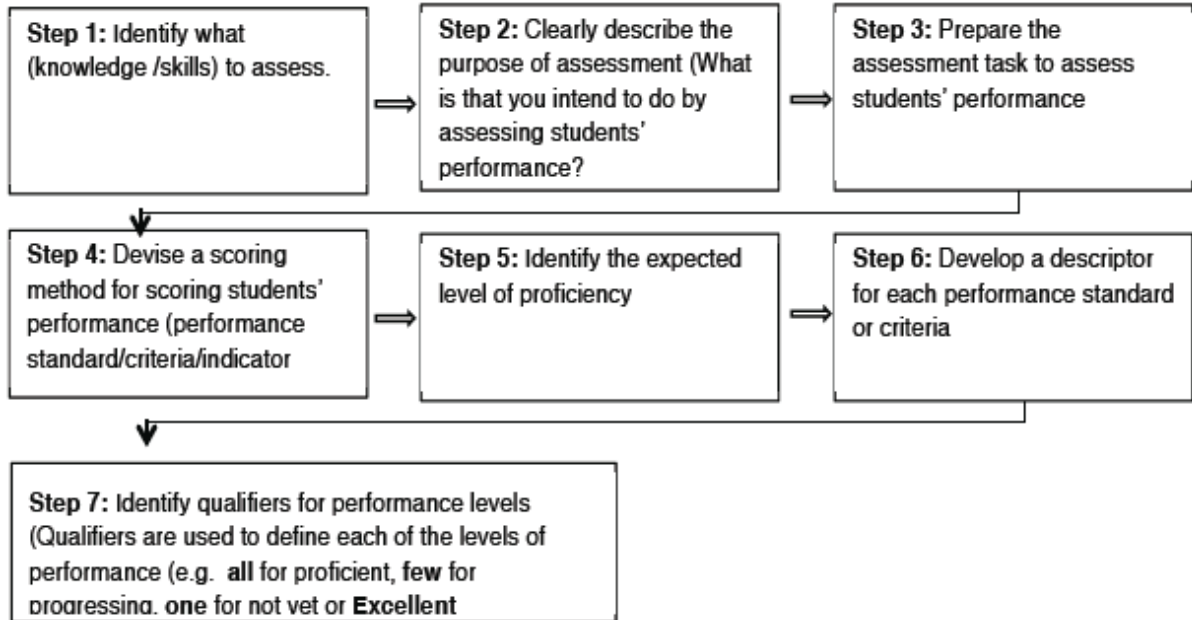
Provided in the appendices is a list of suggested strategies you can use to assess student's performances. These strategies are applicable in all the standards-based assessment types. ***Please refer to the Appendices to see the suggested strategies.***

Standards-Based Assessment Process



Assessment Samples

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.



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Enable teachers to ascertain each student’s development against the unit or topic objectives and to set future directions for learning.

Help students to evaluate, reflect on, and prepare for next stage of learning.

Authentic Assessment

Is performed in a real life context that approximates as much as possible, the use of 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 Criteria

Authentic assessment refers to assessment that:

Looks at students actively engaged in completing a task that represents the achievement of a learning objective or standard.

Takes place in real life situations.

Asks students to apply their knowledge, skills, values and attitudes in real life situations.

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Self-assessment activities.

Goal setting, deciding a strategy and monitoring progress towards achievement.

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provide the basis (performance indicators) for evaluating, reporting, and monitoring students' level of proficiency in the use of a specific knowledge, skill, 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 the grade-level benchmarks and content standards.

Scoring Students Assessment

Assessment scoring methods describe how students' assessment tasks will be scored. The most commonly used methods of scoring students' assessment are:

Checklists

Rating scales

Rubrics

Students' performance is assessed and scored using:

A set of well-defined criteria

Performance standards or indicators

Checklists, rating scales, and rubrics are tools that state specific-criteria and allow teachers and students to gather information and to make judgments about what students know and can do in relation to the standards. They offer systematic ways of collecting data about specific behaviors, knowledge and skills.

