Agriculture for Rwanda Schools Secondary 2

Teacher's Guide

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1.0 Introduction

The rationale behind the agriculture syllabus review process was to ensure that the syllabus is responsive to the needs of the learners' and to shift from the knowledge -based learning to competence-based learning. Competence-based learning allows students to advance based on their ability to master a skill on competency as their own pay regardless of environment. It is tailored to meet different learning abilities and can lead to more efficient student's outcome.

This teacher's guide has been prepared in line with the competence-based curriculum. It is intended to assist the teacher to interpret the topics in the syllabus for quality and effective teaching. The guide has been written to be used together with the Secondary Two (S2) students' book. The Secondary Two (S2) competence-based syllabus by Rwanda Education Board 2015, which has been used in developing both the students' book and this teacher's guide has important information in the following areas:

1.1 Rationale of Teaching and Learning Agriculture

1.1.1 Agriculture and Society

Agriculture, as both an applied science and art, is the pillar of our economy.

It is a composite of rural and urban industries that are structured to produce both raw and value-added material from plants and animals to meet identified consumer's needs. It provides food, fibre, fuel, shelter and other possibilities of diverse lifestyles.

Agricultural industries make a significant contribution to Rwandan's economy through investment, employment of skilled workers, consumption of products from other sectors of the economy and exports.

Increasing the knowledge and skills in the majority of Rwandans will, therefore, go to past integration of agriculture courses, in Basic Education/Ordinary level self-reliance. It will help the learners to have a competency that help them to develop and view agriculture as source of income in the view that arable land, in limited agriculture courses, is important to resort to modern agricultural techniques in order to increase food production and generate Rwandan's export income.

1.1.2 Agriculture and Learners

Agriculture is a worthwhile subject because it prepares the learners for real world of work through career pathways like crop production, crop protection, veterinary medicine, rural development, food sciences, rural engineering, agribusiness and agriculture mechanisation. It provides the skills that guide and help the learners to explain all techniques of crop production and animal rearing, both agricultural and animal products processing and preservation.

This course provides students with an understanding of the relationships between

production, processing and consumption to enable them to participate in discussion and solve problems facing our society. Thus, the government of Rwanda has encouraged the market oriented agriculture through policies like crop intensification and land use consolidation, one cow for one family, increase the productivity of agriculture as one of four priorities of rural development in ECPRSII, productive High Value and Market Oriented Agriculture in Vision 2020. To achieve these policies, all sectors are involved including learners who learned agriculture courses.

1.1.3 Competences

Competences are statements of the characteristics that students should demonstrate which indicate they are prepared and have the ability to perform independently professional practices. There are two types of competences, basic and generic.

(i) Basic competences: These competences are the essential knowledge and skills acquired by the learners in relation to the learning objectives set out in the curriculum for each level of learning.

Basic competences are addressed in the stated broad subject competences and in objectives highlighted year on year basis and in each of the units of S2.

They include the following:

- Literacy – This include the four essentials of learning a language, which are; reading a variety of text accurately and quickly, expressing ideas through writing, communicating ideas through speaking and listening carefully for proper understanding.
- Numeracy – This involves computing and manipulating mathematic numbers to accomplish task involving calculation measures and estimation. It also involves use of numerical patterns to solve problems related to every activity in management and interpretation of basic statistical data such as tables, diagrams, charts and graphs.
- ICT and digital competences – This involves using search engines to retrieve information for leisure business and communicating to enhance learning.
- Citizenship and national identity – This involves relating historical, cultural, geographical, heritage of Rwanda with global dimension. It also helps to advocate for a harmonious cohesive society working with people from diverse cultural backgrounds.
- Entrepreneurship and business development – This entails decision-making in planning and managing micro-projects and small and medium enterprises, risk taking in business and evaluating resources needed for business.
- Science and technology – This involves Science and Technological skills to solve problems in real life situations and developing curiosity inquisitiveness while researching to explain theories hypothesis and natural phenomena to draw appropriate conclusion.

(ii) Generic Competences:

- Critical thinking and problem solving skills – The acquisition of such skills will help learners to think imaginatively, innovatively and broadly to evaluate and find solutions to problems encountered in our surrounding.
- Creative and innovation – The acquisition of such skills will help learners to take initiatives and use imagination beyond knowledge provided in classroom to generate new ideas and construct new concepts.
- Research – This will help learners to find answers to questions based on existing information and concepts and use it explain phenomena from gathered information.
- Communication in official languages – Teachers, irrespective of being language teachers, will ensure the proper use of the language of instruction by learners. The teacher should communicate clearly and confidently and convey ideas effectively through spoken and written by applying appropriate language and relevant vocabulary.
- Co-operation, inter personal management and life skills – This will help the learners to co-operate as a team in whatever task assigned to practise positive ethical moral values while respecting rights, feelings and views of others. Perform practical activities related to environmental conservation and protection. Advocate for personal, family and community health, hygiene and nutrition and responding creatively to a variety of challenges encountered in life.
- Lifelong learning – The acquisition of such skills will help learners to update knowledge and skills with minimum external support. The learners will be able to cope with evolution of knowledge advances for personal fulfillment in areas that are relevant to their improvement and development.

1.1.4 Broad Competences for the Agriculture Subject

At the end of Senior Two, the student should be able to:

- Demonstrate basic knowledge, skills and attitudes that accurately lead him/her to modern farming practices.
- Show the importance of using the good soil with necessary nutrients and knowing its composition and properties.
- Demonstrate the ability to cultivate a variety of crops both subsistence and cash crops.
- Rear and treat domestic animals.
- Comprehend and apply the processes involved from the planting to the harvesting of crops.
- Acquire necessary knowledge and skills in processing, preserving and adding value to agricultural products.
- Appreciating the economic, social and environmental implications of agriculture.

1.1.5 Cross-cutting issues

Cross-cutting issues are also referred to as emerging issues. The teacher is required to

infuse these issues in learning while teaching for the benefits of the learning.
The competence-based syllabus has integrated eight cross-cutting issues through the various learning activities in the units. These cross-cutting issues are:

(i) Genocide Studies

This provides young people with an understanding of circumstances that led to the genocide. It also brings to the attention the remarkable story of recovery and fosters national unity. It will help the learners to comprehend the role of each individual in ensuring that nothing of the sort ever happens again.

(ii) Environment and Sustainability

This ensures that the young people understands the importance of sustainability as they grow up and become responsible for the world around them. Learners need basic knowledge from the natural sciences, social sciences and humanities to understand and interpret principles of sustainability.

(iii) Gender

This helps to create awareness of the need to accord every individual basic human rights. With a good understanding of the principles of gender equality, it is hoped that future generations will ensure that the potential of the whole population is realised.

(iv) Comprehensive sexuality education (HIV/AIDS, STIs, Family planning, Gender Equality and Reproductive Health).

Comprehensive sexuality education which is age appropiate, gender sensitive and life skills based can provide young people with the knowledge and skills to make informed decisions about their sexuality and life style. The learners should be prepared for the transition from childhood to adulthood which has been a major challenge to humanity. Young people should be helped to overcome challenges related to onset of puberty and adolescence so as to avoid teenage pregnancies and sexually transmited infections including HIV/AIDS.

(v) Peace and Values Education

Peace is critical for any country's economic growth and development. Values form a key element of the strategy for ensurimg young people recognise the importance of contributing to the society, working for peace and harmony and being committed to avoiding conflict.

(vi) Financial Education

Financial education makes learning relevant to real life situations. It provides the tools for sound money management practices on earnings, spending, saving, borrowing and investing.

(vii) Standardisation Culture

It helps to develop learners' understanding of the importance of standards as a pillar of economic development. The adoption of the standardisation culture is intended to have an impact upon health improvement, economic growth, industrialisation, trade and general welfare of the people.

(viii) Inclusive Education

It involves ensuring that all learners are engaged in education and that they are welcomed by other students so that everyone can achieve their potential. Inclusive practices embrace every individual regardless of gender or ability including those with learning difficulties and disabilities. To be successful, inclusive education entails a range of issues including teachers' positive attitudes, improvising the learning resources, variation of teaching and learning methods and working together.

1.1.6 Agriculture and Development of Competences

The national policy document basing on national aspirations identify some 'basic competences' alongside the generic competences that will develop higher order thinking skills and which will help subject learning and application of what has been learned in real life situation.

Through practices, observation and presentation of information during the learning process, the learners develop not only deductive and inductive skills but also communication and co-operation in working groups, tasks management by accomplishing them at set time and correctly, critical thinking while observing demonstrations and doing practices (during field trip, field work and group discussion), skills in trying to make inferences and conclusion.

Also, the group work and co-operative learning of agriculture promotes interpersonal relations and teamwork.

2.0 Pedagogical Approaches in the Teaching of Agriculture

The teacher/trainer is required to mainly orient the course delivery in a practical manner. In line with this, the teacher will set student's hands-on activities, organise, work groups, experiments and adapts practical activities to climatic constraints. In addition, the teacher will organise field visits recommended in this syllabus.

In groups, the learners apply the agricultural concepts through learning activities. The observation during field visits increases understanding of theoretical courses and the most hands-on activities are made in the school's garden. This will help the student to learn more practical as an aim of competence-based learning.

2.1 Role of Learners

This approach of learning encourages learners to construct the knowledge, skills and attitude either individually or in groups in an acute way.

Learners work on one competence at a time in form of concrete units with specific learners' outcomes broken down into knowledge, skills and attitude.

In practical lessons, learners will work in groups where the availability of the apparatus will not permit working individually but they will be encouraged to do simple practices like plot model individually.

2.2 Role of Teacher

The change to a competence-based learning curriculum is about transforming learning, ensuring that learning is deep, enjoyable and habit-forming.

The teacher is no longer an instructor but a facilitator in this new approach of learning. The participation of the learners, during this new approach, facilitates the teacher to evaluate learners' individual needs and expectations.

The teacher identifies the needs of the learners, the nature of learning to be done and the means to shape learning experiences accordingly.

The teacher's roles are to organise, coach the learners in the classroom or outside and engage them through participatory and interactive methods.

2.2.1 Teaching Methods

These are varieties of teaching methods that are used in the teaching of agriculture. In many cases the methods can be integrated as per the demand of the lesson. The following are suggested methods used in the teaching of agriculture:

(a) Demonstration

This is a method in which the teacher shows and explains to the learners how to carry out certain procedure. The method is appropriate when a new topic is being handled for the first time. It can also be used when resources are limited.

In this method, the teacher introduces the topic and explains its importance. He/she explains the steps to be taken in carrying out the demonstration and then carries it out as the students watch. The teacher should organise the class in such a way that all the learners are able to see whatever is being done. The learners are then allowed to ask questions. The teacher then selects a learner to carry out the practice. At this point the teacher makes correction if there is need. By the end of the demonstration the learners will have been exposed to the activity.

(b) Supervised Practice/Activity

This is a method in which the learners are actively involved in the learning process, that is, they learn by doing. Skills and positive attitude in Agriculture are enhanced by involving the learners in practical activities. Proper preparation by the teacher before conducting a practical lesson is very important, as it ensures proper flow of the lesson.

The method closely follows a demonstration by the teacher. At the end of the demonstration, the teacher groups the learners and makes sure that each group has the necessary apparatus and materials. Each learner in the group carries out the activity

following the steps demonstrated by the teacher. The teacher moves from group to group observing, giving further instructions, correcting and motivating them. Learners record and discuss their observations. They then give a report of their findings to the class. Lastly, the teacher may allow a concluding discussion at the end of the lesson in which the learners will take summary notes.

(c) Discussion

This is a verbal interaction between learners on a given topic with the teacher acting as a facilitator. This method enhances participation of learners in the lesson. The discussion should be carefully planned, to ensure that it focuses on the lesson objective(s). For this method to be effective, it is important for the teacher to encourage participation by all learners.

The teacher involves learners in the teaching/learning process, by giving them an opportunity to express their opinions and experiences freely on a particular topic. This can be done by a whole class, large groups or small groups. The teacher introduces the topic of discussion and may also give guiding questions orally or written form to the class or to each group. Learners are given time to discuss, write down their findings and then report to the whole class. The teacher eventually gives a final conclusion comprising facts about the topic.

(d) Problem solving

This is a method where learners actively participate in the lesson by putting to use the skills, which they have acquired.

In this method, learners are sensitised about an existing problem to be solved. They are encouraged to study the problem through investigations, observations, experimentations and making predictions. In this way, the leaners use their initiatives and efforts to further understand what the problem is, its origin and where it may lead to if not solved. Once the learners have studied and understood the problem, they should come up with suggested solutions. Learners discuss the merits and demerits of each suggested solution and make decisions on which solution(s) is best. Once learners have made a decision on the best option of the solution, they are allowed to take action. The teacher may at this point invite experts, depending on the type of action to be taken. Learners should be encouraged to evaluate the outcome of their decision and actions. This evaluation is very important part of the learning process because through it, learners will determine the effectiveness of an action and whether they can apply it in future.

(e) Role playing

This is an approach that involves acting out particular ways of behaviour in order to learn from a situation. In this method, learners are asked to enact certain characters and situations. This helps to bring out learners' activity and imaginations. The aim of this act is to help learners to visualise the real situation. The teacher should be able to

select topics that can be taught well using this method. Role plays are different from dramatisation in that they are instantaneous. Learners use their own words and the role player does not have to put on costumes. It also takes a short time probably 2–5 minutes.

(f) Exhibitions/Agricultural Shows

These are displays which are arranged from time to time and teachers take the opportunity to expose learners to certain information and experiences which would not be found elsewhere. The teacher should also utilise the exhibitors, as resource persons for his/her learners. The teacher should encourage learners to carry writing materials, to record the information displayed in the exhibition. Exhibitions could be school or externally based. When learners come back to class, the teacher should make clarifications and follow up.

An exhibition covers many areas, topic and objectives. Agricultural shows should be treated in the same way as exhibitions.

(g) Project

This is work that is organised or designed to achieve a particular objective. In agriculture, learners are usually given plots to carry out crop husbandry practices, which are taught in class. The project can also be in animal production. This method is used to enable the learners practice what they have been taught. The project is fully managed by the learner, with minimum supervision by the teacher. However, the teacher provides all the necessary inputs for the project. The project normally takes a long duration, from few weeks to many months. A project can also be used for experimental purposes.

(h) Agricultural Field Days

These are organised by extension officers or other agricultural officers for the purpose of demonstrating particular far practices. The teacher should liaise with the organisers of the field days, in order to take advantage of such opportunities to enhance classroom teaching.

The teacher should:

- Be aware of where the field day is taking place in advance. The field day should be relevant to agriculture and even to specific topic(s) in the syllabus.
- Make travel and subsistence arrangements.
- Talk about field day to the learners on what they need to carry and how to behave during the field day.
- Develop writing guidelines on what to observe and record.

During the field day, the teacher will either guide or have somebody to guide and explain to the learners.

After the field day, the learners will report on what they observed.

(i) Field Trips

These are visits organised by the teacher outside the classroom. Trips are organised after covering a large area of syllabus, to emphasise certain agricultural practices. Although a teacher may organise a field trip for the purpose of enhancing the understanding of a particular farm practices, he/she should take the opportunity to point out other important practices along the way. It might also be important for teachers in different subjects, to collaborate in the organisation of such field trips, in order to make it economical.

Learners should be given a questionnaire during a field trip. A questionnaire is a research instrument which is prepared for the purpose of respondents. It consists of a set of leading questions that help in obtaining information from people for various reasons. In the case of learners questionnaires, the information gathered is used for learning. There are several field trips to be conducted during the course of learning the content for the Secondary Two Agriculture. Questionnaires for each field trip have been prepared for the teacher and marked as Annexes attached on pages of this teacher's guide.

A SAMPLE QUESTIONNAIRE FOR A FIELD TRIP TO AN ORCHARD TO IDENTIFY CULTIVATED FRUITS IN RWANDA

Part 1: Administrative information: _____

(i) Name of the farm to be visited : _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading questions

These are questions to guide the learners on the specific activities to be carried out, observations to be done and the area of interest. The teacher is required to add more questions depending on the need of the lesson.

(j) Discovery Method

It is also known as the research method. In this method, learners are given a topic to research on. They are given references of relevant resource materials. They read on their own and prepare a report of their findings. Learners acquire knowledge in the course of the reading. This method is suitable for learners who can work on their own without supervision.

2.3 Special Needs Education and Inclusive Approach

All Rwandans have the right to access education regardless of their different needs. The underpinning of this provision would actually hold that all citizens benefit from

the same menu of educational programmes. The possibility of this assumption is the focus of special needs education. The critical issue is that we have persons/learners who are totally different in their ways of living and learning as opposed to the majority. The difference can either be emotional, physical, sensory and intellectual learning challenged traditionally known as mental retardation.

These learners equally have the right to benefit from the free and compulsory basic education in the nearby ordinary/mainstream schools. Therefore, the school's role is to enroll them and also set strategies to provide relevant education to them. The teacher, therefore, is requested to consider each learner's needs during teaching and learning process. Assessment strategies and conditions should also be standardised to the needs of these learners. Detailed guidance for each category of learners with special education needs is provided for in the guidance for teachers.

3.0 Assessment Approaches

Assessment is the process of evaluating the teaching and learning processes through collecting and interpreting evidence of individual learner's progress in learning and to make a judgement about a learner's achievements measured against defined standards. Assessment is an integrated part of the teaching/learning processes. In the new competence-based curriculum, assessment must also be competence-based, whereby a learner is given a complex situation related to his/her everyday life and asked to try to overcome the situation by applying what he/she learned.

Assessment will be organised at the following levels: School-based assessment, District examination, National assessment (LARS) and National examinations.

3.1 Types of Assessments

3.1.1 Formative and Continuous Assessment (assessment for learners)

Continuous assessment involves formal and informal methods used by schools to check whether learning is taking place. When a teacher is planning his/her lesson, he/she should establish criteria for performance and behaviour changes of the beginning of a unit. Then at the end of every unit, the teacher should ensure that all the learners have mastered the stated key unit competences basing on the criteria stated, before going to the next unit. The teacher will assess how well each learner masters both the subject and the generic competences described in the syllabus and from this, the teacher will gain a picture of the all-round progress of the learner. The teacher will use one of a combination of the following:

(a) Observation.
(b) Pen and paper.
(c) Oral questioning.

3.1.2 Summative Assessment (assessment for learners)

When assessment is used to record a judgement of a competence or performance of

the learners, it serves a summative purpose. Summative assessment gives a picture of a learner's competence or progress at any specific moment. The main purpose of summative assessment is to evaluate whether learning objectives have been achieved and to use the results for the ranking or grading of learners, for deciding on progression, for selection into the next level of education and for certification. This assessment should have an integrative aspect whereby a student must be able to show mastery of all competences.

It can be internal school-based assessment or external assessment in the form of national examination. School-based summative assessment should take place once at the end of each term and once at the end of the year. School summative assessment average scores for agriculture subject will be weighed and included in the final national examinations grade. School-based assessment average grade will contribute a certain percentage as teachers gain more experience and confidence in assessment techniques and in the third year of the implementation of a new curriculum it will contribute 10 per cent of the final grade, but will be progressively increased. District will be supported to continue their initiative to organise a common test per class for all the schools to evaluate the performance and the achievement level of learners in individual schools. External summative assessment will be done at the end of S3.

3.2 Record Keeping

This is gathering facts and evidence from assessment instruments and using them to judge the students' performance by assigning an indicator against the set criteria or standard. Whatever assessment procedures used shall generate data in the form of scores which will be carefully recorded and stored in a portfolio because they will contribute for remedial actions, for alternative instructions strategy and feedback to the learners and to the parents to check the learning progress and to advise accordingly or to the final assessment of the students.

This portfolio is a folder (or binder or even a digital collection) containing the students' work as well as the students' evaluation of the strengths and weaknesses of the work. Portfolios reflect not only work produced (such as paper and assignments), but also it is a record of the activities undertaken over time as part of student learning. Besides, it will serve as a verification tool for each learner that attended the whole learning before undergoing the summative assessment for the subject.

3.3 Item Writing in Summative Assessment

Before developing a question paper, a plan or specification of what is to be tested or examined must be elaborated to show the units or topics to be tested on the number of questions in each level of Bloom's Taxonomy and the marks allocation for each questions. In a competence based curriculum, questions from higher levels of Bloom's Taxonomy should be given more weight than those from knowledge and comprehension level.

Before developing a question paper, the item writer must ensure that the test or

examination questions are tailored towards competence-based assessment by doing the following:

- Identify topic areas to be tested on from the subject syllabus.
- Outline subject-matter content to be considered as the basis for the test.
- Identify learning outcomes to be measured by the test.
- Prepare a table of specifications.
- Ensure that the verbs used in the formulation of questions do not require memorisation or recall answers only but testing broad competences as stated in the syllabus.

Sample Table of Specification for Paper 1: Soil Science and Crop Production Technologies (out of 40 Marks)

TOPIC AREA	CONTENT UNIT	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
SOIL SCIENCE	Soil (10 lessons)	1	—	2	2	2	1	8
CROP AND MUSHROOM PRODUCTION AND PROCESSING	Mushrooms (4 lessons)	—	1	2	—	—	—	3
	Fruits (20 lessons)	1	1	4	4	3	3	16
	Legumes (16 lessons)	1	1	3	3	3	2	13
	Total	3	3	11	9	8	6	40

Note: The paper to be done in 45 minutes.

Explanation on the allocation of marks in the table of specification

In the table of specification, marks are allocated on the basis of the weight of a unit in terms of the number of lessons. There are four units (areas) to be tested in this table of specification. These are:

(i) Soil : 10 lessons
(ii) Mushrooms : 4 lessons
(iii) Fruits : 20 lessons
(iv) Legumes : 16 lessons

Total : 50 lessons

For a 40 marks paper, the marks would be allocated as follows:

(i) Soil : $10/50 \times 40 = 8$ marks
(ii) Mushrooms : $4/50 \times 40 = 3.2$ approximately 3 marks
(iii) Fruits : $20/50 \times 40 = 16$ marks
(iv) Legumes : $16/50 \times 40 = 12.8$ approximately 13 marks

The examiner then decides on the types of questions to set based on the Bloom's Taxonomy of educational objectives. Alternatively, table of specification may be prepared for 100% and then the marks reduced to 40% after marking. The same formula may be used for paper 2 and 3.

Structure and Format of the Examination

There will be 3 paper(s) in Agriculture subject and time for each paper will be 45 minutes per trainee or per team of trainees doing the same task (activity). During the 45 minutes, each trainee or team of trainees will be assigned to do practical exercises on which some theoretical questions can be asked to the assessed person. The paper will be structured as follows:

- Paper 1 will be based on Practices of crop production techniques (40%).
- Paper 2 will be based on Practices of animal production techniques (30%).
- Paper 3 will be based on Crop and animal products preservation and processing and principles of agriculture economics (30%). All components will be externally assessed and based on O'level syllabus content.

3.4 Reporting to Parents

The wider range of learning in the new curriculum means that it is necessary to think again about how to share learners' progress with parents. A single mark is not sufficient to convey the different expectations of learning which are in the learning objectives. The most helpful reporting is to share what students are doing well and where they need to improve.

4.0 Teaching/Learning Resources

To facilitate the implementation of competence-based learning in agriculture course in this level, several materials/equipment are needed.

A detailed list of didactic materials is found in the footer of each unit writing. Here is mentioned different sources, categories and types of didactic materials. Didactic materials can originate from improvisation by the teacher in close or remote school environment. As far as assist nature is concerned, didactic materials can be non-living materials or physical living, some of which are listed below:

(a) School field

The school compound forms the most immediate environment from which the teacher can source teaching aids. It can, therefore, be used as a teaching resource to enhance learning.

(b) School farm

If the school has a commercial farm, it can be used for teaching of agriculture to enhance learning in units involving animal and crop production and soil science. The teacher should work closely with those managing the farm in order to have access to the farm. The learners should be closely monitored while in the farm.

(c) Demonstration Plots

These are small-sized plots that the teacher has established for the purpose of enhancing his/her teaching. Income generation is not a priority but any surplus can be sold. They are used by the teacher to demonstrate agricultural practices to the learners before they carry the activities in their project plots.

(d) Crop Museum

This is an area set aside for growing different crops in small quantities for students' use. The crops planted in the museum are mainly those not commonly found within the locality. Sometimes the teacher may plant such crops so that he/she has specimen within the locality. Each species of planted crop should be well labelled, maintained and used to demonstrate the management practices of crops.

(e) Project Plots

These are run either by individuals, groups of students or the whole class clubs. This is where students practise what they have learnt in class. They should work on their project plots outside class time. The Agriculture teacher should make constant assessment of the work. It is in these plots that students carry out any practical activities in the Students' Book 2.

(f) Farm Inputs

Farm inputs can be useful teaching/learning resources. They are categorised into variable and fixed inputs. The variable inputs include fertilisers, herbicides, pesticides, seeds or planting materials, livestock feeds and casual labour. The fixed inputs include: land, machinery, permanent labour, tools and equipment.

(g) Neighbouring Farms

These are farms close to the school which the teacher can use to enhance the learning process. Teachers can take their learners to see a well-managed ruminant shelters, a crush, orchards, farm animals, irrigation systems, mushroom cultivation and others.

(h) Community Resources

The surrounding community can offer useful teaching/learning resources for agriculture. Some of these include: cattle dips, co-operative and markets.

(i) Agricultural Shows/Field Days/Exhibitions

Shows, field days and exhibitions offer important learning/teaching opportunities. Shows and field days organised by the National Agricultural Export Development Board (NAEB) for the local communities provide good learning resources for the teacher because they provide valuable learning opportunities. The learners are able to observe exhibit items which may have been taught in class. Learners are also exposed to experts who explain various agricultural processes and principles, and learn through enquiry.

(j) Agricultural-based Industries

These can be used by the teacher to strengthen what has been taught. Examples of such industries include: fruit processing, dairies, slaughter houses, where teachers can organise for learners to visit.

(k) Guest speakers

These are resource persons who are knowledgeable in agriculture and related fields. They can be invited to schools to demonstrate certain practices in the curriculum.

(l) Printing Materials

These are very important sources of information because they are readily available and can be used directly by teachers and students. They include text books, magazines, academic articles and newspapers. They are found in the school libraries.

(m) Audio-Visual Aids

These resources can be audio, visual or audio-visual. They are either prepared by the teacher or pre-prepared. Some are easily used directly by learners while others require some equipment to assist in their use.

The teacher must either be able to use the equipment or have somebody who is conversant with their usage to assist. Resources in this group should be handled with care and kept safely as they are expensive. Such resources include: films, videos, television, radio, audio tapes, slides, photographs, laptops, desktops tablets and charts.

(n) Human Resource

The effective implementation for this syllabus needs a joint collaboration of educators at all levels. Given the materials requirements, teachers are expected to accomplish their noble role as stated above. However, teacher should be equipped with a strong pedagogical content knowledge (PCK) and enough teaching experience. Furthermore, a science and elementary technology teacher should be creative and able to improvise since many of teaching aids can be found around the school and hand-made by the teachers themselves.

On the other hand, school head teachers and directors of studies should be trained on the use of competence-based syllabus then, they will be able to make a follow-up and assess the teaching and learning of this subject due to their profiles in the schools. These combined efforts will ensure bright future careers and lives for learners as well as the contemporary development of the country.

4.1 Skills required for the Agricultural Teacher

Ability to:

- Engage learners in variety of learning activities.
- Use multiple teaching and assessment methods.
- Adjust instructions to the level of the learner.
- Be creative and innovative.
- Make connections/relations with other subjects.
- Instill discipline to the learners.
- Organise and manage the class.
- Communicate well.
- Guide and counsel the learners.
- Have passion for teaching and supervising learning.
- Have a high level of knowledge of the subject content.

5.0 Syllabus units

5.1 Presentation of the structure of the syllabus units

Agriculture subject is taught and learned in lower secondary education as an elective subject. At every grade, the syllabus is structured in Topic Areas, and then further broken down in Units. The units have the following elements:

1. Unit is aligned with the Number of Lessons.
2. Each Unit has a Key Unit Competence whose achievement is pursued by all teaching and learning activities undertaken by both the teacher and the learners.
3. Each Unit Key Competence is broken into three types of Learning Objectives as follows:
   (a) Type I: Learning Objectives relating to Knowledge and Understanding (Type 1 Learning Objectives are also known as Lower Order Thinking Skills or LOTS).
   (b) Type II and Type III: These Learning Objectives relate to acquisition of skills, Attitudes and Values (Type II and Type III) Learning objectives are also known as Higher Order Thinking Skills or HOTS) – These Learning Objectives are actually considered to be the ones targeted by present reviewed syllabus.
4. Each Unit has a Content which indicates the scope of coverage of what a teacher should teach and learner should learn in line with stated learning objectives.
5. Each Unit suggested Learning Activities that are expected to engage learners in an interactive learning process as much as possible (learner-centred and participatory approach).
6. Finally, each unit is linked to other Subjects, its Assessment Criteria and the Materials (or Resources) that are expected to be used in teaching and learning process.

In all, the syllabus of agriculture for O'level has got 4 Topic Areas (Soil Science, Crop Production and Processing, Animal Production and Agriculture Economics). As for the units, they are 7 in S1,7 in S2 and 8 in S3.

THE CONTENT MAP FOR AGRICULTURE SECONDARY 2

Unit 1	Soil
Number of periods	**10**
Introduction	• Definition of soil fertility. • Characteristics of fertile soil (dark colour and contains plenty of humus, enough humus to keep the pH above neutral) and its plant indicators. • Factors affecting soil fertility (availability of water, water drainage, activity of soil organisms). • Factors affecting availability of plant nutrients (soil pH, organic matter, soil texture, climate, leaching from sandy soil, soil compaction, crop removal, use of sensitive crops and nutrient interactions). • Symptoms of mineral nutrients, deficiencies. • Definition of organic manures. • Types of organic manures (compost, farmyard manure, green manure and right soil). • Types of compost (heap and pit compost) • Steps of making compost/pit compost (have the pit for waste, add the manure, add the soil, repeat the activity until the pit is filled, cover the pit with the soil. When it is full, use a long stick to monitor the temperature in the middle of the pile). • Steps of making farmyard manure. • Main inorganic fertilisers (NKP, Urea and DAP).
Classroom Organisation	Individual, group and whole class
Materials required/ resources	• pH meter • Plot soil/garden soil • Colour indicator papers • Sample of inorganic fertilisers • Organic wastes • Manures • Water • Sticks • Soil • Ash

Activities	• Finding out the meaning of soil fertility. • Field visit to study characteristics of fertile soil. • Observing the role of water in plants. • Observing deficiency symptoms in crops. • Finding out the meaning of organic manures • Identification of different types of manure. • Field visit to observe the steps followed in making manure. • Making compost manure using the pit compost method. • A visit to a zero grazing unit to observe steps in making farm manure. • Preparation of farmyard manure. • Field visit to a shop of inorganic fertilisers to observe and manipulate fertilisers.
Competences practised	• Critical thinking and problem solving skills. • Information gathering. • Report writing and presentation. • Co-operation/Teamwork. • Communication skills. • Identifying fertile soils.
Vocabulary acquisition	• Terminologies related to soil science such as soil fertility, symptoms of nutrient deficencies in plant, manures and inorganic fertilisers. • Key terms used at the end of this unit.
Numeracy	• Measurements of land size, weight of fertilisers, manures and amount of money.
Study skills	• Reading and note taking. • Observation. • Experimentation. • Data collection. • Data analysis and recording. • Drawing of conclusion. • Presentation of findings.
Revision	• Revision questions at the end of the unit.
Assessment	• A formative assessment in the course of the unit and a summative evaluation at the end of the unit.

Learning outcomes	• Identifying fertile soils. • Detecting fertile soils with indicatory plants. • Ability to make organic manures. • Ability to identify and use main inorganic fertilisers. • Ability to make a report of an investigation. • Co-operating with others in discussion groups. • Acquiring communication skills.

Unit 2	**Mushrooms**
Number of periods	**4**
Introduction	• Definition of mushrooms. • Propagation of mushrooms. • Types of mushrooms (edible and non-edible mushrooms). • Production of mushroom tubes (compost sterilisation, dying, crushing, packing up, bagging, mycelium sowing). • Mushroom cultivation techniques (Arranging mushrooms tubes in a nursery bed, shading, watering, weeding) • Factors affecting mushroom cultivation.
Classroom Organisation	Individual, group and whole classroom
Materials and equipment	• Mushroom seed making from households or co-operatives. • Mushroom farming households or co-operatives or schools. • Mushroom tubes, compost bags. • Hoe. • Computer room with internet connection. • Library.

Activities	• Finding out the meaning of mushrooms. • Finding out the different types of mushrooms. • Finding out the meaning of propagation of mushrooms. • Mushroom tube making. • Field visit to observe mushrooms tube making and mushroom cultivation. • Cultivating mushrooms in the nursery.
Competences practised	• Critical thinking and problem solving report. • Information gathering. • Team work/co-operation. • Creativity and discovery. • Communication and social skills. • ICT skills.
Vocabulary acquisition	• Terminologies related to mushroom cultivation such as, definition of mushroom, mushroom tube, subtrate mushroom spawn. • Terminologies related to factors affecting mushroom cultivation such as environment, pests and diseases. • Key terms at the end of this unit.
Numeracy	• Measuring of weights in preparation of mushrooms and mushroom cultivation.
Study skills	• Acquiring information. • Note-taking. • Organisation of materials for presentation. • Project support work.
Revision	• Formative evaluation. • Summary notes at the end of the topic. • Revision exercises at the end of the topic. • Summative evaluation of the end of the unit.
Assessment	• Formative assessment as the lesson progresses. • Assessment of practical activity. • Group tasks and project support during field visits.
Learning outcomes	• Defining the term mushroom. • Identifying types of mushrooms. • Identifying edible and non-edible mushrooms. • Making of mushroom tubes. • Practising mushroom cultivation.

Unit 3	Fruits
Number of periods	**20**
Introduction	• Fruit trees definition. • Importance of fruits. • Some fruits cultivated in Rwanda (avocados, papaya, mangoes, tamarillo, citrus, pineapples, passion fruits, strawberries). • Propagation methods of fruits (layering, grafting, seed propagation, stem cuttings, seeds). • Grafting of avocado and citrus fruit trees. • Orchard management practices (site selection, planting, watering, pruning, pest and disease control). • Definition of processing and preservation of fruits. • Importance of processing and preservation of fruits. • Objectives of applying post-harvest technologies (maintain quality: flavour appearance, nutritive value; to protect food safety, prevent losses both physical and in market value). • Preservation techniques of fruits: refrigeration, freezing, sugaring, canning, curving, fermentation). • Some fruits to be processed: strawberries, passion fruits, papaya, pineapples, citrus, tamarillo). • Products processed from fruits (Jam, juice, marmalade and steps involved in their processing).
Classroom Organisation	• Whole class. • Group work. • Individual work.
Equipment Required	• Students' course book S2 agriculture. • School farm, neighbouring farms. • Library, video of citrus pruning and grafting, materials for pruning and grafting. Tree seedlings in nursery, fruit trees, processed fruits into jam, jellies and marmalade. • Fruit cans and jars, blenders, cookers, source pans, refrigerators, pruning saws and secateurs, budding and grafting tapes, wax, knives. • Hand hoes, slashers, garden lines, garden chains and wooden pegs. • Computers, laptops and internet, magazines, newspaper cuttings, chart.

Activities	• Finding out the meaning of fruits. • Field visit to explore and identify cultivated fruits and their importance. • Finding out fruits cultivated in Rwanda. • Researching different methods of fruit propagation. • Field visit to observe grafting of avocados and citrus. • Grafting of avocado trees. • Building citrus trees. • Field tour to select site for an orchard. • Land preparation to establish an orchard. • Laying out an orchard. • Preparation of planting holes. • Transplanting fruit tree seedlings. • Identifying fruit pests and diseases. • Controlling pests and diseases in an orchard. • Watching a video on pruning of fruit trees. • Pruning citrus fruit trees. • Field trip to a fruit processing and preservation plant or factory. • Finding out the importance of processing and preservation of fruits. • Using search engines to find out the importance of applying post-harvest technologies. • Finding out the preservation techniques in different fruits. • Applying preservation techniques in different fruits. • Observing and identifying fruits to be processed. • Finding out the products processed. • Finding out the products processed from fruits.
Competences practised	• Critical thinking and problem solving skills. • Data collection methods. • ICT skills. • Communication skills. • Team work/ Co-operation. • Public speaking skills. • Creativity. • Fruit processing and preservation skills.
Vocabulary acquisition (key terms to be introduced and explained to learners)	• Terminology related to fruit production, such as definition of fruits, propagation, layering, grafting seeds, cuttings). • Terminologies related to fruits processing and preservation. • Key terms at the end of this unit.

Numeracy	• Knowledge of how measuring, spacing, using metres and centimetres. • Measuring plant heights when grafting. • Calculating fertiliser rates. • Ensuring chemical dosage. • Measuring quantified in recipes in fruit preservation.
Study skills (including language competence)	• Acquiring information. • Note taking and writing. • Organising ideas and presentation when reporting. • Observation skills. • Mastering examination terms such as procedures.
Revision	• Revision exercises at the end of the unit in the students' book. • Assignment given by the teacher. • Summary of the points and things to remember.
Assessment	• A formative assessment of competency in practical work. • Oral questions. • Continuous assessment test. • Summative evaluation at the end of the unit.
Learning outcomes	• Exploring cultivated fruits and their importance. • Recognising fruits cultivated in Rwanda. • Cultivating acceptable behaviour of team playing. • Performing grafting and budding. • Respecting those in leadership position. • Public speaking and presentation. • Observation and perception skills. • Carrying out fruit preservation and processing. • Appreciating fruit growing, processing and preservation.

Unit 4	Legumes
Number of periods	**16**
Introduction	• Definition of legumes. • Legumes names, types, (fodder edible by human) and their importance. • Importance of legumes (soya beans and groundnuts, fodder, feed, livestock, stakes for climbing crops, soil fertility and soil conservation). • Propagation methods of legume (cuttings, seeds, propagation, layering). • Cultural practices of legumes (land preparation, planting materials, sowing, maintenance/management and harvesting). • Post-harvest techniques for soya beans, groundnuts, (threshing, and transport, drying, cleaning, handling, conditioning, packaging and storage and fodder.
Classroom Organisation	• Individual work. • Group work. • Whole class.
Equipment Required	• Hoes, rakes, measuring tapes, *pangas,* pegs, ropes, sacs, labels and small farm. • Library, computers, laboratory with tools. • Internet, school fields, neighbouring farms.
Activities	• Finding out the definition of legumes. • Identifying legumes. • Field visit to find out the importance of legumes. • Field visit to observe and find out the propagation methods of legumes. • Field work to carry out cultural practices in legumes. • A field visit to observe post-harvest techniques of legumes. • A vist tom a farm growing fodder legumes to observe post-harvest activities carried out on fodder legumes.
Competences practised	• Critical thinking and problem solving. • Data collection methods. • Presentation of findings. • Team work/co-operation. • Digital skills. • Legume propagation and post-harvest technique skills.

Vocabulary acquisition (key terms to be introduced and explained to learners)	• Terminologies related to post-harvest techniques of fodder. • Key terms at the end of this unit.
Numeracy	• Measurement of inter row and interplant spacing in metres and centimetres. • Dosages of insecticides and fungicides. • Measurement of fertiliser rates in kilograms and grams. • Measurement of yields in kilograms and bags.
Study skills (including language competence)	• Discussion skills. • Acquiring information. • Note-taking. • Information organisation.
Revision	• Summary notes. • Revision exercise at the end of the unit. • Group discussions.
Assessment	• Formative assessment through observation, pen and paper, oral questions, continuous assessment tests. • Summative assessment, evaluation at the end of the unit.
Learning outcomes	• Identify legumes cultivated in Rwanda. • Positive attitude towards colleagues. • Ability to carry out legume cultivation. • Acquire post-harvest skills of soya beans and groundnuts.

Unit 5	Ruminants
Number of periods	**14**
Introduction	• Definition of ruminant. • Ruminant species reared in Rwanda (cattle, sheep, goats). • Ruminant breeds (cattle: Ankole, Friesian, Jersey; Goats: local, alpine, Boar, Ethiopian Galla, Saneen; Sheep: local, mountain white, Merino). • Characteristics of ruminants and breeds. • Ruminants shelter standards. • Selection criteria of breed to rear (**Goats and sheep**): Natural base width, muscling, volume and capacity, style and balance, growth potential, age; **Cattle**: Head, topline, the legs, main body and ribs, humps, hooves and pasterns, walking, fat and muscle for beef and udders, teat size, fertility, navel for dairy cows). • Feeding ruminants using fodder species: (fodder grasses and fodder legumes and concentrates. • Feeding plan for goats. • Ruminants disease (**Cattle**: Brucellosis, babesiosis, tuberculosis, bovine anaplasmosis, East coast fever, heart water, **Goats:** Blue tongue, heart fever, vesicular, stomatitis, caprine arthritis, encephalitis, clostridia disease; **Sheep**: blue tongue, Cryptococcosis, vesicular stomatitis) • Sanitation (rules for a ruminants' farm sanitation).
Classroom Organisation	Individual, group and whole classroom
Materials and equipment	• Ruminant farms, projector, CD-videos on ruminants, ruminant shelter, construction materials, fodder and concentrate water. Timber, nails, tools like hammers and crowbars, Napier grass, lucerne calliandra, leuceana pictures of ruminants and videos of ruminant animals suffering different diseases-free internet sites.

Activities	• Finding the meaning of the term ruminant. • A visit to an agricultural and veterinary schools or ruminant farms to observe ruminant species kept in Rwanda. • Finding out different ruminant breeds. • Finding out the characteristics of ruminant breeds. • A visit to a multipurpose farm to observe ruminant shelter standards. • Field trip to a multipurpose farm to observe a goat shelter. • Construction of a goat shelter. • Field visit to observe the selection criteria for ruminant animals. • Finding out the types of feeds required for feeding ruminants. • A visit to a farm to observe feeding of goats. • Observing different goat diseases. • A visit to a ruminant farm to observe sanitation.
Competences practised	• Critical thinking and problem solving skills. • Lifelong learning. • Presentation of findings. • Team work/Co-operation. • Creativity and discovery. • Communication and social skills. • ICT skills.
Vocabulary acquisition	• Terminologies related to ruminants and ruminant breeds and characteristics such as topline, muscling, volume, growth potential, fertility. • Terminologies related to ruminant shelter standards such as materials and sanitation. • Terminologies related to ruminant feeding such as fodder and concentrates. • Terminologies related to ruminant diseases such as symptoms and damages. • Key terms defined at the end of this unit.

Numeracy	• Measuring of distance when making farm structure, slope of land. • Measuring different selection criteria such as natural base width, muscling, volume and capacity of cattle, sheep and goats. • Estimating quantities of feed when making a feeding plan for goats.
Study skills	• Acquiring information. • Note-taking. • Organisation of materials for presentation. • Project support work.
Revision	• Formative evaluation. • Summary notes at the end of the topic. • Revision exercises at the end of the topic. • Summative evaluation at the end of the unit.
Assessment	• Formative assessment as the lesson progresses. • Assessment of practical activity. • Group tasks and project support during field visits.
Learning outcomes	• Defining the term ruminant. • Identifying species of ruminants reared in Rwanda. • Identifying ruminant breeds kept in Rwanda. • Making of goat shelters. • Identifying ruminant feeds. • Practising goat feeding. • Identifying diseases and enemies affecting goats. and other ruminant livestock kept in Rwanda. • Practise sanitation rules in ruminant shelters.

Unit 6	Livestock products
Number of periods	**4**
Introduction	• Importance of preservation. • Preservation of cattle products (meat, milk, ice cream, cheese, yoghurt and by-products (hide, tallow, gelatin, leather, blood, horns and bones). • Preservation of pig products (meat, lard) and by-products (suede for shoes and clothing, gelatin for food and non-food uses). • Preservation of poultry products (meat, eggs). • Preservation of rabbit products (meat, and fur for making socks).
Classroom Organisation	Individual, group and whole class.
Materials required/ resources	• Damaged livestock products. • Fresh livestock products. • Processing industries. • Diaries. • Hand gloves. • Laboratory equipment.
Activities	• Observing destroyed products. • Field trip to livestock processing industries and dairy. • Discussions on preservation of cattle products and by-products. • Discussion on preservation of pig products and by-products. • Discussion on poultry products. • Discussion on rabbit products.
Competences practised	• Critical thinking and problem solving. • Information gathering. • Report writing and presentation. • Team work/ co-operation. • Communication skills. • Ability to preserve various livestock products.
Vocabulary acquisition	• Terminology related to preservation of livestock products such as salting, sugaring, smoking, drying, freezing and fermentation. • Key terms defined at the end of this unit.

Numeracy	• Measurements of weight of livestock products, temperatures and money, manures and amount of money.
Study skills	• Reading and note-taking. • Observation. • Data collection. • Data analysis and recording. • Drawing of conclusion. • Presentation of findings.
Revision	• Revision of questions at the end of the unit.
Assessment	• A formative assessment in the course of the unit and a summative evaluation at the end of the unit.
Learning outcomes	• Identifying damaged products by colour, smell, taste and look. • Ability to preserve livestock products. • Ability to make a report of an investigation. • Co-operating with others in discussion groups. • Acquiring communication skills.

Unit 7	**Problems and Solutions of Agriculture in Rwanda**
Number of periods	**4**
Introduction	• Problems facing agriculture (land shortage, lack of capital, pests and diseases, unstable prices, poor rainfall distribution, bad attitudes towards agriculture, malnutrition, poor road network, lack of market for agricutural goods, lack of proper storage facilities and poor transport facilities. • Solutions to problems that agriculture is facing (intensive agriculture, borrowing money from banks, construction and maintainance of feeder roads, plant protection, searching proper market).
Classroom Organisation	Individual, group and whole class.

Materials required/ resources	• Computer laboratory with internet. • Library books/library. • Land use in Rwanda map. • Weather charts. • Histogram of rainfall distribution in Kigali/any other major town in Rwanda.
Activities	• Finding out problems facing agriculture in Rwanda. • Visit to a field day organised by an agricultural institution or agricultural research institute to find out how farmers respond to challenges they face while farming in Rwanda. • Discussion on intensive farming under; characteristics, systems, merits and demerits.
Competences practised	• Critical thinking and problem solving. • Life skills. • Information gathering. • Report writing and presentation. • Team work/co-operation. • Communication skills.
Vocabulary acquisition	• Terminology related to problems and solutions of agriculture such as capital, demand and supply, price fluctuations, buffer stock, contracting, stabilisation funds and subsidy. • Key terms defined at the end of this unit.
Numeracy	• Measurements of rainfall, land and money.
Study skills	• Reading and note-taking. • Discussion. • Information gathering. • Data analysis and recording. • Drawing of conclusion. • Presentation of findings.
Revision	• Revision questions at the end of the unit.
Assessment	• A formative assessment in the course of the unit.

Learning outcomes	• Ability of identifying problems facing agriculture in Rwanda. • Ability to solve problems facing agriculture in Rwanda. • Critical thinking and decision making skills in handling issues. • Ability to co-operate with others in group discussion. • Acquiring communication skills. • Report writing and presentation of findings.

A SAMPLE SCHEMES OF WORK FOR SOCONDARY 2 AGRICULTURE, UNIT 1: SOIL

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
1	1	SOIL FERTILITY -Definition of soil fertility	By the end of the lesson, the learners should be able to define soil fertility.	• Finding out the meaning of soil fertility. • Discussing and recording their findings. • Presenting their findings to the class. • Taking teacher's summary notes.	Computers with modems, library.	• Dictionary. Library. • Books. • Internet.	Well covered.
	2	Characteristics of a fertile soil and its plant indicators	By the end of the lesson, the learners should be able to describe the characteristics of a fertile soil and its plant indicators.	• Observing soil physical characteristics such as colour, texture and structure. • Estimating soil pH by use of a pH meter or colour indicator paper.	• pH meter • Garden soil. • Water. • Colour indicator • Papers. • Beakers. • Test tubes. • Stirring rods.	• Internet. • Library. • Books. • Dictionaries.	Well covered.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
				• Discussing and recording their findings. • Presenting their findings to the class. • Taking teacher's summary notes.			
2	1	Factors affecting soil fertility.	By the end of the lesson, the learner should be able to recognise the factors affecting soil fertility.	• Growing two sets of crops A and B, one under adequate water supply and the other inadequate water supply and making observations on a daily basis. • Discussing and recording their findings. • Presenting their findings to the class after the project. • Taking teacher's summary notes.	• Portable containers labelled A&B. • Tomato or kale seedlings. • Water. • Stakes. • Pesticides. • Phosphoric and nitrogenous fertilisers. • Knapsack sprayers. • Library.	• Library books • Dictionaries • Internet • Secondary 2 Agriculture Students' Book.	The activity will take longer than the 40 minutes to make observations and get the final results. Learners given the assignment of watering the crops and making necessary observations.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
	2	Factors affecting the availability of nutrients.	By the end of the lesson, the learner should be able to distinguish the factors affecting the availability of plant nutrients.	Watching a video on: • Effects of water stress on crop production. • Mineral deficiency symptoms in crops. • Effects of saline soils on crop production. • Discuss and record the observations made. • Present findings to the class. • Take teacher's summary notes.	• Library • Computers • Modems • Videotape	• Library books. • Internet. • Secondary 2 Agriculture Students' Book.	Watch a video on effects of water stress and saline soils on crop production but did not watch one on mineral deficiency symptoms. Time should be created for it.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
3	1	Symptoms of mineral nutrients deficiencies.	By the end of the lesson , the learners should be able to describe the symptoms of plants deficient in minerals.	• Growing crops under conditions of fertiliser applications and making observations. • Watching a video on mineral deficiency symptoms in crops. • Discussing and recording observations daily. • Presenting their findings before the class. • Taking teacher's summary notes.	• Plot of land measuring • 4 m by 3 m. • Planting materials. • Phosphatic and nitrogenous fertilisers. • Water. • Library. • Computers with modem. • Videotape	• Library books. • Secondary 2 Agriculture Students' Book.	The activity will require more times than the 40 minutes allocated for the lesson. Learners assigned the task of watering their crops during their own free time and making necessary observations.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
	2	• Definition of organic manures. • Types of organic manures.	By the end of the lesson, the learner should be able to define organic manures and name different types of organic manures or fertilisers.	• Finding out the meaning of organic manures from internet and library books. • Identifying different types of manures provided by the teacher. • Discussing and recording their findings. • Presenting their findings to the class. • Taking teacher's summary notes.	• Library. • Computers with modems. • Different types of manures.	• Internet • Library books • Dictionaries • Secondary 2 Agriculture Students' Book.	Well covered.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
4	1	Types of composts.	By the end of the lesson, the learner should be able to distinguish between heap and pit composts.	• Finding the types of composts from the internet and library books. • Discussing and recording their findings. • Presenting their findings to the class. • Taking teacher's summary notes.	• Computers with modem. • Library.	• Internet • Library books • Dictionaries • Secondary • Agriculture Students' Book.	Well covered.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
	2	Steps of making compost manure using the pit method.	By the end of the lesson, the learner should be able to make compost manure using the pit method.	• Carrying out the steps of making compost manure using the pit method. • Discussing and recording findings or observations. • Presenting their findings to the class. • Taking teacher's summary notes.	• Hand hoe. • Maize stalks. • Wood ash. • Well rotten manure. • Green leaves. • Kitchen wastes, grass • Garden soil. • Spade. • Temperature stick.	• Library books • Secondary 2 Agriculture Students' Book. • Internet.	Preparation stage well done but the activity will require more time before getting the final product.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
5	1	Steps of making farmyard manure.	By the end of the lesson, the learner should be able to make farmyard manure.	• Carrying out the steps of making farm yard manure. • Discussing and recording findings or observations. • Presenting their findings to the class. • Taking teacher's summary notes.	• Farm animals dwelling houses/ places. • Litter materials for the animal houses. • Shovel. • Manure fork. • Manure shed. • Wheelbarrow.	• Internet. • Library books. • Dictionaries. • Secondary 2 Agriculture Students' Book.	The activity will require more time before getting the final product. Learners assigned the task of collecting and heaping materials from the animal houses.

WEEK	LESSON	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	LEARNING ACTIVITIES	LEARNING RESOURCES	REFERENCES	REMARKS
	2	Main inorganic fertilisers.	By the end of the lesson, the learner should be able to identify different fertilisers used in agriculture.	• Identifying different inorganic fertilisers exhibited by the teacher or sold in a shop. • Calculating the fertiliser ratio of compound fertilisers identified. • Observing the colours of the various fertilisers exhibited or sold in a shop. • Manipulating the fertilisers exhibited or sold in a shop • Discussing and recording their findings. • Presenting their findings to the class. • Taking teacher's summary notes.	Various types of fertilisers.	• Internet. • Library books. • Dictionaries. • Secondary 2 Agriculture Students' Book.	Well covered.

Note: The remarks column is filled after covering the lesson. The remarks indicate how well the lesson was covered and whether a re-teach may be neccessary if the lesson was not adequately covered. It may also indicate whether a project was completed within the stipulated time or is ongoing.

SAMPLE LESSON PLAN

School Name..... Teacher's Name .....

Term	Date	Subject	Class	Unit No.	Lesson No.	Duration	Class Size
	– / – 2017	Agriculture		1	1/10	40 min	40

Type of special Education Needs to be catered for in this lesson and number of learners in each category	**Visual impairement (2)**: Let the learner be in a way that he/she can see the teacher facial expressions and gestures.
Unit Title	**Soil**
Key unit competence	The learner should be able to describe the characteristics of fertile soil, differentiate inorganic fertilisers and make organic fertilisers.
Title of lesson	Characteristics of fertile soil and its plant indicators.
Instructional objectives	Having pH-meter/indicator paper, hoe, beaker test tube and water, in school farm, learners should be able to describe 5 characteristics of fertile soil and identify its plant indicators.
Plan for the class (location in/ outside)	Outside the classroom/school farm
Learning materials (for ALL learners)	*pH* meter, garden soil, water, indicator papers, beaker, test tubes, stirring rods.
References	– Rwanda National agriculture syllabus , senior two – Agriculture pupil's book, senior two – Library textbooks

	Description of teaching and learning activity Teacher lead learners to school farm, learners observe and make test on characteristics of soil.		**Generic competences and cross cutting issues to be addressed + a short explanation**
Timing for each step	**Teacher's activities**	**Learners activities**	

Introduction (5 mins)	Review soil composition and soil properties by asking probing questions. • **Possible questions** 1. Name one or two components of soil 2. Give one of the physical properties of soil	Learners respond to the question • **Possible answers** 1. Rock particles, water, air, humus 2. Water holding capacity/porosity, texture ...	
Development of the lesson (30 mins)	• In groups of 4 learners, teacher allows learners to observe colour of soil and fertile plant indicators. • Teacher asks learners to test soil by touching. • Teacher asks learner to use hoe to determine the depth of soil. • Teacher asks learners, in groups of five to determine the pH of sampled soil.	Learners observe and present their findings as follows: 1. Dark colour for frtile soil. 2. Galinsoga palviflora, Bidens pilosa, comellina bengalensis • Each learners touch soil and determine the fitness of soil • By digging the soil, learner determine its depth • With pH-meter/ indicator paper learner read the pH of sampled soil.	**Communication** • Working together in grouThe working groups of classmates provide an open environment to group members which facilitate communication. **Co-operation** • The working group of classmates is organised well and allows all members to participate efficiently. **Gender balance** in groups formed **Critical thinking** • Learners will think about different colours of soil and determine which among them characterise a fertile soil.

			Peace and values • While using of digging tools (hoe) attention is needed in order to prevent accident.
Conclusion: **Summary** **Assessment** **(5 min)**	• The teacher assess the lesson by requesting to the learners to describe 5 characteristics of fertile soil. • Teacher asks learner to list the common plant indicator of fertile soil.	The learners respond to assessment task. **Possible answers:** Characteristics of fertile soil are: • Good depth of soil. • Dark in colour. • Rich in humus. • Correct soil pH. • Presence of plant indicator of fertile soil. The learner list common plant indicators of fertility/ infertility. Possible answers (a) Fertility plant indicators • Galinsoga palviflora/kimali • Bidens pilosa/ inyarabas anyi • Comellina bengalensis/uru teja (b) Plant indicators of fertility • Eragrostris/ ishinge • Branchen/ igishihe	
Teacher self-evaluation	• All learners are able to describe characteristics of fertile soil and its plant indicators.		

Topic Area: Soil Science

Unit 1: Soil

Number of Periods: 10

Key Unit Competence: Learners should be able to describe the characteristics of fertile soil, differentiate non-organic fertilisers and make organic fertilisers.

1.1 Learning Objectives

(a) Knowledge and Understanding

(i) Define soil fertility.
(ii) Describe characteristics of soil fertility and state indicatory plants of fertile soils.
(iii) Distinguish factors affecting availability of plant nutrients.
(iv) Describe symptoms of plants deficient in minerals.
(v) Name organic fertilisers.
(vi) Carry out steps of making compost.
(vii) Apply methods of making farmyard manures.
(viii) Identify different fertilisers used in agriculture.

(b) Skills

(i) Conduct experiments illustrating soil fertility.
(ii) Detect fertile soils with indicatory plants.
(iii) Try to understand the problem of insufficient water and propose solution.
(iv) Recognise factors affecting availability of plant nutrients.
(v) Recognise some plant symptoms and deficiencies for mineral nutrients.
(vi) Discriminate organic fertilisers.
(vii) Perform steps of making compost.
(viii) Perform steps of making farmyard manures.
(ix) Recognise major inorganic fertilisers used in agriculture.

(c) Attitudes and values

(i) Show patience awaiting agricultural result.
(ii) Be careful and attentive while detecting soil fertility characteristics.
(iii) Assume responsibility of solving problem.
(iv) Be attentive while observing plant nutrients deficiencies.
(v) Be aware on organic manure types.
(vi) Conform on compost making.
(vii) Conform on making farmyard manures.
(viii) Be careful and attentive while observing and manipulate fertilisers.

1.2 Content Students' Book page 1–23

(i) Definition of soil fertility.

(ii) Characteristics of fertile soil, (dark colour-contains plenty of humus, enough lime to keep the pH about neutral) and its plants indicator.

(iii) Factors affecting soil fertility (availability of water, water drainage, activity of soil organism).

(iv) Factors affecting availability of plants nutrients (Soil pH, organic matter, soil texture, climate, leaching from sandy soils, soil compaction, crop removal, use of sensitive crops, nutrient interaction).

(v) Symptoms of mineral nutrients deficiencies.

Answers to questions in table 1.1: Comparison between healthy and deficient plants in the students' book page 9 –11

Healthy plant	Deficient plant	Symptoms Identified	Deduction
(a) Strawberry plant	Stunted plant	Stunted growth	The soil is lacking nitrogen, phosphorus, potassium, sulphur and calcium
(b) Raspberry plant/leaves	Chlorotic leaves	Chlorosis/ yellowing of leaves	The soil is lacking nitrogen, potassium and sulphur
(c) Healthy green leaves (citrus)	Yellow patches between the veins in leaves	Inter-veinial chlorosis	The soils lack magnesium
(d) Healthy citrus branch	Shoot tips drying backward in citrus	Die-back	The soils is lacking calcium
(e) Healthy tomato plant	Purple colour in tomato leaves	Anthocyanin pigment	The soil is lacking nitrogen, phosphorus and magnesium
(f) Healthy citrus leaves	Leaves curved along the margin	Leaf curl	Soil is lacking magnesium.
(g) Healthy maize plant	Falling of the maize plant	Lodging	Soil is lacking phosphorus and potassium.

(h) Developed root nodules	Lack of root nodules	Poor nodulation in legume plants	The soil is lacking phosphorus and sulphur

(vi) Definition of organic manures.
(vii) Types of organic manures (compost, farmyard manure, green manure night soil).
(viii) Types of compost (heap and pit compost) and steps of making compost/ pit compost (have a pit for waste, add the manure, add the soil, repeat the activity until the pit is filled, cover the pit with the soil when it is full, use a long stick to monitor the temperature in the middle of pile).
(ix) Steps of making farmyard manure.
(x) Main organic fertilisers; (NPK, UREA and DAP).

1.3 Learning Activities

(i) Field activity to characterise fertile soil by observation of the colour, by touching with hands, by estimation of its pH using pH meter or indicator paper and by observing plant indicators.
(ii) Problem solving by showing plants grown in soil with insufficiency of water and discuss among themselves on the problem and find its solution.
(iii) Field work to follow the whole process of making a compost and farmyard manure and imitate that process/steps in groups themselves.
(iv) Field trip to a shop of inorganic fertilisers to observe and manipulate fertilisers.

1.4 Links to other Subjects

This unit is linked to Geography (soil formation), Chemistry especially group five elements in the periodic table, Biology (plant nutrition) and Biotechnology.

1.5 Assessment Criteria

Assessment will be based on the ability to:

(i) Characterise fertile soil depending on colour, humus content, lime content and pH value or degree.
(ii) Recognise the fertile soil by referring to the plant deficient in minerals.
(iii) Make compost and farmyard manure by respecting steps involved in that process.
(iv) Recognise inorganic fertilisers displayed at the market.

1.6 Learning Materials/Resources

The following learning materials will be required in this unit:

(i) pH meter.
(ii) Plot soil/garden soil.
(iii) Colour indicator papers.
(iv) Samples of inorganic fertilisers.
(v) Organic wastes.
(vi) Manure.

(vii) Water.
(viii) Land.
(ix) Sticks.
(x) Soil and ash.

1.7 Suggested Low Cost or No Cost Materials

(a) Ask the learners to bring materials such as wood ash, seedlings and tools for cutting vegetative materials for making compost manure.
(b) Share facilities such as laboratories and laboratory equipment with neighbouring schools when carrying out soil pH testing.

1.8 Methods of Teaching

The following methods are recommended in the teaching of this unit: The methods used are explained in the previous pages of this book as shown.

Content	Method(s)
1. Definition of soil fertility	**Discussion**: Teacher gives the learners an opportunity to define soil fertility in their groups. The teacher facilitates and allows the learners time to present their findings. The teacher then gives a final conclusion.
2. Characteristics of fertile soils and its plant indicators	**Field visit**: The teacher prepares a questionnaire which is provided in Annex 1 and instructs the learners to observe fertile soils and their plant indicators during the field visit. Learners to make observations on characteristics of the soil such as colour, records them in their note books and present them to the class. Teacher to maintain discipline and clarify issues arising from the trip.
3. Factors affecting soil fertility	**Problem solving**: Teacher sensitises the learners on factors affecting soil fertility. Learners investigate, discuss and give solutions to the problem of soil infertility such as applications of organic manures and fertilisers. They then analyse the outcome to see whether it can be applied in future.

4. Factors affecting availability of plant nutrients	**Discussion**: Teacher gives the learners an opportunity to suggest factors affecting the availability of plant nutrients. Learners record their findings and then present them to the class. Teacher to supervise the discussions and then give a final conclusion.
5. Symptoms of mineral nutrient deficiencies	**Supervised practice/activity**: The learners observe the symptoms of mineral deficiencies in plants as the teacher supervises, record and discuss their observations. They then present their findings to the class. Teacher then makes a final conclusion.
6. Definition of organic manures	**Discussion**: Teacher asks the learners to find out the meaning of organic manures from internet and library books. Learners record their findings and then present them to the class. Teacher to supervise the discussion and then give a final conclusion.
7. Types of organic manures	**Exhibition**: Teacher to display compost manure, farmyard manure and green leafy leguminous plant in shallow containers. Learners to make observations, discuss and present the findings to the class. Teacher to make clarifications and follow up.
8. Type of compost manures	**Discussion**: Teacher asks the learners find out the types of compost manure from internet and library books. Learners record their findings and then present them to the class. Teacher supervises the discussions and makes a final conclusion.

9. Steps in making compost manure	**(i) Field visit**: Teacher to provide questionnaire/asks the learners to observe the steps involved in making compost manure during the field visit. The questionnaire is provided in Annex 2. Learners to make observations, record them in their note books and present them to the class. Teacher to maintain displine and clarify issues arising from the trip. **(ii) Supervised practice/activity**: Teacher supervises the learners as they make compost manure using the steps observed during the field trip. Learners record and discuss their observations. They then present their findings to the class. Teacher then makes a final conclusion.

10. Steps in making farmyard manure	**(i)** **Field visit**: Teacher to provide questionnaire and then asks the learners to observe the steps involved in making farmyard manure during their visit to a zero grazing unit. The questionnaire to be used is provided in Annex 3. Learners to make observations, record them in their note books and present them to the class. Teacher to maintain discipline and clarify issues arising from the trip. **(ii)** **Supervised practice/activity**: Teacher supervises the learners as they make farmyard manure using the steps observed during the field trip. The learners to carry out the practical activities as demonstrated by the teacher in their respective groups, record and discuss their observations. They then present their findings to the class. Teacher then makes the final conclusion.
11. Main inorganic fertilisers	**(i)** **Field visit:** Teacher to provide questionnaire and asks the learners to identify displayed fertilisers or fertilisers sold in a shop during their field study. The questionnaire to be used is provided in Annex 4. Learners to observe and manipulated NPK, UREA and DAP and record them in their note books and present them to the class. Teacher to maintain discipline and clarify issues arising from the trip.

References

(i) S2 Agriculture Students' Book.
(ii) Dictionary.
(iii) Library books.
(iv) Internet.

1.9 Suggested Teaching/Learning activities and exercises to support delivery of content and development of students competences

1. Field visit to study the characteristics of fertile soil.
2. Observing the role of water in plants.
3. Observing deficiency symptoms in crops.
4. Field visit to observe the steps followed in making compost manure.
5. Making compost manure using the pit method.
6. A visit to a zero grazing unit to observe steps in making farmyard manure.
7. Preparation of farmyard manure.
8. A field visit to a shop of inorganic fertilisers to observe and manipulate fertilisers.
9. Discussion on the advantages and disadvantages of using organic manure as compared to the use of inorganic fertilisers.