The quality of information acquired through the use of checklists, rating scales and rubrics is highly dependent on the quality of the descriptors chosen for assessment

Checklists usually offer a yes/no format in relation to student's demonstration of specific criteria. This is similar to a light switch; light is either on or off. They may be used to record observations of an individual, a group or a whole class.

Rating scales allow teachers to indicate the degree or frequency of the behavior, skills and strategies displayed by the learner. Rating scales state the criteria and provide three or four response selections to decide the quality or frequency of student work.

Teachers can use rating scales to record observations and students can use them as self- assessment tools. Teaching students to use descriptive words such as always, usually, sometimes and never helps them to pinpoint specific strengths and needs. Rating scales also give students information for setting goals and improving performance. In a rating scale, the descriptive word is more important than the related number. The more precise and descriptive the words for each scale point, the more reliable the tool.

Effective rating scales use descriptors with clearly understood measures, such as frequency scales that rely on subjective descriptors of quality, such as fair, good, excellent, are less effective because the single adjective does not contain enough information on what criteria are indicated at each of these points on the scale.

Rubrics use a set of criteria to evaluate a students' performance. They consist of a fixed measurement scale and detailed description of the characteristics for each level of performance. These descriptions focus on quality of the product or performance and not the quantity; e.g. not number of paragraphs, examples to support an idea, and spelling errors. Rubrics are commonly used to evaluate students' performance with intention of including the result in a grade for reporting purposes. Rubrics can increase the consistency and reliability of scoring.

Rubrics use a set of specific criteria to evaluate students' performance. They may be used to assess individuals or groups and, as with rating scales, may be compared over time.

Rubrics are recognised as a way to effectively assess students learning and communicate expectations directly, clearly, and concisely to students. The inclusion of rubrics in a resource provides opportunities to consider

what demonstrations of learning look like, and to describe stages in the development and growth of knowledge, understandings and skills. To be most effective, rubrics should allow students to see the progression of mastery in the development of understandings and skills.

However, regardless of which method is used, students' performance, proficiency, and quality of learning should be meaningfully and effectively measured. This will help ascertain if students are meeting grade-level expectations and progressing towards meeting the content standard.

Formative Assessment

This assessment is given during the lesson.

Benchmark 9.2.1.1 Analyse the relationship between domesticated and farmed monogastric and polygastric animals and discuss environments which they are domesticated or farmed.

Topic: Relationship between domesticated and farmed monogastric and polygastric animals

Lesson Title: Types of domesticated and farmed monogastric and polygastric animals

What are you assessing?

Comparison of domestic and farmed animals and types of environments which they live

Assessment Task

From a list/ pictures of different types of domesticated and farmed monogastric and polygastric animals, each student will point out and categorize the type of animal under the category it falls under. Students will complete this table

Name of animal	Type of animal	Environment which it lives in

Performance Indicator/Standard

Identify and describe the differences between domesticated and farmed monogastric and polygastric animals.

Assessment Scoring

Checklist		
Date: 29 th September 2022		
Performance Criteria/standard	Yes	No
Differentiate between domestic and farmed animals		
Distinguish between monogastric and polygastric animals		
Classify animals according to environments which they live in		

Sample Summative Assessment

Rubric					
Date: 31 st August 2022					
Performance standard/ Criteria					

This assessment is conducted at the end of the topic, which means that it assesses the benchmark

Strand: 2 Animals**Unit: 1 Types of animals**

Content Standard 2.1: Students will be able to identify and appraise the characteristics of different types of domestic and farm animals, categorise them according to their characteristics, feeding system, purposes and their benefits and investigate the different context, environments, and places where they are farmed.