1.10 Cross-cutting issues to be integrated in teaching and learning activities

The teacher should:

(i) Sensitise the learners on environmental pollution as a result of overuse of inorganic fertilisers.
(ii) Emphasise the importance of producing organic products that lead to healthy living.
(iii) Create awareness on the use of cost effective methods of agriculture.

1.11 Suggestions for accommodating special education needs (SEN)

When teaching this unit, special needs learners can be assisted as follows:

(a) Sensory impairment (visual)
- Use large prints in the instruction sheets, questionnaires and assessment paper.
- Allow them to sit near the chalkboard when in class.
- Pair them with learners with good vision.
- Assist them to recognise different colours.

(b) Sensory impairment (hearing)
- Be audible enough to the learner.
- Ask them whether they have heard.
- Allow learners to stay close to the teacher.

(c) Motor impairment (movement)
- Pair them with other learners to be assisted to carry tools and equipment.
- Conduct practical activities in one place to avoid too much movement.

(d) Gifted or talented learners

- Assign them extra duties.
- Encourage them to assist the slow learners.
- Place them in different working groups.

(e) Slow learners

- Give them individualised attention.
- Ask fast learners to assist them.
- Take time when going through the procedures.
- Give them remedial teaching.

1.12 Formative Evaluation

1. (a) What is organic manure?
   (b) Name four types of organic manures.
2. (a) What is a fertiliser element?
   (b) Name three fertiliser elements.
3. What is the purpose of applying agricultural lime with the soil?
4. Name five nutrient deficiency symptoms in plants.
5. State two ways of determining the fertility of a soil.

1.13 Additional Content for the Teacher

Main inorganic fertilisers

The amount of each of the three primary macro-nutrients (NPK) contained in a fertiliser is expressed in two ways. These are:

1. Fertiliser grade or analysis

Fertiliser grade indicates the amount of each nutrient contained in a fertiliser expressed as a percentage. It is usually indicated on a fertiliser bag or container; for example, a 100 kg bag of fertiliser with a fertiliser grade of 10-10-10 contains 10 kgs of nitrogen (N), 10 kg of phosphate (P_2O_5) and 10 kg of potassium oxide (K_2O). From the above fertiliser grade, the active elements constitute only 30 kg of the fertilisers, the remaining 70 kgs is made up of filler or carrier materials. Carrier materials are non-fertiliser materials which may also help to improve soil conditions.

Fertiliser grade helps to determine the amount of fertiliser required per hectare and, therefore, the amount of fertiliser needed. For example, a farmer has five hectares of land on a tomato crop.

The farmer plans to topdress the crop with a nitrogenous fertilisers. The available nitrogenous fertilisers available in the market is sulphate of Ammonia (SA) which is 20% Nitrogen. Sulphate of Ammonia is applied at the rate of 120 kg per hectare calculate:

(i) The amount of fertiliser in kilograms (kg) that the farmer will need.

(ii) The amount of nitrogen in kg that the farmer will apply in the five hectare field of tomatoes.

(iii) The number of bags that the farmer will buy if the fertilisers are sold in 50 kg bags.

(iv) The amount of money the farmer will spend if the fertiliser costs Rwf 2,000 per bag.

Solution

(i) Amount of fertiliser the farmer will need in equal to 120 kg C × 5 = 600 kg of Sulphate of Ammonia.

(ii) The amount of nitrogen to be applied in the field is equal to 600 kg × 20/100 = 120 kg Nitrogen.

(iii) The amount of bags that the farmer will buy = 600 kg of SA/50 = 12 bags of SA fertilisers

(iv) The amount of money the farmer will spend is equal to 12 bags × Rwf 2,000 Rwf 24,000.

2. Fertiliser ratio

Fertiliser ratio refers to the relative proportion of the three primary macronutrients (NPK) in a fertiliser expressed as a ratio. In that case a fertiliser grade of 10-10-10 has a fertiliser ratio of 10/10:10/10:10/10 = 1:1:1 of NPK, while a fertiliser grade of 20-10-10 has a fertiliser ratio of 2:1:1.

A fertiliser that contains only one primary macro nutrient is referred to as a straight fertiliser, for example, Sulphate of Ammonia (SA), Calcium Ammonium Nitrate (CAN) Ammonium Sulphate Nitrate (ASN), urea, single super phosphate (SSP) Double Superphosphate (DSP) Muriate of Potash (KCL) and Sulphate of potash (K_2O). If a fertiliser contains only Nitrogen as the only primary macronutrient, it is referred to as a nitrogenous fertiliser, for example, SA, CAN, ASN and urea. If a fertiliser contains only phosphorus as the only primary macronutrient, it is referred to as a phosphatic fertiliser, for example; SSP and DSP while a fertiliser that contains potassium as the only primary macronutrient is referred to as a potassium fertiliser, for example, muriate of potash and sulphate of potash. A fertiliser that contains two or more of the primary micronutrients (NPK) is known as a compound fertiliser. For example, Diammonium Phosphate (MP), Mono-ammonium Phosphate (MAP), 20-20-0, 20-10, 10-10-10, 17-17-17 and 15-15-15. A fertiliser that contains all the three primary macronutrients (NPK) is referred to as complete fertiliser. For example, 20-10-10, 10-10-10, 17-17-17 and 15-15-15.

Fertilisers are also classified on the basis of their effect on soil pH. The fertiliser that increase acidity of the soil (lowest soil pH) are said to be acidic fertilisers. While those that increased the alkalinity of the soil (increases soil pH) are said to be basic fertilisers. Fertilisers with no effect to the soil pH are said to be neutral fertilisers. For example, Calcium Ammonium Nitrate (CAN).

Generally, fertilisers containing phosphorus are referred to as planting fertilisers because they are applied at planting time while Nitrogenous fertilisers are used for top dressing or as folia feed when the crop is already growing in the field. Fertiliser rates are determined by the specific soil conditions in a given farm. Farmers are, therefore,

advised to take their soil to agricultural laboratories for soil testing to ascertain the specific nutrients that are lacking in the soil. This will help to determine the specific fertilisers to apply in their farms and their quantities.

1.14 Notes to the Teacher

When teaching this unit, the teacher should:

(i) Prepare a questionnaire for the learners when going for a field trip/visit.
(ii) Prepare the learners for a field visit a day before the field visit.
(iii) Demonstrate the procedure to be followed when teaching a practical lesson as the learners observe.
(iv) Divide the learners into groups and assign them activities.
(v) Provide the learners with the materials required for the practical activities.
(vi) Supervise the learners as they carry out the practical activities.
(vii) Give the learners adequate time to discuss and report their findings to the class.
(viii) Give summary notes to the learners after the activities as indicated in the students' book.
(ix) Keep the learner's progressive record and give feedback to the parents.

1.15 Additional remedial consolidation and extension activities

High order questions for fast learners

1. Explain how humus increases soil temperature.
   Humus absorbs and retains the heat of the sun in the soil.
2. Name one symbiotic Nitrogen fixing bacteria in the soil.
   Rhizobium
3. Analyse the following fertilisers in terms of their physical characterisics.
   (a) Diammonium phosphate
      (i) *It is grey in colour*
      (ii) *It is granular in formulation*
   (b) Urea
      (i) *It is white in colour*
      (ii) *It is granular in formulation*
4. Study the information below which describes the characteristics of soil A and B and then answer the questions that follow:

Soil A	**Soil B**
Has large particles Dries very quickly Is light in colour	Dark in colour Has plant remains Has a spongy feeling

   (a) Which one of the soils show colour characteristics of a fertile soil?
   Soil B

(b) Which soils would hold more plant nutrients?
Soil B

(c) Which one of the soil is easy to cultivate?
Soil A

(d) Which of the soils can easily be leached.
Soil A

5. Name two forms in which Nitrogen is available to the plants.
(i) *NO_3 (nitrates)* (ii) *NH_4 (Ammonium ions)*

Low order questions for average learners

1. State two activities of micro-organisms that improves soil fertility.
(i) *Decompose organic matter to add nutrients to the soil.*
(ii) *Fix nitrogen into the soil.*
(iii) *Detoxify toxic substances in the soil.*
2. A student saw that the crops they had planted in the school farm started turning into a uniform yellow colour.
What nutrients do you think was missing in the soil?
Nitrogen
Which of the following remedies would be appropriate for the student to use?
(i) Add a phosphate fertiliser in the soil?
(ii) Use compost manure?
(iii) Spray the leaves with water?
Use compost manure
3. Describe how leaching takes place.
Rain water infiltrates into the soil dissolving and carrying all the soluble nutrients from the top zones of the soil to the lower zones where plant roots cannot reach them.
4. Compare and contrast between pit and heap methods of preparing compost manure.

Pit method	**Heap method**
(i) Made below the ground level *(ii) A pit is dug* *(iii) Can easily be waterlogged* *(iv) Mixing is easily done* *(v) Difficult to remove ready manure*	*(i) Made above the ground level* *(ii) Posts are erected to form the four corners of the heap.* *(iii) Can easily become dry.* *(iv) Mixing is difficult* *(v) Easy to remove manure*

5. What is the use of stick placed in the middle of the compost pit?
(i) *Used to check the temperature of the material.*
(ii) *Used to check whether the materials are fully decomposed.*

1.16 Summative Evaluation

1. Explain the merits and demerits of organic manures in farming.
2. Describe the steps of preparing farmyard manure in the farm.
3. Explain two important roles of soil micro-organisms in improving soil fertility.
4. Explain the importance of soil testing.
5. Differentiate between straight and compound fertilisers.

1.17 Additional Questions

1. Explain the importance of humus in the soil.
   (i) *Humus influence the soil pH by moderating its effects.*
   (ii) *Humus improves the cation exchange capacity of the soil to make nutrients easily available*
   (iii) *It absorbs heat, hence improves the soil temperature.*
   (iv) *It reduces soil toxicity.*

2. Describe the importance of the following materials when making compost manure:
   (a) Manure
   (b) Top soil

   (a) *Manure is used to provide feed for the micro-organisms which decompose the compost materials.*
   (b) *Top soil is used to introduce micro-organisms which decompose the compost materials.*
3. Make three observations why night soil is not suitable for use in vegetable crop gardens.
   (i) *It may not be easily available.*
   (ii) *It is not easy to treat it to kill harmful disease causing organisms to human.*
   (iii) *It may contain deposits of heavy metals which may be absorbed by vegetables making it unfit for human use.*

1.18 Suggestions for Assignments

1. (a) Examine crops growing in the field to observe nutrients deficiency, symptoms from the observation made, find out the possible nutrients that might be lacking in the soil.
   (b) Suggest the fertilisers that can be applied to solve the problem in the soil.

1.19 Support for the development of positive skills, values and attitude

1. Positive skills

Learners develop problem solving skills as they use the correct fertilisers at the recommended rate and time.

2. Values and attitudes

- Learners learn to co-operate and appreciate one another.
- Learners appreciate the importance of maintaining soil fertility for sustainable food production.

1.20 Suggested answers to formative evaluation

1. (a) Organic fertilisers that are derived from decomposed plants and animal remains which are applied to the soil to release plant nutrients.

   (b) (i) Compost manure
   (ii) Farmyard manure
   (iii) Green manure
   (iv) Night soil

2. (a) This is a major nutrient element contained in a fertiliser.
   (i) Nitrogen
   (ii) Phosphorus
   (iii) Potassium

3. It is normally applied into the acidity soils to raise their pH values and, therefore, make it possible to grow crops that do not require low pH values.

4. (i) Leaf chlorosis/yellowing of leaves
   (ii) Stunted growth
   (iii) Leaf fall and flower fail
   (iv) Lodging
   (v) Shoot dieback
   (vi) Leaf curling
   (vii) Production of anthocyanin(purple) pigment

5. (i) Soil testing
   (ii) Use of plant indicator signs.

1.21 Suggested Answers to Summative Evaluation

1. (a) Merits

(i) They are cheap to prepare.
(ii) They have a long residual effects in the soil.
(iii) They moderate soil pH.
(iv) They increase soil temperature due to their dark colour.
(v) They improve the soil physical properties.
(vi) They provide food for soil micro-organisms.
(vii) They improve water holding capacity of the soil.
(viii) They improve the water infiltration rate.
(ix) They supply a wide range of nutrients.
(x) They improve the aeration of the soil.

(b) Demerits

(i) They release their nutrients slowly.
(ii) It is not possible to determine the types and amounts of nutrients contained in organic manures.
(iii) Manures are bulky to transport and apply.
(iv) Manures have scorching effect on crops if applied when not completely decomposed.

2. (i) Provide beddings in the houses of farm animals.
(ii) Animals deposit their droppings and urine on the beddings.
(iii) Animals mix their dropping and beddings through tramping.
(iv) The beddings together with dung are removed and heaped under a shed to decompose.
(v) In 3–4 months, the materials decompose and the farmyard manure is ready for use in the farm.

3. (i) Decomposition of organic matter–Some soil micro-organisms break down organic matter in the soil and release plant nutrients. The nutrients are then taken up by plants.
(ii) Nitrogen fixation – Some bacteria in association with leguminous plants or free-living in the soil convert free nitrogen in the soil into nitrates. The nitrate ions are then absorbed by plants as nutrients.

4. (i) To establish pH of the soil.
(ii) To determine the types and amounts of nutrients in the soil.
(iii) To find out whether the soil contains nitrogen fixing bacteria and thus determine the correct inoculants to use on leguminous seed.
5. A straight fertiliser is one that contain only one primary micro-nutrient.
While a compound fertiliser contains two or more primary micro-nutrients.

Key Terms (Pages 23–25 of the Students' Book 2)

1. **Soil fertility** – Ability of the soil to provide crops with the required nutrients in their proper proportions for sustained high production.
2. **Soil pH** – This is the degree of acidity or alkalinity of a soil solution.
3. **Saline soils** – Soils with excessive amount of salts.
4. **Irrigation** – Artificial application of water to the crops.
5. **Water stress** – Shortage of water in crops.
6. **Stunted growth** – Slowed growth in crops.
7. **Waterlogged soils** – Soil with excessive amounts of water.
8. **Pathogenic** – Disease causing.
9. **Chlorosis** – Yellowing of leaves.

10. **Leaf curling** – Folding of leaves.
11. **Nodulation** – Production of nodules in the roots of leguminous crops.
12. **Macronutrient** – Mineral elements needed by plants in large quantities/amounts.
13. **Micro** – Nutrient mineral elements that are needed by plants in small amounts.
14. **Anaerobic respiration** – Respiration that takes place only in the presence of oxygen.
15. **Aerobic respiration** – Respiration that takes place only in the presence of oxygen.
16. **Fungal diseases** – Diseases caused by fungi.
17. **Bacterial diseases** – Diseases caused by bacteria.
18. **Microbial activity** – The activity of micro-organism.
19. **Agro-chemicals** – Agricultural chemicals.
20. **Compost manure** – Manure prepared by composting (heaping) vegetative materials.
21. **Farmyard manure** – Manure prepared from animal wastes.
22. **Green manure** – Manure prepared by incorporating green plants into the soil.
23. **Night soil** – Manure prepared from human wastes.
24. **Inorganic fertilisers** – Chemically produced compounds added to the soil to improve its fertility.
25. **Hygroscopic** – Ability to absorb atmospheric water/moisture.
26. **Volatilisation** – Ability to escape into the atmosphere in form of a gas.
27. **Zero grazing unit** – Structure used for holding animals in livestock rearing system that does not allow animals to graze on pastures.
28. **Straight fertiliser** – A fertiliser that contains only one of the primary macro-nutrients (NPK).
29. **Compound fertiliser** – A fertilieer that contains two more of the primary macronutrients (NPK).
30. **Complete fertiliser** – A fertiliser that contains all the three primary macro-nutrients (NPK).
31. **Organic manures** – Organic substances added to improve soil fertilisers and other soil physical properties.
32. **Nitrogenous fertilisers** – A fertiliser that contains nitrogen as the only primary macronutrient.
33. **Phosphatic fertiliser** – A fertiliser that contains phosphorus as the only micro-nutrient.

Suggested answers to revision questions (refer to Students' Book pages 25– 26)

1. The ability of soil to provide crops with the required nutrients in their proper proportions for sustained high production.
2. Characteristics of fertile soils
   (i) Good depth – Deep soils give plant roots greater volume to obtain plant nutrients and provide strong anchorage.

(ii) Well drained – A well drained soil is properly aerated thus promoting healthy root development. Well aerated soils also allow for the respiration of living organisms and reduces the build up of carbon(IV)oxide to toxic levels.

(iii) Good water holding capacity – A fertile soil will ensure that enough water is retained for plant use.

(iv) Adequate nutrient supply – A fertile soil should supply the nutrients needed by plants in the correct amount and in the form that is available to the plants, for example, NO_3 for nitrogen, P_2O_5 for phosphorus and K_2O_5 for potassium.

(v) Correct soil pH – Different soils have different soil pH requirements. Soil pH affect the availability of certain plant nutrients. Most crops will do well at pH around neutrality.

(vi) Free from excessive infestation of soil borne pests and diseases.

(vii) Not saline – Fertile soils should not have excess accumulation of salts. Excess salts in the soil lead to water stress in plants.

3. (i) Availability of water.
   (ii) Water drainage.
   (iii) Activity of soil micro-organisms.

4. (a) The degree of acidity or alkalinity of a soil solution.
   (b) A soil sample is taken from the field through the soil sampling procedure. A soil solution is made from the sample by adding water to the soil in a test tube followed by vigorous shaking. The soil water mixture is allowed to settle. The soil particles decent leaving a soil solution at the top. The electrode of the pH meter are then placed in the water solution and then meter readings are taken. The reading is the pH value for that particular soil.

5. (i) Clostridium.
   (ii) Azotobacter.

6. (a) Lack of nitrogen, potassium and sulphur.
   (b) Lack of phosphorus and sulphur
   (c) Lack of calcium

7. (i) Soil pH – The degree of acidity or alkalinity of the soil influence the availability of various nutrients in the soil in some nutrients are only available within range of soil pH.
   (ii) Organic matter content – Organic matter breakdown to release various nutrients into the soil.
   (iii) Soil texture – This affect the amount of water and air in the soil. Coarse texture soils have a lot of air and little amount of water while fine textured soils tend to hold a lot of water but little amount of air.
   (iv) Climate – Climatic factors such as temperatures and rainfall affects availability of nutrients in the soil.
   (v) Leaching – The washing down of nutrients from the top horizons to the lower horizons make the nutrient sun available in the soil.

(vi) Soil compaction – Compaction of the soil reduces air spaces leading to poor respiration by soil living organisms such as soil micro-organisms.

(vii) Crop removal – Continuous cropping results in a lot of nutrients being removed from the soil through harvesting.

(viii) Use of sensitive crops – Different crops have different nutrients requirement. Continuous growing of certain crops make the soil deficient in some nutrients.

(ix) Nutrients interactions in the soil – The presence of some nutrients in the soil hinder the availability of others.

8. (a) Manure prepared from human waste.

(b) (i) Heap method

(ii) Pit method.

9. (a) It is manure prepared from human excreta.

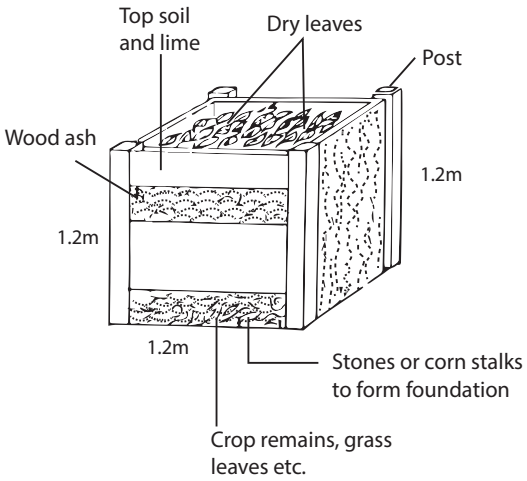


Fig. 1.1 Compost heap

10. (i) Highly vegetative or leafy.

(ii) Fast growth rate.

(iii) High nitrogen content.

(iv) Ability to rot or decompose quickly.

(v) Hardy/able to grow in poor soil conditions.

11. (i) **Beans**: They are highly suitable for use in the production of green manure. This is because they are highly vegetative, have a fast growth rate, have a high nitrogen content and decompose easily. However, they are rarely used for the production of green manure since they are mostly grown for food.

(ii) **Napier grass:** They are not used for green manure. This is because they

do not decompose easily due to their high fibre content. They are also low in nitrogen content.

(iii) **Desmodium:** They are highly suitable for use in the production of green manure. This is because they are highly vegetative, have a fast growth rate, have high nitrogen content, decompose easily and are not grown as food for human beings. They are usually grown as livestock fodder and are therefore used for green manure production.

12. (i) Leaching – The washing down of nutrients from the top horizons to lower horizons of the soil profile by water.

(ii) Volatilisation – Escape of nutrients into the atmosphere in gaseous form.

13. (i) Well rotten manure – It acts as food for micro-organisms in the compost.

(ii) Garden soil – Source of micro-organisms to decompose the organic matter include in the compost.

(iii) Wood ash – Adds essential mineral elements such as potassium, sodium, calcium, sulphur, magnesium to the compost/enrich the compost with essential elements.

14. (i) Straight fertilisers – A fertiliser containing only one of the primary macro nutrients (NPK).

(ii) Compound fertiliser – A fertiliser containing two or more of the three primary macronutrients NPK.

(iii) Complete fertiliser – A fertiliser containing all the three primary macro-nutrients; Nitrogen(N), phosphorus (P_2O_5) and potassium (K_2O).

15. (i) Urea.

- It contain 45–46% nitrogen.
- It has a white granular appearance.
- It is highly susceptible to volatilisation and soluble in water.
- It has a high scorching effect due to the ammonium content.

(ii) DAP

- It contains 18% nitrogen and 46% phosphorus.
- It is moderately acidic.
- It has grey granular appearance.

Topic Area: Crop and Mushroom Production and Processing

Unit 2: Mushrooms

Number of periods: 4

Key Unit Competence: Learners should be able to conduct successfully mushroom tubes preparation and mushrooms cultivation.

2.1 Learning Objectives

(a) Knowledge and Understanding

(i) Define mushroom.
(ii) Explain mushroom propagation process.
(iii) Classify mushroom types.
(iv) Factors affecting mushroom tubes making.
(v) Factors affecting mushroom cultivation.
(vi) Explain mushroom cultivation technique.

(b) Skills

(i) Manufacture mushroom tubes (mushroom substratum making, inoculation mycelium).
(ii) Apply mushroom cultivation technique.

(c) Attitudes and values

(i) Observe attentively mycelium and mushroom development.
(ii) Show positive attitude in group discussion and take account of students' point of view.
(iii) Respect the protocol of making mushroom tubes and mushrooms cultivation.

2.2 Content Students' Book page 27 – 43

(i) Definition of mushroom.
(ii) Propagation of mushroom.
(iii) Types of mushrooms (edible and non-edible mushrooms).
(iv) Production of mushroom tubes (compost sterilisation, drying, crushing, packing up/bagging, mycelium sowing).

Answers to questions in table 2.1: Inoculation process in the students' book page 37–38

Stage	Material required	Procedure
(a) Chopping straw	• Straw • Machete	The straw is cut into small pieces using machete.
(b) Washing straw	• Water and straw	The straw is washed by use of water.
(c) Packing straw in polythene tubes	• Polythene tube and substrate	Materials are packed in polythene tubes to form mushroom tube on which mushrooms are grown.
(d) Sterilisation	• Chemicals • Source of heat	Materials are steamed for 3 hours to kill fungi. Chemicals such as isopropyl alcohol and hydrogen peroxide may also be used.
(e) Spawning substrate	• Mushroom. • Spores • Sterilising • Culture	Involves sprinking of mushroom spores on the sterilising culture which then is left to establish under controlled conditions.

(v) Mushroom cultivation technique (arranging mushroom tubes in a nursery bed, shading, watering, weeding).

2.3 Learning Activities

1. Research on internet or school library and discuss in groups on mushroom definition, mushroom propagation, types of mushroom, mushroom tube making and mushroom cultivation.
2. Field visit in co-operative or household growing mushrooms or making mushroom tubes to observe and find out mushroom tubes production and cultivation works, deduce factors affecting mushroom tube making, mushroom cropping and imitate in school nursery mushroom tube making and practise mushroom cultivation.
3. Problem solving in choosing the type of compost to inoculate with mycelium when making mushroom tubes.

2.4 Link to other Subjects

Biology:

Classification of living organisms or biodiversity

Learners to use their knowledge of members of the kingdom fungi.

2.5 Assessment Criteria

Ability to conduct mushroom tubes preparation and cultivation.

The learners should be able to make mushroom tubes and conduct mushroom cultivation.

2.6 Material and Resources

- Mushroom seed making of household or co-operatives, mushroom farming households or co-operatives or schools.
- Mushroom tubes
- Compost bags
- Hoe
- Computer room with internet connection
- Library
- Pictures and photographs of mushrooms
- Mushroom spores

2.7 Suggested Low Cost or No Cost Materials

(a) Ask learners to bring materials such as polythene bags, mushroom making substrates such as maize cobs, banana fibre from home.

(b) Borrow mushroom seeds or spawn from co-operatives and or neighbouring schools with surplus.

2.8 Methods of Teaching

Content	**Method(s)**
1. Definition of mushroom	**Discussion**: Teacher to instruct the learners to find out the meaning of mushrooms from the references provided. The learners discuss and present their findings. The teacher then gives a final conclusion as the learners take summary notes.
2. Types of mushrooms	**Discussion**: The teacher to provide pictures of mushrooms, library books and internet facilities and asks the learners to find out the types of mushrooms. The learners discuss and present their finds to the class. The teacher then gives a final conclusion.
3. Propagation of mushrooms	**Discussion**: Teacher instructs the learners to find out the process of propagation of mushrooms from internet, library books and textbooks. The teacher then facilitates the discussion of their findings and allows the learners time to present their findings. The teacher gives a final conclusion.

4. Production of mushroom tubes (compost sterilisation, drying, crushing, packing up/ bagging, mycelium sowing)	**Supervised practice/Activity**: Teacher to provide materials for making mushroom tubes and assists the learners to make mushroom tubes. The learners carry out the mushroom tube production, record and discuss their observations. They then present their findings to the class. The teacher then makes the final conclusion.
5. Factors affecting mushrooms tube making	**Field visit**: The teacher prepares quetionnnaires (see Annex 5) and takes the learners for a visit to a mushroom farm to observe factors affecting mushrooms tube making. The learners discuss and present their findings to the class. The teacher then gives a final conclusion.
6. Mushroom cultivation technique (arranging mushroom tubes in a nursery bed, shading, watering, weeding)	**Supervised practice/Activity**: The teacher to supervise learners as they cultivate mushrooms in the nurseries given. The teacher supervises, as the learners discuss and then present their findings in class. The teacher then makes a final conclusion.
7. Factors affecting mushroom cultivation	**Discussion**: The teacher to provide references where the learners can find out the factors affecting mushroom cultivation. Learners to discuss and present their findings. The teacher then gives a final conclusion.

2.9 Suggested teaching and learning activities and exercises to support delivery of content and development of students' competences

1. Field visit to mushroom seed making households or co-operative or a mushroom farm to observe mushroom tube making and mushroom cultivation.
2. Observing and identifying types of mushrooms using photographs and internet.
3. Use of resource person to guide the learners on the process of mushroom tube making.

4. Field visit to a mushroom production farm to observe and participate in mushroom cultivation techniques such as weeding, watering and harvesting.

2.10 Cross-cutting issues to be integrated in the teaching and learning activities

- Sensitise learners on the contribution of mushrooms to the economy of Rwanda.
- Sensitise learners on the danger of consuming non-edible mushrooms.
- Enlighten the learners on other uses of mushrooms apart from providing food such as medicine.
- Create awareness of dangers of premarital sex HIV/AIDS, drugs, crimes in the farming communities.

2.11 Suggestions for accommodating special education needs (SEN)

(a) Visual impairment
- Ask others to assist in colour identification.
- Use large print in instruction sheets questionnaires and assessments papers.
- Allow them to sit near the chalkboard while in class.

(b) Hearing impairment
- Be audible enough to learners.
- Allow learners to stay close to teacher.

(c) Physical impairments
- Pair them with other able-bodied learners to be assisted.
- Organise activity to be close to prevent too much movement.

(d) Gifted learners
- Give them extra questions.
- Place them in different working groups to assist other learners.

(e) Slow learners
- Take them slowly through the learning process.
- Take time when going through the procedures.
- Ask fast learners to assist them.

2.12 Formative Evaluation

1. Define the term mushroom.
2. What are the types of commercial mushrooms produced in Rwanda?
3. What are some of the commercial mushroom types cultivated in your home area?
4. Give examples of materials used as mushroom substrates.
5. What is the importance of mixing substrates with supplements?
6. What is the importance of sterilising mushroom substrate?
7. State two methods of arranging the mushroom tubes in a mushroom house.
8. Name activities observed during mushroom cultivation.

2.13 Additional Content to the Teacher

Advantages of mushroom production:

- Uses less land.

- Fast growth.
- Uses agricultural plants wastes.
- Does not use fertilisers.
- Growing substrate can be used as compost manure.

Procedure of making mushroom tubes

- Select a clean working area.
- Weigh the required amount of growing materials.
- Spread the growing materials on the preparation table.
- Mix supplements with substrate with the following specification 1% lime, 1% soya meal and 1% molasses mix thoroughly.
- Squeeze the materials to dry.
- Fill the mushroom tubes and tie at the end.
- Sterilise the substrate by heating in a drum with water.
- Cool overnight.
- Spread the spawn over the mycelium.
- Cover with a polythene sheet.

Mushroom cultivation technique

- Arrange the mushrooms in the mushroom house or bed.
- Water the mushrooms twice a day.
- Maintain the temperature at about 20^{o}C.
- Maintain humidity at 90%–95%.

2.14 Notes to the Teacher

(i) Prepare assessment sheets.
(ii) Collect materials for practical activity before the exercise.
(iii) Carry demonstration before practical activity.
(iv) Prepare practical sheets.
(v) Carry out a reconnaissance tour to the site before trip.
(vi) Prepare questionnaires before a trip.
(vii) Prepare the students a day before the trip.
(viii) Allow the learners adequate time to give reports of their findings after a practical activity.
(ix) Give summary notes to the learners after a practical activity.
(x) Keep learners' progressive records and give feedback to the parents.

2.15 Additional Remmedial Consolidation and Extension Activities

High order questions for fast learners

1. Use high order questions to stimulate the learners' imagination and thinking; examples of these questions include:

    1. Describe the process of sterilisation in mushroom production.

The substrate or compost materials are steamed at 70–80 °C for at least 3–4 hours then left to cool overnight. Chemicals such as isopropyl alcohol and hydrogen peroxide are mixed into the materials. These methods help to kill competitive micro-organisms such as bacteria.

2. Explain the importance of maintaining light and humidity in mushroom cultivation.
   (i) *Regular strong reading light in the cultivation house produces mushrooms with strong caps and stalks.*
   (ii) *The humidity should be maintained at 90%–95% to prevent the production of mushrooms with scaly skins and to control the fungal disease called dry bubble.*
3. Carry out the activities involved in mycelium sowing.
   (i) *Sterilise the preparation table and spread the substance on it.*
   (ii) *Spread the mushroom spawn on the substrate evenly and cover.*
   (iii) *Control the temperature and humidity at 20 °C and 90–95% humidity.*
   (iv) *Transfer the substrate with white mycelium to the mushroom tubes.*

Low order questions for average learners

1. Interpret the meaning of substrate.
   A substrate means a constituent of grass chaff, saw dust, straw, sugarcane bargasse, dry groundnut waste, banana fibres, dry banana leaves, straws, maize cobs and stalks, which are used to grow mushroom and provide them with carbohydrates.

2. Analyse the supplements used in mushroom cultivation.
   - *Lime molasses – Provide sugars for giving energy to the growing mushrooms.*
   - *Animal concentrates – Provide proteins from animal origin.*
   - *Soya beans meal – Provide proteins from plant origin.*
3. Differentiate between mushroom spawns and mycelium.
   Spawns are minute mushroom seeds which appear like powder and spread over a sterile culture substrate during inoculation while mycelium *are fungal threads spread over the substrate and which later sprount to mushrooms.*

2.16 Summative Evaluation

1. What is a mushroom?
2. Below are photographs of mushrooms. Study them carefully and answer the questions that follow.

Fig. 2.1(a)

Fig. 2.1(b)

(a) Name the mushrooms A and B in the photograph.
(b) Which of the mushroom A and B in the photograph is edible and which one is poisonous.

3. Analyse the following materials to show their importance in mushroom tube making.
   (a) Straws
   (b) Containers
   (c) Soya meal
   (d) Lime
4. Explain the importance of the following activities in mushroom tube making:
   (a) Sterilisation of straws
   (b) Drying of the straw before inoculation
   (c) Spreading mushroom spawn over the sterilised mushroom substrate during planting.

2.17 Additional Questions

1. Explain the importance of maintaining a clean and sterile mushroom house and mycelium.
   To prevent the growth of competitive micro-organisms such as bacteria and to control diseases and pests of mushrooms.
2. Analyse two diseases that affect mushrooms during cultivation.
   (i) **Dry bubble** *disease is a fungal disease which is characterised by brown spots on the mushroom caps.*
   (ii) **Wet bubble** *disease is a fungal disease which is characterised by malformed caps and stalks. The diseased mushrooms are covered with white mycelium on the cap and produce foul smell.*

3. Give three containers that are used to pack in mushroom substrate.
   (i) *Gunny bags*
   (ii) *Crates*
   (iii) *Wooden racks*
   (iv) *Polythene bags*

2.18 Suggestions for Assignment

Visit a group growing mushroom neighbouring your school and find out:

- The types of mushroom grown.
- The materials used for growing mushrooms.
- The steps involved in making mushroom tubes.
- The source of mushroom spawn for the group.
- The mushroom cultivation process.

2.19 Support for Developing Positive Skills, Values and Attitudes

- Learners learn to co-operate with one another and appreciate other member's suggestions and proposal.
- Observe attentively mycelium and mushroom development.
- Show respects for each other in group discussion and take account of colleague's point of view.
- Follow the procedure of making mushroom tubes and mushroom cultivation accurately.
- Observe high standards of hygiene when making mushroom tubes.
- Learners to appreciate problem solving as they collect substrate, make mushroom tubes and mushroom cultivation.

2.20 Answers to Formative Evaluation Questions

1. A mushroom is a fruity body of a macro-fungus.
2. (i) Button mushrooms
   (ii) Oyster mushrooms
   (iii) Shiitake mushrooms
   (iv) Chinese mushrooms
3. (i) Button mushrooms
   (ii) Oyster mushrooms
4. (i) Straw
   (ii) Maize stalk
   (iii) Banana fibre
   (iv) Bagasse
   (v) Maize cob
5. To provide nutrients.
6. To kill competing fungi and harmful bacteria.
7. (i) Linear method
   (ii) Hanging from the roof
8. (i) Arranging mushroom tubes in a nursery bed
   (ii) Shading

(iii) Watering
(iv) Weeding

2.21 Suggested answers to summative evaluation questions

1. A mushroom is a fruity body of a macro-fungus
2. (a) A – Chinese mushroom
   B – *Chlorophyllum molybdites* mushroom
   (b) Edible mushroom–Chinese mushroom
   Poisonous mushroom–*Chlorophyllum molybdites*
3. (a) Straws – Provides energy
   (b) Containers – Used to make mushroom tubes
   (c) Soya meal – Provides protein
   (d) Lime – Provides calcium/minerals
4. (a) To kill competitive micro-organisms such as bacteria and any unwanted spores of other fungi.
   (b) Prevents growth of unwanted fungi and bacteria.
   (c) To prevent colonisation of the subtrate with other competitive fungi, bacteria and pests such as termites.

Key Terms Used (page 43 of the Students' Book 2)

1. **Mycelium** – These are fungal threads that spread over and in the substrate which later sprout to mushroom.
2. **Spores** – These are minute mushroom seeds that appear like powder. They are spread over a sterile culture during inoculation.
3. **Compost or substrate** – This is a mixture of straw, sawdust, lime water, wheat and soya where the spores are inoculated after sterilisation.
4. **Nursery bed** – This is the space used to grow mushrooms where the temperature, humidity, light and oxygen concentration are controlled. They can also be referred to as shelves.
5. **Mushroom** – This is a fruity body of a macro-fungus.
6. **Mushroom tube –** is a sack, bag or crate containing mushroom growing materials.
7. **Bagging** – This is the process of putting mushroom growing substrate in a bag or tray.
8. **Composite sterilisation** – Is the process of killing germs and other unwanted micro-organisms in a substrate using heat, steam or chemicals.
9. **Spawning** – This is the introduction of pre-sown substrate mycelium known as spawn into substrate by sprinkling.
10. **Inoculation** – Used similarly as spawning.

Answers to Revision Questions (Students' Book pages 44–45)

1. A mushroom is a fruity body of a macro-fungus.
2. (a) Edible mushroom
   (b) Non-edible mushroom.

3. Button mushrooms
   Oyster mushrooms
   Shiitake mushrooms
   Chinese mushrooms
4. Oyster mushroom
5. (c) Allowing a mushroom spawn to colonise a substrate by providing the optimum condition for mushroom growth.
6. Banana fibres, straw/sawdust, sugarcane bagasse
7. (i) Gathering substrate – Materials such as grass, saw dust, sugarcane bagasse are used.
   (ii) Washing the substrate – To remove any harmful substances.
   (iii) Mixing substrate with supplement – To provide nutrients for the growth of mushrooms.
   (iv) Drying the mixed substrate – To prevent the growth of unwanted fungi and bacteria.
   (v) Packing of substrate – Packed in bags when it is semi-dried.
   (vi) Sterilisation – To kill unwanted spores done through steaming or use of chemicals.
   (vii) Mycelium sowing – Mushroom spawn is spread on the substrate and covered and then transferred to mushroom tubes when white mycelium appears.
   (viii) Arranging tubes in the nursery – This is a room with controlled condition where mushrooms will grow from the tubes.
   (ix) Maintenance – Shading, watering and weeding is carried.
   (x) Harvesting – Mushrooms are fully grown four days after fruiting caps appear and are picked by twisting the stalk.
8. (i) To prevent the growth of unwanted fungi and bacteria.
   (ii) To ensure that the mushroom is grown in clean non-competitive environment.
9. (i) Availability of mushroom substrate.
   (ii) Cleanliness of the mushroom substrate.
   (iii) Method of sterilisation.
   (iv) Type of substrate packing materials.
   (v) Temperature and humidity of the mushroom growing house and substrate.
10. (i) Arranging of the mushroom tubes in the nursery bed.
    (ii) Watering and weeding are carried out.
    (iii) Harvesting is done when fruiting caps are mature.
11. To prevent the entry of other unwanted fungi and bacterial in the substrate.
12. To maintain high humidity.
13. Twisting and removing the mushroom stalk from the substrate.
14. Little water and humidity causes slow growth of the mushrooms and lead to cracking of the fruit caps. Too much water results in rotting of the substrate and also encourages growth of unwanted bacterial and fungi.
15. B (i) and (iv)

Unit 3: Fruits

Number of periods: 20

Key Unit Competence: Learners should be able to conduct appropriate propagation methods of fruits, management of fruit trees, processing and preservation of fruits.

3.1 Learning Objectives

(a) Knowledge and Understanding

(i) Define fruit tree.
(ii) Discuss the importance of fruit trees.
(iii) Give examples of fruit trees in Rwanda.
(iv) Discuss the method of propagation of fruit trees.
(v) Describe grafting techniques on fruit trees.
(vi) Carry out orchard management practices.
(vii) Define fruit processing and preservation.
(viii) Discuss on importance of fruits processing.
(ix) Explain the aims of post-harvest technologies.
(x) Discuss on preservation techniques of fruits.
(xi) Discuss on fruits that may be processed.
(xii) Describe steps involved in processing of fruits.

(b) Skills

(i) Explore cultivated fruits and view their importance.
(ii) Recognise fruits cultivated in Rwanda.
(iii) Recognise the propagation methods of fruit trees.
(iv) Perform grafting of fruit trees.
(v) Maintain efficiently fruit trees.
(vi) Observe processed fruits and taste preserved ones.
(vii) Recognise the aims of post-harvest technologies.
(viii) Perform fruits preservation techniques.
(ix) Perceive some fruits which require processing.
(x) Observe and differentiate steps involved in fruits processing up to final product.

(c) Attitudes and values

(i) Appraise the importance of fruit trees.
(ii) Answer freely to get fruits cultivated in Rwanda.
(iii) Co-operate with colleagues while discussing in groups.
(iv) Be careful and cautious while doing grafting.
(v) Show concern while doing site selection, planting, watering, pruning, pest and diseases control of fruits.

(vi) Be attentive in observing fruits preservation and processing.
(vii) Be aware of the importance of fruits preservation.
(viii) Participate willingly in discussion on aims of post-harvest technologies.
(ix) Show concern while choosing preservation technique in fruits.
(x) Contribute in discussions on fruits to be processed.
(xi) Pay attention while observing and describing steps involved in fruits processing.

3.2 Content Students' Book page 46 – 96

(i) Fruit trees definition.
(ii) Importance of fruits.
(iii) Some fruits cultivated in Rwanda (avocados, papaya, mangoes, tamarillo, citrus, strawberries passion fruits, pineapples).

Answers to questions in table 3.1: Cultivated fruit trees in Rwanda and their fruits on pages 49 – 51

Fruit tree	**Name of tree**
(a) Mango tree	Mango fruits
(b) Avocado tree	Avocado fruits
(c) Papaya tree	Papaya fruits
(d) Tamarillo tree	Tamarillo fruits
(e) Citrus fruit tree	Citrus fruits
(f) Pineapple plant	Pineapple fruits
(g) Passion fruit vine	Passion fruits
(h) Strawberry vine	Strawberries
(i) Banana tree	Banana fruits

(iv) Propagation methods of fruits (layering, grafting, seed propagation, stem cuttings).
(v) Grafting of avocado fruit and citrus fruit trees.

Answers to the activity on page 58 of the Students' Book
Correct order of the steps

1 and 3 – Matching "tongue"cut on both sides and rootstock
4 – Scion wood cut placed on the rootstock cut
2 – Healed whip graft

(vi) Orchard management practice (site selection, planting, watering, pruning, pest and diseases control).

Answers to the activity on pages 72 of the Students' Book

Correct order of steps in transplanting fruit trees

Fig.3.20 (f) – dig a hole

Fig.3.20 (b) – mix top soil with manure and return the mixture to the hole

Fig.3.20 (d) – open and remove the seedling container

Fig.3.20 (a) – place the seedling with soil into the planting hole

Fig.3.20 (e) – cover the roots with soil

Fig.3.20 (c) – firm the soil around the seedling

(vii) Definition of processing and preservation of fruits.

Answers to the activity on page 76 Students' Book

Identification of pests illustrated

(i) Army worm
(ii) Aphid
(iii) Leaf hopper
(iv) Leaf skeletonizer
(v) Bird

Answers to the activity on page 76 of the Students' Book

Identification of the sap suckers:

(i) Aphids
(ii) Thrips
(iii) Spider mite
(iv) Scales

Identification of the stems and fruits bores (**page 76 – 77 of the Students' Book**)

(i) Fruit flies
(ii) False candling moth larvae
(iii) Banana weevil
(viii) Importance of processing and preservation of fruit.
(ix) Objectives of applying post-harvest technologies (maintain quality flavour, appearance, texture and nutritive value; to protect food safety, reduce losses both physical and market value).
(x) Preservation techniques of fruits (refrigeration, freezing, sugaring, canning, curing, fermentation).
(xi) Some fruits to be processed (strawberries, passion fruits, papaya, pineapples, citrus, tamarillo).
(xii) Products processed from fruits (jam, juice, marmalade) and steps involved in their processing.

3.3 Learning Activities

When learning the unit, the learners should carry out the following activities:

(i) Field visit to explore cultivated fruits and deduce their definition and importance.
(ii) Group discussion to enumerate cultivated fruits in Rwanda.
(iii) Entering the search engines or library and search the different methods of propagation and discussion in groups and make presentations.
(iv) Field work in a fruit nursery to observe the demonstration of grafting an avocado and citrus fruits and apply it themselves.
(v) Watch video of pruning of fruit trees and discuss in groups how, why and when to prune fruits trees.
(vi) Practical work on fruit trees pruning by learners.
(vii) Trip to areas where fruits are processed and preserved to discuss on definition and their importance after observing and testing processed fruits.
(viii) Entering in search engine or library after group discussions to find out the importance of applying post-harvest technologies.
(ix) Entering in search engines or school library to find out different fruits preservation technologies and apply them to fruits availed by the teacher in groups.
(x) Trip to an orchard to observe and discuss on fruits that may be processed.

3.4 Links to other Subjects

The following subjects are linked to this unit and will provide information and more knowledge on the following areas:

1. Biology – Provide more information on plant and sexual reproduction.
2. Home science – Provide information on nutrition and importance of fruits in Human Health
3. Chemistry – Provide more information on organic chemistry to understand more about fruits preservation and the use of fertilisers.

3.5 Assessment Criteria

1. Ability to conduct propagation of fruit trees by respecting/applying all the steps of grafting.
2. Ability to carry out management activities of orchard by removing old branches, leaves and dead parts; applying the required amount of water, fertilisers and chemical (pesticides).
3. Ability to preserve fruits by choosing required techniques according to their rate of damaging and added value.

3.6 Material/Resources

For this unit, the following materials/resources will be required:

- Fruit trees growing in an orchard or in school compound or the neighbouring farm.
- School library for reference books, magazines and charts.

- Video of citrus pruning and avocado pruning.
- Video on fruits processing and different preservation techniques.
- Material and tools for pruning and grafting such as pruning shears, secateurs, grafting knife, tapes and grafting wax as required in the students' book.
- Young fruit tree seedlings growing in the nursery.
- Different types of fruits to be processed and preserved, such as strawberries, passion fruits, papaya, pineapples, citrus and tamarillo. The teacher is advised to use the fruits in season.
- Packing and storage materials for the processed fruits such as cans and jars.
- Tools and equipment for processing fruits into different products. For example, blenders and juicers, saucepans, heating source or cooker, refrigerators (where available) and sugar.
- Computer lab with internet.

3.7 Suggested Low Cost or No Cost Materials

(a) Ask the learners to bring items from home for them to share, such as saucepans, blenders, fruits in season and hand tools.
(b) Share resources with neighbouring school such as land and tools.
(c) Request for computers from the administration and return after the lessons.

3.8 Methods of Teaching

This unit requires that the teacher uses a variety of teaching methods that are suitable to achieve the required competences. This depends on the knowledge and understanding, skills, attitude and values to acquire the necessary learning outcomes.

In this unit, the following methods of teaching can be used:

Content	Method(s)
1. Friut trees definition	**Discussion**: The teacher asks the learners to find out the meaning of fruits from the internet and library books as the teacher supervises them. Learners discuss and record their findings then present their findings to the class. Teacher makes a summary for the class.
2. Importance of fruits	**Field trip**: Teacher provides a questionnaire as shown in Annex 6 to the learners and instructs them to explore and identify types of fruits growing in the orchard. Learners observe and identify fruits growing, take notes and present their findings to class. Teacher gives a summary of the lesson.

3. Some fruits cultivated in Rwanda	**Discussion**: Teacher to instruct the learners to find out the fruits cultivated in Rwanda from the internet and library books. Learners discuss and record their findings. The group leaders to present their findings to the class. Teacher to make conclusion by correcting any misconceptions.
4. Propagation methods of fruits	**Discussion**: Teacher to instruct the learners to search on the methods of fruit propagation from the library books and internet. Learners to research on the topics and give their opinion in groups. Leaders of the groups present their findings to the class. Teacher to make conclusion and summarise the lesson.
5. Grafting of avocado and citrus fruit trees.	(i) **Field trip**: Teacher to provide a questionnaire. See annex 7 and organise for a trip to a farm for the learners to observe grafting of avocado and citrus fruit trees. The learners to make observation of grafting procudure, discuss and present to the class their findings then carry out grafting under the supervised activity. (ii) **Supervised activity**: Teacher provide matrerials for grafting avocado and citrus fruits. Learners to carry out grafting in avocado and citrus fruits as the teacher supervises them. Record and present their findings to the class. Teacher to summarise and conclude the activity.

6. Orchard management practices	(i) **Field visit**: Teacher organises a field trip and prepares a questionnaire during the field visit as shown in Annex 8. Teacher then instructs the learners to make observations on factors to consider insiting an orchard such as slope of the land, drainage and soil type. Learners discuss and record the observations, present their findings to the class. Teacher gives summary notes and makes a final conclusion. (ii) **Supervised activity**: Teacher provides materials for land preparation and instructs the learners to carry out land demarcation, clearing vegetation, primary and secondary cultivation. Learners carry out land preparation, discuss and record their findings, present their findings to the class. Teacher then give summary notes and makes a final conclusion. (iii) **Supervised activity**: Teacher provides materials for laying out an orchard and a practical site for laying out an orchard. Teacher then instructs the learners to carry out the activity of laying out an orchard using the materials provided. Learners carry out the activity, discuss and record their findings, present their findings to the class. Teacher gives summary notes and makes a final conclusion of the lesson.

	(iv) **Supervised activity**: Teacher provides the materials for preparation of planting holes and instructs the learners to prepare planting holes according to the layout already made. Learners prepare planting holes, discuss and record their findings then present their findings to the class. Teacher gives summary notes and then makes a final conclusion. (v) **Supervised activity**: The teacher provides materials for transplanting fruit trees seedlings and instructs the learners to carry out the transplanting. Learners carry out transplanting of tree seedlings, discuss and record their findings, present their findings to the class. Teacher gives summary notes and makes a final conclusion. (vi) **Supervised activity**: Teacher provides materials for watering fruit tree seedlings and instructs the learners to water tree seedlings. Learners water the fruit trees, discuss and record their findings. Learners present their findings to the class. The teacher gives summary notes and then concludes the lesson. (vii) **Discussion**: The teacher instructs the learners to identify pests and diseases from the various references provided and to find out their control methods from the internet and library books. Learners carry out the activity, discuss and record their findings and then present their findings to the class. Teacher gives summary notes and concludes the lesson.

	(viii) **Discussion**: Teacher prepares for a video show on pruning fruit trees and instructs the learners to identify different methods of pruning fruit trees together with reasons and timing for pruning. Learners watch the video, discuss and record their findings and then present their findings to the class. The teacher gives summary notes and makes the final conclusion. (ix) **Supervised activity**: The teacher provides tools for carrying out pruning of citrus fruit trees. Teacher instructs learners to carry out pruning of citrus fruit trees using the tools provided. Learners carry out the activity, discuss and record their findings. Learners present their findings to the class. Teacher gives summary notes then makes a final conclusion of the lesson.
7. Definition of processing and preservations of fruits	**Field visit**: Teacher provides questionnaire and asks the learners to make observations on the processing and preservation of fruits in the plant or factory visited. The teacher supervises the learners and maintains discipline. Learners discuss their findings and present to the class. The teacher summarises and concludes the lesson.
8. Importance of processing and preservation of fruits	**Discussion**: Teacher asks the learners to find out the importance of processing and preservation of fruits from books, magazines and search engines and assists the learners with difficulties. Learners to express themselves by giving their opinion on their findings, record and give presentations to the class. Teacher to summarise and conclude the lessson.

9. Objectives of applying post-harvest technologies	**Discussion**: The teacher asks the learners to use search engines, textbook and magazines to find out the importance of applying post-harvest technologies on fruits. They then give opinion of their findings, make a report and the group leader to present to class. Teacher to supervise the group discussions and presentations then give summary and conclusion of the lesson.
10. Preservation techniques of fruits	**Discussion:**The teacher asks the learners to find out from the library books and internet different fruit preservation techniques, record and present their findings to the class. Teacher to supervise the discussion and presentation and then concludes the lesson. **Supervised activity:** Teacher instructs the learners to watch a video show on different fruit preservation techniques. Teacher supervises the learners in groups and assists those in difficulties. Learners to watch the video, discuss in groups and present their findings. Teacher to conclude the lesson.
11. Some fruits to be processed	**Field visit:** Teacher to provide questionnaire (see Annex 10), give instructions to the learners to observe and identify the various fruits being processed in the orchard. The teacher to control the learners and maintain discipline. Learners to make observations, discuss in groups and present their findings. Teacher to conclude the lesson.
12. Products processed from fruits	**Discussion**: Learners to find out the products processed from different fruits grown in Rwanda, prepare report and present to the class. Teacher to control the discussion and correct any wrong information, give summary notes and conclude the lesson.

13. Group Activity	**Supervised activity**: The teacher divides learners into groups and provides materials for the preparation of different fruit products to all the groups by moving from group to group. Learners carry out the activities, as the teacher supervises, discuss, record their findings and present them to the class. The teacher concludes and gives summary notes.

3.9 Suggested teaching and learning activities and exercises to support delivery of content and development of student competences

1. Class discussion on propagation management, processing and preservation of fruits.
2. Group discussion on propagation, management, processing and preservation of fruits.
3. Learners to share their experiences on propagation, management, processing and preservation of fruits.
4. Watching relevant video clips and documentaries, reading, magazines, library books, newspaper cuttings and observing photographs on propagation management, processing and preservation of fruits.
5. Attending to field visits in neighbouring farms, agricultural shows, field days and factory visits to see propagation, management, processing and preservation of fruits.
6. Carrying out practical activities in groups observing demonstrations on procedural practices in propagation, management, processing and preservation of fruits.
7. Question and answer method during discussion on propagation, management, processing and preservation of fruits.
8. Report writing and preservation to the class after group discussion on propagation, management, processing and preservation of fruits.

3.10 Cross-cutting issues to be integrated in the teaching and learning activities

When teaching this unit, the teacher should address the following cross-cutting issues:

(i) Environment and sustainability.
(ii) Standardisation culture – Standards as a pillar of economic development.
(iii) Inclusive education – Engage all the learners.
(iv) Peace and values education – Working together helps to avoid conflicts.

3.11 Suggestions for accommodating special education need (SEN)

When teaching this unit, learners with special needs can be assisted as follows:

(a) Sensory impairment (visual)
- Use large prints instructions sheets, questionnaires and in assessment papers.
- Allow them to sit near the chalkboard when class.
- Use large legible letters.
- Pair them with learners with good vision to be assisting them with practical activities.

(b) Sensory impairment (hearing)
- Be audible enough to the learners and ask whether if they heard.
- Allow them to sit close to the teacher.

(c) Motor impairment (movement)
- Pair them with other learners to be assisted to carry tools or equipment that may be required.
- Where possible, practical activities should be carried out in one place to avoid a lot of movement.

(d) Gifted or talented learners:
- Assign them extra duties.
- Encourage them to assist the slow learners.
- Distribute them to different groups when assigning working groups.

(e) Slow learners
- Take time when going through the procedures to use.
- Assist them when carrying out a task.
- Arrange for remedial teaching.

3.12 Formative Evaluation

The teacher to use the following methods of evaluating the competences acquired by the learners in propagation, management, processing and preservation of fruits.
- Use of assignments given after every activity.
- Oral questions.
- Continuous assessment test.

The following questions will guide the teacher in formative evaluation:
1. What is a fruit?
2. State four importance of fruits.
3. Name six types of fruits grown in Rwanda.
4. List three methods of propagating fruit trees.
5. What is grafting?
6. List three methods of watering fruits trees.
7. What is the importance of fruit processing and preservation?
8. List four products produced from fruits.
9. State four methods of preservation in fruits.

3.13 Additional Content to the Teacher

Grafting – Apart from whip grafting other methods of grafting include:

- Side grafting
- Approach grafting
- Bark grafting
- Notch grafting
- Cleft grafting
- Bud grafting

Bark grafting

This technique of grafting is best suited for avocado trees with large diameter. To make a bark graft, the following procedures are used:

(i) The stem is cut off completely from the rootstock at about 50 cm from the ground level.

(ii) One branch is retained below the cut to act as the nurse plant to provide the scion with nutrition.

(iii) Vertical slit about 6.0–8.0 cm long are cut through the bark of the remaining stump of the rootstock down to the wood.

(iv) The slits should be spaced 7.0–12 cm apart.

(v) The scion stick should be 12.5–15.0 cm long width 4-6 buds and slopping cuts are made at the base about 7.5 cm long.

(vi) The bark of the rootstock is lifted using the tip of the grafting knife.

(vii) The scion is then inserted into the slits with the long-cut surface facing the wood of the rootstock.

(viii) The cambiums on both slits should be aligned properly.

(ix) The scion are then secured onto the rootstock stump by nailing them in place with thin flathead or they can be tied tightly with a string or tree tape.

(x) All the cut surface should be thoroughly coated with grafting wax or pruning paint.

(xi) To protect the graft from sunburn it should be painted white interior water based paint.

(xii) Once the scion begins to grow well, all the other scion are removed to leave one part rootstock.

(xiii) The nurse branch is then pruned off.

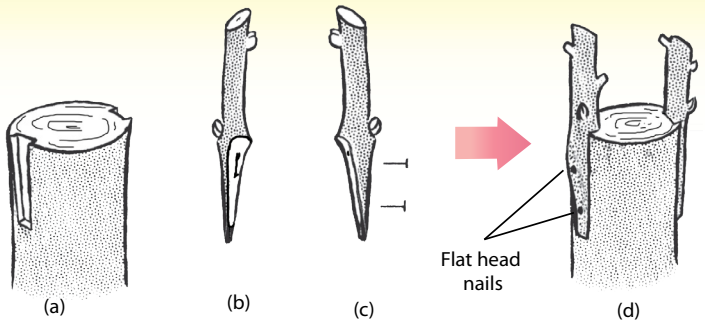


fig. 3.1: Grafting procedure

A – Plant stump prepared for back grafting

B and **C** – Scions prepared for back grafting

D – Scions properly fitted in position with flat head nails

Fig. 3.1: Bark grafting procedure

System of training fruit trees

(i) Open-centre system.

This system is also called vase. The tree is capped to allow a low spreading tree.

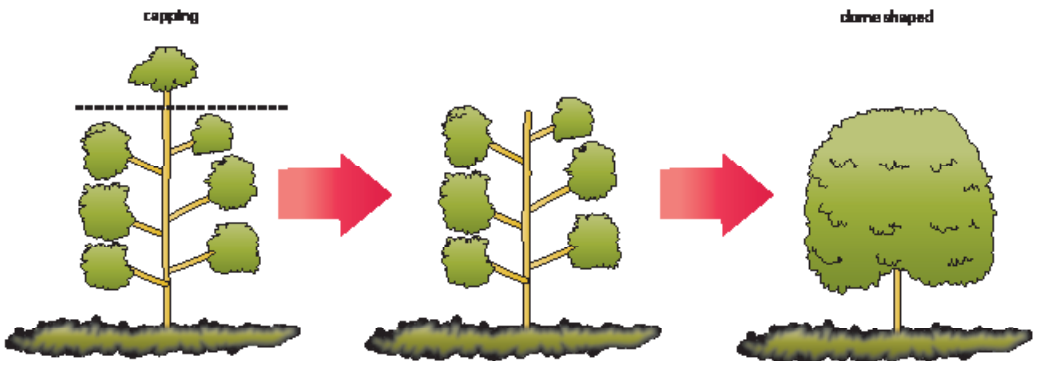
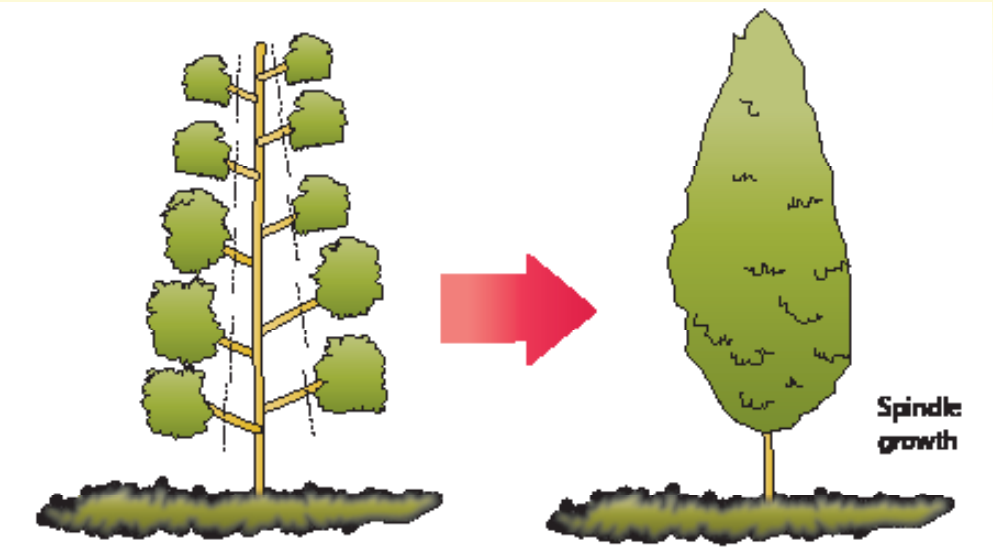


Fig. 3.2: Capping

(ii) Central leader system

The sideway branches are capped at their tips in a manner that the branches in length upwards to the middle of the tree and then decreases toward the tip of the tree. The main stem is not capped and allowed to grow tall. It encourages more upward growth than horizontal growth hence forms a spindle shape.



(a) (b)

Fig. 3.3: Central leader system

3.14 Notes to the Teacher

(i) Prepare lesson plan based on the schemes of work.
(ii) Make lesson notes based on the competences for the unit.
(iii) Prepare demonstration materials needed.
(iv) Prepare practical sheets beforehand if a practical activity is to be carried out by the learners.
(v) Prepare and collect the practical materials beforehand.
(vi) Prepare questionnaires for the field trip in advance.
(vii) Prepare the learners for field trip a day before the trip.
(viii) Attempt the learning activities in Secondary Agriculture Students' Book 2 before giving them to the learners.
(ix) Cater for the varied abilities of the learners.
(x) Prepare and assure for the safety of the learners when carrying out a practical activity.
(xi) Arrange the learners in groups of five to carry out activities while you guide them. Mix learners of different abilities in groups.
(xii) Lead class discussions by asking probing questions and allow learners to use their experiences.
(xiii) Guide the learners to define key terms such as propagation, layering and others as used in the Students' Book.
(xiv) Use formative evaluation techniques and activities provided to gauge the learners.

(xv) Guide the learners when using magazines, photographs, other textbooks and internet facilities if available in the school.
(xvi) Encourage learners to make presentations on their experience in fruit processing and preservation.
(xvii) Keep learners' progressive record and give feedback to the parents.

3.15 Additional remedial consolidation and extension activities

High order questions for fast learners

1. Explain the importance of fruit production.
   (i) *Nutritional importance – Provides vitamins, proteins, minerals, carbohydrates, fibre and water in the body.*
   (ii) *Provides income – Farmers earn income after selling fruits.*
   (iii) *Provides employment – Fruit processing and canning industries employ a large percentage of the population.*
   (iv) *Industrial development – Secondary industries use fruits as raw materials.*
   (v) *Ecological functions – Fruit trees and vines protect the soil from erosive forces.*
   (vi) *Aesthetic value – Fruits beautify the environment.*
   (vii) *Medicinal value – Some fruits are used to produce medicine because they contain chemicals with healing properties.*
   (viii) *Traditional functions – Some fruits are used to make traditional brew used in social functions.*
   (ix) *Diversification functions – Provide a balance between food crops and cash crops.*
2. Describe the procedure for whip grafting in avocado fruit trees.
   (i) *Select a mature green wood with buds from a mother plant species with desirable characteristics.*
   (ii) *Cut the green wood about 2.5–60 cm long, remove the leaves and leave buds to make a scion stick.*
   (iii) *Cut a "tongue" cut on the rootstock and a matching tongue on the scion stick. The rootstock plant should be growing in the nursery.*
   (iv) *Make the tongues the same length on the scion as on the rootstock so that they lock together to make a union.*
   (v) *Wrap the union with a polythene strip or cellotape and smear grafting wax.*
   (vi) *Leave the grafted plants under a shed to protect the new graft from the sun until the scion begins to grow.*
   (vii) *Remove any growth below the graft union.*
   (viii) *Support the new shoot growing to avoid splitting.*
3. Carry out the practices required when transplanting fruit trees from the nursery.
   (i) *Mark the holes for planting the trees by laying out the archard using the triangular system or square systems.*
   (ii) *Dig the holes at 60 cm × 60 cm × 60 cm and separating topsoil from subsoil.*

(iii) *Mix topsoil, organic manure, 300 grams of phosphatic fertiliser such as double super phosphate and one tablespoonful of insecticide powder to prepare the soil mixture.*

(iv) *Re-fill the hole with the same mixture ready for planting.*

4. Analyse the importance of applying post-harvest technologies in fruit production.
   (i) *It makes fruit handling easy.*
   (ii) *Makes fruits available throughout the year.*
   (iii) *Increases the keeping quality of fruits.*
   (iv) *Produces a variety of products from fruits.*
   (v) *Reduces poisoning effects, which results from fruit spoilage.*

Low order questions for average learners

1. Interpret the importance of fruit trees in environmental conservation.
   (i) *Tree roots hold soil particles from being carried away by the water or wind.*
   (ii) *Tree leaves decompose to release organic matter, which improves the physical properties of the soil.*
   (iii) *Tree intercepts the raindrop, reducing their impact on the soil.*
   (iv) *Trees take part in the hydrological cycle thus increasing the likelihood of cloud formation through their transpiration process.*
   (v) *Trees provide shade to the soil living organisms, which decompose organic matter into humus.*
2. Name three products made from fruits.
   (i) *Fruit jam*
   (ii) *Marmalade*
   (iii) *Jelly*
   (iv) *Juice*

3.16 Summative Evaluation Questions

1. Outline the procedure for tip layering.
2. Explain six reasons for pruning fruit trees.
3. State four importance of fruit processing.
4. Explain the aims of post-harvest technologies.
5. Describe three orchard management practices.