Benchmark 9.2.1.1 Analyse the relationship between domesticated and farmed monogastric and polygastric animals and discuss environments which they are domesticated or farmed

Topic:**Learning objective/s;****Purpose of this assessment:**

The purpose of this assessment is to measure student's achievement of the benchmark, i.e. if students have used analytical skills to identify and categorize variety of animals and justify why each animal differs from the other based on identified characteristics and environments which they live in. also to find out if students can work independently and have confidence in their abilities and evaluate the effectiveness of their research.

Expected level of proficiency

1. Identify the type of animal
2. Describe whether it is a monogastric or polygastric animal
3. Explain where it lives and why

Performance Task

Create a booklet on domesticated and farmed monogastric and polygastric animals. This will include; carrying out a research on types of animals and environments which they live in. Illustrations of the different animals, general layout of the booklet (cover, content, references)

Assessment Strategy

Project to assess the quality of the end product

Scoring Rubric

Authentic Assessment

Insert sample here

<p>Presentation</p>	<p>presented in a logical sequence. Presentation reflects a full knowledge of the topic with clear answers and explanations to questions asked.</p>	<p>information presented in a logical sequence. Answers to questions were vague or lacked clarity or accuracy.</p>	<p>lacked a logical sequence. Presentation reflected little attention to detail. Answers to questions were inaccurate and confusing.</p>	<p>and reflects a lack of organization or knowledge of the topic. Presentation shows little effort to meet expectations.</p>
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Glossary

Vocabulary	Meaning
Aggregates	are groups of soil particles held together by organic matter or chemical forces.
Arboriculture	the cultivation of trees and shrubs especially for ornamental purposes
Crops	Crop, in agriculture, a plant or plant product that can be grown and harvested extensively for profit or subsistence.
cultivation	the action of cultivating land, or the state of being cultivated
horticulture	Horticulture is defined as that branch of agriculture concerned with growing plants that are used by people for food, for medicinal purposes, and for aesthetic gratification.
Aquaculture	Aquaculture is breeding, raising, and harvesting fish, shellfish, and aquatic plants. Basically, it's farming in water.
Crop farming	the art and science of cultivating land for growing crops (farming) or raising livestock (ranching).
hydroponics	Hydroponics, also called aquaculture, nutriculture, soilless culture, or tank farming, the cultivation of plants in nutrient-enriched water, with or without the mechanical support of an inert medium such as sand, gravel, or perlite.
floriculture	Floriculture is the cultivation and management of cut flowers, flowering plants, and foliage plants.
physiology	the branch of biology that deals with the normal functions of living organisms and their parts. the way in which a living organism or bodily part functions
pomology	The science and practice of fruit production is called pomology. Pomological crops include apples, oranges, blueberries, and strawberries.
propagation	the breeding of specimens of a plant or animal by natural processes from the parent stock. "the propagation of plants by root cuttings"
preservation	The action of preserving something
processing	perform a series of mechanical or chemical operations on (something) in order to change or preserve it. "the salmon is quickly processed after harvest to preserve the flavour"
species	a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. The species is the principal natural taxonomic unit, ranking below a genus and denoted by a Latin binomial, e.g. <i>Homo sapiens</i> .
Crop cultivation	Cultivation of crops often first involves tilling (or plowing) the land. (A machine that does this is called a cultivator). It also involves planting seeds and then watering them and making sure they are growing properly. When crops and plants are cultivated, they are taken care of until they are ready to be harvested.
Crop production	Crop production is the process of growing crops for domestic and commercial purposes. Some of the crops produced on a large scale include rice, wheat, maize, jute, etc.