3.17 Additional Questions

1. Suggest four tools and materials used when grafting.
   (i) *Grafting knife.*
   (ii) *Grafting tape/polythene strip.*
   (iii) *Grafting wax.*
   (iv) *Seedlings in a nursery.*
2. Explain the procedure of using the sugaring method in the preservation of pineapple fruits.

The fresh pineapple fruits are cut into various shapes. They are then canned in sugar syrup. The canned pineapple fruits are then heated in a water bath. The sugar preserves the pineapple fruits for a long time.

3. Apart from avocado fruit trees, name any other two types of fruit trees that are grafted.
   (i) *Citrus fruit trees.*
   (ii) *Mango trees.*
4. Differentiate between fruit jam and fruit juice.
   Fruit jam *refers to the product made from the whole fruit while* ***fruit juice*** *is that product which is made from the liquid part of succulent fruits.*

3.18 Suggestions for assignments

1. Find out whether there are specific dates for planting different fruit trees in Rwanda.
2. Find out whether there are other traditional methods of processing and preservation of fruits in Rwanda.
3. Using your observation and experience in the fruit processing factory visited from the search engines; write a report on the processes that take place when processing fruits from delivery to the time the products are placed. This should be done in groups.

3.19 Support for developing of positive skills values and attitude

(a) Positive life skills developed include:
   (i) Handling and safe use of agricultural tools and agro-chemicals.
   (ii) Report writing skills.
   (iii) Public speaking and speech development skills.
   (iv) Fruit preservation methods.
   (v) Skills in use of limited resources.
   (vi) Use of modern methods in fruit processing.
   (vii) Skills in operating and use of search engine.

(b) Positive values and attitude developed include:
   (i) Co-operation with others when working in groups.
   (ii) Curiosity to discover after grafting avocado trees.
   (iii) Appreciation of the farmers duty of food production.
   (iv) Respect for each other when working in groups.
   (v) Positive perception of agriculture as a business.

3.20 Suggested answers to formative evaluation questions

1. A fruit is a ripened ovary of a flower which contains one or more seeds.
2. (i) Provide nutrients, fibre and water in human diet.
   (ii) Provide income to the farmer.

(iii) Provide employment.
(iv) Provide raw materials for industries.
(v) Protect the environment.
(vi) Have aesthetic value/beautifies the environment.
(vii) Some fruits have medicinal value.
(viii) Used in traditional functions.
(ix) Help diversity production by giving a balance between food crops and cash crops.

3. Avocado, tarmarillo, passion fruits, papaya, mangoes, citrus, strawberries, pineapples.
4. (i) Use of layering.
(ii) Grafting.
(iii) Use of stem cuttings.
(iv) Use of seeds.
5. The practice of uniting two different woody stems together to grow into new individual plant.
6. (i) Overhead irrigation/use of watering cans/use of sprinklers
(ii) Drip irrigation/use of perforated pipes/bottle.
(iii) Furrow irrigation.
7. (i) To maintain quality.
(ii) To protect food safety.
(iii) Reduce physical losses.
(iv) To prevent loss in market value.
8. Jam, juice, marmalade and jelly.
9. (i) Refrigeration
(ii) Freezing
(iii) Sugaring
(iv) Canning
(v) Curling
(vi) Fermentation

3.21 Suggested Answers to Summative Evaluation Questions

1. Tip layering
(i) The tip bearing the terminal bud is bent to the ground and then held with a peg.
(ii) It is covered with a layer of moist soil.
(iii) The covered part of the shoot is induced to produce roots.
(iv) The shoot is cut off from the mother plant and transplanted.
2. Reasons for pruning fruit trees
(i) To control pests and diseases – This is done by getting rid of the micro-climate created by bushy trees which encourage pests and disease breeding.

(ii) Control spread of pests and diseases – This is by preventing mechanical rubbing of the plant parts with each other.
(iii) Control cropping– Removal of extra fruits prevents overbearing and improves equality of fruits.
(iv) Facilitates harvesting– When pruned fruit trees achieve a convenient height for harvesting and spraying.
(v) Allow chemical penetration– Branches removed open up the plant making easy for chemicals to reach the inner parts.
(vi) Economise on chemicals – Little chemicals are used to wet the few branches that remain after pruning.

3. Importance of fruit processing
   (i) To prevent deterioration– This can be physical, microbial and chemical.
   (ii) To produce other more consumable products.
   (iii) To reduce bulkiness for easy handling.
   (iv) To increase their keeping quality.
4. Aims of post-harvest technologies
   (i) To maintain quality – When fruits are processed, they have a longer keeping quality, they maintain their flavour, texture and nutritive value.
   (ii) To protect food safety – This helps prevent fruits becoming poisonous to human beings.
   (iii) To maintain market value – Processed fruits retain their natural quality and so market value.
   (iv) To protect their physical appearance
5. Orchard Management Practices
   (i) Pruning – It is carried out to give a balance between crop and the vegetative parts to increase quality.
   (ii) Pests and disease control – This is carried out to increase the quality and quantity of fruits harvested.
   (iii) Watering – Water application is carried out during the dry seasons. This promotes all season fruit production.

Key Terms (Students' Book pages 96–98)

1. **Ovaries** – Part of a flower which develops into a fruit and seed or seeds.
2. **Diversification** – Growing several types of crops on a piece of land to safeguard against total failure.
3. **Flavours** – A characteristic taste.
4. **Secondary industries** – Manufacturing or processing industries developed as a result of fruit production so as to process fruit products.
5. **Ecology** – The study of living things in relationship to their surroundings.
6. **Plant propagation** – Multiplication of plants and planting materials.
7. **Vegetative propagation** – Multiplication of plants using plant parts other than seeds.

8. **Dormancy** – A condition where seed or bud in which growth cannot take place even after provision of necessary conditions for germination.
9. **Fungicides** – Chemical used to control fungal diseases.
10. **Insecticides** – Chemical used to control insect pests.
11. **Pesticides** – Any agro-chemicals used to control destructive organisms referred to as pests.
12. **Nitro-culture** – A growth medium mixed with Nitrogen fixing bacteria.
13. **Mucilage** – The slimy substance found on the fruit or seed coat which prevent water absorption.
14. **Endocarp** – The inner part of a fleshy fruit which covers the seed.
15. **Mother plant** – Mature plants from which vegetative planting materials are acquired
16. **Rooting medium** – A mixture of hormones, nutrients and substrate on which plants can grow and attach roots.
17. **Ring-barking**– Removal of the bark from a stem to leave an exposed ring.
18. **Polythene sleeves** – These are polythene bags made to specific dimensions for raising seedlings singly.
19. **Wooden pegs**– Strong pieces of sticks with sharp ends used for making whole positions.
20. **Terminal bud** – The topmost part of a stem or shoot where elongation takes place.
21. **Transplanting** – The practice of removing seedlings from nursery or polythene sleeves to the holes in the seedbed.
22. **Detach** – Disconnect by cutting.
23. **Economic life** – The productive period of a plant growth which is profitable to the farmer.
24. **Dwarfing** – Reduce in size or becoming smaller than normal.
25. **Compatible** – Can exist, breed together or able to form a successful union.
26. **Scion stick** – The part that contains buds which grow to become a new shoot after grafting.
27. **Leaf bud** – A vegetative part of the leaf which grows into a shoot or a branch.
28. **Staking** – The practice of supporting a creeping plant with a stick in order to grow upright.
29. **Water shoot** – A vigorous sprout arising from the trunk or the main branch of the trees.
30. **Nurse plant** – A branch left on a rootstock to provide food to the young growing bud. The nurse plant is pruned off when the bud grows into a shoot.
31. **Containerised seedlings** – Seedlings planted singly in a container such as polythene sleeve.
32. **Windbreaks** – Trees or other barriers used to prevent and reduce the speed of wind over planted crops.

33. **Evapotranspiration** – Loss of water vapour from the leaf surface through evaporation.
34. **All weather roads** – Roads that allow vehicles to move through without getting stuck regardless of the season.
35. **Baseline** – The position of the first row of the fruit trees in an orchard. It is used as a guide when making the position of the planting holes.
36. **Hypotenuse** – This is the longest side of a right angled triangle. It forms the diagonals of two right angled joined together.
37. **Wettable power** – Agro-chemicals in powder form that cannot dissolve but mix well with water.
38. **Soil field capacity** – A state where soil holds enough water for the plants.
39. **Blossoming** – Starting to produce flowers.
40. **Fruit set** – After pollination when the flower withers and fruit forms.
41. **Canopy** – The top foliage of a growing plant.
42. **Vascular bundles** – Vessels that transport water and nutrients in a plant.
43. **Flush growth** – New plant parts that sprout suddenly and at once.
44. **Lignification**– The process of thickening due to deposition of complex carbohydrate materials known as lignin.
45. **Apical dominance** – Prevention of sprouting of lateral buds to the presence of a terminal bud.
46. **Cultural practices** – Routine crop production practices carried out to control weeds, pests and diseases.
47. **Capping** – Cutting off the terminal bud of a plant to allow spreading.
48. **Deterioration** – Change in quality of a product from good to bad.
49. **Enzymes** – Chemicals produced in plants that are used to regulate metabolic rate.
50. **Physiological changes** – Changes that occur in the functioning of an organism.
51. **Tainting** – Having traces of unwanted substances such as colour, flavour or smell.
52. **Lethal** – Causes sudden death.
53. **Pectin** – A complex polysaccharide extracted from fruits mainly citrus and used as a jelly agent to make jellies and jams.
54. **Parasitoides** – A living organism used as a biological control agent to parasitise crop parasites.
55. **Predator** – A living organism that eats other organisms that destroys crops.
56. **Blemish** – A mark or stain that spoils the natural beauty.
57. **PVC pipes** – Plastic pipes made of rigid polyvinyl chloride.

Answers to Revision Questions (Students' Book pages 98–100)

1. A fruit is the fleshy part of the flowering plant which develops from an ovary.
2. (i) Provide nutrients, fibre and water.
   (ii) Human diet.

(iii) Provide income to the farmer.
(iv) Provide raw materials for industries.
(v) Provide employment.
(vi) Have aesthetic value/beautifies the environment.
(vii) Some fruits have medicinal value.
(viii) Fruit are used in traditional functions.
(ix) Provide a balance between food crops and cash crops.

3. Types of fruits grown in Rwanda include:
   (i) Avocado
   (ii) Papaya
   (iii) Mangoes
   (iv) Tamarillo
   (v) Citrus
   (vi) Strawberries
   (vii) Passion fruits
   (viii) Pineapples
4. Methods of propagating fruit trees:
   (i) Use of seeds
   (ii) Vegetative propagation
5. Methods of vegetative propagation in fruits trees include:
   (i) Grafting.
   (ii) Layering.
   (iii) Use of stem cutting.
6. Fruit propagation using stem cuttings – strawberries.
7. Procedures of whip grafting in avocado fruit trees.
   (i) A bud is cut from the scion stick with a sharp budding knife.
   (ii) The scion is held with its upper end towards the body and the knife drawn towards the body to remove the bud with the bark of the shoot.
   (iii) A T-cut is made on the stem of the rootstock seedlings at about 25–35 cm above the ground.
   The bark around the T-cut is gently loosened from wood, using the tip of the budding knife.
   (iv) The bud is pushed down into the T-cut of the rootstock and held with the bark. The upper part of the bud is removed.
   (v) The bud is firmly bound with budding tape or polythene strip to prevent entry of water. Budding wax is applied around the tape.
   (vi) The upper shoot of the seedling is left to grow as a nurse branch. It is then cut off completely when the bud grows and develops about six leaves.
8. Factors considered when sitting an orchard:
   (i) Slope of the land area
   (ii) Drainage

(iii) Depth of soil
(iv) Wind direction
(v) Previous crop
(vi) Nearness to homestead
(vii) Water sources
(viii) Orientation in respect to the sun

9. Land preparation/operations for an orchard:
   (i) Clearing –To remove vegetative materials to allow easy cultivation.
   (ii) Primary cultivation – Open up land to make planting easy and remove weeds.
   (iii) Laying out of an orchard – Measuring the position of planting holes.
   (iv) Digging of holes – About 60 × 60 × 60 cm in size.
10. Methods of laying out fruit trees in an orchard:
   (i) Triangular method
   (ii) Square method
   (iii) Quincox method
   (iv) Contour or terrace method.
11. Methods of pruning fruit trees:
   (i) Capping
   (ii) Thinning out
   (iii) De-shooting
12. (a) Aphid – Pierce and sack sap from different parts of fruit trees.
   (b) Caterpillars – Eat parts of the leaf reducing surface area for photosynthesis.
   (c) Fruitfly –Burrow through fruits, laying eggs and causing fruit fall and fruit rot.
13. Difference between processing and preservations in fruits.
   Processing is any deliberate change or transformation of raw fruits by chemical or physical means. Whereas preservation is the application of the processes that inhibit deterioration of fruit before use.
14. Objectives of applying post-harvest technologies in fruits.
   (i) To maintain quality.
   (ii) To protect food safety.
   (iii) To reduce physical losses.
   (iv) To prevent loss in market value.
15. Preservation techniques used in fruits include:
   (i) Refrigeration
   (ii) Freezing
   (iii) Sugaring
   (iv) Canning
   (v) Curing
   (vi) Fermentation

16. Difference between jam and marmalade:
    Jam is a product made by heating crushed fruits mixed with sugar and water while marmalade is a fruit product made from boiling the fruit peels and juice of orange with sugar and water.
17. Steps followed when making fruit jam from strawberries:
    (i) Wash and slice ripe fruits into small cubes.
    (ii) Crush the fruits with a wooden spoon or blender.
    (iii) Place the crushed fruits into a large sauce pan.
    (iv) Add lemon juice and warm butter or margarine and stir.
    (v) Allow the fruit mixture to simmer for 5–20 minutes to make a thick syrup.
    (vi) Remove the mixture from the heat.
    (vii) Skin out the foam and pour into sterilised jars and seal.
    (viii) Boil the jar in a water bath for 10 minutes.
    (ix) Cool the jars by washing in cold water.
    (x) Place in a refrigerator or store in a cool place.

Unit 4 : Legumes

Number of periods: 16

Key Unit Competence: Learners should be able to practise cultivation of legumes and post-harvest practices of both soya beans and groundnuts.

4.1 Learning Objectives

(a) Knowledge and Understanding

(i) Define the legumes.
(ii) Explain the importance of legumes.
(iii) Explain propagation methods of legumes.
(iv) Apply cultural practices of legumes.
(v) Explain post-harvest techniques for legumes (soya beans, fodder and ground nuts).

(b) Skills

(i) Recognise the legumes.
(ii) Select common legumes cultivated in Rwanda.
(iii) Practise legumes propagation methods.
(iv) Conduct legume cultivation.
(v) Perceive post-harvest techniques of soya beans, fodder and groundnuts.

(c) Attitudes and values

(i) Initiative to identify legumes cultivated in Rwanda.
(ii) Respect legumes propagation methods.
(iii) Pay attention while observing.
(iv) Have positive attitude towards colleagues.
(v) Show concern while doing cultivation techniques of legumes.
(vi) Be careful when conducting cultural activities.
(vii) Pay attention while observing post-harvest operation of groundnuts, fodder and soya beans.
(viii) Beware of post-harvest techniques of soya beans, groundnuts and fodder.

4.2 Content Students' Book page 101 – 125

(i) Definition of legumes, legumes names, types (fodder, edible by human).
(ii) Importance of legumes (soya beans, peas, beans and groundnuts, fodder: feed livestock, stakes for climbing crops, soil fertility and soil conservation)

Answers to question in table 4.1:Cultivated legumes for humans and fodder on page 103 – 104 of the Students' Book.

Legume	Consumed by
(a) Lupins	Livestock
(b) Soya bean	Human
(c) Green leaf desmodium	Livestock
(d) Lentil	Humans
(e) Silver leaf desmodium	Livestock
(f) Pea plant	Humans
(g) Lucerne	Livestock

Answers to questions in table 4.2 (a): Fungal diseases of legumes on page 114 – 115 of Students' Book.

Disease illustration	Crops attacked	Control measure
(a) Angular leaf Spot	Beans/legumes	Regular spraying with fungicides, planting certified seeds and use of resistant varieties.
(b) Late blight (*Phytophthora intestans*)	Beans/legumes	Regular spraying with fungicides, planting certified seeds and use of resistant varieties.
(c) Anthracnose	Beans/legumes	Regular spraying with fungicides, planting certified seeds and use of resistant varieties.
(d) Soya beans rust disease (*Phakopsora pachyrhizi)*	Soya beans	Rogueing, crop rotation, control of vectors and use of clean seeds and certified seeds.
(e) Mildew	Beans	Regular spraying with fungicides, planting certified seeds and use of resistant varieties.
(f) Groundnut Rosette virus	Groundnuts	Rogueing, use of certified seeds, crop rotation and control of vectors.
(g) Mosaic virus disease	Citrus	Rogueing, crop rotation and control of vectors.

Answers to questions in table 4.2: (b) Bacterial diseases in legumes Students' Book on page 116

Disease illustration	Crops attacked	Control measure
(a) Bacterial blight	Beans	Rogueing, use of clean and certified seeds, crop rotation and control of vectors.
(b) Halo blight	Beans	Rogueing, use of clean and certified seeds, crop rotation and control of vectors.

(iii) Propagation methods of legumes (cutting, feed propagation, layering)
(iv) Cultural practices of legumes (land preparation, planting material, sowing maintenance/management and harvesting).
(v) Post-harvest techniques for soya beans and groundnuts (threshing and transport, drying, cleaning, handling, conditioning, packing and storage).

Answers group activity on page 122 of the Students' Book

Correct order of the steps is as follows:
(iii) Drying the fodder.
(ii) Preparing the box and the strings.
(v) Packing the box with dry fodder.
(i) Compacting the fodder into the box.
(iv) Tying the bale tightly.

4.3 Learning Activities

(i) Field visit to explore cultivated legumes and deduce their definition, types and importance (socio-economic, nutritive value).
(ii) Field visit on farms to observe and deduce after group discussion on propagation methods for legumes.
(iii) Field work to conduct cultural practices of legumes by groups of learners in school garden.
(iv) Trip to a farm to observe all post-harvest techniques of legumes (harvesting, drying, cleaning, handling, packaging, conditioning and storage) and discuss on ways they are done.

4.4 Links to Other Subjects

This unit is linked to Biology especially reproduction in plants, animals and microscopic fungi, plant asexual reproduction; Mathematics especially calculation, surface and land measurement, geometry; Home Science especially nutrition.

4.5 Assessment Criteria

Assessment of this unit will be based on the ability of the learners to practise cultivation of legumes and post-harvest of both soya beans and groundnuts.

4.6 Learning Materials and Resources

The following materials/resources will be required in the teaching of this unit:

(i) Grain of groundnuts and soya beans.
(ii) Hoes
(iii) Rakes
(iv) Measuring tapes
(v) *Pangas*
(vi) Pegs
(vii) Ropes
(viii) Sacks
(ix) Labels
(x) Fodder–legume cuttings /seeds
(xi) Library
(xii) Computer laboratory with internet
(xiii) School field
(xiv) Various small farm tools.

4.7 Suggested Low Cost or No Cost Materials

(i) Ask the learners to bring materials such as soya beans and groundnut seeds, ropes, sacks, pegs, *pangas,* hoes, rakes and other farm tools.
(ii) Ask the administration to assist with search engines and return after use.
(iii) Borrow facilities such as computer laboratory and resources such as library books from neighbouring schools.

4.8 Methods of Teaching

The following methods are recommended for the teaching of this unit:

Content	Method(s)
1. Definition of legumes, legume names, types (fodder, edible by human)	**Discussion**: The teacher asks the learners to find out the meaning of legumes from dictionaries, library books and internet and supervises the discussions by moving from group to group. The teacher allows the learners time to present their findings to the class. The teacher then makes the final conclusion.

2. Legume names and types	**Exhibition**: The teacher displays different legumes to be identified. The teacher allows the learners time to identify the materials, record and discuss their findings. The learners present their findings to the class and then the teacher makes a final conclusion.
3. Importance of legumes	**Field visit**: The teacher organises a visit and prepares a questionnaire to be used by the learners during the visit as shown in Annex 2. The teacher instructs the learners to find out the importance of the legumes cultivated in the farm. Learners make observations, record and discuss their findings. They then present their findings to the class. The teacher makes the final conclusion.
4. Propagation methods of legumes	**Field visit**: The teacher organises a visit and prepares a questionnaire to be used by the learners during the visit as shown in Annex 11. The teacher instructs the learners to observe different propagation methods of legumes in the farm. Learners make observations, record and discuss their findings to the class. The teacher makes the final conclusion.

5. Cultural practices in legumes	(i) **Field visit**: The teacher organises a visit and prepares a questionnaire to be used by the learners during the visit as shown in Annex 12. The teacher instructs the learners to carry out various cultural practices in the farm. Learners carry out activities, record and discuss their findings to the class. The teacher makes the final conclusion. (ii) **Project**: The teacher instructs the learners to carry out a project on the growing of soya beans or ground nuts. The project is fully managed by the learner with minimum supervision by the teacher. The learners make their observations, record and discuss their findings. They then present their findings to the class. The teacher makes the final conclusion.
6. Post-harvest techniques for soya beans and groundnuts	**Field visit**: Teacher organises a visit and prepares a questionnaire to be used by the learners during the visit as shown in Annex 13. The teacher instructs the learners to observe the various post harvest practices carried out in the farm. Learners make observations, record and discuss their findings. They then present their findings to the class. The teacher then makes a final conclusion.

4.9 Suggested teaching and learning activities and exercise to support delivery of content and development of students' competences

(i) Class discussion on cultivation of legumes and post-harvest of both soya beans and groundnuts.
(ii) Conducting field work for the learners to observe and practise propagation of cultural practices of legume production.
(iii) Practical activities in groups on legumes production applying all the cultural practices.
(iv) Use of question and answer techniques to probe the learners when discussing

cultivation of legumes and post-harvest of both soya beans and groundnuts.

(v) Field trips to observe the post-harvest techniques of legumes.

(vi) Report writing and presentation on cultivation of legumes and post-harvest of both soya beans and groundnuts.

4.10 Cross-cutting issues to be integrated in the teaching and learning activities

The teacher to find ways of incorporating cross-cutting issues in the teaching of legumes production and post-harvest activities such as:

(i) **Environment and sustainability**: Acquired skills and attitudes that will enable them to address issues of environment and climate change.

(ii) **Peace and values education**: Working together contributes to peace and harmony and being committed to avoiding conflicts.

(iii) **Inclusive education**: Engage all the people in learning regardless of the gender and ability.

4.11 Suggestions for accommodating special education need (SEN)

The teacher should know the learners and identify those with special needs. This will help the teacher be able to help learners to undertake the learning activities. The type of special needs and learners support is as listed below:

Type of special need	Assistance to the learners
Sensory impairment (hearing)	• Speak loudly for all to hear. • Make sure that the learners sit close to the teacher. • Alert the learner so as to seek for their attention.
Sensory impairment (visual)	• Use extra-large print in practical sheets, questionnaires and assessment papers. • Large diagrams and use bold letters on the chalkboard. • Those using braille machines should be given a comfortable place for them. • Should be paired with sighted learners.
Sensory impairment (motor)	• Assigned to other learners to assist. • Practical activities to be conducted in one area to reduce movement.
Gifted or talented learners	• Give them more tasks to do. • Assign them to different groups. • Encourage them to assist the slow learners.

Slow learners	• Assist them when carrying out practical activities. • Take time when giving instructions. • Arrange for remedial teaching. • Assign them to gifted learners to be assisted.

4.12 Formative Evaluation

1. Describe the procedure of making hay from legumes fodder.
2. Explain four cultural practices carried out when growing groundnuts.
3. State two reasons why fodder legumes should be chopped into small pieces ensiling.
4. Outline three control measures taken against soya bean rust disease.
5. Explain three practices carried out to prepare legume seed for planting.

4.13 Additional Content to the Teacher

Importance of legumes

Legumes are grouped into two broad categories. These are legumes grown for human consumption and those grown for livestock, also known as fodder legumes.

1. Legumes grown for human consumption

Legumes grown for human consumption are either consumed when fresh as vegetables or when dry. Those consumed fresh include; French beans, garden pea and pigeon. Legumes that are consumed after the seeds dry are referred to as pulses that are consumed together with cereal crops such as maize and rice. They include; peas and grams. Soya bean is used as a beverage while groundnut is used for production of oil. They are also roasted and eaten as a confectionary.

(a) Importance of soya beans

(i) They are used as a source of protein in the production of mushrooms.
(ii) It is an excellent substitute for tea when processed.
(iii) They are useful in the preparation of a variety of fresh, fermented and dried food products such as milk.
(iv) Soya beans have mechanical value and serves as a cure for ailments such as heart, liver, kidneys and stomach ailments.
(v) They are processed to extract oil for food such as salad oil and cooking oil.
(vi) Produce soya beans, seed cake, a livestock feed.

(b) Importance of groundnuts

(i) They provide a substrate for mushroom production.
(ii) They are processed to produce peanut butter which is used on bread as margarine.
(iii) They are believed to promote fertility in human beings.

(iv) They help in reducing mental depression since they contain amino acid, tryptophan which produces serotomin a brain chemical involved in mood regulation.
(v) They contain vitamin B2 which boosts memory power and normal brain functioning.
(vi) They protect the body against cancer and blood pressure because they contain phytosterols which interfere with cholesterol absorption and inhibition of tumor growth.
(vii) They reduce the risk of developing gall stone.
(viii) They lower the risk of obesity.
(ix) Used as a source of livestock feed as groundnut seed cake.

(c) Importance of peas

(i) They boost the body's immune system because they contain anti-oxidants.
(ii) They help in the prevention of stomach cancers since they contain chemical called coumestrol.
(iii) They prevent wrinkles in human beings.
(iv) They have medicinal value and are believed to cure arthritis and bronchitis.
(v) They prevent constipation in human beings due to their high fibre content.
(vi) They promote healthy bones because they are rich in vitamin K.
(vii) They help in improving eyesight because they have vitamin A.
(viii) They lower the risk of obesity.

2. Fodder legumes

(i) They complement natural pastures as a source of protein in livestock.
(ii) Legume fodders reduce water consumption in livestock and hence are essential for semi-arid areas where water for livestock is scarce.
(iii) They lower the cost of livestock production where they replace expensive commercial protein concentrates.
(iv) Legumes fodder trees and shrubs provide shades for livestock.
(v) They also form an important component of agroforestry trees and shrubs.
(vi) Legumes fix nitrogen to the soil improving soil fertility.
(vii) Their roots protect the soil against soil erosion by holding the soil and binding soil particles together improving soil structure.
(viii) Legume trees and shrubs increase soil and water infiltration during flush floods reducing soil water seen off and hence checking on soil erosion.
(ix) Their flowers provide food for honey bees increasing honey production.
(x) Fodder trees and shrubs provide fuel reducing pressure on natural and planted forests.
(xi) Some fodder trees provide timber for construction of farm structures and also act as windbreakers.
(xii) Some fodders shrubs and trees act as nurse crops for other planted crops.
(xiii) Desmodium grown in association with maize and Napier grass helps in

controlling the maize stalkborer through what is called push and pull technology. Desmoduim produces a chemical that repulses the stalkborer while Napier grass produces a chemical that attracts them. The Napier then produces a substance that drowns them. They also produce chemical that destroys witch weed.

(xiv) Some legumes such as the pigeon pea *(canjanus canjan)* can be used as stakes for climbing plants such as passion fruits.

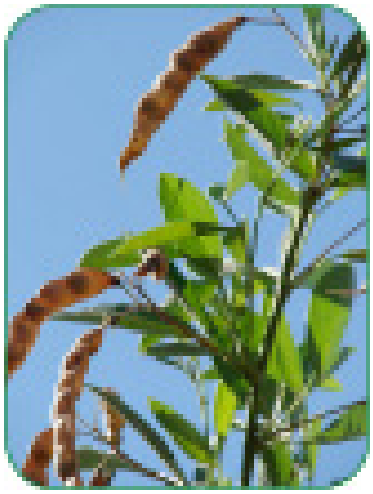


Fig. 4.1: Peas plant

4.14 Notes to the Teacher

(i) Prepare lesson plans in advance so as to plan the materials and methods to be used in teaching.
(ii) Prepare practical sheets required for the practical activities.
(iii) Prepare questionnaire for field trips beforehand.
(iv) Prepare the learner for field trips a day before the trip.
(v) Attempt the practical activities beforehand to make sure that they are workable.
(vi) Attempt the assignments before giving the learners.
(vii) Cater for the varied abilities of the learners.
(viii) Guide the learners in defining the key terms.
(ix) Encourage learners to make presentations on their experience in legume production.
(x) Keep progressive records on the learners and give feedback to the parents.

4.15 Additional remedial consolidation and extension activities

High order questions for fast learners

1. Describe the procedure of making silage from lucerne through the trench silo method.
   (i) A gentle slopy ground is selected for making the trench silo.
   (ii) A trench silo measuring 5 m long × 3 m wide and 1.25 m deep is prepared.
   (iii) The lucerne crop is harvested when 20 –50% of the crop has flowered.
   (iv) The harvested crop is chopped into small pieces using a machete or chaff cutter.
   (v) The chopped plant materials are wilted.
   (vi) A polythene sheet is laid in the trench. It should be large enough to overlap on the surface.
   (vii) The chopped materials are filled into the silo and compacted at every stage.
   (viii) Heavy rollers are used to compact the materials or a drum full of water is used to compact the materials.
   (ix) The temperature within the silo should be maintained at 32°C optimum. A thermometer should be used to check temperature.
   (x) The material is covered with the polythene sheet to keep off the oxygen and maintain anaerobic conditions.
   (xi) A layer of soil is put over the polythene to form a dome shape.
   (xii) A trench is dug around the silo to prevent water runoff from entering the silo.
   (xiii) The temperature should constantly be checked during the first three weeks until it becomes stable.
   (xiv) The lactic acid produced by the action anaerobic micro-organisms stops further action by the micro-organisms and preserves the material for a long period of time.
2. Explain the importance of legumes in soil conservation.
   (i) The canopy of the growing legume crop covers the ground preventing rain drop/splash erosion.
   (ii) The roots of the legume crop holds the soil particles together thus preventing soil erosion.
   (iii) The vines and leaves of the creeping type legumes traps/filters the soil particles in the running water thus preventing the carrying away of the soil by runoff.
   (iv) The leaves dropping from the legumes decompose adding nutrients to the soil.
   (v) The Nitrogen fixing bacteria in the root nodules of the legumes convert free Nitrogen in the soil into Nitrates thus improving soil fertility.
   (vi) The leave cover prevents excessive evaporation of soil moisture.
3. Describe four post-harvest techniques carried out on groundnuts.
   (i) Shelling – This is the removal of the nuts from the shells. It can be done

manually or by hand operated machine which separates the shells from the nuts.

(ii) Drying – The shelled grains are sun-dried to a moisture content of 6.6 – 7.0%. Driers can be used in case of a cloudy day.

(iii) Cleaning and grading – Cleaning is done to ensure that all foreign materials such as weed seeds, split seeds, stones and leaves are removed. The nuts are then sorted according to colour and size.

(iv) Packaging and storage – Dry nuts are packed in dry containers such as gunny bags, pots and gourds. The bags are stacked up to 10 bags high on separate stacks to allow free circulation of air. The bags should be dusted with insecticides to protect the pods from pests.

4. Give two reasons why shallow cultivation is recommended in a field of young legumes.
   (i) To prevent root disturbance.
   (ii) To prevent loss of soil moisture through evaporation.
   (iii) To prevent destruction of soil structure.

Low order questions

1. Give four cultural practices carried when growing soya beans.
   (i) Gapping
   (ii) Thinning
   (iii) Weed control
   (iv) Fertiliser application
   (v) Pests and disease control
2. What is a pulse crop?
   It is a legume crop grown for its grains which are used as food for human beings.
3. Give two reasons why legumes fodder for hay making should be harvested at 50% flowering.
   (i) At this stage the herbage/leaves have the highest nutrient content before seed formation starts.
   (ii) At this stage the plants are less fibrous.
4. Why is top dressing legumes with nitrogenous fertilisers not recommended?
   Because legumes fix nitrogen in their root nodules with the help of Nitrogen fixing bacteria.

4.16 Summative Evaluation Questions

1. Explain importance of legumes.
2. Explain the conditions necessary for the rooting of stem cutting when propagating legumes.
3. Explain how weed control is carried out when growing groundnuts.
4. Explain the process of making silage.