Farming practices	Agricultural practices mean basically a collection of principles to apply for farm production processes in order to get better agricultural products. They are simply practices used in agriculture to facilitate farming.
Management practices	Management practices are the working methods, innovations, and initiatives that are used by managers to improve the efficiency and effectiveness of the business processes. It is important for a manager to know and excel in good management practices in order to maintain a good management career.
Fishery	Fishery can mean either the enterprise of raising or harvesting fish and other aquatic life; or more commonly, the site where such enterprise takes place ...
domestic	existing or occurring inside a particular country; not foreign or international.
monogastric	A monogastric is an animal with a single-compartmented stomach. Examples of monogastrics include humans, poultry, pigs, horses, rabbits, dogs and cats.
polygastric	A polygastric is an animal with or appearing to have many stomachs. as an animalcule; specifically, of or pertaining to the Polygastrica.
olericulture	a branch of horticulture that deals with the production, storage, processing, and marketing of vegetables.
anatomy	the branch of science concerned with the bodily structure of humans, animals, and other living organisms, especially as revealed by dissection and the separation of parts.
breeds	a stock of animals or plants within a species having a distinctive appearance and typically having been developed by deliberate selection.
species	a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. The species is the principal natural taxonomic unit, ranking below a genus and denoted by a Latin binomial, e.g. <i>Homo sapiens</i> .
poultry	Poultry, in animal husbandry, birds raised commercially or domestically for meat, eggs, and feathers. Chickens, ducks, turkeys, and geese are of primary commercial importance, while guinea fowl and squabs are chiefly of local interest.
technology	Application of scientific knowledge for practical purposes, especially in industry “advances in computer technology” Machinery and equipment developed from the application of scientific knowledge. “it will reduce the industry’s ability to spend money on new technology”
agriculture	the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food, wool, and other products. “fungicide resistance is a serious problem facing modern agriculture”
Brackish water	Brackish water is water that is saltier than fresh water but not as saltier than sea water
Fresh water	Fresh water or freshwater is any naturally occurring liquid or frozen water containing low concentrations of dissolved salts and other total dissolved solids. Although the term specifically excludes seawater and brackish water, it does include non-salty mineral-rich waters such as chalybeate springs.

Salt water	naturally occurring salty water, especially seawater, or water to which salt has been added. “fishing in both fresh and salt water”
biomes	a large naturally occurring community of flora and fauna occupying a major habitat, e.g. forest or tundra.
mariculture	Mariculture is the farming of marine organisms for food and other products such as pharmaceuticals, food additives, jewelry (e.g., cultured pearls), nutraceuticals, and cosmetics, either in the natural marine environment, or in land- or sea-based enclosures, such as cages, ponds, or raceways.
alga culture	Algaculture is a form of aquaculture involving the farming of species of algae. The majority of algae that are intentionally cultivated fall into the category of microalgae (also referred to as phytoplankton, microphytes, or planktonic algae).
gears	a toothed wheel that works with others to alter the relation between the speed of a driving mechanism (such as the engine of a vehicle) and the speed of the driven parts (the wheels).
devices	a machine or tool used for a specific task; contrivance.
Capture fishery	Capture fishery refers to all kinds of harvesting of naturally occurring living resources in both marine and freshwater environments
Aquatic organisms	Aquatic organism means an animal or plant of any species or hybrid thereof, and includes gametes, seeds, egg, sperm, larvae, juvenile and adult stages that lives in water
Aquatic plants	Aquatic plants are plants that live in shallow coastal zones, wetlands, rivers, and lakes. Aquatic plants provide important food and habitat for other organisms. Coastal aquatic plants such as mangroves
Aquatic animals	An aquatic animal is an animal that lives in water for most or all of its life. Aquatic animals may breathe air or extract oxygen from that dissolved in water through specialized organs called gills, or directly through the skin.
forests	A forest is an area of land dominated by trees ; Forests are the predominant terrestrial ecosystem
forestry	Forestry is the science and craft of creating, managing, planting, using, conserving and repairing forests and woodlands for associated resources for huma
restoration	an act of restoring or the condition of being restored: such as. : a bringing back to a former position or condition : reinstatement. the restoration of peace. : restitution. : a restoring to an unimpaired or improved condition.
ecosystems	An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life. Ecosystems contain biotic or living, parts, as well as abiotic factors, or nonliving parts.
timber	Timbers are large squared lengths of wood used for building a house or a boat
regeneration	act or the process of regenerating : the state of being regenerated. : the renewal, regrowth, or restoration of a body or a bodily part, tissue, or substance after injury or as a normal bodily process
natural resource	Natural resources are resources that are drawn from nature and used with few modifications.

sustainability	<p>The ability to be maintained at a certain rate or level.</p> <p>“the sustainability of economic growth”</p> <p>Avoidance of the depletion of natural resources in order to maintain an ecological balance.</p> <p>“the pursuit of global environmental sustainability”</p>
Agribusiness	The term agribusiness is used to refer to economic activities derived from or connected to farm products. In other words, crop production, as well as crop processing, transportation and distribution.
microeconomics	Microeconomics is the study of individuals, households and firms’ behavior in decision making and allocation of resources. It generally applies to markets of goods and services and deals with individual and economic issues.
macroeconomics	<p>What is macroeconomic in simple words?</p> <p>Macroeconomics is the study of whole economies--the part of economics concerned with large-scale or general economic factors and how they interact in economies</p>
agricultural export	An agricultural export commodity is the product of any export crop. For example, palm oil and palm kernel are two by-products of the oil palm. A holding is the total land area devoted to the cultivation of any of the 14 listed export crops by an individual called a farmer.
agricultural imports	Imports are products or raw materials bought from another country for use in your own country.
enterprise	<p>a project or undertaking that is especially difficult, complicated, or risky.</p> <p>a unit of economic organization or activity. especially : a business organizatio</p>
Machinery and equipment	From a mechanical standpoint, equipment has a much wider definition and is often required to create something (such as a machine). Machines are the completed product. In other words, machines are by products of the equipment used to create them, but they are not often needed in the same environment.
insurance	Insurance is a legal agreement between two parties – the insurer and the insured, also known as insurance coverage or insurance policy. The insurer provides financial coverage for the losses of the insured that s/he may bear under certain circumstance
tariff	A tariff is a tax on goods and services imported into a country.
partnership business	<u>A sole proprietorship refers to a single-owner business where the owner isn’t treated as a separate legal entity from the business.</u>
sole proprietorship	A sole proprietorship is a business that can be owned and controlled by an individual, a company or a limited liability partnership. There are no partners in the business. The legal status of a sole proprietorship can be defined as follows: It is not a separate legal entity from the business owner.
entrepreneur	<p>a person who sets up a business or businesses, taking on financial risks in the hope of profit.</p> <p>“many entrepreneurs see potential in this market”</p>