4.17 Additional Questions

1. Give two uses of soya beans.
   (i) Used for making protein based supplement used as human food.
   (ii) Used for making concentrates for livestock.
   (iii) Soya beans are roasted and ground to prepare beverage.
2. Name two fodder legumes grown in Rwanda
   (i) Lucerne
   (ii) Desmodium
   (iii) White clover
   (iv) Lupins
3. Name one fodder legume propagated using layering method
   (i) Desmodium
   (ii) Sesbania
   (iii) Leuceana
4. Give four methods of controlling bacterial blight in soya beans.
   (i) Use of clean and certified seeds to prevent infection.
   (ii) Crop rotation
   (iii) Close season
   (iv) Control of vectors
   (v) Rogueing/destroying infected plants

4.18 Suggestions for assignment

(i) Identifying the legumes locally grown at home.
(ii) Visit a nearby farm produce shop and identify the pulses being sold.

4.19 Support for developing of positive skills, value and attitudes

1. Positive life skills developed in this unit include:
   (i) Post-harvest techniques in legumes.
   (ii) Skills in propagation of legumes
   (iii) Creative and critical thinking skills.
   (iv) Report writing and public speaking skills.
2. Positive values and attitude developed:
   (i) Group work encourages co-operation with others.
   (ii) Practical activities build curiosity to explore more.
   (iii) Sharing materials in group activities encourage unity and caring for each other.
   (iv) Reporting develops responsibility and leadership.

4.20 Suggested answers to formative evaluation questions

1. (i) The fodder is cut when 50% of the crop has flowered.
   (ii) The fodder is spread on the ground under a shade to dry.
   (iii) The fodder is turned regularly to ensure uniform drying.
   (iv) It is chopped into small pieces when dry.
   (v) A bailing box measuring about 75 × 30 × 30 cm is used for bailing.
   (vi) Two sisal strings are placed inside the box at both sides.
   (vii) Dry chopped fodder filled in the box and compressed properly to remove air.
   (viii) The compressed materials are tied tightly with the string on both ends.
   (ix) The box is turned upside down to remove the hay bale.

2. (i) Land preparation – This is done early
   - Land is ploughed deeply
   - Land is harrowed to a fine tilt.

   (ii) Planting:
   - Planting is done at the onset of rains.
   - Certified seeds of groundnuts are used.
   - Seeds are planted at 30–35 cm × 4 – 7 cm spacing.
   - Seeds are placed at 5–7 cm deep.
   - Phosphatic fertilisers are used at planting

   (iii) Weed control:
   - The field is kept weed free during the early stages of groundnuts growth.
   - Cultivation is carried out physically.
   - Weeding should be avoided during flowering to prevent shedding of flowers.
   - Uprooting of weeds is done at podding stage to prevent injury.

   (iv) Diseases and pest control:
   - Aphids are controlled using insecticides and also close spacing.
   - Groundnuts mosaic virus disease is controlled by controlling aphids.

   (v) Harvesting:
   - Done when the crop is dry and the pods are mature.
   - Pods are mature when they turn to dare brown colour.
   - Harvesting is done by lifting the pods from the soil with a fork *jembe*.
   - Pods are further dried and shelter.

3. (i) To facilitate compaction.
   (ii) To make it easy for the animal to eat.

4. (i) Planting resistance varieties.
   (ii) Use foliar fungicides such as Benlate.
   (iii) Use of crop rotation with cereals.

5. (i) Seed inoculation – Seeds are coated with nitro-culture.
   (ii) Breaking seeds dormancy – This is done by soaking the seeds in water.
   (iii) Seed dressing – Seeds which are not inoculated are coated with a mixture of powder insecticides and fungicides.

4.21 Suggested Answers to Summative Evaluation Questions

1. (a) Provide food for human and livestock – Legume grains provide pretentious food for human beings while fodder legumes provide proteinous feeds for livestock.
   (b) Provide stakes for climbing crops – Legume shrubs such as pigeon peas, calliandra leucaena produce woody stems which are used to support vine growing crops.
   (c) Importance of soil fertility – Legume fix nitrogen into the soil, enriching soil with nutrients.
   (d) Raw materials for industries – Legume seeds such as groundnuts are used to produce manufactured products such as peanut butter.
   (e) Sold for income – The farmer gets income from the sales of the legume grains.
   (f) Some have medicinal value – They produce certain chemical substances which control some disorders in human body.
   (g) Source of fuel – When the woody legumes are pruned, they provide wood fuel.

2. (i) Temperature – The day and night temperatures of 15^{o} –27^{o} C are suitable for inducing rooting in cuttings.
   (ii) Relative humidity – This should be high.
   (iii) Light intensity– Soft wood cuttings require high light intensity, while hardwood cuttings require dark conditions for rooting.
   (iv) Oxygen supply – Cuttings require proper air circulation in order to root.
   (v) Chemical treatment – rooting of cuttings can be induced using growths hormones.
   (vi) Leaf area – Soft wood cuttings produce roots faster when planted with leaves while the hardwood cuttings, the leaves are pruned off.

3. (i) The groundnut field should be kept weed free during the early stages of growth.
   (ii) Shallow weeding is done to prevent root damage.
   (iii) Weeding should be carried out when the ground is moist.
   (iv) Weeds should be uprooted during flowering to prevent shedding off the flowers.
   (v) Chemical weed control is discouraged since groundnuts are very susceptible to chemicals.

4. (i) A silo trench of 5 long × 3 m wide should be made.
   (ii) It should be on a gently sloppy ground.
   (iii) The crop is harvested at 20–50% flowering.
   (iv) The material is chopped into small pieces.
   (v) A polythene sheet should be spread on the trench made/silo.
   (vi) The chopped materials is filled into the trench and compacted.
   (vii) The temperature of the compacted materials should be checked and maintained at 32° C.
   (viii) The material is covered with the polythene sheet at the top and left airtight.
   (ix) A layer of soil is then placed over the polythene sheet.
   (x) Runoff is prevented from getting in by digging a trench around the silo.

Key Terms (page 125 – 126 of Students' Book 2)

1. **Legume** – Plant which bears its fruit inside a pod.
2. **Pulse** – Legume used as food.
3. **Fodder** – Pasture cut before feeding to livestock.
4. **Substrate** – A substance or materials that provide nutrients and support to a growing plant.
5. **Agroforestry** – Growing of trees or shrubs, pasture (keeping livestock) and growing crops on the same piece of land.
6. **Commercial concentrates** – Processed livestock supplementary feeds which are usually used to provide protein, energy, minerals and vitamins to livestock.
7. **Nurse crops**– Crops that provide shade to other crops.
8. **Pull and push technology** – A technique of controlling stolk borer pest by using the association of Napier, desmodium and cereals attacker by stalk borer such as maize. The desmodium pushes the stalk borer away from the cereals while Napier's grasses attack and destroys them.
9. **Witch weed** – A parasitic weed in some cereals.
10. **Stakes** – Support for growing plants.
11. **Layering** – Forcing part of a plant, usually a branch to produce roots while still attached to the mother plant. The layered part is then cut off and planted to give a new plant.
12. **Plant propagation** – Multiplication of plant.
13. **Dormancy** – A period when planting materials cannot sprout or germinate.
14. **Scarification** – Mechanical damage to a seed coat to break dormancy.
15. **Growth regulator** – Hormones that control growth.
16. **Certified seeds** – Seeds that are of high quality and resistant to diseases attack.
17. **Volunteer plants** – Undesired plants that emerge on their own in a described crop field.
18. **Threshing** – Separation of the seed from the pod. It is also called shelling.
19. **Conditioning** – Preparing produce to escape rotting and attack by pest, for example, by drying to the right moisture content.

20. **Viability** – Ability to germinate or sprout.
21. **Ecology** – Environment conditions which affect plants distribution and growth.
22. **Crop rotation** – Growing of different crops on the same piece of landing in particular order or sequence.
23. **Inoculation** – Coating legumes seeds with the right type of artificial nitrogen fixing bacterium to increase their nitrogen fixation ability.
24. **Herbicides** – Chemicals that kill weeds.
25. **Sorting**– Selecting.
26. **Grading** – Grouping according to size, colour, texture and quality.
27. **Forage** – Plant materials either growing naturally or planted for the purpose of feeding to livestock.
28. **Hay** – Fodder preserved in dry form.
29. **Silage** – Fodder preserved in fermented and succulent form.
30. **Silo** – Structure for preserving silage.
31. **Ensiling** – Preparation of silage.

Answers to Revision Questions (page 126 – 127 of Students' Book 2)

1. A plant which bears a fruit known as a pod.
2. (i) Soya beans (ii) Beans

3. (i) They are used as cover reducing soil erosion
   (ii) Their roots bind soil particles together improving soil structure
   (iii) Their leaves drop and decomposed to form humus which binds the soil particles together.
   (iv) Their roots encourage water infiltration reducing surface water runoff and thus reducing soil erosion.
   (v) Their roots hold the soil reducing the erosive power of moving water after heavy rains.
4. (a) Pulses – edible by humans
   (b) Fodder legumes – those fed on livestock.
5. (i) Should be fertile.
   (ii) Well drained.
   (iii) Good water holding capacity.
   (iv) Free from disease-causing organisms.
6. A (ii) (iii) (i) (iv)
7. (i) Shelling – To free the nuts from the shells.
   (ii) Drying – To reduce moisture content of 7% to prevent rotting.
   (iii) Cleaning and grading – Removing foreign materials to enable sorting.
   (iv) Handling – Need carefull handling to prevent contact with water.
   (v) Conditioning, packing and storage – Dry nuts are packed in dry containers and stored on racks to prevent dampness.
8. (a) Hay – Less succulent with low moisture content.

(b) Silage – Succulent with high moisture content.

9. (i) Cut the crop when about 50% of the crops have flowered.
   (ii) Spread the cut crop on the ground under a shade to dry.
   (iii) Turn it regularly as it dries to ensure uniform drying.
   (iv) Dry the crop 2–3 days ensuring the fodder retains its original colour and rattles with little noise.
   (v) When the stems are twisted, they should not break and sap should not ooze out.
   (vi) Chop the forage with a machete to make it easy to compact during balling.
   (vii) Use a balling box with the dimensions of the hay bales measuring 75 cm × 30 cm × 30 cm.
   (viii) Place two strings at each end of the balling box.
   (ix) Fill the box with dry fodder (Hay).
   (x) Compress the hay to make a compact cube in the box.
   (xi) Tie the bale tightly with a string and turn the box upside down to remove the bale of hay.
   (xii) Store the hay bales in a shade.

10. The coating of legume seeds with the right strain of Rhizobium bacteria to increase nitrogen fixation.
11. Give five methods of breaking dormancy in legume seeds.
   (i) Stratification – Exposure to cold temperatures.
   (ii) Scarification – Mechanical damage.
   (iii) Soaking in water.
   (iv) Exposure to light.
   (v) Slight burning.
   (vi) Drying in the sun.
12. B. (iii) (iv)

Topic Area: Animal Production

Unit 5: Ruminants

Number of periods: 14

Key Unit Competence: Learners should be able to conduct successfully ruminant rearing.

5.1 Learning Objectives

(a) Knowledge and Understanding

- Give examples of ruminant species and breeds.
- Describe ruminant species and breeds by their physical appearances.
- Explain characteristics of ruminant breeds.
- Propose materials to construct a goat shelter.
- Outline the characteristics of ruminant breeds to real.
- Identify the components of an appropriate diet for goat.
- Identify and describe common diseases for ruminant.
- Carry out sanitation rules in ruminant fur.

(b) Skills

- Recognise ruminant definition.
- Observe ruminant species for deducing their differences.
- Detect ruminant breeds.
- Watch and distinguish ruminant breeds with comparison of their characteristics.
- Select and gather materials to construct a goat shelter.
- Perform a goat shelter construction.
- Recognise characteristics of good ruminant breed.
- Practise goat feeding.
- Proceed correctly in solving problems of diseases.
- Perform hygiene in ruminant shelters.

5.2 Content Students' Book page 128 – 179

- Definition of ruminant.
- Ruminant species reared in Rwanda (cattle, goat, sheep).
- Ruminant breeds (cattle: Ankole, Fresian, Jersey; Goat: local, Alpine, Boe, Ethiopian Galla, Saneen; Sheep: Local, mountain white, Merinos.
- Characteristics of ruminant breeds.

Answers to group work activity on page 131 of the Students' Book

(i) Ankole cattle

(ii) Local goats

(iii) Local sheep

- Ruminant shelter standards.
- Selection criteria of breed to rear (Goat and sheep: Natural base width, muscling, volume and capacity, style and balance, growth potential, a hooves and pasterns, walking, fat and muscle for beef and udders, tear size, fertility, navel for cows).
- Feeding (Fodder species: for ruminants (fodder grasses and fodder legumes) and concentrate).
- Feeding (fodder species for ruminants and concentrates).
- Ruminant diseases (cattle: brucellosis, theirelliosis, tuberculosis, bovine anaplasmosis, East coast fever, heart water, enteric; Goats: encephalitis, clostridia diseases; sheep: blue tonge, cryptococcosis, heart fever, vesicular stomatitis

5.3 Learning Activities

- Visit to Agricultural and Veterinary schools or ruminant farms to observe ruminant species and indicate through discussion the difference between them by their characteristics.
- Watching videos on different ruminant animals to find out after groups' discussions characteristics of each breed.
- Field visit on multipurpose farm to observe a goat shelter and materials it is made of and how they are arranged and discuss in groups used standards and different operation to carry out in constructing a goat shelter.
- Field work to construct a standardised goat shelter according to the number of goats in one shelter.
- Field trip to ruminant farms to find out criteria (age, types of products, quantity of products, prolificacy) taken into account when choosing good ruminant breeds for rearing.
- Field trip to goat farms to find out distributed food with a given frequency and in group discussions extrapolate different ingredients of goat's diet and come up with a feeding plan as implemented in the farm.
- Videos or pictures of different goat diseases to observe and list characteristic (symptoms and damages) of each diseases individually and after discussion in groups on found characteristics (symptom damages) for each diseases.
- Field trip to a ruminant farm to find out required activities to be performed and inmate them in school farm.

5.4 Links to Other Subjects

- Mathematics – For measurement of distance and dimensions of structures.
- Geometry – For measuring angles, plane and slope of the floor of structures.

- Home science – For nutritious, proper nutrition for livestock, provision of a balance diet, feeding pan for all ages.
- Biology – For genetic and classification of animal organisms.

5.5 Assessment Criteria

Assess the learner's ability to:

- Differentiate ruminant species and breeds by their characteristics.
- Construct a goat shelter according to the number of goats in one shelter and to sort out materials available in the area.
- Conduct goat feeding successfully in a goat farm considering the weight, production-quality, type of intended product.
- Find out/recognise goat diseases and enemies in a goat farm by referring to their symptoms and damages.
- Carry out sanitation in ruminant shelter.

5.6 Materials and Resources

Ruminant farms, projector, CD-videos on ruminant shelter, construction materials, fodder and concentrates, water, brooms, sholve, manure fold, wheelbarrow, disinfectants feeding equipment and waters.

5.7 Suggested Low Cost or No Cost Materials

(a) Ask learners to bring materials such as timber, nails, tools like hammers and crowbars from home.

(b) Ask learners to bring sample of livestock fodder and concentrates such as Napier grass, Lucerne calliandra, leucaena.

(c) Borrow pictures of ruminants and videos of ruminant animals suffering different diseases from neighbouring schools, research institutions and veterinary institutions.

(d) Use free sites in the internet to download and observe ruminant breeds, fodders and concentrate, ruminant diseases and routine sanitation plan.

5.8 Methods of Teaching

Content	Method(s)
1. Definition of ruminants	**Discussion**: Learners to interact among themselves by giving their opinion on the definition of ruminants after searching from the internet, library books and textbooks. They write their findings and present them to the class. The teacher to introduce the topic and guide the discussion then makes final conclusion.

2. Ruminant species reared in Rwanda	**Field visit**: The teacher to organise a visit, prepare questionnaires as shown in Annex 14 and control the learners' discipline. The learners make observations of the ruminant species reared in Rwanda as required in the questionnaire, discuss and present their findings to the class. The teacher concludes the lesson and gives summary notes.
3. Ruminant breeds	**Discussion**: The teacher introduces the topic ruminant breeds and their characteristics and guides the discussion. **Note:** *The two activities on ruminant breeds and their characteristics can be combined as an activity.* The learners to find out the ruminant breeds and their characteristics from internet, library books and text books. The learners then give their opinion, record and present their findings to class. The teacher to summarise by giving conclusion about the facts and summary notes.
4. Characteristics of ruminant breeds	**Discussion**: The teacher to introduce the topic, divide the learners in groups and guides the discussion. The learners to give their opinion, record and present their findings to the class. The teacher to conclude and give summary notes.

5. Ruminant shelter standards	(i) **Field visit**: The teacher to prepare a questionnaire as shown in Annex 15, organise for the trip and instructs the learners to make observations on ruminant shelter standards (cattle, sheep and goat structures). The teacher also controls the learners while in the visit. The learners to make observations on the ruminant shelter standards, discuss and present their findings to the class. The teacher to give conclusion and summary notes. (ii) **Supervised activity**: The teacher should provide the materials needed and supervises the learners when constructing a goat shelter. The learners to discuss and record their observations and experiences and then present to the class. The teacher to make conclusion and give summary notes.
6. Selection criteria of breeds to rear (goats, sheep and cattle)	**Field visit**: The teacher to prepare a questionnaire as shown in Annex 16 and organise a field visit and instructs the learners to observe the selection criteria of ruminant breeds to rear. The learners to observe, discuss and present their findings to the class. The teacher to conclude and give summary notes.

7. Feeding ruminants	(i) **Discussion**: The teacher to introduce the topic on the feeding of ruminants on fodder and concentrates, divide the learners into groups and supervise the discussion from group to group. The learners to interact freely by giving the opinion and suggestions on feeding of ruminants on fodder and concentrates and present their findings to the class. The teacher then concludes and gives summary notes. (ii) **Field visit**: The teacher to prepare a questionnaire as shown in Annex 17 and organises for a field visit for the learners to observe the feeding of ruminants. cattle, sheep and goats and make a feeding plan for goats. The learners make observations on how ruminants are fed and feeds. Then learners make observations, discuss in groups and present their findings to the class. The teacher to give conclusion and summary notes.

8. Diseases of ruminants	(i) **Field visit**: The teacher to prepare a questionnaire and organise a field trip to a ruminant farm, instruct the learners to make observations on ruminant diseases, activity to be carried out and maintain discipline. The learners to make observations on diseases that attack cattle, sheep and goats, discuss and present their findings to class. The teacher to conclude and give summary notes. (ii) **Discussion**: The teacher uses a video show and colour photographs for the learners to view diseases that attack goats. The teacher to divide the learners into groups, guide the learners to discuss what they saw on the video and photographs. The learners observe and interact freely by giving their opinion on what they viewed. They record and present their findings to the class. The teacher concludes and gives summary notes.
9. Sanitation	**Field visit**: The teacher to prepare a questionnaire as shown in Annex 19 and organises a field trip to a ruminant farm for the learners to observe sanitation. The learners to make observations, discuss and present their findings to the class. The teacher to give conclusion and summary notes.

10. Group activity	(i) **Field visit**: The teacher to prepare a questionnaire as shown in Annex 20 and organises a field trip to the school farm or outside for the learners to participate in the maintenance of sanitation in a ruminant livestock farm. The learners to use their findings to carry out the supervised activity when back to school. (ii) **Supervised activity**: The teacher to avail materials required and then supervise the learners carrying out sanitation measures in ruminant shelters. The learners to carry out sanitation measures indicated in the questionnaire, discuss their findings and experiences and present these to the class.

5.9 Suggested teaching and learning activities and exercise to support delivery of content and development of students' competences

Competences

(i) Explaining key concepts in the topic such as definitions, the selection criteria.
(ii) Teacher demonstrating feeding a goat, how to make the goat house and how to carry out sanitation in the ruminant shelter.
(iii) Group discussion on how to feed goats, the factors to consider when siting a goat shelter, diseases which affect ruminant livestock.
(iv) Practical activities in groups.
(v) Report writing and reporting.
(vi) Questions and answers.
(vii) Assessment of practical activities

5.10 Cross-cutting issues to be integrated in the teaching and learning activities

(i) Environment and sustainability – Acquires skills and attitudes to address environment and climate change issues.

(ii) Peace and values education – Working together brings peace and harmony and commitment to avoid conflict.
(iii) Standardisation culture – Develops understanding of the importance of standards as a pillar of economic development.
(iv) Inclusive education– Embraces every individual regardless of gender or ability.

5.11 Suggestions for accommodating special education needs (SEN)

(a) Visual impairment
- Ask other learners to assist in colour identification.
- Use large prints instruction sheets, questionnaires and assessment papers.
- Allow them to sit near the chalkboard when in class.

(b) Hearing impairment
- Be audible enough to the learners.
- Allow them to sit close to the teacher.

(c) Physical impairment
- Pair them with other able-bodied learners to be assisted.
- Organise activities to be close to prevent too much movement.

(d) Gifted learners
- Give extra duties such as assisting slow learners and special need learners.
- Place them in different working groups to assist other learners.

(e) Slow learners
- Give individualised attention.
- Take time when going through the procedures.
- Ask fast learners to assist them.

5.12 Formative Evaluation

1. Define a ruminant.
2. Name the ruminant reared in Rwanda using the local names.
3. Give difference between ruminant species reared and possibly the products they produce.
4. List the characteristics of the Ankole breed.
5. Which colour is a Jersey breed of cattle?
6. Both the Saanen goat and Galla goat are white in colour. What is used to differentiate them?
7. Give difference between the Boer goat and Alpine goat.
8. Give the different characteristics between the local sheep and merino.

9. Name the sheep kept for both wool and mutton.
10. Which observable differences can be seen between dorper breed and mountain white breed?
11. Give the reasons for carrying out selection in ruminants.
12. Name the types of feed given to goats.
13. Name the types of plants that goats feed on.
14. Apart from plants, which other materials are given to goats for feeding?
15. What do we use to feed young goats?
16. What is weaning?
17. Why would we give a lactating doe extra feed?
18. Do goats like browsing or grazing?
19. What is a disease?
20. What are the symptoms that we can observe when the goats are sick and when they are healthy?
21. Name some methods we can use to control diseases which are transmitted with ticks.
22. Give a simple routine practice which is carried out daily in a ruminant shelter.

5.13 Additional Content to the Teacher

Importance of keeping livestock

- To provide food such as milk and meat.
- To provide livestock by-products such as wool and skin.
- For cultural practices such as paying dowry.
- To provide animal power.
- Used for recreation.

Other ruminant livestock breeds

- Dairy cattle breeds kept in Rwanda also include brown Swiss. These dairy breeds are used to upgrade the local breeds for milk and meat production improvement.
- Dual purpose breeds of cattle provide both meat and milk; these breeds include sahiwal.
- Goat breeds are classified into meat and dairy goats. Some breeds are kept for hair production such as Boer and Alpine.
- Sheep provide both wool and mutton, wool sheep are best in the highlands while mutton sheep are best kept in the lowlands.

Ruminant shelter standards

When selecting structure for making livestock houses, it is important to consider the following:

(i) The number of operations to be carried out.
(ii) The number of livestock to be kept.

(iii) The potential for expansion.
(iv) Accessibility.

Selection of materials for a goat house:
When selecting the materials to construct a goat house, the following factors are considered.
(i) Availability of materials.
(ii) Cost of materials.
(iii) Suitability of materials.
(iv) Durability of materials.
(v) Strength of materials.
(vi) Workability of materials.

Ruminant livestock diseases:
Causes of livestock diseases include nutritional, physical, chemical and pathogens. Pathogens include viruses, bacteria, protozoa, rickets and fungi.

Large organisms that affect ruminants are parasites and can either be classified as internal or external parasites. These include tapeworms, round worms, ticks, tsetse flies, mosquitos, among others.

Most viral diseases are notifiable and are controlled through vaccination, quarantine and isolation. Viral diseases have no cure.

Bacterial diseases are infectious and contagious, are controlled through vaccination, quarantine, isolation, culling and treatment using antibiotics.

Protozoa and rickettsia diseases are mainly vector borne. These are controlled effectively through management of vectors. Fungus diseases may affect livestock with low immunity. These are controlled using antifungal medication.

Some of the diseases which affect livestock can also affect man. These are said to be zoonotic. Farmers are advised to be cautious when handling the livestock and their products. These include brucellosis, anthrax, clostridia infection and cryptococcosis.

5.14 Notes to the Teacher

- Prepare assessment sheets.
- Prepare lesson plan for method of teaching.
- Collect materials for practical activity before the exercise.
- Carry demonstration before practical activity to ensure the practical works.
- Prepare practical sheets.
- Carry out a reconnaissance tour to the site before trip.
- Prepare questionnaire before trip.
- Prepare students a day before the trip.
- Allow learners adequate time to give report of the findings after a practical activity.
- Encourage learners to discuss and present their findings.
- Probe fast learners with simulating questions.

- Encourage slow learners to participate in discussion and answering low order questions.
- Provide physical and moral support to physically, visually and hearing impaired students.
- Give summary notes to the learners after a practical activity.
- Keep learners progressive record and give feedback to the parents.

5.15 Additional Remedial Consolidation and Extension Activities

High order questions for fast learners

1. Explain the meaning of the term breed.
   A group of animals with similar characteristics and common origin which when mated produce young ones with characteristics similar to those of parents.
2. Describe the observable differences between Saanen and the local goat breeds.
   Saanen has purely white coat colour while the local goat breed have a mixture of colours on their skin.
3. Explain the structural requirement of a goat shelter.
   (i) *Spacious enough – to allow freedom of movement.*
   (ii) *Draught free – should not allow any cold dry winds to prevent pneumonia.*
   (iii) *Well ventilated – to allow for free gaseous exchange.*
   (iv) *Leak proof roof – to avoid humid conditions that may predispose the goats to infections.*
   (v) *Strong – to support the intended weight of goats and farmer while working inside.*
4. Analyse the nutrients contained in the following foodstuffs in ruminant production.
   (a) Napier grass – *rich in carbohydrates*
   (b) Molasses – *supply carbohydrates*
   (c) Oil seed cakes – *supply carbohydrates and proteins*

Low order questions for average learners

1. List the observable characteristics of Friesian.
   (i) *Black colour with white patches or white colour with black patches*
   (ii) *Large in size with bulls weighing 900 – 1000 kgs and cows 550 – 680 kgs. Calves are born with a weight of 35 – 40 kgs liveweight.*
   (iii) *It produces the highest milk yield of 9,150 kg per a lactation of 305 days (10 months) with good management.*
   (iv) *Heifers mature at 21 months and calves down at the age of 30 months.*

2. Give the observable differences between the Ankole and the Jersey breed.

Ankole	Jersey
(i) Long distinctive horns that can reach a length of up to 1.2 metres each. *(ii) Brown in colour or deep red though there are some shades of black and white.* *(iii) Have a pendulous dewlap and an umbilical fold.* *(iv) Have humps of varying sizes.*	*(i) They are polled.* *(ii) Colour varies from light yellow, brown or fawn to a shade of black.* *(iii) Have no dewlap and umbilical fold.* *(iv) Have no humps.*

3. List the materials and tools used to construct

(i) Timber
(ii) Plywood
(iii) Crow bar
(iv) Concrete
(v) Claw hammer
(vi) Nails
(vii) Iron sheets
(viii) Wire mesh

4. Name feedstuffs given to a goat

(i) *Grass fodder such as Napier grass, Guatemala grass such as grass and maize.*
(ii) *Legume fodder such as Lucerne desmodium, vetch and leucaene and sosbania.*
(iii) *Energy concentrates such as molasses and ground flow of various grains.*
(iv) *Protein concentrates obtained from animal sources such as milk, blood, bones, legume plants, oil crops such as soya beans, groundnuts, simsim and sunflower.*

5.16 Summative Evaluation Questions

1. Identify the ruminant species shown in the diagrams below.

(a)

(b)

2. List the goat breeds reared in Rwanda.
3. Describe the rearing of goats under the following topics:
   (a) Breeds
   (b) Feeding
   (c) List of sanitation rules in a goat farm

5.17 Additional Questions

1. Explain the selection criteria for the following animals

(i) Dairy Cattle

- **Body conformation–**Dairy cattle should have wedge shaped body also known as the dairy conformation while beef cattle should have blocky shaped body conformation.
- **Hind quarters**–Should have well developed hind quarters with a wide space for large udder.
- **Udder**– Large and well developed udder and teats with prominent milk veins
- **Body size**–Have lean body with little flesh.
- **Stomach capacity**– Large stomach capacity to hold a lot of food.
- **Temperament**–Should have mild temperament and docile.
- **Calving period**– Should be fertile with short calving period/regular breeders.
- **Umbilical fold–**Little or no umbilical fold/reduced navel.

(ii) Wool Sheep

- **Wool staple length**– Should have long staple length with low shrinkage.
- **Wool colour**– Preferably white for easy dyeing.
- **Fleece weight**– Should have a high fleece weight.
- **Wool elasticity**–Wool should be of high elasticity.

(iii) Dairy goats

- **Udder structure and teat placement**–Should have a large udder. The udder should have two teats.
- **Growth rate**– Should have a fast growth rate and mature early.
- **Health**– Should be alert and active.
- **Appetite**–Should have a normal and good appetite (ravenous appetite indicates abnormality).

2. **East coast fever**–A protozoa known as *Thieleria parva.*
   Tuberculosis – A bacterium known as *Mycobacterium bovis.*

3. Colostrum is highly nutritive, digestible and contains antibodies needed by the young animals.
4. (i) **Steaming up** – To give the pregnant animals energy in preparation for giving birth so that they will have enough energy and produce enough milk for the young ones.

(ii) **Flushing up**– To give the males enough energy for mating and increase chances of conception in females.

5. **Notifiable disease**–A disease that is highly contagious and infectious and whose outbreak must be reported to the relevant government authorities for appropriate action to be taken.
   Zoonotic disease– A disease that affects both livestock and human beings.

5.18 Suggestions for Assignment

(a) Identify ruminant species kept in Rwanda.
(b) Visit an abattoir to observe the digestive system of ruminant.
(c) Visit a carpenter and observe the use of tools when working with timber.
(d) Visit an agrochemical shop and observe commercial livestock feeds.

5.19 Support for Developing of Positive Skills and Values

- Active participation in group discussion and interact positively with other colleagues.
- Be aware of differences between ruminant species and breeds.
- Appreciating each other's views when discussing characteristics of ruminant breed.
- Choose required materials for a given activity with diligence.
- Showing kindness and gentleness to the animals when inspecting them.
- Take initiative to feed ruminants.
- Be creative to solve problems of diseases.
- Take initiative to feed ruminants so as to ensure a healthy herd/flock.
- Be creative and attentive to solve problems of diseases in ruminants.
- Co-operate with colleagues to carry out sanitation rules fostering communicating and participating in community work positively.

5.20 Suggested answers to formative evaluation questions

1. A herbivorous mammal that chews cud and has a special stomach chamber known as rumen.
2. (i) Cattle give milk and meat. They are large livestock.
   (ii) Sheep give wool and mutton. They are small and have fleece on their body.
   (iii) Goats give milk and meat. They are small, hardy and have hair covering their bodies.
3. (i) Long horns
   (ii) Has long loose dewlap and umbilical fold
   (iii) Has a hump
   (iv) Medium sized
   (v) Originates from Africa
4. Roan to cream colour with jet black eyes
5. Skin colour

6. Boer is large and kept for meat, alpine is kept for milk.
7. Local sheep is kept for mutton, merino is kept for wool.
8. Corriadale.
9. Dorper lacks fleece, has a black head and kept for mutton, mountain white is kept for wool.
10. To fetch good market prices.
11. Fodder, concetrates, mineral licks and vitamins.
12. Napier grass, Lucerne, desmodium, sesbania, calloiandra.
13. Vitamin supplements and mineral salts.
14. Colostrum and pellets.
15. Introducing solid feeds to young goats when they are two time market size.
16. To supplement production of milk.
17. Browsing.
18. Any alteration is normal. State any function of livestock.
19. (i) Poor appetite
    (ii) Poor gait
    (iii) Emaciation
    (iv) Diarrhoea
    (v) Coughing
    (vi) Ulcerated mucus membrane, normal mucus membrane
20. Dipping, spraying, fencing, picking and killing, trapping
21. Washing, mopping, removal of water and feed left-overs.

5.21 Answers to Summative Evaluation

1. A. Cattle
   B. Goat
2. (i) Local
   (ii) Saanen
   (iii) Ethiopian galla
   (iv) Alpine
3. **(a) Goat breeds**
   Local
   Alpine
   Boer
   Ethiopian Galla
   Saneen

   (b) Feeding
   Feeding goats mainly involves giving plant materials.
   Goats should also be fed according to their age and type of enterprise, either milk goats or meat goats

The following are some of the feeding practices for goats:

(a) Creep feeding or feeding of kids
(b) Feeding when weaning goats
(c) Feeding of adult goats which involve:
    (i) Flushing
    (ii) Steaming up
    (iii) Fattening

When carrying out maintenance, all food nutrient requirements are provided in their correct proportions but only to sustain the animal life.

When feeding for production, an extra amount above the maintenance is given to support production such as milk production and meat production.