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Appendices

APPENDIX 1: BLOOM'S TAXONOMY

LEVEL OF UNDERSTANDING	KEY VERBS
CREATING Can the student create a new product or point of view?	Construct, design, and develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce, assemble, formulate,
EVALUATING 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 Can the student distinguish between the different parts?	Analyzing, characterize, classify, compare, contrast, debate, criticize, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, experiment, question, test,
APPLYING Can the student use the information in a 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 Can the student comprehend ideas or concepts?	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report, translate, describe, classify,
REMEMBERING Can the student recall or remember the 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	<p>Creativity and innovation</p> <ul style="list-style-type: none"> <input type="checkbox"/> Think creatively <input type="checkbox"/> Work creatively with others <input type="checkbox"/> Implement innovations <p>Critical thinking, problem solving and decision making</p> <ul style="list-style-type: none"> <input type="checkbox"/> Reason effectively and evaluate evidence <input type="checkbox"/> Solve problems <input type="checkbox"/> Articulate findings <p>Learning to learn and meta-cognition</p> <ul style="list-style-type: none"> <input type="checkbox"/> Self-motivation <input type="checkbox"/> Positive appreciation of learning <input type="checkbox"/> Adaptability and flexibility
WAYS OF WORKING	<p>Communication</p> <ul style="list-style-type: none"> <input type="checkbox"/> Competency in written and oral language <input type="checkbox"/> Open minded and preparedness to listen <input type="checkbox"/> Sensitivity to cultural differences <p>Collaboration and teamwork</p> <ul style="list-style-type: none"> <input type="checkbox"/> Interact effectively with others <input type="checkbox"/> Work effectively in diverse teams <input type="checkbox"/> Prioritise, plan and manage projects
TOOLS FOR WORKING	<p>Information literacy</p> <ul style="list-style-type: none"> <input type="checkbox"/> Access and evaluate information <input type="checkbox"/> Use and manage information <input type="checkbox"/> Apply technology effectively <p>ICT literacy</p> <ul style="list-style-type: none"> <input type="checkbox"/> Open to new ideas, information, tools and ways of thinking <input type="checkbox"/> Use ICT accurately, creatively, ethically and legally <input type="checkbox"/> Be aware of cultural and social differences <input type="checkbox"/> Apply technology appropriately and effectively
LIVING IN THE WORLD	<p>Citizenship – global and local</p> <ul style="list-style-type: none"> <input type="checkbox"/> Awareness and understanding of rights and responsibilities as a global citizen <input type="checkbox"/> Preparedness to participate in community activities <input type="checkbox"/> Respect the values and privacy of others <p>Personal and social responsibility</p> <ul style="list-style-type: none"> <input type="checkbox"/> Communicate constructively in different social situations <input type="checkbox"/> Understand different viewpoints and perspectives <p>Life and career</p> <ul style="list-style-type: none"> <input type="checkbox"/> Adapt to change <input type="checkbox"/> Manage goals and time <input type="checkbox"/> Be a self-directed learner <input type="checkbox"/> Interact effectively with others

APPENDIX 3: TEACHING AND LEARNING STRATEGIES

STRATEGY	TEACHER	STUDENTS
<p>CASE STUDY Used to extend students' understanding of real life issues</p>	Provide students with case studies related to the topic of the lesson and allow them to analyze and evaluate.	Study the case study and identify the problem addressed. They analyze the problem and suggest solutions supported by conceptual justifications and make presentations. This enriches the students' existing knowledge of the topic.
<p>DEBATE A method used to increase students' interest, involvement and participation</p>	Provide the topic or question of debate on current issues affecting a bigger population, clearly outlining the expectations of the debate. Explain the steps involved in debating and set a criteria/standard to be achieved.	Conduct researches to gather supporting evidence about the selected topic and summarizing the points. They are engaged in collaborative learning by delegating and sharing tasks to group members. When debating, they improve their communication skills.
<p>DISCUSSION The purpose of discussion is to educate students about the process of group thinking and collective decision.</p>	<p>The teacher opens a discussion on certain topic by asking essential questions.</p> <p>During the discussion, the teacher reinforces and emphasizes on important points from students responses. Teacher guide the direction to motivate students to explore the topic in greater depth and the topic in more detail.</p> <p>Use how and why follow-up questions to guide the discussion toward the objective of helping students understand the subject and summarize main ideas.</p>	Students ponder over the question and answer by providing ideas, experiences and examples. Students participate in the discussion by exchanging ideas with others.
<p>GAMES AND SIMULATIONS Encourages motivation and creates a spirit of competition and challenge to enhance learning</p>	<p>Being creative and select appropriate games for the topic of the lesson.</p> <p>Give clear instructions and guidelines. The game selected must be fun and build a competitive spirit to score more than their peers to win small prizes.</p>	Go into groups and organize. Follow the instructions and play to win