Feeding your goats after birth

- Colostrum is the first milk that a doe produces after giving birth.
- Suckle colostrum during the first 3–4 hours and continue for three days.
- Meat goats are left with mothers to continue suckling until weaning.
- Dairy goats are separated after 7 days and hand feeding is done or bottle feeding is done. Giving 0.5 litres of milk per day for the first week and increased to 1.25 litres of milk per day by 12th week or weaning time twice daily.
- Introduce soft herbage in form of wilted Lucerne and hay at 8 weeks or two and a half times the birth weight.
- Dairy meal can be given at a rate of 250 grams per day, also an artificial grain mix.

Weaning

- Weaning is the introduction of solid feeds to kids of young goats.
- They introduce micro-organisms in the rumen and make rumen strong to adapt and accept solid feeds.
- Early weaning is done at 35 days of age and when there is a limited supply of milk.
- The following can be given:
    (i) Hay
    (ii) Wilted Lucerne
    (iii) Dairy concentrates
    (iv) Milk in limited amounts

Late weaning is mainly done to meat goats. Weaning is mainly done when the young goats are two and a half times their birth weight.

Feeding adult goats

- Goats are browsers and prefer feeding on leaves from twigs and short trees.

- Goats would browse on moist indigenous shrubs such as acacia, lantana and grass.
- Supplemented using
  (i) Pasture Hay
  (ii) Lucerne
  (iii) Grain rations
  (iv) Concentrations in form of dairy meal
  (v) Salt licks or mineral licks
  (vi) Vitamin premixes
  (vii) Give enough clean water

(c) Sanitation in a goat house

1. Proper housing and hygiene
2. Use of antiseptic and disinfectants
3. Proper disposal of carcasses and waste
4. Isolation of sick animals
5. Imposition of quarantine
6. Slaughtering and burning infected animals
7. Proper nutrition
8. Provision of clean equipment

Key Terms (pages 179 –180 of the Students' Book 2)

1. **Oxen** – Castrated male animal used in providing power when pulling carts or ploughs.
2. **Wealth** – The assets owned by an individual.
3. **Lactation period** – A period when a cow produces milk after birth until is dried up.
4. **Butter fat content** – The proportion of butter fat in milk.
5. **Exotic** – Imported from Europe or temperate countries.
6. **Polled** – Without horns.
7. **Native/indigenous** – Originated or found locally.
8. **Staple length of wool** – The quality measure of length of wool.
9. **Concrete** – A mixture of cement, sand and gravel mixed with water and used for building.
10. **Infectious** – A disease which spreads very fast through air, water and food.
11. **Contagious** –A disease which is spread through contact with the disease-causing agent.
12. **Paralysis** – Inability to co-ordinate the body due to damage in the nervous system.
13. **Vaccine** – A weakened disease-causing agent introduced to animals to stimulate the body to produce antibodies.

14. **Neurological signs** – Deviation from the normal behaviour caused by nervous disorder.
15. **Fever** – Change in temperature.
16. **Isolation** – Separation of livestock.
17. **Anaemia** – Loss of red blood cells.
18. **Constipation** – Inability to digest.
19. **Cross breeding** – Breeding two animal breeds of the same species which are not related.
20. **Dehydration**– Loss of water in the body.
21. **Tick** – An external parasite that transmits diseases to livestock.
22. **Acaricide** – A chemical used to control ticks.
23. **Antibiotic** – A chemical used to treat bacterial diseases.
24. **Ad-libutum** – Without a measure.
25. **Abbatoir** – A livestock slaughter house.
26. **Slated floor** – A wooden floor with small space between timber slabs to allow passage of droppings in the goat houses.
27. **Tropical diseases** – Diseases commonly found within the tropics.
28. **Fodder** – Crop grown and harvested for livestock.
29. **Concentrates** – Feeds containing high protein content and low fibre content.
30. **Tubercles** – Swellings in body tissues due to tuberculosis infection.

Answers to Revision Questions (page 180 – 182 of Students' Book 2)

1. A ruminant is mammal that chews cud and has a special stomach chambers known as rumen.
2. (i) Cattle
   (ii) Sheep
   (iii) Goats
3. (i) Provide food
   (ii) Provide powder
   (iii) Used for cultural activities
   (iv) Provide wool, skin, bones and horns
4. A – Face
   B – Muzzle
   C – Brisket
   D – Udder
   E – Switch
   F – Rump
5. (a) Mixture of colours from black to speckled brown or white.
   (b) Brown to grey in colour with strip on the back and face.
   (c) White in colour with white skin.
   (d) White in colour with black skin.
   (e) White in colour with brown head.

6. (a) Merino sheep
   (b) Mountain white

7. (i) The direction of prevailing wind
   (ii) Accessibility
   (iii) Location of homestead
   (iv) Security
   (v) Drainage
   (vi) Relationship with other structures
   (vii) Farmers preference and taste
   (viii) Nearness to amenities

8. • Select a suitable site with flat gently sloping ground.
   • Beware of the wind direction with the windward side facing behind of the house.
   • Clear vegetation and measure at least 3.3m × 3.3m for 3 goats.
   • Dig hole measuring 60-90 cm apart at the corner.
   • Place poles in the holes and reinforce with concrete.
   • Fix wooden board on the three sides exposed to wind. Nail the end of the board to fix them to the poles.
   • Make wall plate, fix rafter over the sloping length of the roof.
   • Fix purlins.
   • Construct a raised slated floor 0.6 m –0.9 m above the ground.
   • Fix a floor frame and put on it timber 1.4 cm –1.6 cm apart.
   • Construct an inclined passage to the door with an elevation of less than 45^{o}C.
   • Put in feeders and waterers and raised bed where the goats can sleep.

9. Large udder
   Natural base width, muscling, volume and capacity, style and balance, fast growth potential, young age;
   Natural base width, muscling, volume and capacity, style and balance, fast growth potential, young age;
10. Napier grass, sorghum, maize, Guatemala grass.
11. Lucerne, desmodium and vetch.
12. It is a feed with a high plane of nutrients.
13. Laxative.
    Nutritious
    Have antibodies
    Palatable and highly digestible

14. Give milk
    Wilted Lucerne and hay
    Give enough water
15. Feeding plan for a goat.
    - Feed kids with colostrum during the first 3-4 hours.
    - Separate dairy kids with their mothers, leave meat goat kid with their mothers.
    - Give 0.5 litres of milk per day.
    - Give dairy meal or artificial grain.
    - Give water.
    - Wean kids at 2 ½ times their birth weight.
    - Give wilted lucerne and hay.
    - Provide lucerne, hay and other fodder.
    - Give vitamins.
    - Give enough water.
16. Nutritional, chemical, physical and photogenic.
17. *Brucella abortus*
    Babesia spp
    Mycobacteriyum bovis
18. (a) Caprine arthritis encephalitis
    (b) Vesicular stomatitis
19. (a) East Coast fever
        Control
        (i) Control ticks by dipping
        (ii) Fencing
        (iii) Treatment
        (iv) Cross breeding with local breeds
    (b) Black quarter
        (i) Vaccination using blanthrax
        (ii) Treatment with antibiotics
        (iii) Use of antitoxins
        (iv) Burry carcass deep in soil
    (c) Cryptococcosis
        (i) Killing of affected sheep
        (ii) Treatment using fungicides
        (iii) Management of stein lesions
        (iv) Isolation and treatment of sick animals

20. (a) Proper housing and hygiene. A ruminant house should have the following structural features:
        (i) Well ventilated but free from drought
        (ii) Adequate spaces
        (iii) Well drained

(iv) Have leak-proof roof
(v) Well lit
(vi) Easy to clean

(b) Use anticeptics and disinfectants. The ruminant house should be disinfected using recommended antiseptic and disinfectants such as formalin, chlorine, water and soap detergents.

(c) Proper disposal of carcasses and waste. Carcasses from sick animals should be buried deeply in soil or burnt completely to prevent spread of diseases. Droppings and other wastes are possible provisions of clean equipment
Feed and water troughs should be cleaned everyday. Surgical instruments should be sterilised before use. Animal handling equipment should be cleaned thoroughly before use to prevent spread of diseases.

(d) Isolation of sick animals
All animals showing clinical symptoms are separated from the rest of the herd to prevent the spread of infectious and contagious diseases. Isolation should be continued until the animal recovers.

(e) Imposing quarantine
The movement of animals and their products from a region with a disease outbreak is restricted. This prevents the spread of diseases. During this period of restriction, other measures of disease control such as vaccination and treatment are employed.

(f) Slaughtering and burning infected animals
In this method sick animals with dangerous contagious diseases are slaughtered and burnt or buried deeply in the soil. In some cases the whole herd is slaughtered to prevent the spread of the disease.

(g) Proper nutrition
Animals should be provided with clean and fresh foods to prevent disease spread through water. Provide a high plan of nutrition to give the animals energy and helps to control nutritional deficiency disorder.

Topic Area: Animal Production

Unit 6: Livestock Products

Number of periods: 4

Key Unit Competence: Learners should be able to preserve safely high quality livestock products.

6.1 Learning Objectives

(a) Knowledge and Understanding

(i) Discuss the importance of preservation.
(ii) Discuss on the operation of preservation of products and by-products of cattle.
(iii) Discuss on the operation of preservation of products and by-products of pigs.
(iv) Analyse a problem of poultry meat that needs a solution.
(v) Give real examples of rabbit products and operation of preserving them.

(b) Skills

(i) Recognise the importance of preservation.
(ii) See and find out the operations of preservation products and by-products of cattle.
(iii) See and find out the operations of preservation products and by-products of pigs.
(iv) Pace to find out problem of bad preservation of poultry meat.
(v) Recognise products of rabbit that require preservation and indicate the best measure of their preservation.

(c) Attitudes and values

(i) Pay attention while discussing in groups.
(ii) Participate actively in group discussion and interact positively with colleagues.
(iii) Beware of preservation operations of products and by-products of pigs.
(iv) Read voluntarily and obey mentioned instructions to solve problem.
(v) Follow attentively and pay attention to interpret with others for discovering required measures to preserve rabbit products.

6.2 Content Students' Book page 183 – 199

(i) Importance of preservation.
(ii) Preservation of cattle products and by-products (meat, milk, skin, ice cream,

cheese, yoghurt) and by-products (tallow, gelatin, lather, blood, horns and bones).

Answers to the questions in table 6.2: Cattle by-products in the Students' Book page 193

Cattle by-products	Method of preservation
(a) Tallow	(i) Freezing (ii) Use of air-tight containers to keep off oxygen that may cause oxidation of unsaturated fats
(b) Gelatin	(i) Cooling (ii) Refrigeration (iii) Freezing
(c) Leather	(i) Dying (ii) Use of chemicals
(d) Blood	(i) Cooling (ii) Refrigeration (iii) Adding of salt/additives
(e) Horns and Bones	(i) Drying

(iii) Preservation of pig products (meat, lard) and by-products (suede for shows and clothing, gelatin for fur and non-food uses).

Answers to questions in table 6.3: Methods of preserving pig by-products in the Students' Book page 197

Pig by-products	Method of preservation
(a) Suede	(i) Drying to remove water and prevent putrification (ii) Use of chemicals, e.g., tannins
(b) Gelatin	(i) Cooling (ii) Refrigeration (iii) Freezing

(iv) Preservation of poultry products (meat, eggs).

Answers to questions in table 6.4: Methods of preserving poultry products in the Students' Book page 197

Poultry product	Method of preservation
(a) Meat	(i) Refrigeration (ii) Cooking/boiling (iii) Freezing
(b) Eggs	(i) Pickling/storing under olive oil (ii) Cooling/keeping in a dry cool place (iii) Refrigeration

(v) Preservation of rabbit products (meat for making socks).

Answers to questions in table 6.5: Method of preserving Rabbit products in the Students' Book page 198

Rabbit product	Method of preservation
(a) Meat	(i) Refrigeration (ii) Heat treatment/cooking (iii) Freezing
(b) Fur	(i) Storing in a cool dry place (ii) Use of chemicals to prevent pest attack.

6.3 Learning Activities

(i) Observation of destroyed products to identify their characteristics based on smell, taste, look, colour and deduce the importance of preservation after group discussion.

(ii) Trip to livestock products processing industries and dairies to observe and discuss on different operations to carry out in preserving safely livestock products.

6.4 Links to Other Subjects

This unit is linked to other subjects such as Home Science on nutrition, Biology on importance of bacterial and fungi and biotechnology.

6.5 Assessment Criteria

The assessment of this unit will be based on the ability of the learner's to identify livestock products preserved badly according to their smell, colour, taste and physical appearances and preserve livestock products safely referring to required operations.

6.6 Learning Materials/Resources

The following learning materials/resources are needed in teaching this unit:

(i) Damaged livestock products such as rotten meat and eggs.
(ii) Processing industries.
(iii) Dairies.

6.7 Suggested Low Cost or No Cost Materials

The teacher can ask the learners to bring livestock products such as milk, meat, eggs, skin, ice cream, yoghurt, horns, bones, leather, tallow; lard, rabbit fur and any other products fresh or damaged from home.

6.8 Methods of Teaching

The following methods are recommended in the teaching of this unit:

Content	Method(s)
1. Importance of preservation	**Supervise practised activity**: The teacher to exhibit livestock products and instruct the learners to compare the destroyed and fresh characteristics of both products. The learners to make observations, discuss and present their findings to the class. The teacher to make conclusions and give summary notes.
2. Presevation of cattle products and by-products	**Field trip**: The teacher to prepare questionnaire as shown in Annex 21 and organises a field trip to a livestock processing industry, activity to be carried out. The learners make observations of the cattle products and by-products and how they are processed and preserved. The learners then discuss and present their findings to the class. The teacher to make conclusions and give summary notes.
3. Preservation of pig products and by-products	**Discussion**: The teacher to introduce the topic and instructs the learners to use internet, photographs, library books and text books to find out how the products are processed and preserved. The learners record and discuss their findings and then present them to class. The teacher to give a conclusion and summary notes.

4. Preservation of poultry products	**Discussion**: The teacher to introduce the topic on preservation of poultry products and instructs the learners to find out from internet, library books, photographs and textbooks how the products are processed and preserved. The learners record and discuss their findings and then present them to the class. The teacher to make neccessary corrections, give the conclusion and summary notes.
5. Preservation of rabbit products	**Discussion**: The teacher to introduce the topic on the preservation of rabbit products and instructs the learners to use internet, library books, photographs and textbooks to find out how they are processed and preserved. The teacher to conclude and give summary notes.
Group Activity	**Discussion**: The teacher to divide learners into groups and assign each group the topic to discuss as follows: Group I: Different methods of preserving cattle products and by-products. Group II: Methods of preserving pig products. Group III: Methods of preserving poultry products. Group IV: Methods of preserving rabbit products. The learners give their suggestions freely, record and present their findings to the class.The teacher to conclude and give summary notes.

References

1. *S2 Agriculture Students' Book.*
2. Dictionaries.
3. Library books.
4. Internet.

6.9 Suggested teaching and learning activities and exercise to support delivery of content and development of students' competences

The following activities are suggested in the teaching of this unit:

(i) Observation of destroyed products.

(ii) A trip to livestock processing industry and a dairy.
(iii) Discussion on the preservation of the following products; cattle products, pig products, poultry products and rabbit products.
(iv) Report writing and reporting.
(v) Answering the revision questions at the end of the unit.

6.10 Cross-cutting issues

1. Environment and sustainability–Addresses environment and climate issues.
2. Standardisation culture–Develops understanding of the importance of standards as a pillar of economic development.
3. Inclusive education–Embraces every individual regardless of gender or ability.

6.11 Suggestion for accommodating special education needs (SEN)

The teacher should identify learners with special needs and cater for them during teaching.

(a) Sensory impairment (visual)
(i) Teacher to write large print letters on the board.
(ii) Those using braille machines to be provided with comfortable sitting place and desk for the machine.

(b) Sensory impairment (hearing)
(i) Teacher should be loud enough for the learners.
(ii) Allow learners to sit near the teacher.

(c) Motor impairment (movement)
(i) As much as possible activities should be done in one place to avoid too much movement.
(ii) Ask the other learners to assist them in identifying damaged livestock products.

(d) Gifted or talented learners
(i) Give them extra duties during the lesson.
(ii) Ask them to assist slow learners when carrying out activities.
(iii) Place them in different discussion groups while assigning activities.

6.12 Formative Evaluation

1. What is a pathogen?
2. Differentiate between aerobic and anaerobic respiration.
3. State four methods of curing hides.
4. What is drying?
5. Why is drying more commonly used as a method of preservation?
6. What is shelf life?

6.13 Additional content to the Teacher

General Method of Preserving Livestock Products

The following are general methods of preserving livestock products:

(a) Drying

This is a method of preservation where water is removed through evaporation. The evaporation may be done through sun drying or by use an air current (air drying). Drying inhibit the growth of micro-organisms that causes spoilage of the products. It is one of the oldest method of preservation. It is used for preserving meat, fish, hides and skin.

(b) Salting

This is a method of preservation where dry table salt is applied on the surface of the product. The salt removes water from the products by osmosis. Salting inhibits the growth of pathogenic organisms such as bacteria and fungi as they get dehydrated by highly salty environment and die or become temporarily inactivated. It is also one of the oldest methods of preservation and is used for preservation of meat, fish, hides and skin.

(c) Smoking

This is a method of preservation where the product is exposed to a smoke from the burning material usually wood. This method is applied on food products. Besides preserving the food, smoking also add flavour to it. This method is used on meat, fish and cheese.

(d) Cooling and refrigeration

Cooling is a method of preservation where ambient temperatures are lowered to the level where microbial activities are greatly reduced. This may be done through refrigeration or use of any other coolant such as water to conduct heat away from the product. It is used for preserving food substances such as meat, milk and fish.

(e) Heat treatment

This is the preservation of livestock products by the application of heat to the product. It includes such heat treatment measures as boiling of food, milk (pasteurisation), cooking and roasting meat. Very high temperatures destroy micro-organisms that causes food spoilage.

(f) Freezing

This is a method of preservation where the growth of micro-organisms is slowed down by very low temperatures of about -23^{o}C. The frozen water is also available to the micro-organisms and this further reduced the activity of micro-organisms.

(g) Canning

In this method of preservation, food is cooked and sealed in sterile container. It is then boiled to kill any remaining bacteria. This method is used for preserving meat and milk products.

(h) Fermentation
The carbohydrates in the food are converted into alcohol and organic acids, for example, lactic acids. Lactic acids prevent further action by micro-organisms thus preserving the food. Fermentation is brought about by beneficial micro-organisms under anaerobic conditions. This is an old method of food preservation. It is used to preserve meat and milk products.

(i) Sugaring
This is a method of preserving meat where sugar is applied in form of honey, syrup and solids. The sugar then absorbs water in the products through osmosis. This lowers the activity of the micro-organisms which destroys the product. Sugar also promotes the growth of favourable micro-organisms such as lactobacillus which produce lactic acid. Lactic acid prevents growth of unwanted micro-organisms.

(j) Jellying – This is a method of preservation where the materials to be preserved is kept in a substance that solidifies to form a gel, for example, gelatin. It is used in the preservation of meat.

(k) Use of chemicals
This is the use of chemicals to preserve materials. It is commonly used in the preservation of food materials such as meat and hides and skins. Common chemicals used in food preservation include, sodium benzoate, sodium nitrate and sulphur dioxide. These chemicals inhibit the growth of micro-organisms that spoil food.

(l) Pickling – This is the use of an edible anti-microbial liquid to preserve food. Examples of such liquids include brine (strong salt solution), vinegar and vegetable oils such as olives. This method is used in storing meat and eggs.

(m) Vacuum packing – This is the storing of food in a vacuum environment usually in an airtight bag or bottle. The vacuum condition deprives micro-organism of oxygen thus reducing their activity. This method is used for preserving cheese.

6.14 Notes to the Teacher

When teaching this unit, the teacher should do the following:

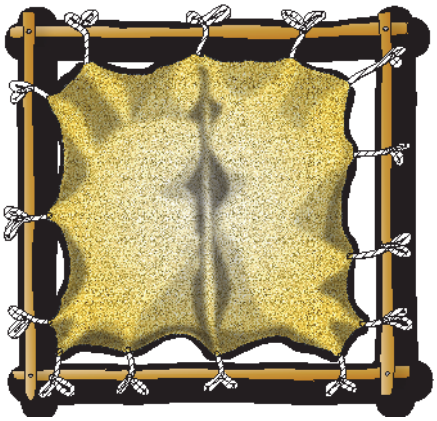
(i) Prepare a questionnaire for learners when going out for field visit trips.
(ii) Prepare the learners for a field visit a day before the field visit.
(iii) Do follow up activities after the field trips.
(iv) Demonstrate the procedure to be followed as the learners observe.
(v) Divide the learners into groups of five and assign them activities.
(vi) Ensure each group has a leader and a secretary for purpose of order drawing the activity/discussion.
(vii) Provide the learners with the materials required for the practical activity.
(viii) Supervise the learners as they carry out the practical activity.
(ix) Give the learners adequate time to discuss and report their findings to the class.
(x) Give summary notes to the learners after the activity as indicated in the Students' Book.

(xi) Keep the learners progressive records and give feedback to the parents.

6.15 Additional remedial consolidation and extension activity

High order questions for fast learners

1. Identify the method of curing hides illustrated in the diagram below
   Frame drying



2. Differentiate between tallow and lard.
   Tallow is a cattle fat while lard is pig fat.
3. Explain how freezing preserves livestock products.
   It makes the water in the product and micro-organisms to solidify thus denying the micro-organism water. This ends up killing the micro-organisms or making them inactive.
4. Explain how fermentation preserves food products from livestock.
   Fermentation which is brought about by anaerobic micro-organisms converts the sugars in the livestock product into lactic acid. This acid prevents further action by micro-organisms thus preserving the product.
5. What is pickling– *This is the preservation of a livestock product by placing it in an anti-microbial liquid to preserve it*.

Low order questions

1. List four products from milk
   (i) *Cheese*
   (ii) *Yoghurt*
   (iii) *Ice cream*
   (iv) *Long life milk/UHT milk*
2. Differentiate between beef and pork.
   Beef is fresh meat from cattle while pork is fresh meat from pigs.
3. Name two rabbit products
   (i) *Meat*

(ii) *Fur*
(iii) *Skin/pelt*

4. Name those methods of curing
   (i) *Salting*
   (ii) *Sugaring*
   (iii) *Smoking*
5. State two importance of smoking as a method of preservation.
   (i) *It removes water from the product thus reducing microbial activities*
   (ii) *Improves the flavour of the product.*

6.16 Additional Questions

1. Give one method of preserving bones.
   Drying
2. What is the industrial use of tallow?
   Preparation of soap.
3. What is suede?
   It is leather from the inner lining of the pig skin.
4. What is pasteurisation of milk?
   It is the heating of milk up to a temperature of between 50 and 60 °C to preserve it.
5. Describe the process of preserving blood.
   Salt is added to the blood in a container. The blood solidifies. Water is drained from the blood leaving a solid substance. The solid substance is then kept in a refrigerator or a freezer for preservation.

6.17 Suggestions for Assignment

(a) Find out the traditional methods of preserving livestock products in Rwanda.
(b) Visit a slaughter house and find out how the following livestock products are preserved after slaughtering the animal:
   (i) Blood
   (ii) Skin
(c) Practise answering the revision questions at the end of this unit in the Students' Book on page 200 – 201.

6.18 Support for development of positive skills, values and attitudes

(a) Life skills
   (i) The learner develops skills in preserving livestock products.
   (ii) Learners develop skills of making interferences and skill conclusion.
(b) Value and attitudes

Working in groups promotes interpersonal relationships, teamwork, respect for each other and good time management.

6.19 Suggested answers to formative evaluation questions

1. A pathogen is a disease causing organism.
2. Aerobic respiration takes place only in the presence of oxygen(air) while anaerobic respiration takes place in the absence of oxygen (air).
3.
   (i) Wet salting
   (ii) Brining
   (iii) Dry salting
   (iv) Quick salting
4. It is the removal of water from a substance.
5. It is the cheapest and the easiest method of preserving livestock products.
6. Period of time that a product can remain in good condition under storage.

6.20 Suggested answers to summative evaluation questions

1. (a) Curing is the removal of excess water from a substance thus reducing microbial activity.
   (b) Meat is first cut into strips, salt, sugar or smoking is then applied on the meat strips.
   The application of salt on the meat strips is known as salting, the application of sugar is known as sugaring, while the application of smoke is known as smoking. The application of salt, sugar or smoke removes excess water and the meat is said to be cured.
2. Meat is crushed to form minced meat and then mixed with spiced vinegar and wine. These cause the meat to ferment. It is then packed in natural edible cellulose casing and hung to dry.
3. Pork is fresh pig meat while bacon is processed pig meat.
4. (i) Refrigeration
   (ii) Cooking
   (iii) Drying

Key Terms (pages 199–200 Students' Book)

1. **Preservation** – Process of preventing deterioration of livestock products.
2. **Perishable** – Rots easily.
3. **Shelf- life**– Period of time that a product remains in good condition under storage.
4. **Micro-organism** – Organisms that are too small to be observed through the naked eyes.
5. **Pathogens** – Organisms that cause diseases.
6. **Salting** – Application of dry salt on the surface of a product to preserve it.
7. **Smoking** – Exposing a product to smoke in order to preserve it.

8. **Drying** – Removal of water from a product through evaporation.
9. **Refrigeration** – Removal of heat from a substance under controlled conditions.
10. **Cooling** – Lowering the temperature of a substance.
11. **Freezing** – Lowering the temperature of a substance to a point where water solidifies to form ice.
12. **Canning** – Preservation of cooked food in sealed containers.
13. **Anaerobic respiration** –Type of respiration that occurs in the absence of oxygen
14. **Fermentation** – Preservation by allowing the sugars in a food substance undergo anaerobic respiration where the organic acids of alcohol produced protect the food from further spoilage by micro-organisms.
15. **Sugaring** – The application of sugar to the surface of a substance to withdraw water by osmosis and thus preserve it.
16. **Jellying**– Preservation of a food material in a substance that later on solidifies to form a gel.
17. **Pickling** – Preservation of food in an anti-microbial edible liquid such as olive oil.
18. **Vacuum packing** – Preservation of food in an airtight bag or bottle.
19. **Tallow** – Fats from cattle meat.
20. **Lard** –Fats from pig meat.
21. **Gelatin** – A translucent flavourless food derived from collagen obtained from various animals by-product.
22. **Pork** – Fresh pig meat.
23. **Bacon** – Processed pig meat that has been preserved through salting or brining.
24. **Suede** – Leather from pig skin.
25. **Beef** – Cattle meat.

Answers to Revision Questions (Students' Book page 200–201)

1. Process of preventing damage of livestock products
2. (i) To increase their shelf-life.
   (ii) To lower the activity of micro-organism and therefore prevent rotting.
   (iii) To add value to the products.
   (iv) To add flavours to the products.
   (v) To add flavour to the food products.
3. (i) Smell
   (ii) Colour
   (iii) Texture
   (iv) Appearance (looks)
   (v) Taste

4.

Products	By-products
(i) Raw milk	(i) Hide
(ii) Eggs	(ii) Fur
(iii) Yoghurt	(iii) Tallow
(iv) Pork	(iv) Suede

5. Water is removed from the substance
6. (a) Drying
   Meat is cut into thin strips or flat pieces
   The strips of meat are sun-dried or open-air-dried to reduce moisture content. This discourages the growth of micro-organisms.
   (b) Curing – Curing of the meat may be done through salting, sugaring and smoking. Curing removes excess water from the meat through reducing microbial spoilage. In salting and sugaring, the pieces of meat are covered with either salt or sugar which absorb moisture from the meat. In smoking, the pieces of meat are covered with smoke which removes water from the meat and prevents microbial attack of the meat.
   (c) Boiling or cooking – The meat is cooked or boiled and then packed in sterile containers.
   (d) Freezing or refrigeration – In this method, pieces of raw meat are put in a freezer where temperatures are low to inactivate the micro-organisms.
   (e) Fermentation – In this method, the meat to be preserved is first crushed to form minced meat and then mixed with spices, vinegar and wine. It is then packed in natural edible cellulose casing and hung to dry.
7. (i) Fermentation – During fermentation, the carbohydrates in the food product are converted to alcohol and lactic acid which prevent further action by micro-organisms thus preserving the food. It is brought about by beneficial micro-organisms under aerobic conditions.
   (ii) Uses of honey – Cooked food materials, for example, meat are placed in honey and these can remain there for many years without going bad.
   (iii) Pickling– This is the use of an edible anti-microbial liquid to preserve food. The food is placed in such edible liquids as brine, vinegar and olive oil.
8. (i) Remove pieces of meat and fat from the hide.
   (ii) Wash the hide to remove blood.
   (iii) Suspend the hide in a wooden frame in such a way that there is air circulation from all the sides.
   (iv) Use sisal strings in lacing the hide on the frames to ensure the hide is not teared during the suspension.

9. Salting
10. (i) Meat
    (ii) Fur
11. (i) It prevents damage of the material by micro-organisms.
    (ii) Adds flavour to the product especially the food products such as meat.
12. C. (iii) and (iv)

Topic Area: Agriculture Economics

Unit 7: Problems and Solutions of Agriculture in Rwanda

Number of periods: 4

Key Unit Competence: Learners should be able to explain problems and solutions of agriculture in Rwanda.

7.1 Learning Objectives

(a) **Knowledge and Understanding**
   (i) Describe problems facing agriculture in Rwanda.
   (ii) Explain solutions to problems that agriculture in Rwanda is facing.

(b) **Skills**
   (i) Recognise the problems facing agriculture in Rwanda.
   (ii) Propose solutions to problems facing agriculture in Rwanda.

(c) **Attitudes and values**
   (i) Show awareness of problems prevailing in agriculture in Rwanda.
   (ii) Display courage in solving agriculture problems.

7.2 Content Students' Book pages 202 – 210

(i) Problems facing agriculture:
Shortage of land, lack of capital, pest and disease, unstable prices, rainfall distribution, bad attitude towards agriculture.

(ii) Solutions to problems that agriculture is facing:
Intensive agriculture, borrowing money from banks, construction and maintenance of feeder roads, plants protection, searching proper market.

7.3 Learning Activities

(i) Entering a research engine or library and find out after group discussion problems prevailing to agriculture.

(ii) Problem solving of a region faced with different problems (malnutrition, pest and diseases, shortage of land) and proposing required solutions.

7.4 Links to Other Subjects

The unit is linked to Geography and especially human economic geography.

7.5 Assessment Criteria

The assessment of this unit will depend on the ability of the learners to explain problems of agriculture in Rwanda and matching them with adequate solutions.

7.6 Learning Material/Resources

The following learning resources will be required in this unit:

- Computer laboratory with internet.
- Library books.

7.7 Suggested Low Cost or No Cost Materials

(a) Request for computers from the administration and return them after the lesson.
(b) Ask learners to bring the learning materials they would like to share, for example, computer equipment.
(c) Use computer labs from the neighbouring schools.

7.8 Methods of Teaching

The following methods are recommended in the teaching of this unit:

Content	Method(s)
1. Problems facing Agriculture in Rwanda	**Discussion**: The teacher to introduce the topics on the problems facing agriculture in Rwanda. Divide the learners into groups and instruct them to use internet, library books, magazines and textbooks to find out about these problems. Learners to give their findings after discussion. They then present their findings to the class. The teacher to correct any wrong information and give summary notes.
2. Solutions to problems that Agriculture in Rwanda is facing	**Field visit**: The teacher to prepare a questionnaire as shown in Annex 22 and organise a visit to an agricultural institute for the learners to enquire and find out about the problems facing farming in Rwanda and how the problems are solved. The learners to make enquiries, record and discuss in groups and present their findings to class. The teacher to correct any misconceptions, make conclusions and give summary notes.

Group Activity	**Discussion**: The teacher to divide the learners into groups and assign them discussion activities as follows: Group I: To find out the meaning of intensive farming. Groip II: To find out characteristics of intensive farming. Group III: To find out various systems of intensive farming in Rwanda. Group IV: To find out merits and demerits of intensive farming as a solution to the problems of farming in Rwanda. The teacher to assist the groups by moving from group to group. The learners to give their opinion, record and present their findings to the class. The teacher to conclude and give summary notes.

References

1. *S2 Agriculture Students' Book.*
2. Dictionary.
3. Library books.
4. Internet.

7.9 Suggested teaching and learning activities and exercise to support delivery of content and development of students' competences

(i) Discussion on problems facing agriculture in Rwanda.

(ii) Entering search engines or library to find out solutions prevailing in agriculture.

(iii) Entering search engine to find out solutions of problems facing agriculture in Rwanda.

(iv) Discussion on the term intensive farming under the following:
- Meaning
- Characteristics
- System of intensive farming
- Merits and demerits

(v) Case study of a region faced with different problems such as malnutrition, pests and diseases and shortage of land.

7.10 Cross-cutting issues to be integrated in the teaching

Address the following emerging issues that may affect the economy of Rwanda:

(i) Environment and sustainability – Skills and attitudes to enable them address the environment and climate change issues.