<p>OBSERVATION</p> <p>Method used to allow students to work independently to discover why and how things happen as the way they are. It builds curiosity.</p>	<p>Give instructions and monitor every activity students do</p>	<p>Students possess instinct of curiosity and are curious to see the things for themselves and particularly those things which exist around them. A thing observed and a fact discovered by the child for himself becomes a part of mental life of the child. It is certainly more valuable to him than the same fact or facts learnt from the teacher or a book. Students</p> <ul style="list-style-type: none"> <input type="checkbox"/> Observe and ask essential questions <input type="checkbox"/> Record <input type="checkbox"/> Interpret
<p>PEER TEACHING & LEARNING (<i>power point presentations, pair learning</i>)</p> <p>Students teach each other using different ways to learn from each other. It encourages; team work, develops confidence, feel free to ask questions, improves communication skills and most importantly develop the spirit of inquiry.</p>	<p>Distribute topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching.</p>	<p>Go into their established working groups. Develop a plan for the topic. Each group member is allocated a task to work on. Research and collect information about the topic allocated to the group. Outline the important points from the research and present their findings in class.</p>
<p>PERFORMANCE-RELATED TASKS (<i>dramatization, song/ lyrics, wall magazines</i>)</p> <p>Encourages creativity and take on the overarching ideas of the topic and are able to recall them at a later date</p>	<p>Students are given the opportunity to perform the using the main ideas of a topic. Provide the guidelines, expectations and the set criteria</p>	<p>Go into their established working groups. Being creative and create dramas, songs/lyrics or wall magazines in line with the topic.</p>
<p>PROJECT (<i>individual/group</i>)</p> <p>Helps students complete tasks individually or collectively</p>	<p>Teacher outline the steps and procedures of how to do and the criteria</p>	<p>Students are involved in investigations and finding solutions to problems to real life experiences. They carry out researches to analyse the causes and effects of problems to provide achievable solutions. Students carefully utilise the problem-solving approach to complete projects.</p>

USE MEDIA & TECHNOLOGY to teach and generate engagement <u>depending on the age of the students</u>	Show a full movie, an animated one, a few episodes form documentaries, you tube movies and others depending on the lesson. Provide questions for students to answer before viewing	Viewing can provoke questions, debates, critical thinking, emotion and reaction. After viewing, students engage in critical thinking and debate
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APPENDIX 4: ASSESSMENT STRATEGIES

STRATEGY	DESCRIPTION
ANALOGIES	Students create an analogy between something they are familiar with and the 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 students to verbalize their knowledge, select and present samples of finished work, and organize their thoughts about a topic in order to present a summary of their 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. A conference 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 has already 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 to reflect their learning before the discussion commences.
ESSAYS	An essay is a writing sample in which a student constructs a response to a question, topic, or brief statement, and supplies supporting details or 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.

APPENDIX 4: Standard-Based Lesson Plan (STEAM integrated) Template

TOPIC:

Lesson Topic:

Grade:

Length of Lesson:

Content Standard:

Grade-Level Benchmark

Essential Knowledge, Skills, Values, and Attitudes

Knowledge

Skills:

Values:

Attitudes

STEAM Knowledge and Skill

Knowledge:

Skill:

Performance Indicator:

STEAM Performance Indicator:

Materials:

Lesson Objective:

Essential Questions:

Lesson Procedure

Teacher Activities	Student Activities
Introduction	
Body	
Modelling	
Guided Practice	
Independent Practice	
Conclusion	

Performance Assessment and Standards

Content Standard:						
Lesson Topic	Topic	Benchmark	Performance Assessment			
			PROFICIENCY RUBRIC			
			Advanced	Proficient	Partially Proficient	Novice

STEAM Activity

Appendix 5: Project Rubric

Category	Advanced	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 and turned in on time. Student worked diligently when project time was available. Student was on task most of the time.	Project was completed, but had notable 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 on task less than 60% of the time.	Project was not turned in on time and 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 building components and resources. Always returns building components 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/contribute to 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 without relying 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 or plans.
Writing/ Reflection	Writing/reflection is very well organized and explained. Student includes all details in design process. Document has almost no grammatical errors.	Writing/reflection is somewhat organized and explained. Student includes most details in design process. Document has very few grammatical errors.	Writing/reflection is not organized and explained. Student includes only a few details in design process. Document has many grammatical errors.	Writing/reflection is incomplete or not turned in. Student includes no details in design process. Document has many grammatical errors.
	Presentation was well organized and	Presentation was fairly organized and most	Presentation was unorganized and	Presentation was not acceptable

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