(ii) Peace and values education – Working together for peace and harmony to avoid conflict.

(iii) Standardisation culture – Understand the importance of standards as a pillar of economic developmet.

(iv) Inclusive education – Include every individual regardless of gender or ability.

7.11 Suggestions for accommodating special education needs (SEN)

(i) The teacher should arrange the class in such a way that learners who have hearing problems sit near the teacher, those with visual problems be given large print to read.

(ii) Pair the learners with motor impairment to others so as to be assisted during field trips and practical activities.

(iii) Slow learners should be given remedial questions.

(iv) Gifted/talented learners to be given extra questions.

7.12 Formative Evaluation

1. Give one solution to the problem of poor distribution of rainfall.
2. (a) What is diversification?
   (b) What is the role of diversification in ensuring economic stability in Rwanda?
3. Give two ways in which intensive farming may be carried out in Rwanda.
4. (a) What is a pest?
   (b) Give three ways of controlling crop pests.
5. (a) What is credit?
   (b) Give two sources of credit for farmers.

7.13 Additional Content to the Teacher

Risks and uncertainties in farming

Farming as a business is faced with a lot of risks and uncertainties. Farmers face many variables which are beyond their control, for example, changes in weather/ climate changes, outbreak of pest and diseases and fluctuation of commodity prices. Uncertainty is, therefore, the state of not knowing about future events or outcome due to the uncontrollable variables. Risks on the other hand are the difference or divergence between what the farmer expects and the actual outcome.

Risks and uncertainties go hand in hand and offer a lot of challenges to the farmers. This calls for great determination on the part of the farmer in bearing the risk involved so as to succeed in farming.

Types of risks and uncertainties

(i) Fluctuation of commodity prices. Farmers may not predict the future market prices.

(ii) Physical yield uncertainty. The farmer does not know how much to expect.

(iii) Ownership uncertainty. The farmer may lose part or whole of the produce through theft, changes in government policy, fire, death and association with other business or institutions such as banks.

(iv) Outbreak of pests and diseases. This will affect the expected outcome.

(v) Sickness and injury uncertainty. This is where the farmer or a member of the family or employee is affected and loses the ability to work due to sickness or injury.

(vi) New production techniques uncertainty. The farmer may not be certain as whether the new technology is as effective as the previous one.

(vii) Obsolescence. A farmer may invest in machinery which may become outdated within a short time.

(viii) Natural catastrophies or calamities. These include things like floods, droughts, earthquakes, storms and strong winds may destroy the crops or kill livestock.

Ways in which a farmer may adjust to risks and uncertainties

(i) Diversification

This involves setting up several and different enterprises on the farm so that should one fail, the farmer does not suffer a total loss.

(ii) Selecting more certain enterprises

Some enterprises have more steady income over time than others; for example, a maize enterprise has a less variation income than an Irish potato one. Under conditions of uncertainty, it is better to choose an enterprise which earns a more steady income though less profitable than to choose a more profitable enterprise which has a high degree of income variation.

(iii) Contradicting

Farmers may enter into a contract with consumer to supply certain goods over a specified period of time and at an agreed price. Such a contract guarantees them a constant, fixed market for their produce.

(iv) Insurance

Insurance companies take the risk of insuring farm machinery, crops and livestock against loss. Farmers pay small amount of money known as premiums as insurance cover to the insurance companies. This cover guarantees them compensation in the event of loss. It covers losses due to crop failure, death of livestock, theft, fire and accidents involving farm machinery.

(v) Input rationing

In this case farmers control the quantities of inputs used in variation enterprises. They may apply less input than the optimum required for an enterprise so that,

should unfavourable conditions lower yields or price falls, they suffer less loss than if they had used the optimum amount of inputs in enterprises that have better chances of giving their returns.

(vi) Flexibility in production methods

Farmers should design their enterprises such that should there be a need to change from one enterprise to another in response to a change in demand, they can easily do so with minimum expenses. Livestock building, for example, should be constructed in such a way that they can with minimum modification be used to house different types of livestock.

(vii) Adopting modern methods of production

This can be used to reduce the amount of risk, for example, spraying crops against diseases and pests, vaccinating livestock against diseases and irrigating crops can enhance the chances of high production. Adopting these modern methods must involve extra costs. However, by incurring them, they avoid the would be losses.

7.14 Notes to the Teacher

When teaching this unit the teacher should:

(i) Collect enough economic data/information from newspapers and other sources to support discussions on problems and solutions of Agriculture in Rwanda.
(ii) Divide the class into groups of five and assign them discussion activities.
(iii) Ensure each group has a leader and a secretary to keep order in the discussion.
(iv) Supervise the discussions.
(v) Allow the learners adequate time to discuss and report their findings to the class.
(vi) Give summary notes to the learners after the activity as indicated in the students' book.
(vii) Keep the learners' progressive record and give feedback to the parent.

7.15 Additional remedial consolidation and extension activities

High order questions for fast learners

1. What is the meaning of the following terms as used in agriculture economics?
   (a) Buffer stock– *Agricultural produce that is stored in large quantities only to be released during time of scarcity to offset shortage and stabilise prices of commodities.*
   (b) Stabilisation fund– *Money set aside by the government to import agricultural commodities in times of a shortage so as to stabilise the prices of commodities.*
2. Describe two types of labour in the farm.
   (a) *Family labour– This is labour from the members of the nuclear family. Tasks are assigned to members of the family according to age and abilities.*
   (b) *Hired labour– This is labour employed to supplement family labour. It is further divided into casual labour and permanent labour. Casual labour is*

that labour which is hired during labour peak periods and is paid a wage either weekly or after a fortnight. Permanent labour is hired on a monthly basis and is paid as a salary after the end of the month.

3. What is demand?
   (a) *This is the quantity of goods and services that consumers are willing and able to buy at a specified price in a given market and time.*
   (b) *How is demand related to the price of a commodity?*
   When the demand of a commodity goes up, the price also goes up and vice versa. This relationship is referred to as direct proportionality.
4. What is supply?
   (a) *This is the quantity of goods and services that the sellers are willing to sell at a specified period in given market and time.*
   (b) *How is supply related to the price of a commodity?*
   When the supply of a commodity in the market increases, the price of that commodity goes down and vice versa. This relationship is known as indirect relationship.
5. Explain the ways in which the government gives subsidies to the farmers.
   (i) *Lowering the tax on agricultural products such as fertilisers, agro-chemicals and livestock feeds. When the tax is reduced, the prices of these products goes down and farmers are able to buy them at a cheaper price.*
   (ii) *Buying agricultural products at a higher price and later selling them to recover its money.*
   (iii) *Giving agricultural inputs such as seeds and fertilisers to the farmers at planting time.*

Low order questions for average learners

1. What is large scale farming?
   System of farming done on a piece of land that is over 20 hectares.
2. (a) What is capital?
   This is all man-made assets used in the production of goods and services.
   (b) Give two sources of capital for the farmers
      (i) *Credit/loans from commercial banks and other money lending agencies*
      (ii) *Co-operatives*
      (iii) *Personal savings*
      (iv) *Donations/grants*
      (v) *Government subsidies*
3. What is seed dressing?
   This is the coating of seeds with a pesticide to protect them from damage by pests and diseases.
4. State two importance of forming co-operatives to a farmer
   (i) *Source of credit/provide soft loans*
   (ii) *Helps in the marketing/sale of agricultural goods*

(iii) *Provides agricultural education to farmers*
(iv) *Helps in the transport of goods*
(v) *Supply farm inputs to farmers at affordable prices*

5. (a) What is a high value crop?
A highly perishable crop that fetch high prices in the market
(b) (i) *Fruits such as mangoes, citrus fruits and avocados*
(ii) *Vegetables such as tomatoes, cabbages, onions, French beans and carrots*
(iii) *Flowers, e.g., Roses, tuberose and carnations*

7.16 Summative Evaluation

1. Briefly explain how the following problems of agriculture can be solved
(a) Inadequate capital
(b) Instable prices
2. Explain two ways in which the government can give subsidies to the farmers.
3. Explain two advantages of diversification.
4. Differentiate between supply and demand as used in marketing of agricultural produce.

7.17 Additional Questions

1. What is land tenure?
System of land ownership
2. Give two ways in which the problem of bad attitude towards agriculture may be solved.
(i) *Sensitisation of the people on the opportunities existing in agriculture so that they can view agriculture as a business.*
(ii) *Improving wages and provision of incentives in the agricultural sector so as to attract more people into the farms.*
3. (a) What is contracting?
Entering into an agreement that is legally binding between two parties.
(b) State one disadvantage of contracting.
The farmers would not benefit should there be an increase in commodity prices during the period when the contract is in effect.
4. State two ways in which the problem of insufficient markets may be solved.
(i) *Carrying out market research to find out more markets for the agricultural products.*
(ii) *Venturing in across border markets.*
(iii) *Formation of co-operative societies which sells goods for the members.*
(iv) *Use of the marketing boards to assist farmers in marketing their produce.*
5. (a) What is a greenhouse?
It is a crop production structure in which high value crops are grown under controlled environmental conditions.

(b) Give four environmental conditions that are controlled in a greenhouse.
   (i) *Temperature*
   (ii) *Soil moisture*
   (iii) *Carbon (IV) oxide concentration*
   (iv) *Wind*
   (v) *Relative humidity*
   (vi) *Light intensity*
   (vii) *Rainfall intensity*

7.18 Suggestions for Assignments

1. Individually, find out the problems that the farmers in your home areas encounter in the following areas:
   (i) Fertilisers acquisition during the planting seasons.
   (ii) Getting market for their produce.
   (iii) Shortage of produce after harvesting.
   Alternatively, if you live in the urban areas pair with those who live in farming communities and find out about the above problems from them.
2. Find out how the farmers are able to deal with the above problems.
3. Discuss your findings and present a report to the class.

7.19 Support for the development of positive skills, values and attitudes

(a) This topic will help the learners to develop problem solving skills in looking for solutions to the problems facing agriculture in Rwanda.
(b) Values and attitude
   (i) By working together in groups, the learners will learn to appreciate one another.
   (ii) Learners will appreciate the role played by farmers in supporting the economy of Rwanda.

7.20 Suggested answers to formative questions

1. Irrigation
2. (a) Allocating resources in more than one enterprise.
   (b) It ensures that should one enterprise fail, the farmer does not suffer total loss and instead benefit from the other enterprises that have not been affected. This motivates the farmer and encourages them to keep on thus ensuring stability to the economy.
3. (i) Zero grazing.
   (ii) Improved capital investment.
   (iii) Use of green houses.
   (iv) Use of modern farming techniques.
4. (a) A living organism that causes damage to crops.

(b) (i) Use of agro-chemicals
(ii) Crop rotation
(iii) Planting resistant crop varieties
(iv) Use of natural enemies/biological control.

5. (a) Borrowed capital
(b) (i) Commercial banks
(ii) Co-operatives
(iii) Individual money lenders.

7.21 Suggested Answers to Summative Evaluation Questions

1. (a) Inadequate capital. The problem of inadequate capital can be solved through the following:
(i) Borrowing from commercial banks and individual money lenders.
(ii) Pooling resources together in co-operatives.
(iii) Individual/personal savings.
(b) Instable prices– These problems can be solved through the following:
(i) Contracting–Farmers can enter into agreement with a consumer to supply goods at a specified price in a specified period of time.
(ii). Diversification –This is the allocation of resources in more than one enterprise so that should one fail or have poor prices, the farmer benefits from the others.

2. (i) Reducing taxes on agricultural goods. This in turn lowers the price of farm inputs (cost of production) and therefore increase the gross margins.
(ii) Buying produce from farmers at a higher price and then selling the produce to consumers at a higher price to recover its money.

3. (i) Mutual benefits between crop and livestock–Animals get feed from crop residues while crops get farmyard manure from the animals.
(ii) Should one enterprise fail, the farmer benefits from the others. The farmer does not suffer total loss.
(iii) The family is likely to have a balanced diet because materials are available at home.

4. Supply is the quantity of goods that sellers(suppliers) are willing to sell at a given price and time at a given market while demand is the quantity of goods that consumers (buyers) are able and willing to buy at a specified price in a given market and time.

Key Terms (Students' Book pages 210–212)

1. **Field day** – A day set aside when farmers meet in a demonstration farm and taken through various methods of carrying out agricultural activities by agricultural expert.

2. **Capital** – All man-made assets used in the production of goods and services.
3. **Animal drawn implements** – Implements that are pulled by trained animals while working.
4. **Extension services** – Advice given to farmers by experts in certain fields.
5. **"Visit and train"** – A method of giving extension services where agricultural officers visit farmers in their farms and advise them on how to carry out agricultural activities.
6. **Mechanisation** – Use of machines in carrying out agricultural activities.
7. **Intensive farming** – System of farming that involves heavy capital investments.
8. **Seed dressing** – Coating of seeds with a pesticide to protect them from damage by pests and diseases.
9. **Pests** – Living organisms that cause damage to the crops.
10. **Parasite** – A living organism that derive its livelihood from another and causes damage to it.
11. **Supply** – Quantity of goods that the sellers are willing to sell at a specified price in a given market and time.
12. **Demand** – Quantity of goods that consumers are willing and able to buy at a specified price in a given market and time.
13. **Perishable** – Easily go bad.
14. **Middlemen** – Traders who move from one farm to another buying agricultural goods from farmers.
15. **Zero grazing** – Rearing of livestock in structures known as stalls.
16. **Green houses** – Crop production structures in which high value crops are grown under controlled environmental conditions.
17. **High value crops** – Highly perishable crops that fetch high prices when fresh.
18. **Land tenure system** – System of land ownership.
19. **Large scale farming** – System of farming carried on a large piece of land which is over 20 hectares.
20. **Hybrid seeds** – Seeds developed by crossing two or more pure lines of crops.
21. **Upgrading** – The improvement of local animals by crossing with exotic animals for high production.
22. **Co-operative** – Organisation of people who have joined together voluntarily with a common purpose for mutual benefits.
23. **Borrowed capital** – Credit or loan on borrowed funds used in agricultural production.
24. **Buffer stocks** – Agricultural produce that are stored only to be released during time of scarcity to offset shortage and stabilise prices of commodities.
25. **Stabilisation fund** – A fund set aside by government to import agricultural commodities in the event of a shortage so as to stabilise the prices of the commodities.
26. **Diversification** – Allocating resources in more than one enterprise so that should one fail, the farmer benefits from the others.

27. **Enterprise** – A single unit of production.
28. **Agro-chemicals** – Chemicals used in agricultural production.
29. **Government subsidies**– Government incentives given to farmers to motivate them to produce more and therefore prevent shortage.
30. **Contracting** – Entering into an agreement between two parties that is legally binding.
31. **Farm inputs** – Capital used in agricultural production.
32. **Marketing boards** – Statutory bodies established by an act of parliament to oversee the production and marketing of a particular produce.
33. **Gross margin** – Profit realised from the sale of produce when the fixed costs are not considered.

Answers to Revision Questions (pages 212 Students' Book 2)

1.

	Problem		**Solution**
(a)	Shortage of land	(i) (ii) (iii) (iv) (v)	Intensive farming. Use of improved livestock. Use of improved seeds. Use of modern methods of farming. Improved land tenure systems.
(b)	Lack of adequate capital	(i) (iii) (iii)	Forming co-operative societies. Borrowing capital. Government subsidies.
(c)	Pests and diseases	(i) (ii) (iii) (iv) (v)	Supply agro-chemicals and animal drugs. Planting resistant crop varieties. Providing extension services. Proper drying of farm produce before storage. Construction of good storage structures.

(d)	Poor transport facilities	(i) (ii) (iii)	Forming co-operatives to pool resources together. Providing credit facilities to farmers. Use of marketing board facilities in transporting their respective crop produce.

2. (a) Zero-grazing

This is the rearing of animals in structures known as zero grazing stalls or units. It is mainly used for dairy cattle and goat rearing. The structures are designed in such a way that they provide space for feeding, milking and sleeping. Zero grazed animals provide more milk than those on free grazing due to the energy saved from the reduced movements. This system is, however labour intensive and requires heavy capital investments.

(b) Use of greenhouses

Greenhouses are crop production structures in which the environmental conditions such as temperature, relative humidity, soil fertility, wind and carbon (IV) oxide concentrations are regulated to create a micro climate. In these structures, crops which would not grow under normal condition in a particular area are grown. High value horticultural crops such as tomatoes and cabbages are grown in greenhouses. Another advantage of using greenhouses is that, it is possible to grow crops in off seasons because they do not rely on rainfall, instead the crops are irrigated.

3. (i) Mechanisation – Use of machines in carrying out agricultural activities.
   (ii) Diversification – Allocating resources in more than one enterprise so that should one enterprise fail, the farmer benefits from the other.
   (iii) Zero grazing – Rearing of livestock in structures known as stalls.
4. Supply is the quantity of goods that sellers are willing to sell at a specified price in a given market while demand is the quantity of goods that the consumers are willing and able to buy at a specified price in a given market and time.
5. (a) Credit or loan is borrowed funds used in agricultural production.
   (b) (i) Commercial banks.
   (ii) Co-operatives.
   (iii) Individual lenders.

6. (a) Government incentives given to farmers to motivate them to produce more and therefore prevent a shortage.

(b) (i) Reducing taxes on agricultural inputs.

(ii) Buying farm produce at a higher price and then later on selling the produce at a higher price to recover its money.

7. (i) Use of field days.

(ii) Through visit and training.

(iii) Use of demonstration farms.

8. (a) A single unit of production.

(b) Dairy cattle production

(i) Beef cattle production

(ii) Fruit production

(iii) Mushroom production

(iv) Goat production

(v) Sheep production

ANNEXES

Annex 1

Activity 1.2

Questionnaire for a field trip to a neighbouring farm/school farm to study the characteristics of a fertile soil and its plant indicators:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions

1. Identify the colour of the soil in different parts of the farm.
2. Feel the soil between your fingers, when dry and when wet. What is the texture of the soil?
3. Carry out the ribbon test with wet soil. Does the wet soil form ribbons? What type of soil is it from the ribbon test?
4. Carry out a pH test using the pH meter or colour indicators provided. What is the general pH in the farm?
5. Observe the leaves of the crops in the farm. Are there any symptoms of nutrient deficiencies? If yes, which nutrients would be lacking in the soil?
6. Are there any other problems of the soil that can be identified using the plants as the indicators.
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 2

Activity 1.9

Questionnaire for field visit to a farm to observe steps followed in making compost manure:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What method of composting is used in this farm?
2. How would you describe the siting of the compost pit or heap in reference to the homestead and:
   (i) Other farm structures?
   (ii) Where the manure is to be used?
3. What is the measurement of the compost pits or heaps in this farm?
4. What materials are used to make the compost manure and what is their uses in the compost making?
5. What is the order in which the materials are arranged?
6. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 3

Activity 1.12

A questionnaire for a field visit to a zero-grazing unit to observe the steps in making farmyard manure:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What is the zero-grazing unit?
2. Which type of animals are kept in the zero-grazing unit in this farm?
3. What is the farmyard manure?
4. How are these animals able to make farmyard manure?
5. Where is the litter dung and urine removed from the animal sleeping areas kept?
6. How long are these materials kept before the manure is ready for use?
7. Why do the materials have to be sheltered after removing them from the animal's cubicles?
8. Do these materials need constant turning during the decomposition period to make manure? And why?
9. What would happen to the manure if the materials are exposed to the sun and rain?
10. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 4

Activity 1.11

Questionnaire for a visit to a fertiliser shop to observe and manipulate inorganic fertilisers:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Name the fertilisers which are sold in this shop.
2. Observe the colours of the various fertilisers and fill the following table:

Fertiliser	**colour**
Fertiliser A	
Fertiliser B	
Fertiliser C	
Fertiliser D	
Any other fertiliser seen	

3. Describe how the fertiliser feel after touching and feeling them in your hands.
4. What are the farms in which these fertilisers occur?
5. Calculate the fertiliser grades of the compound fertilisers from the grade given on the bag.
6. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 5

Activity 2.5

Questionnaire for a visit to co-operative or a household producing mushrooms to observe factors affecting mushroom tube making and mushroom cultivation:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Observe a mushroom tube and describe what it is.
2. What is the substrate material used in making the mushroom tubes in the farm?
3. How available are these materials or do the farm owners experience problems in acquiring them?
4. Where are the mushroom tubes kept after they are ready for sowing?
5. What are the conditions in these nursery houses? How do they ensure that the substrate materials are clean and sterilised for mushroom growing? Which type of packing materials are used for the substrate?

   Find out the following:

   (i) The market outlets for the mushrooms.

   (ii) Does the farm get problems of marketing?

   (iii) Compare the cost of producing mushrooms and the profit. Would you say it is a good business?
6. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 6

Activity 3.2

A questionnaire for a field to a farm with an established orchard to explore and identify cultivated fruits in Rwanda and their importance:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Identify the types of fruits grown in these farms.
2. Are these the only types of fruits cultivated in Rwanda or are there others not in this farm?
3. What is the importance of each type of fruit grown in the farm, nutritionally, economically and environmentally?
4. How would you describe the site where the orchard is established with respect to the:
   (i) Source of water?
   (ii) Transport system?
   (iii) Security?
5. How are the fruits used both in the farm and after sale?
6. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 7

Activity 3.5

A questionnaire for a field visit to an avocado and citrus fruit tree nurseries to observe grafting of avocado and citrus seedlings:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. At what stage of growth are the citrus and avocado tree seedlings? Are they ready for grafting according to you?
2. Make a list of all the tools and materials required when carrying out grafting.
3. What varieties of avocado and citrus are planted in this farm? Are there other varieties not in this farm? If yes name them.
4. How long will the grafted seedlings take before they are transplanted?
5. What happens to those seedlings that do not succeed after grafting?
6. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 8

Activity 3.8

A questionnaire for field tour to select a site for establishing an orchard:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What type of an orchard is this?
2. Which types of fruits are established in this orchard?
3. Are there fruits grown in mixed stands or in pure stands? If they are in pure stands, then what are the advantages?
4. Describe your observation on the following:
   (i) The slope of the land where the orchard is established.
   (ii) The type of soil and drainage of the orchard.
   (iii) Shelter of the fruit trees from the wind.
   (iv) Distance the orchard is from the homestead and the road.
5. How were you able to access the orchard? What is it easy? How about vehicles?
6. What are other requirements important for selecting an orchard site?
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 9

Activity 3.18

A questionnaire for a field trip to a fruit processing and preservation plant or factory to observe fruits which are processed:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Identify the type of fruits which are processed and preserved in this factory.
2. What is the difference between the fruits which is processed and those that are fresh?
3. How would you define fruit processing and preservation after tasting the processed fruits?
4. What are the methods used to process and preserve fruits in this factory?
5. How are the processed fruits packed for distribution?
6. What is the difference in value between the fresh fruits and those processed?
7. What are the requirements for the starting of a fruit processing plant? In terms of capital and legal requirements? Does processing of fruits change their taste, colour and keeping quality?
8. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 10

Activity 3.23

A questionnaire for a field trip to an orchard to observe and identify fruits that may be processed:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What type of fruits are grown in this orchard that require processing?
2. Give the characteristics of the fruits which require processing.
3. From your observation, why do you think such fruits require processing?
4. What would happen to these fruits if they are not processed?
5. Do you think that processing these fruits makes them better than when kept fresh? Why? Give reasons for you answer.
6. How are the processed fruits handled compared to the fresh fruits?
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 11

Activity 4.3 and Activity 4.4

A questionnaire for a field visit to a farm where legumes are grown to find out the importance of legumes and how they are propagated:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Name the legumes that are cultivated in this farm. What other legumes are not cultivated in this farm?
2. What classes do these legumes fall under?
3. Which legumes are for human consumption and which ones are used as fodder for livestock?
4. What are the importance of each legume that you have identified to:
   (i) Human beings
   (ii) Livestock
   (iii) Environment
5. How are the legumes propagated in this farm? Which legumes are propagated from seeds and which ones are propagated vegetatively?
6. How are the legume seeds prepared for planting?
7. How are the cuttings for propagating fodder legumes prepared for planting?
8. Find out the necessary conditions for the rooting of legume stem or root cuttings.
9. List the fodder legumes that are propagated through layering.
10. Observe and find out how layering is carried out in each of the following le-

gumes: Lucerne, Sesbania, Pigeon peas, Silver leaf desmodium.

11. What are the condition suitable for layering to succeed?
12. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 12

Activity 4.6

A questionnaire for a field trip to a farm where legumes are grown to observe the cultural practices that are carried out:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Which cultural practices are carried out when growing legumes?
2. How many times is a piece of land cultivated when growing legumes?
3. Which type of legumes require a fine tilth?
4. When are the legumes supposed to be planted with respect to the rains.
5. What type of fertilisers are used when planting legumes?
6. What methods of planting are suitable for planting legumes? State the reasons.
7. List all the field management practices that are carried out to maintain legumes in the field.
8. Find out the diseases and pests that attack legumes in the field and how they are controlled.
9. How are legumes harvested and stored?
10. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 13

Activity 4.7

A questionnaire for a field visit to a farm growing legumes to observe post-harvest techniques for soya beans and groundnuts:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. At what stage are soya beans and groundnuts harvested? And how is it possible to know that groundnuts are ready to be harvested?
2. How are groundnuts and soya beans harvested?
3. Groundnuts and soya beans are handled differently after harvesting. What are the processes carried out to remove the grains from their pods?
4. Explain the processes the soya bean and groundnut grains undergo before they are ready for storage or sale.
5. How are the grains of groundnuts and soya beans packaged and stored?
6. How are the storage pests controlled in groundnut and soya bean store to avoid damage of the grains?
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 14

Activity 5.2

A questionnaire for a field visit to an agricultural and veterinary school/a ruminant farm to observe ruminant species kept in Rwanda:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Name the species of ruminant animals kept in this farm.
2. Which other animal species are kept in this farm?
3. Apart from the ruminant species you can see in this farm, are there other ruminant species reared in Rwanda and not in this farm?
4. What are the breeds of each of these ruminants can you identify in these farm?
5. Are there other breeds of these species which are not kept in this farm but reared in Rwanda?
6. Name the other breeds of ruminant species that are kept in Rwanda but not in this farm?
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 15

Activity 5.4 and Activity 5.5

A questionnaire for a visit to a multipurpose farm to observe ruminant (cattle, sheep and goat) shelters and their standards:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What are ruminant shelters?
2. What types of shelters are used for cattle, sheep and goats?
3. Find out the features of these shelters both from outside and inside. What can you see about the security, drainage and space allocated for each animal housed?
4. What were the factors that were considered when siting and constructing these shelters?
5. Observe the materials used for each shelter and find out the reasons for using each material on; the roof, walls and the floors.
6. What would you say about the ease in which the specific animals use the shelters?
7. How do the materials fit into each other during construction?
8. Make a survey of the area around the shelters and find out how each shelter relate to the other. Are there any relationship between:
   (a) Cattle shed and calf pens?
   (b) Goat house and zero grazing unit?

(c) Feed store and zero grazing unit?

(d) Zero grazing unit and calf pens?

(e) Farm house and the ruminant shelters?

9. What are the reasons why the ruminant animals need to be housed other than to be kept outside in the open?

10. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 16

Activity 5.7

A questionnaire for a field visit to a ruminant farm to observe the selection criteria for ruminant animals:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What are the types of the cattle, sheep and goats which are kept in this farm?
2. Does the farm keep meat and dairy goats? Wool sheep and mutton sheep? Dairy cattle and beef cattle?
3. Observe the characteristics of each of the following animals and compare them:
   (i) Compare the characteristics of the dairy and meat goat. What are the differences between them?
   (ii) Compare the wool sheep and mutton sheep. What are the differences in characteristics between them?
   (iii) Compare the dairy cattle and beef cattle. What are the differences between their characteristics?
4. Find out how these differences in characteristics between the different types of ruminants are used in their selection.
5. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 17

Activity 5.9

A questionnaire for a field visit to a ruminant farm to observe feeding of ruminants:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Find out the types of animals kept, are they for dairy or for meat?
2. What types of feeds are given to the meat goats, dairy goats, beef cattle, dairy cattle, mutton sheep and wool sheep? Are the feeds the same in terms of ingredients and nutrients?
3. What is the frequency of feeding these animals? Are they the same for cattle, sheep and goats?
4. What are the main feed ingredients for feeding goats in this farm?
5. Are the goats fed according to type and age? Do they adopt the same feeding practices for all the goats?
6. What types of feeds are given to the following groups of goats:
   (a) Young kids?
   (b) Weaning goats?
   (c) Adult goats during flushing?
   (d) Adult goats during steaming up?
   (e) Adult goats during fattening?
7. How are the young goats after being orphaned?
8. What is the importance of feeding colostrum to the young goats after birth?
9. Prepare a feeding plan for the goats according to the age as follows:
   (i) Feeding plan for kids.

(ii) Feeding plan for weaners.

(iii) Feeding plan for adult goats.

10. Are the nutritional plans for cattle and sheep prepared according to age?
11. What are the following groups of cattle fed on:
    (i) Early weaning calves?
    (ii) Late weaning calves?
    (iii) Heifers?
    (iv) Bulls for fattening?
    (v) Lactating cows?
12. What are the young orphaned lambs fed on?
13. Prepare the feeding plan for an ewe in gestation.
14. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 18

Activity 5.10

A questionnaire for a field visit to a ruminant farm to observe diseases of ruminants:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What is a disease?
2. What type of diseases commonly attack cattle, sheep and goats in this farm?
3. Are the diseases common in the area, and in Rwanda at large?
4. What are the symptoms of each disease that you identify in this farm?
5. Does the farm suffer a lot of loss from the animals attacked? Or is the farm able to contain the diseases?
6. What are the economic implication of these attacks to the farm?
7. Are there diseases that can be transmitted from human beings to animals and from animals to human beings in this farm?
8. How do they prevent such diseases from affecting human beings?
9. Does the farm get any assistance from the government in terms of controlling ruminant diseases? If yes, how and what assistance?
10. Are there diseases in this farm that require the whole country to be notified of their existence (quarantine)?
11. How does this notification take place when such diseases are identified?
12. What are prevalent diseases in this farm and in the area?
13. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 19

Activity 5.10

A questionnaire for a field visit to a livestock farm to observe and carry out sanitation.

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. Find out the daily activities that are carried out in this farm to ensure proper sanitation.
2. Are there any disease outbreaks that have been experienced in this farm? If yes, what would you attribute these outbreaks to?
3. How does the farm carry out practices that keep off diseases? Are there any strict restrictions to unauthorised persons entering the farm? What about when entering the animal shelters?
4. Are there any stray animals that come and leave the farm without notice?
5. What are the daily activities that are carried in cattle, sheep and goat shelter to maintain cleanliness and sanitation?
6. How does the farm dispose of human refuse, animal carcasses, manure and chemical containers which can be a source of infection?
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 20

Group Activity:

A questionnaire for a farm visit to carry out sanitation practices in a ruminant shelter:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What type of ruminant animals are kept in this farm?
2. What type of shelters are used to keep these animals? Are they permanent or temporary shelters?
3. How do you get into the shelter? Are there any restrictions? Any disinfection?
4. What type of cleaning do you carry out when you come into the farm?
5. Describe the procedure you use to clean the area assigned to you. Do you normally have a supervisor accompanying you?
6. What equipment do you use for cleaning? Do you use any disinfectants?
7. How are the conditions of the animals living in these shelters before and after cleaning?
8. How clean is the area surrounding the shelters? Is anybody assigned to work on the compound?
9. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 21

Activity 6.2

A questionnaire for a field trip to a livestock product processing industry and dairy to observe processed products:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What type of plants are there in this industry?
2. How are the meat products processed?
3. Do they produce other meat products from the fresh meat?
4. Find out the processes carried out to produce dried meat, cured meat and sweet meat.
5. Find out the dairy products which are produced from the factory.
6. Explain the process of producing each of the following products from fresh milk: pasteurised milk, Ultra treated milk, ice cream and cheese. Do these products add value to milk?
7. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher

Annex 22

Activity 7.2

A questionnaire for a visit to a field day organised by an agricultural institution to find out how Rwanda farmers respond to challenges they face:

Part I: Administrative information:

(i) Name of the farm to be visited: _____

(ii) Name of the visiting institution/school: _____

(iii) Date of travel: _____

(iv) Purpose of the trip: _____

Part II: Leading Questions:

1. What are the common problems faced by farmers in Rwanda?
2. How well is the field day attended by farmers?
3. Who invited these farmers and how did they know that there was a field day to-day?
4. Which type of farmers attended the field days? Are they the learned and elite in the society?
5. How do the other farmers who don't attend the field day get the information shared here?
6. Are there other forums in Rwanda where the farmers express their problems in family?
7. How do the solutions provided by the Rwandan government and other private institutions reach the farmers?
8. What solution is given to lack of enough capital to develop agriculture? And what initiative do the farmers show to solutions such as:
   (a) Forming co-operative societies?
   (b) Borrowing capital?

(c) Seeking for government subsidies?

9. Present a written report for discussion.

Prepared by M _____

Agriculture Teacher